

Project No. 10-15

# **Guidebook for Airport Winter Operations**

## **FINAL REPORT**

Prepared for  
Airport Cooperative Research Program  
Transportation Research Board  
of  
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#### DISCLAIMER

This is an uncorrected draft as submitted by the research agency. The opinions and conclusions expressed or implied in the report are those of the research agency. They are not necessarily those of the Transportation Research Board, the National Academies, or the program sponsors.

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## CHAPTER 1 BACKGROUND

### Problem Statement

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. It can also present significant costs to the airlines and their passengers. 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. (1) Therefore, the cost of delaying all flight operations for an hour to permit snow removal at a large hub airport could exceed hundreds of thousands of dollars—a fact 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 respond to a continuing winter operations requirement.

Research was needed to develop a guidebook that would provide a useful tool in preparing an effective winter operations plan. Such a guidebook would help to ensure that, based on applicable recommended practices, optimal investments are being made at airports of varying sizes.

### Objective

The objective of this research was to prepare a guidebook to help airports 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, and 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. The audience for this guidebook may include managers, operators, and users of small to large airport facilities.

The guidebook addresses the following program elements as components of an effective winter operations plan adaptable to a variety of airports:

- Operational considerations—friction, weather, and other factors
- Strategies and tactics—equipment, chemicals, and other related factors
- Operational guidelines—personnel, timing, human factors, and other related issues
- Economic and finance considerations—budget analysis, benefit-cost analysis, risk analysis
- Environmental issues—permitting and other applicable regulations

## **Project Scope**

Phase I of the research included tasks for identifying, collecting, and evaluating information necessary to prepare the guidebook. This initial data collection effort included a search of available literature and other published documentation concerning the conduct and regulation of airport winter operations. Phase I implemented the information collection and evaluation process. Information collected was used to prepare the following: 1) a detailed outline for the proposed guidebook, 2) a determination and evaluation of best practices, and 3) an interim report. Tasks included site visits and other program review procedures to review in detail and verify components of effective airport winter operations plans.

At the completion of Phase I, an interim report was developed that described the Phase I work and the steps necessary to prepare the guidebook in Phase II. Following submission and Project Panel review of the interim report, the Gresham, Smith and Partners (GS&P) Research Team (the Research Team) met with the Project Panel to discuss project status, review suggested refinements to the Phase II scope of work, and approve remaining tasks and schedule.

Phase II of this project involved preparation of the guidebook, and preparation of this final research report. This final report documents the entire research effort, and includes the Research Team's recommendation for future research needs and priorities.

## **CHAPTER 2 RESEARCH APPROACH**

### **Overview**

The research and guidebook development for this project were executed through the following tasks:

- Task 1: Project Kickoff
- Task 2: Document Collection, Compilation and Review
- Task 3: Target Airport Selection and ACRP Conference Call
- Task 4: Airport and Stakeholder Data Collection, Review and Evaluation
- Task 5: Airport Site Visits
- Task 6: Winter Event Passenger Experience and Expectations Management Practices Evaluation
- Task 7: Winter Operations Performance Metrics Identification
- Task 8: Self-evaluation Process Development
- Task 9: Prepare Detailed Outline of Guidebook
- Task 10: Prepare Interim Report
- Task 11: Meeting with ACRP Project Panel
- Task 12: Prepare Draft Final Guidebook
- Task 13: Prepare Draft Final Report
- Task 14: Panel Conference Call
- Task 15: Prepare Final Guidebook
- Task 16: Prepare Final Report

Research findings are described in Chapter 3, conclusions and recommendations are described in Chapter 4.

### **Task 1: Project Kickoff**

The Research Team developed an Amplified Work Plan (Work Plan). This plan provided an expansion of the approved Research Plan as outlined in the proposal. It also described the activities to be pursued in conducting the research and clearly demonstrated the anticipated accomplishments of the research within the specified period and funding.

After submittal of the Work Plan to the Project Panel, the Research Team participated in a project kickoff conference call with the Project Panel. The Project Panel provided comments during this meeting and the Research Team incorporated the comments into the updated Work Plan prior to proceeding with executing subsequent elements of the Work Plan.

### **Task 2: Document Collection, Compilation and Review**

The Research Team compiled available and applicable documents relevant to this project including:

- FAA Advisory Circulars,
- U.S. and Canadian regulations,
- Regulatory compliance guidance documents,
- ACRP reports and syntheses,
- Aviation industry winter operations conference presentations,
- Airport presentations,

- Aviation and non-aviation-related pavement snow removal literature, and
- Equipment vendor and new technology literature.

Research Team members, as practitioners in the aviation industry, already possessed or had ready access to many of these documents. The majority of the effort assigned to this task was to identify critical information for evaluation, reference, and/or inclusion in the guidebook. A list of the documents compiled through this effort and used during Phase I of the research is included in **Appendix A**.

### **Task 3: Target Airport Selection and ACRP Conference Call**

The Research Team established a target list of airports to contact as part of the research process. To prepare a recommended list of target airports, industry reputation for strength in winter operations was considered. This included reviewing past industry award recipients and contacting FAA and Airline System Operation Centers (SOCs)/Airline Operation Centers (AOCs) to gather informed opinions on winter weather operational performance. By biasing selection of airports to those having a positive winter operations reputation, the Research Team increased the likelihood of identifying proven effective operational practices. Additionally, several airports that had recently made, or were in the process of making significant investments to improve their winter operations programs were targeted. Understanding how these airports identified their operational gaps and what decision-making processes were used to close the gaps was directly relevant to this project.

The Research Team next established a geographic area and airport category matrix composed of FAA regions and airport categories for U.S. airports, as well as Canadian provinces and Canadian National Airport System airports. This matrix was used to ensure targeted airports that typically conduct snow or ice removal operations represented various geographic regions (and associated meteorological conditions) and airport categories. In total 47 target airports were identified to contact as shown on **Table 1**. The list primarily consisted of commercial service airports. It also included some military, and general aviation (GA) facilities in an effort to capture innovative practices occurring in those components of the industry. The completed matrix is presented in **Table 2**.

### **Task 4: Airport and Stakeholder Data Collection, Review and Evaluation**

#### *Winter Plan Collection*

The Research Team implemented a three-part airport data collection, review and evaluation process. The first step in this process involved researching contact information for the target airports. The next step involved finalizing a list of airport data needs. The Research Team chose not to send out written airport surveys or to use web-based survey tools due to feedback from airport clients that they have been overwhelmed with survey requests and often do not respond. It was determined that the best way to facilitate project data collection and discussion was through an organized list of questions during telephone interviews. The list of data sought is included in **Appendix B**. GS&P then assigned the 47 target airports identified in Task 3 to three Research Team members, each with the ability to leverage an extensive personal network of relationships in the airport community for the benefit of the project. The assignments were based on airport size or geographic region to facilitate interview consistency and promote identification of common “themes” among the target airports.

Research Team members initiated contact with the target airports by first emailing a brief written request to the Airport Director and/or Operations Manager with an explanation of the ACRP project, its objectives, specific data needs and potential need to ask follow-up questions. In some cases the list of data

**TABLE 1 List of Target Airports**

<b>Airport</b>	<b>Airport Code</b>	<b>Airport Category</b>	<b>Geographic Region</b>	<b>City</b>	<b>State/Province</b>	<b>Recommendation Considerations</b>
Ted Stevens Anchorage International Airport	ANC	Medium Hub	Alaskan	Anchorage	Alaska	<ul style="list-style-type: none"> <li>- 2008-2009 Balchen/Post Award-Large Commercial (Honorable Mention)</li> <li>- 2011-2012 Balchen/Post Award-Large Commercial (Winner)</li> </ul>
Centennial Airport	APA	GA	Northwest Mountain	Denver	Colorado	<ul style="list-style-type: none"> <li>- 2007-2008 Balchen/Post Award-Large General Aviation (Winner)</li> <li>- 2009-2010 Balchen/Post Award-Large General Aviation (Winner)</li> <li>- 2010-2011 Balchen/Post Award-Large General Aviation (Winner)</li> <li>- 2011-2012 Balchen/Post Award-Large General Aviation (Honorable Mention)</li> <li>- Recommended by NetJets</li> </ul>
Hartsfield-Jackson Atlanta International Airport	ATL	Large Hub	Southern	Atlanta	Georgia	<ul style="list-style-type: none"> <li>- Major Delta Airlines (DL) hub</li> <li>- Known to have high priority on winter ops</li> <li>- Susceptible to ice storms</li> </ul>
Bradley International Airport	BDL	Medium Hub	New England	Windsor Locks	Connecticut	<ul style="list-style-type: none"> <li>- 2010-2011 Balchen/Post Award Medium-Commercial (Winner)</li> <li>- Medium-hub on East Coast snow track</li> <li>- Significant Irregular Operations (IROPS) event in October 2011</li> </ul>
Laurence G Hanscom Field Airport	BED	Non-Primary	New England	Bedford	Massachusetts	<ul style="list-style-type: none"> <li>- 2007-2008 Balchen/Post Award-Large General Aviation (Honorable Mention)</li> <li>- 2008-2009 Balchen/Post Award-Large General Aviation (Honorable Mention)</li> <li>- 2010-2011 Balchen/Post Award-Large General Aviation (Honorable Mention)</li> <li>- Recommended by NetJets</li> </ul>

TABLE 1 (continued) List of Target Airports

Airport	Airport Code	Airport Category	Geographic Region	City	State/Province	– Recommendation Considerations
Southwest Michigan Regional Airport	BEH	GA	Great Lakes	Benton Harbor	Michigan	<ul style="list-style-type: none"> <li>– 2007-2008 Balchen/Post Award-Small General Aviation (Honorable Mention)</li> <li>– 2008-2009 Balchen/Post Award-Small General Aviation (Winner)</li> </ul>
Bangor International Airport	BGR	Non-Hub	New England	Bangor	Maine	<ul style="list-style-type: none"> <li>– 2010-2011 Balchen/Post Award-Small Commercial (Winner)</li> <li>– 2011-2012 Balchen/Post Award-Small Commercial (Honorable Mention)</li> <li>– Significant non-hub diversion airport</li> <li>– Coastal winter weather</li> </ul>
Rocky Mountain Metropolitan Airport	BJC	GA	Northwest Mountain	Denver	Colorado	<ul style="list-style-type: none"> <li>– 2009-2010 Balchen/Post Award-Large General Aviation (Honorable Mention)</li> <li>– 2011-2012 Balchen/Post Award-Large General Aviation (Winner)</li> </ul>
Boise Air Terminal/Gowen Field	BOI	Small Hub	Northwest Mountain	Boise	Idaho	<ul style="list-style-type: none"> <li>– Recommended by NetJets</li> </ul>
General Edward Lawrence Logan International Airport	BOS	Large Hub	New England	Boston	Massachusetts	<ul style="list-style-type: none"> <li>– 2008-2009 Balchen/Post Award -Large Commercial (Winner)</li> <li>– 2010-2011 Balchen/Post Award -Large Commercial (Winner)</li> <li>– Recommended by NetJets</li> <li>– Industry reputation</li> <li>– Northernmost large hub airport on the Eastern seaboard</li> <li>– Often the last major airport to close during a significant winter storm</li> <li>– Takes heavy diversions of transatlantic traffic bound for more southerly airports</li> <li>– Wet coastal weather</li> </ul>

**TABLE 1 (continued) List of Target Airports**

<b>Airport</b>	<b>Airport Code</b>	<b>Airport Category</b>	<b>Geographic Region</b>	<b>City</b>	<b>State/Province</b>	<b>Recommendation Considerations</b>
Burlington International Airport	BTV	Small Hub	New England	Burlington	Vermont	<ul style="list-style-type: none"> <li>- 2009-2010 Balchen/Post Award-Small Commercial (Honorable Mention)</li> <li>- 2010-2011 Balchen/Post Award-Small Commercial (Honorable Mention)</li> </ul>
Buffalo Niagara International Airport	BUF	Medium Hub	Eastern	Buffalo	New York	<ul style="list-style-type: none"> <li>- 2007-2008 Balchen/Post Award-Medium Commercial (Winner)</li> <li>- 2010-2011 Balchen/Post Award-Medium Commercial (Winner)</li> <li>- Considered a leader in snow removal among medium hubs</li> <li>- Significant lake effect snow</li> </ul>
Cincinnati/Northern Kentucky International Airport	CVG	Medium Hub	Great Lakes	Covington	Kentucky	<ul style="list-style-type: none"> <li>- Recent equipment procurement process</li> </ul>
Denver International Airport	DEN	Large Hub	Northwest Mountain	Denver	Colorado	<ul style="list-style-type: none"> <li>- 2011-2012 Balchen/Post Award-Large Commercial (Honorable Mention)</li> <li>- Recommended by NetJets</li> <li>- Recent equipment procurement process</li> </ul>
Dallas/Ft. Worth International Airport	DFW	Large Hub	Southwest	Dallas-Fort Worth	Texas	<ul style="list-style-type: none"> <li>- Recent equipment procurement process</li> <li>- Major AA hub</li> <li>- Known to have high priority on winter ops</li> <li>- Susceptible to ice storms</li> </ul>
Dover Air Force Base	DOV	U.S. Air Force Base	New England	Dover	Delaware	<ul style="list-style-type: none"> <li>- 2010-2011 Balchen/Post Award-Military (Winner)</li> </ul>
Eagle County Regional Airport	EGE	Non-Hub	Northwest Mountain	Eagle	Colorado	<ul style="list-style-type: none"> <li>- Recommended by NetJets</li> </ul>
Kenai Municipal Airport	ENA	Non-Hub	Alaskan	Kenai	Alaska	<ul style="list-style-type: none"> <li>- 2011-2012 Balchen/Post Award-Small Commercial (Winner)</li> </ul>

**TABLE 1 (continued) List of Target Airports**

<b>Airport</b>	<b>Airport Code</b>	<b>Airport Category</b>	<b>Geographic Region</b>	<b>City</b>	<b>State/Province</b>	<b>Recommendation Considerations</b>
Newark Liberty International Airport	EWR	Large Hub	Eastern	Newark	New Jersey	<ul style="list-style-type: none"> <li>- Major United (Continental) east coast hub.</li> <li>- Regularly delayed airport under even good weather conditions</li> </ul>
Spokane International Airport	GEG	Small Hub	Northwest Mountain	Spokane	Washington	<ul style="list-style-type: none"> <li>- 2008-2009 Balchen/Post Award-Medium Commercial (Winner)</li> </ul>
Hartford-Brainard Airport	HFD	GA	New England	Hartford	Connecticut	<ul style="list-style-type: none"> <li>- 49 inches of snow annually</li> </ul>
Washington Dulles International Airport	IAD	Large Hub	Eastern	Washington	Virginia	<ul style="list-style-type: none"> <li>- 2009-2010 Balchen/Post Award-Large Commercial (Winner)</li> </ul>
Niagara Falls International Airport	IAG	GA	Eastern	Niagara Falls	New York	<ul style="list-style-type: none"> <li>- 2007-2008 Balchen/Post Award-Small General Aviation (Winner)</li> <li>- 2009-2010 Balchen/Post Award-Small General Aviation (Honorable Mention)</li> </ul>
Juneau International Airport	JNU	Small Hub	Alaskan	Juneau	Alaska	<ul style="list-style-type: none"> <li>- State capital without road access</li> <li>- 99 inches of snow annually</li> </ul>
La Guardia Airport	LGA	Large Hub	Eastern	New York	New York	<ul style="list-style-type: none"> <li>- 2010-2011 Balchen/Post Award-Large Commercial (Winner)</li> </ul>
Memphis International Airport	MEM	Medium Hub	Southern	Memphis	Tennessee	<ul style="list-style-type: none"> <li>- 2010-2011 Balchen/Post Award-Medium Commercial (Honorable Mention)</li> <li>- Major FedEx hub</li> <li>- Known to have high priority maintaining the integrity of winter ops</li> </ul>
Mansfield Municipal Airport	1B9	GA	New England	Mansfield	Massachusetts	<ul style="list-style-type: none"> <li>- 2010-2011 Balchen/Post Award-Small General Aviation (Winner)</li> </ul>
General Mitchell International Airport	MKE	Medium Hub	Great Lakes	Milwaukee	Wisconsin	<ul style="list-style-type: none"> <li>- 2009-2010 Balchen/Post Award-Medium Commercial (Honorable Mention)</li> <li>- Recent equipment procurement process</li> </ul>

