Aircraft Deicing Activities

Voluntary Pollution Reduction Program

Phase II Report

November 30, 2017

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EXECUTIVE SUMMARY

The aviation industry's major trade associations are pleased to report on the successful conclusion of our Voluntary Pollution Reduction Program (VPRP or Program). Airlines for America (A4A), Airports Council International-North America (ACI-NA), Regional Airline Association (RAA), and American Association of Airport Executives (AAAE) (the Program Partners) established the Program to build on the aviation industry's long-standing work to reduce the environmental impacts associated with the use of specialized deicing and anti-icing fluids, collectively referred to as aircraft deicing fluid (ADF), which is necessary to ensure safe aircraft operations in winter conditions.

The Program was a five-year effort undertaken by the Program Partners, running from September 2012 to September 2017. The Program documented and tracked the industry's progress towards reducing pollution associated with the use of ADF at 42 airports (the Defined Set) over a Defined Period of January 1, 2005 to September 30, 2017. The Defined Set of airports represents approximately 83% of total national ADF usage.

The Program Partners developed the concept of "Biological Oxygen Demand (BOD) Management Capacity" and a corresponding metric, the "BOD Management Capacity Index" to accurately and fully reflect the aviation industry's deployment of pollution reduction technologies related to aircraft deicing activities. The Program Partners then set the following goal for the Program:

> *For any given deicing season, Pollution Reduction Technologies (PRTs) deployed between January 1, 2005 and September 30, 2017 will increase the BOD Management Capacity of the National PRT Complex relative to the BOD Management Capacity in the absence of those PRTs.*
>
> *The BOD Management Capacity of the National PRT Complex will be evaluated using the BOD Management Capacity Index developed for this Program. The Program Partners target a 20 percent improvement in the BOD Management Capacity Index value at the end of the [Defined[1]] Period (2017) as compared to the 2005 BOD Management Capacity Index value.*

With the conclusion of our Program in September 2017, this fourth and final report on the Program provides the final documentation of the Program Partner activities under the VPRP. Most centrally, this report provides a final assessment of our industry's progress in reducing pollution associated with aircraft deicing activities as measured by the BOD Management Capacity Index. The Program Partners are particularly pleased to report that the industry has improved its BOD Management Capacity Index value by 36% over the 2005-2017 Program Period, exceeding our 20% improvement goal.

This Phase II Report also provides updates on the Program Partners' efforts to facilitate the exchange of information about pollution reduction technologies and practices through outreach, industry events, and Airport Cooperative Research Program participation, as well as providing additional context for interpreting the BOD Management Capacity Index. Although the Program is now concluded, the Program Partners remain committed to refining the suite of PRTs as they evolve, building on the industry's record

[1] This was articulated as "the BOD Management Capacity Index value at the end of the *Program* Period [emphasis added] as compared to the 2005 BOD Management Capacity Index value" in the *Supplemental Phase I Report.* Because the goal pertains to the Defined Period (the 12-year period over which industry progress is to be measured), not the Program Period (the five-year term of the Program), for clarity we have changed this terminology. This makes no material difference because the Defined Period and the Program Period both ended on September 30, 2017. It should also be noted that the 2005 index value reflects PRTs deployed as of the end of the 2004-2005 deicing season (May 2005) and the index value as of the end of the Defined Period reflects the PRTs deployed as of the end of the 2016-2017 deicing season (May 2017).

of reducing environmental impacts related to aircraft deicing operations and encouraging meaningful and substantial progress into the future.

I. INTRODUCTION

The aviation industry's major trade associations are pleased to report on the successful conclusion of our Voluntary Pollution Reduction Program (VPRP or Program). Airlines for America (A4A), Airports Council International-North America (ACI-NA), Regional Airline Association (RAA), and American Association of Airport Executives (AAAE) (the Program Partners) established the Program to build on the aviation industry's long standing work to reduce the environmental impacts associated with the use of specialized deicing and anti-icing fluids, collectively referred to as aircraft deicing fluid (ADF), which is necessary to ensure safe aircraft operations in winter conditions.

This Phase II Report is the fourth and final report on the Program. Most centrally, this report provides the Program Partners' final assessment of our industry's progress in addressing pollution associated with aircraft deicing activities using the metric designed for that purpose, the Biological Oxygen Demand (BOD) Management Capacity Index. The Program Partners report that the industry has improved its BOD Management Capacity Index value by 36% over the 2005-2017 Program Period, exceeding our 20% improvement goal.