**TABLE 1 (continued) List of Target Airports**

<b>Airport</b>	<b>Airport Code</b>	<b>Airport Category</b>	<b>Geographic Region</b>	<b>City</b>	<b>State/Province</b>	<b>Recommendation Considerations</b>
Muskegon County Airport	MKG	Non-Hub	Great Lakes	Muskegon	Michigan	<ul style="list-style-type: none"> <li>- 2007-2008 Balchen/Post Award-Small Commercial (Winner)</li> <li>- 2008-2009 Balchen/Post Award-Small Commercial (Winner)</li> </ul>
Missoula International Airport	MSO	Non-Hub	Northwest Mountain	Missoula	Montana	<ul style="list-style-type: none"> <li>- 2011-2012 Balchen/Post Award-Small General Aviation (Winner)</li> </ul>
Minneapolis/St. Paul International Airport	MSP	Large Hub	Great Lakes	Minneapolis	Minnesota	<ul style="list-style-type: none"> <li>- Industry reputation, well regarded winter ops capability</li> <li>- DL hub</li> <li>- Takeoff/Landing Performance Assessment Aviation Rulemaking Committee (TALPA/ARC) participant</li> </ul>
Chicago O'Hare International Airport	ORD	Large Hub	Great Lakes	Chicago	Illinois	<ul style="list-style-type: none"> <li>- 2009-2010 Balchen/Post Award-Large Commercial (Winner)</li> <li>- 2010-2011 Balchen/Post Award-Large Commercial (Honorable Mention)</li> <li>- Perhaps the U.S. airport most heavily impacted by winter operations disruptions</li> </ul>
Waterbury-Oxford Airport	OXC	GA	New England	Oxford	Connecticut	<ul style="list-style-type: none"> <li>- Recommended by FAA</li> <li>- 170 based aircraft, 50,000 annual operations</li> </ul>
Pittsburgh International Airport	PIT	Medium Hub	Eastern	Pittsburgh	Pennsylvania	<ul style="list-style-type: none"> <li>- 2009-2010 Balchen/Post Award-Medium Commercial (Winner)</li> <li>- Former US Airways hub</li> <li>- May have interesting management issues, given downsizing of activity and physically large facility</li> </ul>
Oakland County International Airport	PTK	GA	Great Lakes	Pontiac	Michigan	<ul style="list-style-type: none"> <li>- 2008-2009 Balchen/Post Award-Large General Aviation (Winner)</li> </ul>

**TABLE 1 (continued) List of Target Airports**

<b>Airport</b>	<b>Airport Code</b>	<b>Airport Category</b>	<b>Geographic Region</b>	<b>City</b>	<b>State/Province</b>	<b>Recommendation Considerations</b>
Greater Rochester International Airport	ROC	Small Hub	Eastern	Rochester	New York	<ul style="list-style-type: none"> <li>- 2009-2010 Balchen/Post Award-Small Commercial (Winner)</li> <li>- Recommended by NetJets</li> </ul>
Steamboat Springs Airport	SBS	GA	Northwest Mountain	Steamboat Springs	Colorado	<ul style="list-style-type: none"> <li>- High altitude</li> <li>- Short runway</li> <li>- Ski resort</li> </ul>
Fairchild AFB	SKA	U.S. Air Force Base	Northwest Mountain	Spokane	Washington	<ul style="list-style-type: none"> <li>- 2008-2009 Balchen/Post Award-Military (Winner)</li> <li>- 2011-2012 Balchen/Post Award-Military (Winner)</li> </ul>
Salt Lake City International Airport	SLC	Large Hub	Northwest Mountain	Salt Lake City	Utah	<ul style="list-style-type: none"> <li>- Recommended by NetJets</li> <li>- DL hub</li> <li>- Cold weather &amp; significant snow fall</li> </ul>
Teterboro Airport	TEB	GA	Eastern	Teterboro	New Jersey	<ul style="list-style-type: none"> <li>- 2009-2010 Balchen/Post Award-Larger General Aviation (Winner)</li> <li>- Recommended by FAA</li> <li>- Major reliever for metro NYC</li> <li>- Approx. 150,000 annual operations</li> </ul>
Cherry Capital Airport	TVC	Non-Hub	Great Lakes	Traverse City	Michigan	<ul style="list-style-type: none"> <li>- Non-hub with significant winter ops experience</li> <li>- TALPA/ARC participant</li> <li>- Significant lake effect snow</li> </ul>
Halifax Stanfield International Airport	YHZ	Canadian	Nova Scotia	Halifax	Nova Scotia	<ul style="list-style-type: none"> <li>- Introduction of new equipment</li> </ul>
Fort McMurray Airport	YMM	Canadian	Alberta	Fort McMurray	Alberta	<ul style="list-style-type: none"> <li>- Single runway airport</li> <li>- Handles over ¾ million passengers per year</li> <li>- Sub-arctic climate</li> </ul>

**TABLE 1 (continued) List of Target Airports**

<b>Airport</b>	<b>Airport Code</b>	<b>Airport Category</b>	<b>Geographic Region</b>	<b>City</b>	<b>State/Province</b>	<b>Recommendation Considerations</b>
Pierre Elliot Trudeau International Airport	YUL	Canadian	Quebec	Montreal	Quebec	<ul style="list-style-type: none"> <li>- 2007-2008 Balchen/Post Award-Large Commercial (Winner)</li> <li>- 2011-1012 Balchen/Post Award-Large Commercial (Honorable Mention)</li> <li>- Quantity of snow, cold climate</li> <li>- Considered a leader in snow control</li> </ul>
Prince George Airport	YXS	Canadian	British Columbia	Prince George	British Columbia	<ul style="list-style-type: none"> <li>- Handles about 400K passengers per year</li> <li>- In an area that gets extreme snowfalls</li> </ul>
Calgary International Airport	YYC	Canadian	Alberta	Calgary	Alberta	<ul style="list-style-type: none"> <li>- Use of maintenance windows</li> <li>- Industry reputation</li> <li>- Canadian Western ski resort</li> </ul>
Toronto Pearson International Airport	YYZ	Canadian	Ontario	Toronto	Ontario	<ul style="list-style-type: none"> <li>- Industry reputation</li> <li>- Benchmarking practices</li> <li>- Air Canada Eastern hub</li> <li>- Canada's busiest airport</li> <li>- Wet, heavy snow common</li> </ul>

**TABLE 2 Target Airport Matrix**

<b>Region</b>	<b>Large Hub</b>	<b>Medium Hub</b>	<b>Small Hub</b>	<b>Non-Hub</b>	<b>Non-Primary</b>	<b>General Aviation</b>	<b>U.S. Air Force Base</b>	<b>Canadian</b>	<b>Total</b>
<b>Alaskan</b>		ANC	JNU	ENA					3
<b>Northwest Mountain</b>	DEN		BOI	EGE		APA BJC	SKA		10
	SLC		GEG	MSO		SBS			
<b>Great Lakes</b>	ORD	CVG		MKG		BEH			8
	MSP	MKE		TVC		PTK			
<b>Eastern</b>	IAD	BUF	ROC			IAG			8
	EWR								
	LGA	PIT				TEB			
<b>New England</b>	BOS	BDL	BTV	BGR	BED	MFD	DOV		9
						HFD			
						OXC			
<b>Southern</b>	ATL	MEM							2
<b>Southwest</b>	DFW								1
<b>Alberta</b>								YMM YYC	2
<b>Quebec</b>								YUL	1
<b>Ontario</b>								YYZ	1
<b>Nova Scotia</b>								YHZ	1
<b>British Columbia</b>								YXS	1
<b>Total</b>	10	7	5	6	1	10	2	6	47

needs was provided to the airports to facilitate their understanding of the required data. Target airports indicating an interest in providing information on their winter operations practices were contacted by Research Team members to schedule a telephone interview. A total of seven targeted airports chose not to participate. In many cases, phone interviews had to be scheduled several weeks in advance to facilitate airport participation.

The telephone interviews lasted one to two hours and were often followed up with an exchange of plans, procedures, and data. During the interviews, Research Team members requested “Snow and Ice Control Plans” (SICPs) and/or “Winter Operations Plans” from the target U.S. airports, and equivalent “Airport Winter Maintenance Plans” from the target Canadian airports identified in Task 3. The FAA-required SICPs offered insight into the unique attributes of the subject U.S. airports, and provided specific information on subjects such as pavement clearing priorities and winter operations equipment. The Research Team understood that many SICPs follow the prescribed format and contain the minimum information outlined in FAA Advisory Circular 150/5200-30C. Therefore in addition to SICPs, the Research Team sought more detailed airport-initiated winter operations plans and procedures. Many facilities have made significant investments in such plans and procedures to document their own best practices, strategies and tactics. These documents represented valuable written resources for the project.

The telephone interviews also offered an opportunity to ask if the airport representative(s) had a particular area of interest or need related to this research project topic. GS&P has found through our past ACRP data collection efforts that this simple effort to engage airport representatives garnered significantly more support and participation. Interviewees also expressed an interest in finding out what other airports are doing with regard to winter operations and measuring winter operations performance.

#### *Winter Plan Review*

The second part of the three-part airport data collection, review and evaluation process required that the Research Team review the winter plans, operational procedures, and interview responses provided by the target airports. The Research Team identified and documented potentially beneficial winter operations practices.

#### *Evaluation of Winter Operations Strategies and Tactics*

The third part of the three-part airport data collection, review and evaluation process required that the Research Team evaluate the data collected on winter operations practices, procedures, strategies, and tactics. Through a systematic process of comparing airport data, the Research Team sought to differentiate newer, more innovative, and ultimately more effective, efficient, and safe practices, procedures, strategies, and tactics from those that are more routine and possibly outdated. As needed, Research Team members followed up with the target airports to gain additional insight and information.

#### *Stakeholder Outreach*

In addition to airport representatives, the Research Team reached out to other aviation stakeholders, including the FAA and air carriers, to gain insight into some of the winter operations practices, procedures, strategies, and tactics considered for inclusion in the guidebook. The Research Team built on the information provided under Task 3 by FAA and airline AOCs/SOCs. Additionally, Research Team members met with various industry representatives attending the 2012 American Association of Airport Executives (AAAE) Large Hub Winter Operations and Deicing Conference and Exhibition, and the 2012 and 2013 AAAE International Aviation Snow Symposiums. At both the 2012 AAAE Large Hub Winter Operations and Deicing Conference and Exhibition and the 2013 AAAE International Aviation Snow

Symposium, GS&P gave presentations about the planned guidebook, ongoing research efforts, and project data needs.

The Research Team also identified a subset of the winter operations practices that might affect other airport stakeholders and distributed these to key stakeholder representatives for further review and feedback. The Research Team solicited input from representatives of FAA, commercial and cargo air carriers, an airline trade organization, and a pilots association. The Research Team emailed letters to each industry representative along with the list of draft practices for review and followed up with a phone call to solicit feedback. The Research Team received feedback on the draft practices from 10 industry stakeholders.

### *Airport Site Visit Recommendations*

Based on research findings from the airport interviews, the Research Team recommended visiting nine airports where winter operations practices, procedures, strategies, and tactics were found to be particularly unique and innovative, or where winter operations were undergoing significant improvement. While many other participating airport representatives described efficient operations, unique practices, or new pieces of equipment, their information was adequately captured during the interviews or in supporting documentation provided subsequent to the interview. The Research Team prepared the following summaries of observations pertaining to each recommended airport's winter operations program.

- Centennial Airport (APA) – APA is a corporate Reliever/GA facility with a clientele that expects airfield availability in all conditions. APA has a 10,000-foot runway yet the Arapahoe County Public Airport Authority (ACPAA) manages to keep it and its associated taxiway infrastructure open with a small crew. It is, therefore, a highly efficient operation, and with that efficiency comes some excellent strategies, tactics and equipment usage directly relevant to the development of the guidebook. In addition, and worthy analysis, ACPAA has built and maintains strong relationships with the agencies and tenants on the field, and has a fairly robust training program including regular reviews of their plan both after an event and after the season. Relationships and training are key factors in a successful winter operations program.
- Boise Air Terminal/Gowen Field (BOI) – BOI is focused on making significant improvements to its mature winter operations program. The City of Boise BOI staff is very motivated to learn from other airports, apply the lessons learned, and is very willing to share their own insights. An in-depth review of their winter operations was recommended by several other airports.
- General Edward Lawrence Logan International Airport (BOS) – The Massachusetts Port Authority (Massport) is an acknowledged industry leader in snow and ice control at BOS, with considerable experience in identifying and implementing new technologies and new methodologies. Massport has a strong communication and coordination program with air traffic control and airport tenants. Massport understands the importance of outbound deicing relative to inbound arrival rates, and deals with multiple air carriers on the issue. BOS was one of the first airports to utilize multi-function equipment (MFE), and also one of the first airports to identify the efficiencies of snow removal circuit routes. Massport maximizes available personnel during snow/ice control events, and their snow plan addresses human performance factors in great detail. Massport understands that high crew morale results in high productivity.
- Denver International Airport (DEN) – The City and County of Denver Department of Aviation at Denver International Airport (DIA) has made significant winter operations program

improvements in response to lessons learned from a widely-publicized airport closure. DIA has an extremely detailed program that includes proposed equipment purchase planning, deployment planning, and cost justification in advance of making program decisions. DIA monitors a wide-range of metrics, likely the most comprehensive program of its type in the country. In response to the widely-publicized closure, DIA identified opportunities for improvement with internal (Operations/Maintenance) and external (DIA/FAA Air Traffic Control) relationships and established programs to improve those relationships. DIA also appears to deal effectively with the special circumstances associated with a municipally-owned and operated facility.

- Dallas/Ft. Worth International Airport (DFW) – DFW staff learned lessons from a highly publicized winter weather event. They also recently procured new equipment and are in the process of developing a completely revised snow and ice control plan as a result of that event. DFW is unique in that several high-ranking airport executives were previously employed by major air carriers, thus providing a unique perspective in airport operational decision-making. Because of those experiences, DFW staff created a highly effective working relationship with the major hub air carrier, and have identified the benefits of such a relationship.
- General Mitchell International Airport (MKE) – Milwaukee County has made significant improvements in the snow and ice control operations at MKE. A few years ago, Northwest Airlines designated MKE as a “special ops” airport and canceled flights into the airport during snow/ice events. MKE has overcome challenges associated with being a county-run facility. Milwaukee County has dynamic leadership at MKE that is continually attempting to identify efficiencies through the development of new procedures or the procurement of new equipment. Milwaukee County utilizes a computerized airport information dissemination system and uses the system to maintain real-time communications with air carriers and airport tenants at MKE.
- Teterboro Airport (TEB) – TEB is a GA facility with numerous business tenants whose air travel needs rival those of commercial carriers. Therefore, it is a GA airport that is different than most. The Port Authority of New York & New Jersey (PANYNJ) has stronger demands placed upon its operation at TEB and, therefore, has had the need to analyze and employ equipment, procedures and planning in a way that will result in the most effective, yet efficient operation. TEB also has a unique governance/management structure, being a PANYNJ airport operated by AvPORTS. This has given TEB management the opportunity to stretch normal operating boundaries resulting in success on the field. AvPORTS has a formal structure in most of their planning, training and reporting processes at TEB that may not be applicable to smaller operations, but works well for them and is a big part of their success. Finally, and most importantly, AvPORTS at TEB is an ISO 9001-certified operation and, as such, has built its success around metrics. This allows the Operations Manager to know what works and what does not. For example, the back pages of their Snow Plan are used for logging weather conditions during the storm and what tactics were employed during those weather conditions (de-icing, plowing, brooming, etc.), so that in the post event review they can better determine their operational effectiveness.
- Calgary International Airport (YYC) – Calgary Airport Authority has a mature winter operations coordination process at YYC that relies on face-to-face meetings of their snow committee during significant events. They collaborate very well with their airport community. They have a well-developed process to forecast capacity during snow events and have procedures that result in flight cancellations to reduce demand until it equals forecast capacity. They have a 10-year history with MFE. They are a cost-conscious airport that tries very hard to minimize all costs associated with their winter operations.

- Toronto Pearson International Airport (YYZ) – YYZ, operated by the Greater Toronto Airport Authority (GTAA), is an established industry leader in winter operations. They have a very mature coordination process that relies on conference calls. GTAA collaborates very well with their airport community (airlines, ground handlers, ATC, etc.). They have a well-developed process to forecast airport capacity during snow events and procedures that result in flight cancellations to reduce demand until it equals forecast capacity. Along with BOS, YYZ has the longest history of any airport in North America with MFE. Additionally, they are taking an in-depth review of performance metrics and are benchmarking with other airports.

### *Summary of Recommended Practices*

Through the implementation of Task 2, the efforts described above for Task 4, and the airport site visits described in Task 5, the Research Team recommended winter operations practices, procedures, strategies, and tactics for inclusion in the guidebook. These practices, procedures, strategies, and tactics were presented as brief descriptions in the Interim Report. Subsequent to the interim meeting with the Project Panel the Research Team further expanded the descriptions of the procedures, strategies and tactics and incorporated them into the guidebook.

### **Task 5: Airport Site Visits**

The Research Team visited the nine airports recommended in Task 4. The site visits involved technical discussions with airport staff and stakeholders on operations and best practices, as well as observation of equipment and technology. The visits were conducted during the winter season in an attempt to observe the actual operations, but did not target winter storm events due to the inherent logistical challenges of timing events. Summaries of each site visit were developed and included in the Interim Report. Information obtained during the site visits regarding practices, implementation of equipment, and use of technology was incorporated into the guidebook..

### **Task 6: Winter Event Passenger Experience and Expectations Management Practices Evaluation**

The Research Team researched how airports with an industry-recognized winter operations program communicate with their customers to improve the airport experience and manage expectations during winter events. The information sought about effective passenger experience and expectations management practices is presented in **Appendix C**. The Research Team attempted to interview communication, public relations, media and/or public affairs representatives at the 31 commercial service airports that elected to participate in Task 4. Contact information was provided by the winter operations contacts at the target airports. Of the 31 airports, 19 airports elected to participate in interviews conducted under Task 6, nine chose not to participate, and no contact was made with three facilities. **Table 3** identifies the 19 airports that chose to participate.

The airports contacted for Task 6 ranged from small single-carrier facilities to large hubs in both the U.S. and Canada. These airports had public relations departments as small as one individual and as large as 20. In some cases the Airport Director at very small facilities handled customer outreach with the aid of an outside consultant.

**TABLE 3 Winter Event Passenger Experience and Expectations Management Practices Evaluation Research Participants**

Airport	Airport Code	Airport Category	Geographic Region
Ted Stevens Anchorage International Airport	ANC	Medium Hub	Alaskan
Bradley International Airport	BDL	Medium Hub	New England
General Edward Lawrence Logan International Airport	BOS	Large Hub	New England
Cincinnati/Northern Kentucky International Airport	CVG	Medium Hub	Great Lakes
Denver International Airport	DEN	Large Hub	Northwest Mountain
Dallas/Ft. Worth International Airport	DFW	Large Hub	Southwest
Washington Dulles International Airport	IAD	Large Hub	Eastern
Memphis International Airport	MEM	Medium Hub	Southern
General Mitchell International Airport	MKE	Medium Hub	Great Lakes
Muskegon County Airport	MKG	Non-Hub	Great Lakes
Missoula International Airport	MSO	Non-Hub	Northwest Mountain
Minneapolis/St. Paul International Airport	MSP	Large Hub	Great Lakes
Chicago O'Hare International Airport	ORD	Large Hub	Great Lakes
Salt Lake City International Airport	SLC	Large Hub	Northwest Mountain
Cherry Capital Airport	TVC	Non-Hub	Great Lakes
Halifax Stanfield International Airport	YHZ	Canadian	Nova Scotia
Fort McMurray Airport	YMM	Canadian	Alberta
Calgary International Airport	YYC	Canadian	Alberta
Toronto Pearson International Airport	YYZ	Canadian	Ontario

Similar to the Task 4 airport interviews, initial contact for Task 6 was made through a brief email explaining the assignment, requesting a 30-minute phone interview, and providing available dates and times from which to select. Generally, the initial response was good, but a second follow-up email and direct phone calls were used to make contact with those who did not respond to the initial email. The Research Team emphasized the project focus on how they provide customer outreach during significant winter events and create the best passenger experience.

The identified practices were initially grouped into three categories: crisis communication planning, social media, and internal communication. Documented practices were then compared and evaluated to determine those that should be included in the guidebook. The data were then added to the list of winter operations practices, procedures, strategies, and tactics prepared under Task 4.

### **Task 7: Winter Operations Performance Measures Identification**

As suggested in *ACRP Report 19: Developing an Airport Performance Measurement System*, the terms “metrics,” “measures,” and “indicators” are synonymous and mean “a standard of measurement or indicator for quantitative comparison” (Infrastructure Management Group, Inc. 2010). To facilitate consistency with *ACRP Report 19* and *ACRP Report 19A: Resource Guide to Airport Performance Indicators*, the Research Team adopted the term “measure” for the ACRP 10-15 guidebook rather than “metric” as originally proposed in the Work Plan. Furthermore, the Research Team adopted the term

“airport performance indicator” (API) to represent beneficial strategic measures of airport winter operations (2). This approach places the emphasis on measuring practices within an airport’s control.

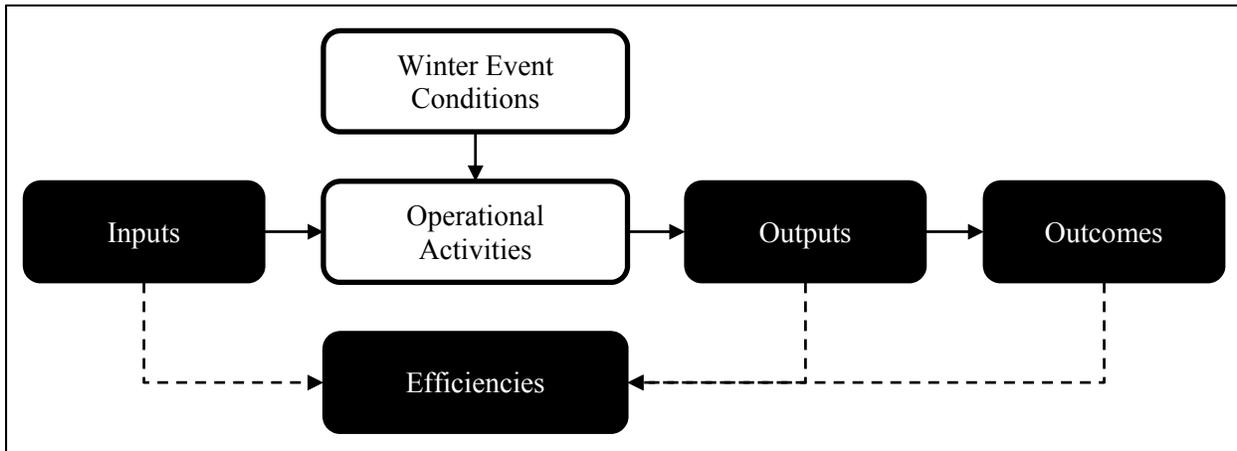
The Research Team identified performance- and operations-related measures in documents collected under Task 2, through airport interviews conducted under Task 4, and during site visits conducted under Task 5 of the Work Plan. Four beneficial documents related to measures included: *ACRP Report 19*; *ACRP Report 19A*; *ACRP Report 14: Deicing Planning Guidelines and Practices for Stormwater Management Systems*; and *NCHRP Web-Only Document 136: Performance Measures for Snow and Ice Control Operations*. Of the 40 airports that participated in the interviews conducted under Task 4, 16 reported tracking one or more measures or were in the process of developing measures for their winter operations.

The Research Team initially identified numerous measures of airport winter operations that were reported by interviewed airports or that were likely being measured but were unreported. It became clear that nearly any facet of a winter operations program could be measured. However, much of that data, if viewed independently, offered little value in assessing winter operational performance. It is simply too far down “in the weeds.” The challenge for the Research Team was to identify higher level APIs that could facilitate a structured, meaningful, self-evaluation process, as well as facilitate potential comparisons of similar practices between two or more similar airports.

To help understand how particular measures relate to winter operations, the Research Team initially categorized identified measures under one of the following four classifications, as illustrated in **Figure 1**:

- Inputs – Resources utilized during an activity. Commonly available data. Typically not a source of APIs.
- Outputs – Quantitative measurements of the results of activities. Typically not a source of APIs.
- Outcomes – Measurements of the impacts or benefits of outputs to the organization and its stakeholders. Often compared to intended results. Common source of APIs.
- Efficiencies – Relate output production or outcome to the use of inputs. Common source of APIs.

**FIGURE 1 Relationship of input, output, outcome, and efficiency measures to winter operations.**



Once the measures were classified, those most suited to be APIs were further categorized into one of the following categories representing key winter operations program components:

- Snow and ice removal,
- Chemical and sand application,
- Equipment,
- Safety,
- Stakeholder coordination,
- Financial, and
- Environmental compliance.

The list of APIs was further reduced after the Research Team took into consideration the following:

- Frequency of industry winter operations practice or process occurrence,
- Relative importance of the process to be measured,
- Process complexity (i.e., number of variables),
- Uncontrollable variables affecting outcomes,
- Ease of data acquisition,
- Measurement accuracy and precision,
- Dependence on related measures, and
- Similarity to other APIs.

### **Task 8: Self-Evaluation Process Development**

The Work Plan initially called for the Research Team to develop a structured and systematic self-evaluation process that will allow airports to make informed risk- and cost-based decisions about their practices and procedures, including basic formulas for determining the optimal level of investment costs that stakeholders would deem acceptable/reasonable due to the anticipated net investment benefits (e.g., delay reduction cost savings). The Research Team discovered through the research that the drivers for purchasing new equipment at small facilities are often very different than at larger airports. Additionally, while estimating a cost to airlines and passengers associated with runway closure is possible for larger commercial services airport, it is far more difficult to quantify at a GA or small airport. As a result, the Research Team experienced substantial challenges while attempting to develop a process that would address the many variables affecting the decision to purchase new equipment, including those that are specific to each airport's unique situation.

The Research Team, through discussion with the Program Officer and Panel Chair, determined that it would be more beneficial to the guidebook user to first determine the drivers for improving winter operations performance and then identify a performance goal. The process developed in the Draft Final guidebook under Task 12 includes a description of the basic components of a cost/benefit evaluation of the investment required to achieve the goal. The primary benefit of investment in equipment to be evaluated is delay cost savings to the airlines and traveling public, which is most applicable to larger airports.

The systematic approach developed for the guidebook adapted self-evaluation practices and winter operations investment analyses utilized by MSP, DEN, BOS, TEB, and YYZ including the following:

- Establishment of target rate(s) of arrival and departure flight operations during defined winter event conditions based on airport stakeholder needs and expectations;

- Determination of the pavement surfaces required to support the desired number of flight operations;
- Use of performance measures to optimize efficiency and effectiveness of current practices;
- Evaluation of new, more efficient and effective practices shared by other airports;
- Determination of the number and type of snow and ice removal equipment to maintain the required pavement surfaces during the defined winter event conditions;
- Determination of the number of operators and support personnel required to operate and maintain the snow and ice removal equipment;
- Determination of the support facilities required to store and support the snow and ice removal equipment;
- Determination of the cost to procure, operate and maintain the snow and ice removal equipment and support facilities;
- Determination of the cost to airport stakeholders if the expected rate of arrival and departure flight operations during defined winter event conditions are not met; and
- Identification of the potential risks of investment in winter operations.

### **Task 9: Prepare Detailed Outline of Guidebook**

The Research Team considered both the results of the research conducted prior to the submission of the Interim Report, and how airports would use a guidebook to develop the draft guidebook outline included in the Interim Report. During the development of the guidebook, the outline was refined based on additional research, Research Team and Project Panel discussion, and further consideration for how airports would use the guidebook. The detailed outline for the guidebook is included as **Appendix D**.

### **Task 10: Prepare Interim Report**

The Research Team prepared and submitted an Interim Report to the Project Panel summarizing the data, descriptions, and processes prepared under Tasks 1 through 7, and Task 9.

### **Task 11: Meeting with ACRP Project Panel**

Two members of the Research Team participated in a meeting with the Project Panel in Washington, D.C. on June 17, 2013, to present and discuss the results of the research summarized in the Interim Report, and to obtain direction from the Project Panel on the remainder of the project. The Project Panel expressed satisfaction with project progress and directed the Research Team to begin preparation of the Task 12 Draft Guidebook. The Research Team and Project Panel also discussed several decisions about the content and format of the guidebook related to the research presented in Chapter 3 and Chapter 4 of this report.

### **Task 12: Prepare Draft Final Guidebook**

The Research Team assembled the information collected and summarized in Tasks 2 through 11 into a guidebook that provides the following:

- Summary of operational requirements, guidelines and other topics for consideration as part of winter operations planning.
- Process for establishing measures to determine winter operational performance.
- Process for critically evaluating operational practices to identify inefficient, ineffective or preferable alternative practices.
- Process for determining the optimal investment in fleet equipment and capability including economic, financial and other risk considerations.

- Effective winter operations strategies and tactics utilized by airports, from forecasting and monitoring meteorological conditions to post-event dig out and recovery.
- Internal and external communication and coordination strategies utilized by airports with airport users and stakeholders on topics such as reporting pavement conditions, snow clearing responsibilities and managing inbound flight diversions.
- Strategies for managing passenger experience and expectations, including proactive communication and providing assistance for stranded passengers.

A detailed description of the contents of the guidebook is presented in Chapter 3.

### **Task 13: Prepare Draft Final Report**

The Research Team prepared an update to the Interim Report documenting the background information and processes used to develop the guidebook, including:

- Documentation of the research effort
- Background information used in developing the Guidebook
- Explanation and justification of recommendations
- Executive summary of the Guidebook; and
- Recommendations for further research that would assist airports in evaluating, comparing and ultimately selecting winter operations practices, strategies and tactics.

### **Task 14: Panel Conference Call**

The Project Panel reviewed the Task 12 and Task 13 Draft Final Deliverables, approved the project for completion and provided final comments to the Research Team to consider for the Final Deliverables. No conference call was needed to discuss final comments from the Project Panel. The Research Team prepared and submitted written summaries of the comments and associated responses or proposed changes.