A. BACKGROUND

The Program Partners established the VPRP as a five-year effort running from September 2012 to September 2017 to focus industry leadership on efforts to document and facilitate our industry's progress towards reducing pollution associated with the use of ADF. To do so, we defined a set of 42 airports (the Defined Set) at which, over a specific period of time (the Defined Period) we would track our progress. The Defined Set comprises airports where, in a typical deicing season, the amount of ADF used accounts for approximately 83% of total national ADF usage. The Defined Period is defined as January 1, 2005, to September 30, 2017. Although the industry had already made very large investments to address environmental impacts associated with aircraft deicing prior to January 1, 2005, the availability of data on technology deployment as of the end of the deicing season in 2005 made it a reliable baseline for measuring industry progress.

Principal purposes of the VPRP included the documentation and information sharing regarding the industry's proactive implementation of practical and effective technologies to reduce pollution associated with aircraft deicing activities. At the Program's core, however, stood our commitments to establish a quantitative pollution reduction goal as a means of measuring our industry's progress in reducing environmental impacts associated with the use of ADF and to evaluate the industry's progress towards that goal over the Program Period. Specifically, we committed to establishing a goal that "on a national basis, will reflect a substantial adoption of Pollution Reduction Technologies [PRTs], enhancing our nation's waters and aquatic ecosystems" and would be "stated in terms of a national estimate of the reduction in oxygen demand projected to result from Pollution Reduction Technologies adopted during the Defined Period." This was not an easy task. However, after a great deal of research and careful analysis, the Program Partners succeeded in developing a metric that would accurately and fully reflect the aviation industry's deployment of pollution reduction technologies – "Biological Oxygen Demand (BOD) Management Capacity" – and set the following goal:

> For any given deicing season, Pollution Reduction Technologies (PRTs) deployed between January 1, 2005 and September 30, 2017 will increase the BOD Management Capacity of the National PRT Complex relative to the BOD Management Capacity in the absence of those PRTs.

> The BOD Management Capacity of the National PRT Complex will be evaluated using the BOD Management Capacity Index developed for this Program. The Program Partners target a 20 percent improvement in the BOD Management Capacity Index value at the end of the [Defined[2]] Period (2017) as compared to the 2005 BOD Management Capacity Index value.

While we report on our progress towards fulfilling other important Program commitments, we are particularly pleased to announce that we have exceeded this goal. Specifically, we are pleased to report that over the course of the Defined Period (2005-2017) our BOD Management Capacity Index value improved 36% from 3,342 in 2005 to 4,534 at the end in 2017.

B. PROGRAM ELEMENTS AND IMPLEMENTATION

1. PROGRAM ELEMENTS

The Program Partners adopted the VPRP in January 2012. In the founding VPRP document, the Program Partners set out the major elements of the Program, which included: Outreach to Facilitate Information Exchange; Encourage Developing, Testing and Deploying PRTs; Characterize Environmental Benefits of PRTs; and Inventory PRTs Adopted. As stated above, the Program Partners' core commitments were to establish a pollution reduction goal and to evaluate industry's progress towards that goal over the Program Period. The commitment to establish a quantitative pollution reduction goal was articulated as follows:

> **Develop a Quantitative Pollution Reduction Goal:** Industry agrees to develop a quantitative pollution reduction goal that, on a national basis, will reflect a substantial adoption of Pollution Reduction Technologies, enhancing our nation's waters and aquatic ecosystems. This pollution reduction goal will be stated in terms of a national estimate of the reduction in oxygen demand projected to result from Pollution Reduction Technologies adopted during the Defined Period relative to what otherwise would have occurred absent industry adoption of such technologies. Industry may also document significant reductions in oxygen demand resulting from the adoption of Pollution Reduction Technologies prior to the Defined Period.

The commitment to evaluate progress toward this goal was articulated as follows:

> **Compare the Environmental Benefits of Pollution Reduction Technologies with the Quantitative Pollution Reduction Goal:** Industry will compare the environmental benefits of Pollution Reduction Technologies adopted during the Defined Period to the quantitative pollution reduction goal established under this Program.

The Program Partners also committed to updating the U.S. Environmental Protection Agency (EPA) and the public on the Program in three reports: an Initial Report, a Phase I Report and this Phase II Report.