### **Task 15: Prepare Final Guidebook**

The Research Team incorporated revisions to the Draft Final Guidebook to address changes proposed in the Task 14 response to Project Panel comments on the Draft Final Guidebook. The Research Team is submitting the Final Guidebook to ACRP for publication with this Final Report.

### **Task 16: Prepare Final Report**

This document represents the results of Task 16.

## CHAPTER 3 FINDINGS AND APPLICATIONS

### Recurring Themes from Airport Interviews, Site Visits, and Documentation

As described in Chapter 2, the Research Team interviewed 40 airports and had the opportunity to gather input and feedback from one or more representatives at each of the facilities. The Research Team identified the following recurring themes from the interviews, site visits, and information collected during, or as a result of the interviews and site visits:

- Improving winter operations is a mature industry initiative with most airports emulating applicable practices shared by a relatively small number of large hub airports after experiencing highly publicized winter operations breakdowns.
- Airports are most interested in practices that will facilitate doing more with less.
- Conference presentations, information sharing sessions, and the relationships built during these industry events are primary mechanisms for the exchange of information on winter operations.
- Most of the practices identified through airport interviews represent standard operating procedures among the 40 airports.
- Many of the current innovations in winter operations identified through the research represent improvements to equipment and technology rather than procedures.
- While the types of equipment may vary by airport, the deployment and operation of similar types of equipment during winter events is fairly standard.
- Methods for reporting runway surface conditions and friction measurements vary greatly across the industry.
- When it comes to MFE, there are four categories of airports: 1) the airport that would like to add MFEs but cannot due to financial constraints; 2) the previously well-equipped airport that is adding MFE as they retire old vehicles; 3) the airport that has partnered with its air carriers and conducted extensive cost/benefit analyses to justify capital expenditures; and 4) the airport that has experienced a well-publicized failure/closure, and therefore justified the significant capital expense to improve performance.
- Commercial service airports without air carrier hub operations are more likely to focus on reducing winter operations costs than reducing runway occupancy times.
- Few airports utilize performance measures to monitor winter operations performance because the effort is perceived to be too labor intensive.
- Few airports believe there is value in benchmarking performance against other airports due to the variations in air service, staffing, equipment, airfield pavement, and local climate.
- The guidebook must emphasize relationships and stakeholder communication, collaboration and coordination.
- Local FAA Air Traffic Control wants to partner with its airport operator, but is often hindered by other FAA organization units.
- A tenuous relationship between Airport Operations and Airfield Maintenance is still commonplace among airports.
- The more closely an airport works with its municipal government, the more effectively it can operate during and recover from winter events.
- Pride and dedication of staff are characteristics most often described when airports are asked what sets them apart from other airports.
- Airports that invest in their Airport Operations and Airfield Maintenance staff (e.g., training, equipment, winter event support) see better performance year round and less employee turnover.

- Airports experience “loss of situational awareness” incidents during less stressful post-event clean-up conditions than during active snow when a high level of performance is expected.
- Airports are waiting for the FAA’s forthcoming Safety Management System (SMS) program before going forward with any assessments.
- During the interviews and case study visits the Research Team received unfiltered input about what works, or does not work, at airports. Some airport representatives expressed concern about specific procedures being attributed to their airports in a public document.
- The drivers for purchasing new equipment at small facilities are often very different than at larger airports. Additionally, while estimating a cost to airlines and passengers associated with runway closure is possible for larger commercial services airport, it is far more difficult to quantify at a GA or small airport.
- The description of practices presented in the guidebook represent an overview that provides users sufficient information to understand the practice objective and general implementation methodology. However, because airports are unique, it was impracticable to identify to which particular airport(s) any given practice would be best or recommended.

## **Guidebook Content**

The ACRP report, *Guidebook for Winter Operations*, is the principal product of this research. It is designed to assist airports with preparing for, operating during, and recovering from disruptive winter events, as well as managing airport passenger expectations. It also provides guidance to airport operators on how determine 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. The guidebook is organized around the concept that a winter operations program can be structured using a management system approach, or a framework of strategies and tactics (defined as processes and procedures) to achieve winter operations goals and objectives.

### *Chapter 1: Introduction*

This chapter provides an introduction to the guidebook scope and describes the guidebook organization and suggested use. The subsequent chapters are grouped by the following recurring airport winter operations program phases:

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

### *Chapter 2: Relationships as the Foundation for Winter Operations Success*

Research for the guidebook revealed that airports with successful and industry-recognized winter operations programs share three essential elements that set a foundation for their success—effective communication, collaboration and coordination. This chapter describes the importance of effective communication, coordination and collaboration stakeholder, and includes a discussion of the process for identifying stakeholders, and the characteristics of effective communication, coordination, and collaboration with stakeholders.

### *Chapter 3: FAA Requirements and Guidance Related to 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 FAA Advisory Circulars applicable to winter operations. To

accommodate this request, this chapter provides an Advisory Circular description including a summary of its purpose extracted from the referenced document. For certain Advisory Circulars, additional information is provided to illustrate their relevance to winter operations.

#### *Chapter 4: Regulation of Winter Operation Impacts on Stormwater*

Familiarity with the laws and regulations intended to control the impact that winter operations have on the environment, including on stormwater runoff quality, is important and expected. Routine operations at an airport are subject to extensive environmental regulation. This chapter focuses on the regulation of winter operation impacts on stormwater runoff quality and methods to mitigate these impacts.

#### *Chapter 5: Historical Winter Storm Event Data*

Characterizing and understanding the range of meteorological conditions associated with winter storm events common to an airport's local geography can help the airport better plan, communicate, and execute its winter operations program, along with better manage expectations. This chapter describes the benefits of utilizing historical meteorological data to better define and evaluate performance. Sources of meteorological data are identified, and methods for manipulating and analyzing the data, including consideration of climate change are also described.

#### *Chapter 6: Winter Operations Performance Measurement*

Many of the airports interviewed had not established clear winter operations performance goals, were not measuring program elements holding strategic importance to their performance, and were not using measures to guide and adjust their operational performance. 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. The chapter describes the process of establishing winter operations goals, defining specific objectives to serve as a pathway to achieving goals, identifying performance measures and collecting data.

#### *Chapter 7: Winter Operations Baseline and Performance Targets*

A performance and cost baseline can be established to understand existing operating capabilities and set performance targets to meet the program goals, objectives and API's identified in Chapter 5. This chapter describes the process for determining the airport's performance and cost baseline, defining the target upper limit of winter operations performance capabilities and setting performance targets for each identified performance measure.

#### *Chapters 8 through 11: Various Best Practices*

The Research Team identified winter operations strategies and tactics representing industry "best practices" that were shared by airports of all sizes in broad geographic areas and winter climates. Each practice was assigned to one of the categories and sub-categories identified in Advisory Circular 150/5200-30C *Airport Winter Safety and Operations*. 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 AC 150/5200-30C table of contents. This will enable incorporation of applicable practices into an existing SICP or other winter operations documentation.

### *Chapter 12: Winter Operations Performance Evaluation*

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 including those that are meeting established performance targets and those that are falling short. This chapter describes the process for conducting qualitative and quantitative performance evaluation, examining performance shortfalls, and identifying improvement opportunities.

### *Chapter 13: Investment to Reduce Snow Removal Equipment (SRE) Runway Occupancy Time*

The results of performance evaluations may indicate the need to invest in new or additional SRE to reduce runway occupancy time and reduce aircraft delays. Investment options should be thoroughly evaluated to justify the resources and capital investment recommended to the investment decision-makers and stakeholders involved in its winter operations program. The challenge for most airports needing to invest in snow removal equipment is the lack of industry guidance on how to determine an optimal level of investment. This chapter describes a method for determining an airport's snow removal capacity shortfall, identifying alternatives to meet performance targets, identifying the variables that affect runway occupancy time, estimating snow removal equipment needs to reduce the performance shortfall, and estimating the benefits of reduced runway occupancy time associated with that snow removal equipment.

### *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 evaluation process that can apply to every airport and improvement opportunity. This chapter presents high-level considerations for implementing an alternatives evaluation process, including establishing evaluation criteria, developing and evaluating alternatives, and planning alternative implementation.

### *Appendix A: Accessing Meteorological Data*

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 across the U.S. This appendix describes how to access the NOAA meteorological data.

### *Appendix B: Example Airport Performance Indicators*

The Research Team's step-wise API identification and evaluation process resulted in the list of 38 APIs presented in Appendix B of the guidebook. However, 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 interviews, documents, and discussion, and were chosen because they each provide a way to monitor airport winter operations decisions, equipment, strategies, or plans. 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 pick and monitor APIs based upon areas of interest and their own specific goals.

## CHAPTER 4 CONCLUSIONS AND RECOMMENDATIONS

### Conclusions

Drawing on the research described in Chapter 2, discussions with the Project Panel, and associated findings presented in Chapter 3, the Research Team reached the following conclusions that shaped the content and format of the *Guidebook for Airport Winter Operations*:

- Controlling capital and operating costs and maintaining safe airport operations are the primary airport drivers affecting airport winter operations programs, and at times, one may be in conflict with the other.
- Interviewed airports are interested in the guidebook as a means of information sharing, but believe it would have provided greater benefit several years ago.
- Biasing interviews and data gathering efforts toward 47 airports recognized for their strong winter operations reputations made it challenging to differentiate industry standard practices from true “best practices” since airports with less robust winter operations programs were not represented in the research.
- Because most airport representatives believe their airports are unique in their operating environment and constraints, the Research Team recommended higher level programmatic elements of a strong winter operations program in the guidebook and provide multiple examples of operating practices that support these elements, rather than attempting to create a compendium of detailed practices uniformly applicable to a broad airport audience.
- To address nearly universal feedback from interviewed airport stakeholders, the guidebook provides substantial emphasis on building stakeholder relationships, and implementing effective communication, collaboration, and coordination practices.
- Airport representatives are familiar with current equipment and technology innovations, and are generally using the equipment and technology consistently. Therefore, in-depth discussion of specific technology and equipment in the guidebook is limited as it would become quickly outdated.
- Airport representatives are interested in having an industry-defined process for identifying optimum equipment and staffing needs to be used as justification to airport management and air carriers.
- Names of example airports implementing specific practices are not included in the guidebook, and specific airport contacts are not included in the Final Report in an effort to be sensitive to the airport representatives that provided candid feedback about what does and what does not work at airports.
- Through the research conducted to identify practices to be included in the guidebook, in addition to unique and innovative practices, the Research Team also identified many practices that were implemented at most, but not all airports interviewed. Although not universally implemented, these standard industry practices are already described in available literature, and the Research Team decided that the guidebook would best serve the users by focusing only on the identified unique and innovative practices.
- The term “measure” is used in the guidebook in lieu of “metric” and “airport performance indicator” (API) in lieu of “key performance indicator” (KPI) to facilitate consistency with two recent ACRP publications related to airport performance measurement systems and airport performance measures. Definitions of these terms are explained in the guidebook, and it is noted that these terms are synonymous with the more traditional metric and KPI terminology.

- The Research Team was concerned by using the term “best practice” or “recommended practice” in the guidebook, that an airport could incur a legal risk for choosing not to implement an industry-identified “best practice” or “recommended practice.” Ultimately, the term “best practice” was selected, but with the inclusion of a definition of the term in the guidebook noting the variability of airports and the potential impracticability of implementing a best practice at any given airport.
- The Research Team experienced substantial challenges while attempting to develop a tool that would address the many variables affecting the decision to purchase new equipment, including those that are specific to each airport’s unique situation. The Research Team determined that it would be more beneficial to the guidebook user to first determine the drivers for improving winter operations performance and then identify a performance goal. The guidebook includes a description of the basic components of a cost/benefit evaluation of the investment required to achieve the goal. The primary benefit of investment in equipment to be evaluated is delay cost savings to the airlines and traveling public, which is most applicable to larger airports.
- When possible, the guidebook directs users to other ACRP guidebooks containing detailed content relevant to airport winter operation. This approach raises user awareness of other ACRP resources, prevents duplication of effort, and maximized the efficient use of ACRP 10-15 project funds.

### **Recommendations for Future Research**

The guidebook developed through this research project describes the process by which an airport would conduct a cost/benefit evaluation of the investment required to achieve an identified performance goal. Airport operators may be interested in a computer software-based benefit/cost analysis tool that would calculate the optimal winter operations investment for a specific airport based on a number of defined characteristics. Further research is recommended to further define the many differing factors that determine the optimal investment in winter operations at specific airports, and to develop an electronic investment evaluation tool.

## REFERENCES

1. Federal Aviation Administration, Office of Investment Planning and Analysis. “Economic Information for Business Case Analysis.” <http://www.ipa.faa.gov/BCToolkit.cfm>. Accessed August 25, 2014.
2. Hazel, Robert A., Jan David Blais, Thomas J. Browne, and Daniel M. Benzon. *ACRP Report 19A: Resource Guide to Airport Performance Indicators*. Washington, DC: Transportation Research Board on the National Academies, 2011.

## ACRONYMS

1B9 – Mansfield Municipal Airport  
A4A – Airlines for America  
AA – American Airlines  
AAAE – American Association of Airport Executives  
AAR – Aircraft Arrival Rate  
ACAP – Airport Capital Assistance Program (Canada)  
ACPAA – Arapahoe County Public Airport Authority  
ACRP – Airport Cooperative Research Program  
ADS-B – Automated Dependent Surveillance Broadcast  
AFB – Air Force Base  
AIP – Airport Improvement Program  
ANC – Ted Stevens Anchorage International Airport  
ANG – Air National Guard  
AOC – Airline or Airport Operation Center  
APA – Centennial Airport  
API – Airport Performance Indicator  
ASDE – Airport Surface Detection Equipment  
ATC – Air Traffic Control  
ATCSCC – Air Traffic Control System Command Center  
ATCT – Air Traffic Control Tower  
ATIDS – Airport Target Identification System  
ATL – Hartsfield-Jackson Atlanta International Airport  
ATSD – Airborne Traffic Situation Display  
BDL – Bradley International Airport  
BED – Laurence G Hanscom Field Airport  
BEH – Southwest Michigan Regional Airport  
BGR – Bangor International Airport  
BJC – Rocky Mountain Metropolitan Airport  
BOI – Boise Air Terminal/Gowen Field  
BOS – General Edward Lawrence Logan International Airport  
BTV – Burlington International Airport  
BUF – Buffalo Niagara International Airport  
CBP – Customs and Border Protection  
CCP – Crisis Communications Plan  
CFME – Continuous Friction Measuring Equipment  
CFR – Code of Federal Regulations  
CVG – Cincinnati/Northern Kentucky International Airport  
DEN – Denver International Airport  
DEVS – Driver-enhanced Vision Systems  
DFW – Dallas/Fort Worth International Airport  
DIA – City and County of Denver Department of Aviation  
DL – Delta Airlines  
DMP – Departure Metering Program  
DOV – Dover Air Force Base  
DPS – Department of Public Safety  
EGE – Eagle County Regional Airport  
ENA – Kenai Municipal Airport

EOC – Emergency Operations Center  
ERM – Enterprise Risk Management  
ETMS – Energy and Transportation Management System  
EWR – Newark Liberty International Airport  
FBO – Fixed-based Operator  
FOD – Foreign Object Debris  
FSS – Flight Services and Systems  
GA – General Aviation  
GEG – Spokane International Airport  
GS&P – Gresham, Smith and Partners  
GTAA – Greater Toronto Airport Authority  
HFD – Hartford-Brainard Airport  
IAD – Washington Dulles International Airport  
IAG – Niagara Falls International Airport  
ICS – Incident Command System  
IFMA – International Facility Management Association  
IROPS – Irregular Operations  
JNU – Juneau International Airport  
LCSS – Low Cost Surface Surveillance  
LGA – La Guardia Airport  
LOA – Letter of Agreement  
LOT – Loop Detection Technology  
MAC – Minneapolis Airports Commission  
Massport – Massachusetts Port Authority  
MEM – Memphis International Airport  
MFE – Multi-function Equipment  
MKE – General Mitchell International Airport  
MKG – Muskegon County Airport  
MRE – Meals Ready to Eat  
MSO – Missoula International Airport  
MSP – Minneapolis/St. Paul International Airport  
NIMS – National Incident Management System  
NOTAM – Notice to Airmen  
NWA – Northwest Airlines  
NWS – National Weather Service  
O&M – Operations and Maintenance  
OCC – Operations Control Center  
Ops – Operations  
ORD – Chicago O’Hare International Airport  
OXC – Waterbury-Oxford Airport  
PANYNJ – Port Authority of New York & New Jersey  
PFC – Passenger Facility Charge  
PIREP – Pilot Report  
PIT – Pittsburgh International Airport  
PR – Public Relations  
PSA – Public Service Announcement  
PTK – Oakland County International Airport  
ROC – Greater Rochester International Airport  
RWSL – Runway Status Lights  
SBS – Steamboat Springs Airport  
SICP – Snow and Ice Control Plan

SKA – Fairchild Air Force Base  
SLC – Salt Lake City International Airport  
SMGCS – Surface Movement Guidance and Control System  
SMS – Safety Management System  
SNOWTAM – Snow Message to Airmen  
SOC – System Operation Center  
SPCC – Spill Prevention Control and Countermeasure  
SRE – Snow Removal Equipment  
SWIFT – Summer/Winter Integrated Field Technologies  
TALPA/ARC - Takeoff/landing Performance Assessment Aviation Rulemaking Committee  
TEB – Teterboro Airport  
TMU – Traffic Management Unit  
TRACON – Terminal Radar Approach Control  
TSA – Transportation Security Administration  
TVC – Cherry Capital Airport  
WWOM – Winter Weather Operations Manual  
YHZ – Halifax Stanfield International Airport  
YMM – Fort McMurray Airport  
YUL – Pierre Elliot Trudeau International Airport  
YXS – Prince George Airport  
YYC – Calgary International Airport  
YYZ – Toronto Pearson International Airport  
ZMP – FAA Minneapolis Center

**APPENDIX A**

**Document Index**

**List of Articles**

<b>Identifier</b>	<b>Author</b>	<b>Title of Article</b>	<b>Title of Periodical</b>	<b>Volume number</b>	<b>Issue number</b>	<b>Publication Date</b>	<b>Page (s)</b>
A1	David C. Richardson	Breaking the Ice	Stormwater	Unknown	Unknown	March/April 2012	42-45
A2	Joshua Paurus	Technology vs the elements	International Airport Review	16	2	Mar-2012	43-46
A3	Kathryn Creedy	Winter Weather Results in \$5.8 Billion Economic Toll on U.S. Passengers, Airlines and Airports	MasFlight	N/A	N/A	3/3/2004	1-8

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Identifier	Author	Title/Description	Document #	Publisher	Date of Publication	Place of Publication
D1	Federal Aviation Administration	Advisory Circular-Surface Movement Guidance and Control System	120-57A	Transportation Research Board of the National Academies	12/19/1996	Unknown
D2	Federal Aviation Administration	Advisory Circular-Buildings for Storage and Maintenance of Airport Snow and Ice Control Equipment and Materials	150/5220-18A	Transportation Research Board of the National Academies	9/14/2007	Unknown
D3	Federal Aviation Administration	Advisory Circular-Airport Snow and Ice Control Equipment	150/5220-20	Transportation Research Board of the National Academies	6/30/1992	Unknown
D4	Federal Aviation Administration	Change 1 to Airport Snow and Ice Control Equipment	150/5220-20 Change 1	Transportation Research Board of the National Academies	3/1/1994	Unknown
D5	Federal Aviation Administration	Measurement, Construction and Maintenance of Skid-Resistant Airport Pavement Surfaces	150/5320-12C	Transportation Research Board of the National Academies	3/18/1997	Unknown
D6	Federal Aviation Administration	Water, Slush and Snow on the Runway	91-6A	Transportation Research Board of the National Academies	5/24/1978	Unknown
D7	Airports Council International-Europe	2011 Airside Safety Survey	N/A	P.P.S Publications Limited	2011	United Kingdom
D8	Airports Council International-Europe	Letter regarding Snow Plan updates for several European Airports	N/A	N/A	11/23/2011	N/A
D9	CH2MHill, Gresham, Smith and Partners, Barnes and Thornburg LLP	Deicing Planning Guidelines and Practices for Stormwater Management Systems	ACRP Report 14	Transportation Research Board of the National Academies	2009	Washington, D.C.
D10	APS Aviation, Inc.	Optimizing the Use of Aircraft Deicing and Anti-Icing Fluids	ACRP Report 45	Transportation Research Board of the National Academies	2011	Washington, D.C.
D11	HNTB Corporation, Spy Pond Partners	Collaborative Airport Capital Planning Handbook	ACRP Report 49	Transportation Research Board of the National Academies	2011	Washington, D.C.
D12	Aviation Innovation LLC, Mead and Hunt Inc., Barich, Inc., Greater Toronto Airports Authority	Guidebook for Airport Irregular Operations (IROPS) Contingency Planning	ACRP Report 65	Transportation Research Board of the National Academies	2012	Washington, D.C.
D13	Western Transportation Institute of Montana State University	Impact of Airport Pavement Deicing Products on Aircraft and Airfield Infrastructure	ACRP Synthesis 6	Transportation Research Board of the National Academies	2008	Washington, D.C.
D14	SMQ Airport Services	Preventing Vehicle-Aircraft Incidents During Winter Operations and Periods of Low Visibility	ACRP Synthesis 12	Transportation Research Board of the National Academies	2008	Washington, D.C.
D15	Heathrow Winter Resilience Enquiry Panel	BAA Heathrow Winter Resilience Enquiry	N/A	BAA	Mar-2011	London, England
D16	Federal Aviation Administration	Anti-Icing Pavement Coating Study at Chicago O'Hare International Airport	DOT/FAA/AR-06/58	Federal Aviation Administration	Mar-2007	Washington, D.C.
D17	Bismarck Airports District Office	Guide for Justifying Snow Removal Buildings	N/A	Bismarck Airports District Office	Jan-2010	Bismarck, ND
D18	US Army Cold Region Research & Engineering	Manual of Practice for an Effective Anti-Icing Program: A Guide for Highway Winter Maintenance Personnel (draft)	N/A	Federal Highway Administration	2/22/1996	Hanover, NH

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Identifier	Author	Title/Description	Document #	Publisher	Date of Publication	Place of Publication
D19	National Cooperative Highway Research Program	Snow and Ice Control: Guidelines for Materials and Methods	NCHRP Report 526	Transportation Research Board of the National Academies	2004	Washington, D.C.
D20	Federal Aviation Administration	FAA Office of Airports Safety Management System (SMS) Desk Reference	N/A	Federal Aviation Administration	6/1/2012	Washington, D.C.
D21	American Association of Airport Executives	Roster of attendees AAAE/NE Chapter Large Hub Winter Operations and Deicing Conference 2012	N/A	N/A	2012	N/A
D22	American Association of Airport Executives	AAAE/NE Chapter Large Hub Winter Operations and Deicing Conference 2012 Program	N/A	N/A	2012	N/A
D23	Aviation Rulemaking Committee	TALPA ARC Airport/Part 139 Working Group Recommendations	N/A	Unknown	4/9/2009	Unknown
D24	Transport Canada	Snow Profile Beyond Runway and Taxiway Edge for Airbus A380 Operations	AC 302-007	Unknown	11/23/2009	Unknown
D25	Transport Canada	Cancellation of Aerodrome Safety Circular 2002-015 De-icing Fluids Containing Potassium Formate	N/A	Unknown	4/2/2002	N/A
D26	U.S. Air Force	Snow and Ice Control	Air Force Instruction 32-1002	Unknown	10/19/2011	Unknown
D27	Federal Aviation Administration	Advisory Circular-Airport Winter Safety and Operations	150/5200-30C	Unknown	12/9/2008	Unknown
D28	Blair Everett	Notes from Snow Symposium and Large Hub Winter Operations 2012 Conferences	N/A	N/A	2012	N/A
D29	U.S. Secretary of Transportation	Appendix A to 2011-2015 National Plan of Integrated Airport Systems (NPIAS) Report: List of NPIAS Airports with 5-Year Forecast Activity and Development Cost	N/A	Unknown	9/27/2010	Unknown
D30	U.S. Secretary of Transportation	2011-2015 National Plan of Integrated Airport Systems (NPIAS) Report of the Secretary of Transportation to the United States Congress	N/A	Unknown	9/27/2010	Unknown
D31	M. A. Farha, Y. Hassan et al	Effects of New Deicing Alternatives on Airfield Asphalt Concrete Pavements	N/A	N/A	2002	N/A
D33	Transport Canada	Aerodrome Safety Circular-Introduction of the Proposed Regulation and Standards Concerning Airport Winter Maintenance and Planning	ASC 2001-011	Transport Canada	11/26/2001	Unknown
D34	Transport Canada	Aerodrome Safety Circular-Aircraft Movement Surface Condition Reporting (AMSCR) for Winter Operations	ASC 2000-002	Transport Canada	9/15/2000	Unknown
D35	Transport Canada	Aerodrome Standards and Recommended Practices	TP 312	Transport Canada	March 1993	Unknown
D36	Robert A. Hazel, Jan David Blais, Thomas J. Browne, Daniel M. Benzon	Resource Guide to Airport Performance Indicators	ACRP Report 19A	Transportation Research Board of the National Academies	2011	Washington, D.C.
D37	Infrastructure Management Group, Inc., The Performance Institute, Counter Technology Incorporated	Developing an Airport Performance-Measurement System	ACRP Report 19	Transportation Research Board of the National Academies	2010	Washington, D.C.
D38	Federal Aviation Administration	Advisory Circular - Airport Ground Vehicle Automatic Dependent Surveillance – Broadcast (ADS-B) Out Squitter Equipment	150/5220-26		11/14/2011	
D39	T.H. Maze, Chris Albrecht, Dennis Kroeger	Performance Measures for Snow and Ice Control Operations	NCHRP Web-Only Document 136	Transportation Research Board of the National Academies	Dec-2007	

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D40	Marsh Risk Consulting, HNTB Corporation, Direct Effect Solutions, Inc.	Application of Enterprise Risk Management at Airports	ACRP Report 74	Transportation Research Board of the National Academies	2012	Washington, D.C.
D41	Dean Mericas, Maris Mangulis, Nancy Schultz, Jeffery Longsworth	Winter Design Storm Factor Determination for Airports	ACRP Report 81	Transportation Research Board of the National Academies	2012	Washington, D.C.
D42	Patrick Kennon, Robert Hazel, Eric Ford, Belinda Hargrove	Preparing Peak Period and Operational Profiles - Guidebook	ACRP Report 82	Transportation Research Board of the National Academies	2013	Washington, D.C.
D43	SITA	2013 Air Transport Industry Insights - Flying into the Future	N/A	SITA	2013	
D44	Bruce Goldberg, David Chesser	Sitting on the Runway: Current Aircraft Taxi Times Now Exceed Pre-9/11 Experience	SR-008	U.S. Department of Transportation	May-2008	
D45	ACI Europe	Airside Safety Survey	N/A	P.P.S. Publications LTD	2011	Horley, Surrey, United Kingdom
D46	Critical Path, Inc. and Landrum & Brown	Denver International Airport Winter Operations Program Review	N/A		Aug-2007	
D47	FAA	Pilot/Controller Glossary	N/A	FAA	3/7/2013	
D48	Timothy Parsons and Clifton Ogden	Recommended Guidelines for the Collection and Use of Geospatially Referenced Data for Airfield Pavement Management	ACRP Report 39	Transportation Research Board of the National Academies	2010	Washington, D.C.
D49	GHD Inc.	Asset and Infrastructure Management for Airports - Primer and Guidebook	ACRP Report 69	Transportation Research Board of the National Academies	2012	Washington, D.C.
D50	Mark Ervin, John Lengel, Jr., Tim Arendt, Devon Seal, Melanie Knecht, Tom Dietrich, Jill Lukehart (Gresham, Smith and Partners), with Dennis Caudell (Terra Hydr, Inc.)	Guidebook for Selecting Methods to Monitor Airport and Aircraft Deicing Materials	ACRP Report 72	Transportation Research Board of the National Academies	2012	Washington, D.C.
D51	George Bowman, Steven R. Corsi, Lee Ferguson, Steven W. Geis, Harris Gold, Kevin Joback, and Dean Mericas	Alternative Aircraft and Pavement Deicers and Anti-icing Formulations with Improved Environmental Characteristics	Research Results Digest 9	Transportation Research Board of the National Academies	2010	Washington, D.C.
D52	University of South Carolina, Infoscitex Corporation, Molecular Knowledge Systems Inc., Wisconsin State Laboratory of Hygiene, CH2M HILL, U.S. Geological Survey	Alternative Aircraft Anti-Icing Formulations with Reduced Aquatic Toxicity and Biochemical Oxygen Demand	ACRP Web-Only Document 8	Transportation Research Board of the National Academies	2010	Washington, D.C.

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Identifier	Author	Title/Description	Document #	Publisher	Date of Publication	Place of Publication
D53	James C. DeLong (Capital Improvement: 1904, LLC), Steve Wareham (Trillion Aviation), John Duval (Austin Commercial, L.P.), Hana Rocek (Airport Consulting Inc.), Jaime Guillen (Faros Infrastructure Partners), Jane Parent (Department of Management, Merrimack College), Rose Agnew (Aviation Innovation, LLC), Steve Loper, Michael Nichols, and Kenzie Rodrigues (Amadeus Consulting Group, Inc.)	Guidebook to Creating a Collaborative Environment Between Airport Operations and Maintenance	ACRP Report 92	Transportation Research Board of the National Academies	2013	Washington, D.C.
D54	IEM, Smith-Woolwine Associates, Inc., Kim Kenville Consulting, Newton and Associates, Inc., Kimley-Horn and Associates, Inc.	Integrating Web-Based Emergency Management Collaboration Tools into Airport Operations - A Primer	ACRP Report 94	Transportation Research Board of the National Academies	2013	Washington, D.C.
D55	Gresham, Smith and Partners, Inland Technologies, ARCADIS U.S., Inc., McGuinness Unlimited, Naturally Wallace, NewFields	Guidance for Treatment of Airport Stormwater Containing Deicers	ACRP Report 99	Transportation Research Board of the National Academies	2013	Washington, D.C.
D56	Hollis Stambaugh and Maria Argabright (System Planning Corporation), Heidi Benaman and Mike Cheston (Faith Grough, LLC)	A Guidebook for Integrating NIMS for Personnel and Resources at Airports	ACRP Report 103	Transportation Research Board of the National Academies	2014	Washington, D.C.
D57	TransSolutions, Futterman Consulting, Harris Miller Miller & Hanson, Inc., Jasenka Rakas	Defining and Measuring Aircraft Delay and Airport Capacity Thresholds	ACRP Report 104	Transportation Research Board of the National Academies	2014	Washington, D.C.
D58	Easter Region Federal Aviation Administration Airports Division	Best Practices for Winter Operations	Airport Certification Information Bulletin: 2011-03	N/A	12/20/2010	N/A
D59	Federal Aviation Administration	Airport Improvement Program Handbook	Order 5100.38C	Federal Aviation Administration	5/28/2005	Washington, D.C.
D60	Ben Castellano	Airport Winter Operations (Friction Measurement Issues)	Certalert	N/A	1/14/2005	N/A
D61	Federal Aviation Administration	Economic Information for Investment Analysis: Prepared for Investment Planning and Analysis	N/A	Federal Aviation Administration	4/25/2013	Washington, D.C.
D62	Federal Aviation Administration	Letter clarifying information on the secondary use of snow removal equipment that is acquired with Airport Improvement Program grant funds at the nonprimary airports	Program Guidance Letter 08-04	N/A	4/24/2008	N/A
D63	Federal Aviation Administration	Letter describing the Revised BCA Guidance	Program Guidance Letter 12-01	N/A	10/28/2011	N/A
D64	Office of Investment Planning and Analysis AFI-1	Acquisition Management System Guidance: Business Case Analysis Guidance	N/A	Federal Aviation Administration	Jan-14	Washington, D.C.
D65	Office of Investment Planning and Analysis AFI-1	Acquisition Management System Guidance: Business Case Benefits Estimating Guide	N/A	Federal Aviation Administration	1/1/2014	Washington, D.C.