2. PROGRAM IMPLEMENTATION

Since its adoption, the Program Partners have implemented the Program in stages. In the initial stage, we undertook several tasks. First, we developed two documents to explain the VPRP more fully: the

[2] See Note 1.

Governing Principles and *Program Q&A*.[3] In addition, we established a number of committees to organize our work under the Program. These included a Steering Group, staffed by representatives of each Program Partner, to manage and direct the VPRP. The Program Partners also created an Advisory Committee and various task-specific Working Groups staffed by representatives from our associations' memberships to help collect and analyze information and draft reports for the Steering Group's review and approval.

The initial stage of the Program culminated with the publication of our *Initial Report* on November 30, 2012, which provides "a summary of any outreach that has been conducted or planned to facilitate the information exchange in support of the Voluntary Program" and a list of the airports included in the Defined Set of airports. The *Initial Report* detailed the process used to select these airports, at which approximately 83% of the nation's aircraft deicing activity occurs. For convenience, a list of the airports included in the Defined Set and the A4A and RAA member airlines that serve those airports is provided in Appendix B.

In the next phase of the Program, we continued our outreach activities and work towards fulfilling other Program tasks. We convened a PRT Workgroup that was tasked with identifying and verifying PRTs that have been utilized nationwide and an Environmental Benefits Workgroup tasked with assembling information regarding the estimated environmental benefits of PRTs. In addition, we began our work to develop our Program Goal in earnest. The work on all of these fronts was augmented by activities within each Program Partner, for example by devoting significant portions of regular meetings to update membership on the status of VPRP activities and promote its goals.

Developing a Program Goal proved to be a difficult task. As our work progressed, we found that measuring industry progress in a manner that meaningfully and fully reflected our industry's deployment of PRTs was very complicated. We found that a large number of variables beyond industry's control, including intensity and type of weather events and air travel demand, affect the level of aircraft deicing activity needed to maintain safety in winter conditions at particular airports across deicing seasons. In addition, we found that the feasibility and effectiveness of PRTs can vary across airports due to factors at particular airports, including space availability, prevailing climatic conditions, proximity to water bodies and hydrology, aircraft fleet mix, airport configuration, etc. Finally, it became apparent that PRTs cannot be thought of as purely additive components assembled together to form a PRT complex.

The overall effectiveness of any given PRT complex cannot be evaluated by simply summing the effectiveness of each individual component. Rather, we found that PRTs are interdependent. For example, PRTs designed to reduce the amount of ADF that must be applied to aircraft to ensure flight safety may reduce the effectiveness of PRTs designed to collect spent ADF entrained in stormwater. Complicating matters further, PRT interdependency varies across airports. Consequently, we found that it is not possible to fully reflect adoption of PRTs in terms of reductions in BOD discharges *per se*, particularly on a nationwide basis. We determined that this required reorienting the analysis to one which focused on assessing how PRT deployment increases the capacity of our industry to manage BOD, both in terms of the application of BOD (in the form of ADF) to ensure air safety and the collection and treatment of BOD (in the form of spent ADF entrained in stormwater). As a result, we determined that it was necessary to articulate our Program Goal in terms of an increase in BOD Management Capacity.

That phase of the VPRP culminated in the second program report (the *Phase I Report*, issued March 31, 2015), in which we updated our outreach activities, provided publicly available information on the environmental benefits of PRTs, and included a National Pollution Reduction Inventory. In addition, we provided a detailed account of our progress to that point in developing the Program Goal, including the analysis and rationale supporting the articulation of the Program Goal in terms of BOD Management

[3] These documents, as well as the other principle Program documents referred to in this section are available at the Program Partner webpages provided in Appendix A - REFERENCES.

Capacity, and announced the following goal:

> For any given deicing season, Pollution Reduction Technologies (PRTs) deployed between January 1, 2005 and September 30, 2017 will increase the BOD Management Capacity of the National PRT Complex relative to the BOD Management Capacity in the absence of those PRTs.

We recognized that this fell short of our commitment to set a quantitative goal for the Program. Accordingly, we made a new commitment to issue a supplemental report that would present the methodology for quantifying BOD Management Capacity and specify a quantitative goal based on that metric.