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Identifier	Author	Title/Description	Document #	Publisher	Date of Publication	Place of Publication
D66	Office of Investment Planning and Analysis AFI-1	Acquisition Management System Guidance: Business Case Cost Estimating Guide	N/A	Federal Aviation Administration	1/1/2014	Washington, D.C.
D67	Office of Investment Planning and Analysis AFI-1	Acquisition Management System Guidance: Guidelines for Conducting Business Case Risk Assessment	N/A	Federal Aviation Administration	1/1/2014	Washington, D.C.
D68	Office of Investment Planning and Analysis AFI-1	Acquisition Management System Guidance: Investment Analysis Plan Guidelines and Template	N/A	Federal Aviation Administration	1/1/2014	Washington, D.C.
D69	Office of Investment Planning and Analysis AFI-1	Acquisition Management System Guidance: FAA Schedule Assessment Guidance	N/A	Federal Aviation Administration	Jan-14	Washington, D.C.
D70	Office of Investment Planning and Analysis AFI-1	Acquisition Management System Guidance: Shortfall Analysis Guidelines and Templates	N/A	Federal Aviation Administration	10/1/2013	Washington, D.C.
D71	Federal Aviation Administration	Memorandum regarding Procurement of Weather Support to Airport Deicing Decision Making Nowcasting System	N/A	N/A	3/30/2004	N/A
D72	IEM, Inc., Smith-Woolwine Associates, Inc., TransSolutions, LLC	Airport-to-Airport Mutual Aid Programs	ACRP Report 73	Transportation Research Board of the National Academies	2012	Washington, D.C.
D73	C. Daniel Prather (Prather Airport Solutions, Inc.)	Expediting Aircraft Recovery at Airports	ACRP Synthesis 38	Transportation Research Board of the National Academies	2012	Washington, D.C.
D74	Landrum & Brown, CDM Smith, George Mason University, University of California, Berkeley, Presentation & Design, Inc.	Evaluating Airfield Capacity	ACRP Report 79	Transportation Research Board of the National Academies	2012	Washington, D.C.

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Identifier	Presenter Name(s), Title(s), Organization(s)	Title of Presentation	Conference Name	Conference Location	Year
P1	Gordon Hayhoe, FAA	Airplane Tire Force Characteristics on Ice and Snow	AAAE Large Hub	Arlington, VA	2012
P2	Stephanie Saracco, Chief Operating Officer, Pittsburgh International Airport	How Financial Instability is Affecting Winter Operations	AAAE Large Hub	Seattle, WA	2011
P3	Keith Brune, Deputy Director of Aviation, Ops and Facilities, Philadelphia International Airport	Economic Outlook: How Financial Instability Affects Winter Operations	AAAE Large Hub	Seattle, WA	2011
P4	Paul Giesman, Flight Operations Engineering, Boeing	Runway Condition Reporting-Flight Operations Considerations and TALPA ARC	AAAE Large Hub	Seattle, WA	2011
P5	Jan Kadlec, Head of Airfield Operations, Prague Airport	Case Study-Winter 2010: European and U.S. Experiences	AAAE Large Hub	Seattle, WA	2011
P6	John Selden, Manager Aeronautical Services, JFK Airport	Large Hub Snow Symposium Snow Brief 2010-2011	AAAE Large Hub	Seattle, WA	2011
P7	Joanne Landry, Principal, Landry Consultants LLC.	Safety Management Systems: Perspectives on SMS and Safety Risk Management	AAAE Large Hub	Seattle, WA	2011
P8	Jason McArthur, SMS Senior Program Analyst, Vancouver International Airport Authority	SMS at YVR: 3 Principles for Building an SMS	AAAE Large Hub	Seattle, WA	2011
P9	Rose Agnew, Principal, Aviation Innovation, LLC.	DOT's Enhanced Airline Passenger Protections Rulemaking Implementation and Its Effect on Operations	AAAE Large Hub	Seattle, WA	2011
P10	Dean Wright, Apron Management Unit, Greater Toronto Airports Authority	Departure Metering Program (DMP)	AAAE Large Hub	Seattle, WA	2011
P11	Dave Cunningham, Airport Operations Manager, Denver International Airport	Snowman Program	AAAE Large Hub	Seattle, WA	2011
P12	Scott Steinbrecher, Traffic Management Officer at DEN, FAA	Increasing Performance and Efficiency in Winter Operations	AAAE Large Hub	Seattle, WA	2011
P13	Melissa Sabatine, Vice President Regulatory Affairs, AAAE	ELG Regulatory Update and a Look Ahead at Compliance	AAAE Large Hub	Seattle, WA	2011
P14	Stacy Fox, Environmental Program Manager, Port of Seattle	Seattle-Tacoma Int'l Airport Environmental Strategies for Winter Operations	AAAE Large Hub	Seattle, WA	2011
P15	Fred Stein, Acting Director of the Office of Runway Safety, FAA	Runway Safety and Winter Operations	AAAE Large Hub	Seattle, WA	2011
P16	Joseph Breen, Airport Technology R&D, FAA	Aircraft Braking Friction Research	AAAE Large Hub	Arlington, VA	2012
P17	Liv Vaughn Chapman, Senior Attorney, Office of General Counsel, USDOT. Ed Masterson, Manager of System Efficiency, FAA. Rose Agnew, National Practice Leader of Aviation Services, Mead & Hunt	IROPS Communication and Development of Airport Contingency Plans	AAAE Large Hub	Arlington, VA	2012
P18	Eric Waldron, Airport Administrator, Bradley International Airport	Bradley International Airport Lessons Learned and Other Considerations	AAAE Large Hub	Arlington, VA	2012
P19	Curt Vainio, Sr. Airport Operations Duty Manager, Washington Dulles International Airport	Managing IROPS Events at Washington Dulles International Airport	AAAE Large Hub	Arlington, VA	2012
P20	Dan Sprinkle, Director of Operations, Denver International Airport	Operational Safety During Winter Ops	AAAE Large Hub	Arlington, VA	2012
P21	Zaramie Lindseth, Manager Airfield Maintenance, Ted Stevens Anchorage International Airport	Operational Safety During Winter Operations-Valuable Reminders from a Challenging Winter	AAAE Large Hub	Arlington, VA	2012
P22	Lisa Gahm, Assistant Chief of Airport Operations, Denver International Airport	Denver International Airport's Snow and Ice Control Plan 2011-2012 Season- Gaining Efficiencies	AAAE Large Hub	Arlington, VA	2012
P23	Steve Tobey, Airfield Operations Manager, Dallas/Fort Worth International Airport	Dallas/Fort Worth International Airport	AAAE Large Hub	Arlington, VA	2012
P24	Michelle Moshner, Airport Duty Manager, Seattle-Tacoma International Airport	2011-2012 Winter Operations January Storm	AAAE Large Hub	Arlington, VA	2012
P25	Mike O'Donnell, Director Office of Airport Safety and Standards, FAA	Office of Airport Safety and Standards	AAAE Large Hub	Arlington, VA	2012
P26	Bill Littlejohn, Manager Technical Maintenance, Greater Toronto Airport Authority	Automated Generation of NOTMJ	AAAE Large Hub	Arlington, VA	2012

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P27	Stephanie Saracco, Chief Operating Officer, Pittsburgh International Airport	SMS Pilot Program at PIT	AAAE Large Hub	Arlington, VA	2012
P28	William Palivos, Deputy Commissioner, Chicago O'Hare Operations	3 in 1	AAAE Large Hub	Arlington, VA	2012
P29	Alex Gertsen, Business Development Manager, Team Eagle	Ground Based Vehicle GPS Runway Incursion Warning System (RIWS)	AAAE Large Hub	Arlington, VA	2012
P31	Susan Tighe, Director Center for Transportation and Pavement Technology	Braking Availability Tester (BAT)	AAAE Large Hub	Arlington, VA	2012
P32	Jeff Longworth, Partner, Barnes and Thornburg, LLP.	Deicing Stormwater Controls	AAAE Large Hub	Arlington, VA	2012
P33	Jan Matsuszko, Branch Chief, EPA	Effluent Guidelines for Airport Deicing Discharges	AAAE Large Hub	Arlington, VA	2012
P34	Nancy N. Young, VP of Environmental Affairs, Airlines for America	Aircraft Deicing-Overview of the Industry's Voluntary Pollution Reduction Program	AAAE Large Hub	Arlington, VA	2012
P35	Birke Rhodes, FAA	Airport Winter Operations	Minnesota Airports Conference		2009
P36	Settle, Metropolitan Washington Airports Authority	Winter Operations Planning for a New Runway at Washington Dulles	AAAE Large Hub	LaGuardia, NY	2008
P37	Wagoner, Wayne County Airport Authority	Overview of Forced Air Deicing (at DTW)	AAAE Large Hub	LaGuardia, NY	2008
P38	Wayne Smook, Calgary International Airport	Airport Vehicle GPS System	AAAE Large Hub	LaGuardia, NY	2008
P39	Paul Sichko, Assistant Director MSP Operations	FAA Takeoff/Landing Performance Assessment Aviation Rulemaking Committee, TALPA ARC Progress Report	AAAE Large Hub	LaGuardia, NY	2008
P40	Paul Sichko, Assistant Director MSP Operations	MSP Runway 17-35 Winter Operations Planning	AAAE Large Hub	LaGuardia, NY	2008
P41	Sarah J. Demory, Runway Activation Manager/Airport Duty Manager, Port of Seattle	Winter Operations Planning for a New Runway-the SEA Approach	AAAE Large Hub	LaGuardia, NY	2008
P42	John Kinney, Deputy Manager of Aviation, Denver International Airport	Denver International Case Study Part II, Snow Plan Changes and MFE Procurement	AAAE Large Hub	LaGuardia, NY	2008
P43	Powers	Advantages of Using Proportional Mixed and Single Manned Operating Deicing Vehicles	AAAE Large Hub	LaGuardia, NY	2008
P44	Jesson, Logan International Airport	Airside Winter Operations	AAAE Large Hub	LaGuardia, NY	2008
P45	Mike Dikon, Airfield Maintenance Superintendent, Reno-Tahoe Airport Authority	Multi Function Equipment: The Reno Experience	AAAE Large Hub	LaGuardia, NY	2008
P46	Dunsky, PASSUR	The Role of New Information Technology in Passenger Care	AAAE Large Hub	LaGuardia, NY	2008
P47	Amann, DTW	DTW Snow Study-Planning for the Future	AAAE Large Hub	LaGuardia, NY	2008
P48	Pennel, Baltimore Washington International Airport	2010 AAAE Northeast Chapter Mid-Atlantic Case Studies	AAAE Large Hub	Atlanta, GA	2010
P49	Settle, Metropolitan Washington Airports Authority	Washington Dulles International Airport-What Worked and What Didn't-the Engineering and Maintenance Point of View	AAAE Large Hub	Atlanta, GA	2010
P50	Tolton, Toronto Pearson Airport	The Evolution of Winter Operations at Toronto Pearson	AAAE Large Hub	Atlanta, GA	2010
P51	Jeffery Longworth, Barnes and Thornburg LLP; John Lengel, Gresham Smith and Partners; Michael Svedruzic, Inland Technologies, Int'l LTD	ELG and Stormwater Issues-Regulatory Update and Next Steps	AAAE Large Hub	Atlanta, GA	2010
P52	Randy Moseng, Federal Aviation Administration	Safety Management Systems: Perspectives on the U.S. SMS	AAAE Large Hub	Atlanta, GA	2010
P53	Jerry Ostronic, FAA Flight Standards, Federal Aviation Administration	Runway Surface Condition Reporting TALPA ARC Matrix	AAAE Large Hub	Atlanta, GA	2010
P54	Dan Amann, Assistant Director Airfield Operations, DTW, Wayne County Airport Authority	SMS-From Concept to Reality	AAAE Large Hub	Atlanta, GA	2010
P55	Dan Amann, Assistant Director Airfield Operations, DTW, Wayne County Airport Authority	SafeLane Surface Overlay at Detroit Metropolitan Airport	AAAE Large Hub	Atlanta, GA	2010
P56	Paul Cudmore, Eagle Integrated Solutions	Emerging Technology: RFID Application at Montreal/ADM "Snow Dump"	AAAE Large Hub	Atlanta, GA	2010

List of Presentations

Identifier	Presenter Name(s), Title(s), Organization(s)	Title of Presentation	Conference Name	Conference Location	Year
P58	Mark Carroll, Delta Airlines Flight Safety, Mike Meigs, Office of Runway Safety, Pete Hahn, Lead Airport Inspector, Rick Schoder, Airport Inspector	Airport Winter Safety and Operations	FAA/ANM	Unknown	2010
P58	LNT Solutions	Next Generation Runway Deicing Gen 3 Runway Deicer	Unknown	Unknown	2011
P59	Lincoln Chan, P.Eng., Principal Project Manager, Associate	Runway Concrete Slab Replacement in Record Time at YVR	SWIFT	Banff, Alberta	2012
P60	Olivier Meier	ICAO NOTAM Transition	SWIFT	Banff, Alberta	2012
P61	Olivier Meier	SNOWiz is ready! Are you?	SWIFT	Banff, Alberta	2012
P62	A.W. (Sandy) Brown, P. Eng., Canadian Regional Engineer - Asphalt Ins	Late Season Paving	SWIFT	Banff, Alberta	2012
P63	Alexander (Sandy) Brown, P.Eng., Canadian Field Engineer - Asphalt I	Asphalt Mix Optimization for Airfield Pavements	SWIFT	Banff, Alberta	2012
P64	David Gamper, Director, Safety & Technical ACI World	Airport Collaborative Decision Making - Enhancing Airport Efficiency	SWIFT	Banff, Alberta	2012
P65	Greater Moncton Airport	Aircraft Over-Run, The Moncton experience when a B727 over-runs a runway	SWIFT	Banff, Alberta	2012
P66	Gary L. Mitchell, P.E., Vice President, Airports Pavement Technology, American Concrete Pavement Association	Best Practices for Airfield Concrete Pavement Design and Construction	SWIFT	Banff, Alberta	2012
P67	Tim Morris, CRAFCO Inc.	Best Practices in Airfield Pavement Maintenance	SWIFT	Banff, Alberta	2012
P68	Gord Drysdale, President, CBR Technology Inc.	Meeting Unpaved Runway Standards: A Discussion of Transport Canada's 2012 Advisory Circulars	SWIFT	Banff, Alberta	2012
P69	Capt. John Gadzinski, Four Winds consulting	Connections in Uncertainty: a Unique History in How We See Risk	SWIFT	Banff, Alberta	2012
P70	Keith Johnson	Airfield Pavement Friction Maintenance at Denver International Airport	SWIFT	Banff, Alberta	2012
P71	Preston "Benny" Benedyk, USAF CE Vehicle Program Manager, HQ AFCEA, Tyndall AFB, FL	Roundtable Discussion	SWIFT	Banff, Alberta	2012
P72	Gordon Hayhoe, FAA Airport Technology R&D Branch	Full-Scale Testing on Asphalt of Heavily Loaded High Inflation Pressure Aircraft Tires	SWIFT	Banff, Alberta	2012
P73	ICAO	Packaging Tomorrow's Aviating System	SWIFT	Banff, Alberta	2012
P74	Northwest Territories Transportation	Runway Grooving, Norman Wells, NWT	SWIFT	Banff, Alberta	2012
P75	Ludomir Uzarowski, Ph.D., P.Eng., and Rabiah Rizvi, B.A.SC., Pavement Materials, Golder Associates Ltd., Ontario	Challenges and Solutions to Airfield Pavement Designs and Construction in North with Severe Climatic Conditions - Case Study	SWIFT	Banff, Alberta	2012
P76	Aeroports de Montreal	Benefits of fleet renewal, equipment's modifications and improvements at Montreal-Trudeau	SWIFT	Banff, Alberta	2012
P77	Joerg Simon, Munich Airport, Head of Airport Operations	Friction Measurement and Runway Condition Assessment	SWIFT	Banff, Alberta	2012
P78	John R. Christianson, Seattle/Tacoma International Airport, Port of Seattle	Runway Surface Friction Management Practices	SWIFT	Banff, Alberta	2012
P79	Unknown	Summer Airfield Maintenance Procedures	SWIFT	Banff, Alberta	2012
P80	Jean-Martin Croteau, P.Eng., Technical Director ColasCanada, Inc.	Existing and Potential Maintenance Techniques for Low-Volume/Municipal Airport Runways	SWIFT	Banff, Alberta	2012
P81	Greater Toronto Airport Administration	Toronto Pearson: For you. The World.	SWIFT	Banff, Alberta	2012
P82	Mike Carlson	Acquisition of Multi-Function Equipment at DIA: Conditions, Factors, Considerations & Integration	SWIFT	Banff, Alberta	2012
P83	Capt. John Gadzinski, Four Winds Consulting	Runway Friction and the High Reliability Organization	SWIFT	Banff, Alberta	2012
P84	Joerg Simon, Munich Airport, John Gadzinski, Southwest Airlines & Four Winds Consulting, Armann Norheim, ICACO Friction Task Force	Runway Surface Friction Reporting Panel	SWIFT	Banff, Alberta	2012
P85	Chetek	Preventing Runway Friction Accidents	SWIFT	Banff, Alberta	2012
P86	Kevin Chee, GTAA, Robert Pouliot, Air Canada, Tony Gerardi, APR Consultants Inc.	"An Innovative Approach to Locate and Repair a Runway Roughness Event at YYZ"	SWIFT	Banff, Alberta	2012
P87	RP Erickson & Associates	Athabasca Oil Sands Airports: Trans-con to Bush Strips	SWIFT	Banff, Alberta	2012

List of Presentations

Identifier	Presenter Name(s), Title(s), Organization(s)	Title of Presentation	Conference Name	Conference Location	Year
P88	Preston "Benny" Benedyk, USAF CE Vehicle Program Manager, HQ AFCESA, Tyndall AFB, FL	Vehicle Optimization Strategies	SWIFT	Banff, Alberta	2012
P89	Joseph Breen, Airport Safety R&D Section, FAA W. J. Hughes Technical Center	Airport Technology R&D Overview of Airport R&D Projects	SWIFT	Banff, Alberta	2012
P90	Winnipeg International Airport & Team Eagle	SNOWTAM Project Update	SWIFT	Banff, Alberta	2012
P91	Paul Sichko, Assistant Director/MSP Operations Metropolitan Airports Commission	Irregular Operations (IROPS) Planning for Large and Small Airports	SWIFT	Banff, Alberta	2012
P92	Hakan Ekim, Teknika Inc.	Best Practices in Airfield Concrete Pavement Maintenance	SWIFT	Banff, Alberta	2012
P93	Unknown	Effectively Managing Fatigue in the Workplace	SWIFT	Banff, Alberta	2012
P94	InterVISTAS	Unknown	SWIFT	Banff, Alberta	2012
P95	Tradewind Scientific Ltd.	Digital SNOWTAM Update	SWIFT	Banff, Alberta	2012
P96	R. Craig Mellerski, Air Force Research Laboratory	USAF Airfield Damage Repair: Contingency Runway Rubber Removal	SWIFT	Banff, Alberta	2012
P97	AJ Borawake, Flight Safety Investigator	Building a Safety Culture	SWIFT	Banff, Alberta	2012
P98	Unknown	Dallas/Fort Worth International Airport Airfield Snow and Ice Removal Equipment	Unknown	Unknown	2011

## List of Regulations

Identifier	Issuing Authority	Title	CFR/Part	Date
R1	U.S. Department of Transportation, Federal Aviation Administration	<i>Certification of Airports</i> . Final Rule	14 CFR, Part 139	2004
R2	U.S. Department of Transportation, Federal Aviation Administration	Certification of Airport. Corrections	14 CFR, Part 139	6/9/2004
R3	Transport Canada	Draft 3 of Winter Maintenance and Planning	Part III, Subpart 2	11/22/2001
R4	Transport Canada	Draft II Winter Maintenance and Planning Standards	Part III, 322	11/22/2001

List of Vendors

Identifier	Author	Title	Document #	Publisher	Date of Publication	Place of Publication
V1	Oshkosh Airport Products	Airport Snow Removal Vehicles & Equipment	OA-0001-SNOWBR	Oshkosh Airport Products	9/11	Unknown
V2	Trackless Vehicles Ltd.	Trackless Vehicles	25M 10/09	Trackless Vehicles Ltd.	Unknown	Canada
V3	SMART Manufacturing Inc.	Triple R Self-Contained Installed Deicer (SCID) Runway De-Icing Units	N/A	SMART Manufacturing Inc.	Unknown	Indiana
V4	SMART Manufacturing Inc.	Smart De-Icer Conversion Kit Runway De-Icing Units	N/A	SMART Manufacturing Inc.	Unknown	Indiana
V5	SMART Manufacturing Inc.	TRIPLE R De-Icer	N/A	SMART Manufacturing Inc.	Unknown	Indiana
V6	SMART Manufacturing Inc.	SMART-Tote 125	N/A	SMART Manufacturing Inc.	Unknown	Indiana
V7	Cryotech Deicing Technology	Cryotech	N/A	Cryotech Deicing Technology	5/27/2010	Iowa
V8	Cryotech Deicing Technology	Cryotech BX36 Bio-Based Liquid Deicer AMS 1435 Certified	MKT200	Cryotech Deicing Technology	11/10/2011	Iowa
V9	Cryotech Deicing Technology	Cryotech E36 Liquid Runway Deicer AMS 1435 Certified	MKT600	Cryotech Deicing Technology	11/11/2011	Iowa
V10	Scarecrow Bio-Acoustic Systems Ltd.	Ultima: Effective Airside Bird and Wildlife Dispersal	N/A	Scarecrow Bio-Acoustic Systems Ltd.	Unknown	England
V11	RejuvaSeal	The Global Leader in Pavement Rejuvenation	N/A	RejuvaSeal	Unknown	Unknown
V12	Hi-Lite	Global Airfield Solutions	N/A	Hi-Lite	Unknown	Unknown
V13	Hi-Lite	A Responsible Approach to Runway Rubber Removal	N/A	Hi-Lite	Unknown	Unknown
V14	Logan Clutch Corporation	Bell Housing PTO's - Heavy Duty Snow Throwers/Waterblasting Systems	N/A	Logan Clutch Corporation	2011	Unknown
V15	Sweepster Aviation	Delivering a Complete Airport Operations Package: Snow Removal, Fod Elimination, Specialty Maintenance Attachments	N/A	Sweepster Aviation	Unknown	Michigan
V16	Airport Technologies, Inc.	Snow Wolf SB-1050	N/A	Airport Technologies, Inc.	Unknown	Manitoba, Canada
V17	Boschung Mecatronic Ltd.	AWIS: Airport Weather Information System: Securing airfields in all weather conditions	03179.4 [a] (EN) 03/09	Boschung Mecatronic Ltd.	Unknown	Unknown
V18	Marcel Boschung Ltd.	Surface Condition Management: Our global solution	231 10/04 /3e	Marcel Boschung Ltd.	Unknown	Unknown
V19	Airport Technologies, Inc.	Snow Mauler PV-350	N/A	Airport Technologies, Inc.	Unknown	Unknown
V20	Halliday Technologies	RT3 Flight: Continuous Friction Meter	N/A	Halliday Technologies	Unknown	Unknown

List of Vendors

Identifier	Author	Title	Document #	Publisher	Date of Publication	Place of Publication
V21	InterFleet	Efficiently Manage Winter Operations Vehicles	N/A	InterFleet	Unknown	Unknown
V22	Boschung	Spreaders	N/A	Boschung	Unknown	Unknown
V23	Bowmonk Ltd.	Bowmonk AFM2 Airfield Friction Meter Mk3 FAA approved for Winter Runway Friction Testing	N/A	Bowmonk Ltd.	Unknown	Unknown
V24	Trackless Vehicles Ltd.	Trackless Vehicles	25M 06/08	Trackless Vehicles Ltd.	Unknown	Unknown
V25	Team Eagle Ltd.	Introducing the revolutionary EagleEdge LITE	N/A	Team Eagle Ltd.	2/11	Unknown
V26	Eagle Integrated Solutions	ChemicalOps Pro	N/A	Eagle Integrated Solutions	3/12	Ontario, Canada
V27	Cryotech Deicing Technology	Cryotech NAAC Solid Runway Deicer	MKT1010	Cryotech Deicing Technology	12/6/2010	Iowa
V28	BioAmber	Biosuccinic Acid	N/A	BioAmber	Unknown	Unknown
V29	BioAmber	Bio-Based Deicing Solutions	N/A	BioAmber	Unknown	Minnesota
V30	Oshkosh Airport Products	H-Series XF Broom	OA-0013-XFBRMSS	Oshkosh Airport Products	4/12	Wisconsin
V31	Oshkosh Airport Products	XRS Extreme Runway System	OA-0012-XRSSS	Oshkosh Airport Products	9/11	Wisconsin
V32	Team Eagle Ltd.	Raiko Icebreaker	V-2	Team Eagle Ltd.	Unknown	Unknown
V33	Oshkosh Airport Products	Beyond Parts. Beyond Service.	OA-0014-CSBR	Oshkosh Airport Products	4/12	Wisconsin
V34	Oshkosh Airport Products	Airport Snow Removal Vehicles & Equipment	OA-0001-SNOWBR	Oshkosh Airport Products	4/12	Unknown
V35	M-B Companies	Airport Snow Removal Products	N/A	M-B Companies	Unknown	Wisconsin
V36	Crouse-Hinds	General Aviation Airport Lighting Products: Illuminating the Way	N/A	Crouse-Hinds	2/12	Texas
V37	Schmidt	Airport Technology Product Range	N/A	Schmidt	9/11	Unknown
V38	Boschung Airport Division	Airport Equipment	N/A	Boschung Airport Division	Unknown	Unknown
V39	Passur Aerospace	Airport Information Network	N/A	Passur Aerospace	Unknown	Unknown
V40	Franklin Paint	Traffic & Athletic Field Marking Paint	N/A	Franklin Paint	Unknown	Massachusetts
V41	Margo Supplies, Ltd.	Bird Scare Products Live Traps Electric Bear Fencing	N/A	Margo Supplies, Ltd.	Unknown	Alabama
V42	Sherwin Industries, Inc.	Catalog	Catalog #0111	Sherwin Industries, Inc.	Unknown	Wisconsin
V43	Oshkosh Airport Products	eXtreme Runway System - Information Packet	N/A	Oshkosh Airport Products	Unknown	Unknown

List of Vendors

Identifier	Author	Title	Document #	Publisher	Date of Publication	Place of Publication
V44	Airport Technologies, Inc.	Snow Wolf SB - 1050 High Speed High Capacity Airport Snow Blower	N/A	Airport Technologies, Inc.	Unknown	Unknown
V45	Tor Truck Corporation	AFI Airport 2012 Video File from disc	N/A	Tor Truck Corporation	Unknown	Unknown
V46	Team Eagle Ltd.	Team Eagle: Your Airfield Solutions Partner	N/A	Team Eagle Ltd.	Unknown	Unknown
V47	LNT Solutions	Gen-3 Runway Deicer 6-4	N/A	LNT Solutions	Unknown	Unknown
V48	LNT Solutions	IceCare Sodium Formate Solid Deicer	N/A	LNT Solutions	Unknown	Unknown

List of Websites

Identifier	Author	Title/Description	Publisher	Place of Publication	Date	URL	Date Accessed
W1	Unknown	Cold Calling	Net Resources International	London, UK	9/3/2009	<a href="http://www.airport-technology.com/features/feature63268/">http://www.airport-technology.com/features/feature63268/</a>	8/9/2012
W2	Unknown	Whether to Fly: The Ice Issue	Net Resources International	London, UK	3/1/2006	<a href="http://www.airport-technology.com/features/feature549/">http://www.airport-technology.com/features/feature549/</a>	8/9/2012
W3	PASSUR Aerospace	PASSUR OPSnet™ product information	PASSUR Aerospace	Stanford, CT	Unknown	<a href="http://www.passur.com/Collateral/Images/English-US/opsnet.gif">http://www.passur.com/Collateral/Images/English-US/opsnet.gif</a>	8/9/2012
W4	Transport Canada	Aerodrome Safety Circular-Introduction of the Proposed Regulation and Standards Concerning Airport Winter Maintenance and Planning (ASC 2001-011)	Transport Canada	Unknown	11/26/2001	<a href="http://www.tc.gc.ca/eng/civilaviation/opssvs/nationalops-audinspmon-program-safetycirculars-2001011-846.htm">http://www.tc.gc.ca/eng/civilaviation/opssvs/nationalops-audinspmon-program-safetycirculars-2001011-846.htm</a>	9/5/2012
W5	Transport Canada	Aerodrome Safety Circular-Aircraft Movement Surface Condition Reporting (AMSCR) for Winter Operations (ASC 2000-002)	Transport Canada	Unknown	9/15/2000	<a href="http://www.tc.gc.ca/eng/civilaviation/opssvs/nationalops-audinspmon-program-safetycirculars-2000002-985.htm">http://www.tc.gc.ca/eng/civilaviation/opssvs/nationalops-audinspmon-program-safetycirculars-2000002-985.htm</a>	9/5/2012
W6	Transport Canada	Aerodrome Standards and Recommended Practices (TP 312)	Transport Canada	Unknown	March 1993	<a href="http://www.tc.gc.ca/eng/civilaviation/publications/tp312-menu-4765.htm">http://www.tc.gc.ca/eng/civilaviation/publications/tp312-menu-4765.htm</a>	9/5/2012
W7	Ray Massey	Why does Scandinavia cope better than Gatwick? Shortage of equipment blamed for two-day closure	Mail Online	Unknown	12/3/2010	<a href="http://www.dailymail.co.uk/travel/article-1335308/UK-snow-Shortage-equipment-blamed-Gatwick-Airports-2-day-closure.html">http://www.dailymail.co.uk/travel/article-1335308/UK-snow-Shortage-equipment-blamed-Gatwick-Airports-2-day-closure.html</a>	8/30/2012
W8	SWIFT Conference	SWIFT 2012 Conference and Trade Show Program	SWIFT Conference	Unknown	8/14/2012	<a href="http://www.swiftconference.org/pdf/SW12Program.pdf">http://www.swiftconference.org/pdf/SW12Program.pdf</a>	9/5/2012
W9	John S. Kinney	DIA-Achieving Balance in Winter Operations	Russell Publishing Limited	United Kingdom	2/7/2009	<a href="http://www.internationalairportreview.com/14/international-airport-review-magazine/past-issues/dia-%e2%80%93-achieving-balance-in-winter-operations/">http://www.internationalairportreview.com/14/international-airport-review-magazine/past-issues/dia-%e2%80%93-achieving-balance-in-winter-operations/</a>	9/5/2012
W10	Airlines for America (A4A)	Annual and Per-Minute Cost of Delays to U.S. Airlines	Airlines for America (A4A)	Washington, DC	1995-2013	<a href="http://www.airlines.org/Pages/Annual-and-Per-Minute-Cost-of-Delays-to-U.S.-Airlines.aspx">http://www.airlines.org/Pages/Annual-and-Per-Minute-Cost-of-Delays-to-U.S.-Airlines.aspx</a>	5/3/2013

## **APPENDIX B**

### **Target Airport Data Needs**

## **Target Airport Data Needs**

### ***Pre-season Planning/Communication/Coordination***

1. What internal winter operations procedural documents (in addition to your FAA approved snow/ice control plan) have you developed?
2. Have you established letter of agreement? If so, with what agencies?
3. What pre-season coordination/planning do you conduct? Do you maintain a routine, annual schedule?
4. What pre-event coordination do you conduct? What agencies are included in any coordination?
5. Do you attempt to forecast airport capacity during a snow/ice event and how do you use that information? Do you have any procedures that result in reduced flights/cancellations?
6. Have you developed an IROPS contingency plan?

### ***Staffing/Staff support and Training***

7. Does your airport conduct training for winter operations staff? If so, what type of training is provided, and how often is staff trained?
8. Does your airport designate separate airside and landside snow removal teams?
9. What is the total personnel tasked with airside winter operations?
10. How many airside personnel are fulltime, part-time, contracted?
11. What is the total personnel tasked with landside winter operations?
12. What percentage of landside personnel is fulltime vs. part-time vs. contracted?
13. What is your supervisor to staff ratio?
14. What are your personnel callback levels?
15. How do you manage human performance factors?
  - a. Do you have standards or a maximum amount of time an employee can be in a vehicle/on assignment?
  - b. How do you manage/schedule crew breaks/rest during prolonged events?
  - c. What sleeping quarters/extended stay arrangements are made available to personnel?
  - d. Do you provide meals?

### ***Equipment/Maintenance/Storage***

16. What is your winter operations equipment inventory (if not identified in your SICP)?
  - a. Plows (number, manufacturer, blade width, horsepower)
  - b. Blowers (number, manufacturer, capacity, horsepower)
  - c. Multifunction Units (number, manufacturer, sweep width, capacity, horsepower)
  - d. Liquid Chemical Dispensers (number, manufacturer, capacity, boom width)
  - e. Solid Chemical Dispensers (number, manufacturer, capacity, spreader width)
  - f. Apron Snow Removal Equipment (number, equipment type, manufacturer, width, horsepower)
17. Are you able to store all of your equipment indoors? If not, what percentage is stored outside?
18. Have you recently evaluated equipment replacement options? What criteria are utilized to determine replacement or new equipment purchases?
19. Have you evaluated multi-function equipment?
20. Do you utilize fleet management software and do you calculate maintenance cost per piece of equipment?
21. Do you utilize GPS-based vehicle position monitoring and tracking?
22. How do you finance new equipment purchases? (Airport Improvement Program (AIP), Passenger Facility Charge (PFC), bond proceeds, cash on-hand, other)

### ***Weather Forecasting/Event prediction***

23. What meteorological forecast sources do you utilize?

## APPENDIX B: Target Airport Data Needs

24. Do you collect on-airport meteorological measurements? If so, what equipment do you use? What does your met system measure?

### ***Surface Conditions Measurement/Reporting***

25. What type of friction tester does your airport use?
26. How often does your airport perform friction tests during winter operations?
27. Do you disseminate friction values? If so, how?
28. What process do you follow to report pavement conditions?
29. Do you have in-pavement surface sensing monitoring equipment? If so, what do you monitor and how? (surface temperature, sub surface temperature, freeze point, moisture, incipient ice formation, ice presence, chemical concentration, snow water equivalent depth, air temperature, wind speed, wind direction, dew point, rainfall.)

### ***Event Communication/Coordination***

30. Do you have an established communications plan (internal notifications)?
31. How do you coordinate surface closures? What parties/agencies are involved in the surface closure coordination process?

### ***Airside Event Operational Strategies and Tactics***

32. What are your priority pavements (is a graphic available?) and why were they selected?
33. Have you established a snow removal “circuit” route or do you remove snow by assigned geographical locations?
34. What is the approximate time it takes to clear and treat your highest priority runway during a storm? (0-1 inches of snow, 1-5 inches of snow, 5-10 inches of snow, 10-20 inches of snow, >20 inches of snow, ice)
35. Is type of snow considered when deploying equipment, or do you maintain a standard method of operations? Is type of pavement considered?
36. What snow bank height control techniques do you employ?
37. Do you stockpile or immediately dispose of snow? How is it done?
38. What airside pavement clearing responsibilities are assigned or contracted to other entities? (apron, taxiway, service roads, runways, etc.)
39. Do you utilize in-ground or portable snow melters? If so, which type?

### ***Landside Event Operational Strategies and Tactics***

40. What are your landside pavement clearing priorities?
41. What landside pavement clearing responsibilities are assigned or contracted to other entities?
42. Do you utilize in-ground or portable snow melters? If so, which type?

### ***Operational Performance Evaluation***

43. Do you benchmark your winter event performance? If so, how?
44. Have you established performance metrics? If so, what... shared?

### ***Post Event Review/Communications***

45. Do you have established priorities for post-event clean-up and recovery?
46. Do you conduct snow critiques/event reviews? If so, who participates?
47. Do you conduct snow plan reviews/process modifications? If so, who participates?

### ***Safety***

48. What lessons learned have come from past incursions/incidents associated with your winter operations?
49. What lessons learned have come from vehicle accidents associated with your winter operations?

## APPENDIX B: Target Airport Data Needs

50. Has the airport evaluated winter operations safety issues or risk through an established Safety Management System (SMS) or Enterprise Risk Management (ERM) approach?

### **General**

51. What procedures or processes set your airport apart from other snow/ice control programs?
52. Is there an airport model you would like to emulate and/or bench mark against?
53. For our public affairs group team members, who is the best contact for providing information regarding your airport's approach to managing passenger experience during winter events/IROPS?
54. Is your airside cost accounting residual or compensatory?
55. Is your landside cost accounting residual or compensatory?

## **APPENDIX C**

### **Passenger Experience Interview Questions**

**Interview Questions for Passenger Experience and Expectations Management**

1. Do you have a public communication guidebook/manual on procedures used at your airport for winter storm weather events?
2. If yes, how often is it updated?
3. Could you discuss some of the key procedures in the manual?
4. What are the strategies for managing passenger experience and expectations you currently use?
5. How do the airport public relations staff and the operations staff coordinate when there is an event?
6. What pre-event coordination/planning do you conduct?
7. How does the airport utilize social media to communicate flight status and options for travelers during winter weather events?
8. What do you consider the most effective communication winter operation tool used?
  - PSA-Email Blasts
  - News Releases
  - News Rooms Contact
  - YouTube
  - Website
  - Facebook
  - Twitter
  - Others
9. Do you provide iPhone/iPad/Kindle/Android applications that passengers can download to their devices that automatically provide updates on weather alerts?
10. How often is the airport's website updated?
11. Is it perceived that the public is satisfied with what the airport website provides?
12. How do you see improving the communication program you currently have in place?
13. What pre-season airline coordination do you conduct for flight cancellations?
14. Have you developed an Airport Irregular Operations (IROPS) contingency plan?
15. Would you be willing to provide a copy of the communication guidebook/manual (if airport has one)?

## **APPENDIX D**

### **Guidebook Outline**

## **Chapter 1** Introduction

- Guidebook Objectives
- Guidebook Organization
  - Operations Planning
  - Strategy and Tactics Implementation
  - Performance Evaluation
  - Improvement Opportunity Identification
- Guidebook Limitations and Disclaimer

## **Chapter 2** Relationships as the Foundation for Winter Operations Success

- Identify Stakeholders
- Communication
- Coordination
- Collaboration
  - Collaborating with Peer Airports

## **Chapter 3** FAA Requirements and Guidance Related to Winter Operations

- ACs Presenting Methods and Procedures for Snow and Ice Control Equipment, Materials, and Removal
  - AC 150/5200-30C, Airport Winter Safety and Operations (including Change 1)
  - AC 150/5220-18A, Buildings for Storage and Maintenance of Airport Snow and Ice Control Equipment and Materials
  - AC 150/5220-20, Airport Snow and Ice Control Equipment (and Change 1)
- Other Winter Operations-related ACs
  - AC 91-6A, Water, Slush, and Snow on the Runway
  - AC 120-57A, Surface Movement Guidance and Control System (SMGCS)
  - AC 150/5200-18C, Airport Safety Self-Inspection
  - AC 150/5200-28D, Notices to Airmen (NOTAMS) for Airport Operators
  - AC 150/5210-20, Ground Vehicle Operations on Airports (Change 1)
  - AC 150/5210-25, Performance Specification for Airport Vehicle Runway Incursion Systems (RIWS)
  - AC 150/5220-16D, Automated Weather Observing Systems (AWOS) for Non-Federal Applications
  - AC 150/5220-22B, Engineered Materials Arresting Systems (EMAS) for Aircraft Overruns
  - AC 150/5220-26, Airport Ground Vehicle Automatic Dependent Surveillance Broadcast (ADS-B) Out Squitter Equipment (including Change 1)
  - AC 150/5300-14C, Design of Aircraft Deicing Facilities
  - AC 150/5320-12C, Measurement, Construction, and Maintenance of Skid-Resistant Airport Pavement Surfaces
  - AC 150/5320-15A, Management of Airport Industrial Waste
  - AC 150/5340-26B, Maintenance of Airport Visual Aid Facilities
  - AC 150/5370-17, Airside Use of Heated Pavement Systems

## **Chapter 4** Regulation of Winter Operation Impacts on Stormwater

- Airport Winter Operation Activities Affecting Clean Water Act (CWA) Regulation and Compliance
  - Application of Chemical Deicers
  - Application of Sand
  - Deicer-contaminated Snow Storage and Mechanical Snow Melting
- National Pollutant Discharge Elimination System (NPDES) Stormwater Discharge Permitting Under the CWA
  - General NPDES Permits
  - Individual NPDES Permits
  - Effluent Limitations Guidelines (ELGs) and New Source Performance Standards (NSPS)
  - Guidance for Interpreting Conditions in NPDES Permits
- Other Regulatory Programs Applicable to Airport Winter Operation Activities
- NPDES Compliance through an Airport Deicer Management System
  - System Components
  - System Planning and Evaluation
  - Stormwater Runoff Monitoring
  - Runoff Collection and Storage
  - Deicer-Impacted Runoff Treatment
  - Annual Operational Review

## **Chapter 5** Historical Winter Storm Event Data

- Benefits of Utilizing Historical Meteorological Data
- Meteorological Data Sources
- Climate Changes Considerations
- Data Manipulation and Analysis
  - Steps for Manipulating Raw Historical Meteorological Data
  - Event Frequency Analysis

## **Chapter 6** Winter Operations Performance Measurement

- Identify Performance Goals, Objectives and Measures
  - Performance Goals
  - Performance Objectives
  - Performance Measures
- Plan Data Collection and Reporting

## **Chapter 7** Winter Operations Baseline and Performance Targets

- Document Performance Baseline
- Associate Performance with Historical Winter Events
  - ATC Runway Closure Duration
  - Aircraft Delays Attributable to ATC Runway Closure Duration
- Document Cost Baseline
  - Airport Winter Operations Costs
  - Airline Delay Costs
  - Passenger Delay Costs
- Define Target Threshold Winter Event Conditions

Set Performance Targets

## **Chapter 8** Winter Operations Best Practices

Airport SICC

Snow Control Center

- Pre-event Planning and Coordination

- Ground Movement Coordination

- Command Center/Snow Desk

- Staffing

- Runway Closure Coordination

- Information Dissemination

Airfield Clearing Priorities for the SICP

Terminal and Landside – Ground Side Priority

Airfield Clearance Times

- Consistency and Predictability

- Multi-function Equipment

Sizing and Staffing Snow and Ice Control Equipment Fleet

- Equipment Procurement and Disposition

- Equipment Maintenance

- Warranties

- Staffing / Shift Management

Storage of Snow and Ice Control Equipment

## **Chapter 9** SICP Best Practices

Safety Requirements

Topics for Pre- and Post-Season SICC Meetings

Outlining an SICP

Topics for Writing Instructions and Procedures for Winter Operations and Notification

Runway Incursion Mitigation and Operations during Non-Towered ATC Periods

Staff Training and Recordkeeping

Other Related Items

- Lease Agreements

- Contracted Snow Removal

- Irregular Operations and Tarmac Delays

- Passenger Assistance

- Winter Event Public and Media Relations

- Passenger Outreach through Social Media

## **Chapter 10** Snow Clearing Operations and Preventive Measures/Ice Prevention Best Practices

Weather Forecasting

Forecasting Runway Surface Conditions

Snow Clearing Principles

- LOA

- Damage Prevention and Repair

- Snow Clearing Operations

## APPENDIX D: Guidebook Outline

- Managing Human Factors
- Tracking and Reviewing Performance
- Snow Disposal
  - Snow Piles
  - Snowmelters
- Methods for Ice Control and Removal
  - Chemical Application
  - Chemical Storage
- Approved Chemicals
- Sand

### **Chapter 11** Runway Surface Assessment and Reporting Best Practices

- Runway Condition Reporting
- Runway Friction Surveys
- Friction Assessment Reporting

### **Chapter 12** Winter Operations Performance Evaluation

- Conduct Performance Evaluations
  - Qualitative Evaluation
  - Quantitative Evaluation
- Examine Significant Performance Shortfalls
  - Performance Shortfall Investigation
  - Root Cause Determination
  - Corrective Action Identification
  - Preventive Action Identification
- Identify Performance Improvement Opportunities
  - Strategy Opportunities
  - Tactic Opportunities
  - Procedure Opportunities

### **Chapter 13** Investment to Reduce SRE Runway Occupancy Time

- FAA Guidance on SRE Procurement
- Variables Affecting SRE Runway Occupancy Time
- Identify Runway Snow Removal Capacity Shortfall
- Estimate SRE Needs to Reduce Snow Removal Capacity Shortfall
- Estimate Benefits of New or Additional SRE
  - Additional Benefits of Multi-function Equipment

### **Chapter 14** Selecting Winter Operations Improvement Alternatives

- Establish Evaluation Criteria
- Develop Alternatives
  - Scope
  - Key Assumptions
- Evaluate Alternatives
  - Comparative Analysis of Alternatives

Plan Alternative Implementation

## **References**

## **Acronyms**

### **Appendix A** Accessing Meteorological Data

Accessing Meteorological Data through the ISD, Hourly, Global Database

Accessing Precipitation Data through Hourly Precipitation Data Publication/Database

### **Appendix B** Example Airport Performance Indicators

Snow and Ice Removal

Chemical and Sand Application

Equipment

Safety

Stakeholder Coordination

Financial

Environmental Compliance