In this next phase of the VPRP, the Program Partners worked extensively with their memberships and convened multiple joint meetings focused on deriving a consistent, objective, and practically reasonable methodology for evaluating BOD Management Capacity. In this work we carefully considered the nature of the problem at hand: how to measure the contributions of varied technologies with wide-ranging capabilities that reduce BOD in fundamentally different ways (with some reducing the amount of BOD introduced into the system and others increasing the amount of BOD extracted from the system), requiring measurement in different units. After studying various approaches that have been used to address similar problems in other contexts, including EPA's approach to measuring the vulnerability of areas to groundwater contamination, the Program Partners determined that BOD Management Capacity should be based on an index.

In our *Supplement to the Phase I Report* (March 31, 2016), we explained that the BOD Management Capacity Index is derived by assigning relative values to various PRTs reflecting their effectiveness in managing BOD, which are then weighted to reflect the extent of their deployment across and within the 42 Defined Set airports, resulting in a composite value that expresses the capacity of the National PRT Complex to manage BOD at any point in time. We also detailed our methodology for evaluating the BOD Management Capacity Index and restated our Program Goal as follows:

> For any given deicing season, Pollution Reduction Technologies (PRTs) deployed between January 1, 2005 and September 30, 2017 will increase the BOD Management Capacity of the National PRT Complex relative to the BOD Management Capacity in the absence of those PRTs.
>
> The BOD Management Capacity of the National PRT Complex will be evaluated using the BOD Management Capacity Index developed for this Program. The Program Partners target a 20 percent improvement in the BOD Management Capacity Index value at the end of the [Defined[4]] Period (2017) as compared to the 2005 BOD Management Capacity Index value.

This document, the *Phase II Report,* builds on our previous reports. Consistent with the Program founding document, in Section II we summarize activities that we have undertaken to fulfill our Program commitments. In addition, in Section III we report on our success in achieving our Program Goal.

[4] See Note 1.

II. PROGRAM PARTNER ACTIONS TO FULFILL PROGRAM COMMITMENTS TO FACILITATE INFORMATION EXCHANGE, ENCOURAGE PRT DEVELOPMENT AND DEPLOYMENT, AND CHARACTERIZE ENVIRONMENTAL BENEFITS

As indicated in the preceding “Program Implementation” section, the Program Partners have undertaken a wide range of actions to fulfill our Program commitments. Many of these activities overlapped and contributed to our commitments to facilitate information exchange and outreach; encourage the development, testing and deployment of PRTs; and provide publicly available information characterizing the environmental benefits of PRTs

The VPRP included outreach activities to facilitate the exchange of information about pollution reduction technologies and practices. These activities involved all industry stakeholders, including airports, airlines, fluid manufacturers, deicing contractors, etc. The Program Partners participated actively in these efforts by sponsoring forums, recruiting and coordinating speakers, making presentations, distributing materials at various industry meetings and conferences, and communicating program details to our membership through Association publications. The *Initial Report* details the outreach activities in 2012, when there was a large amount of activity in order to engage and inform as many stakeholders as possible about the VPRP. The *Phase I Report* provides the outreach activities undertaken in 2013 and 2014.

In addition, during the Program Period ACI-NA and A4A organized and hosted their Stormwater and Deicing Conference in 2013, 2015 and 2017. These conferences further many of the goals of the VPRP – for example, facilitating information exchange and the development and deployment of PRTs, while featuring multiple sessions specifically devoted to furthering the VPRP work. Table 1 in Appendix C lists the events at which formal presentations and discussions were held regarding the VPRP in 2012-2017 (activities in earlier years of the VPRP were previously listed in earlier program reports, but are also included in Appendix C for convenience).

The industry has also devoted extensive time and resources to fostering and supporting various projects conducted by the Airport Cooperative Research Program (ACRP). The ACRP is “an industry-driven, applied research program that develops practical solutions to problems faced by airport operators . . . managed by the Transportation Research Board (TRB) of the National Academies and sponsored by the FAA.”[5] Since 2006, the aviation industry has actively supported 17 ACRP projects focused on and/or directly related to aircraft deicing.[6] In addition to the $5.27 million funding from industry, the success of these projects has depended on the voluntary participation and support of the Program Partners and their memberships. Typically, ACRP projects run for about 18-24 months and, conservatively, a project panel member volunteers approximately 70 hours in fulfilling their responsibilities on an ACRP research project. During the Defined Period, representatives of the Program Partners and their memberships have filled roughly 100 panel positions. In addition, the Program Partners have played an indispensable role in disseminating ACRP research products through ACRP research update sessions and technical presentations at national and regional conferences (including the ACI-NA / A4A Aircraft Deicing and Stormwater Management Conferences), as well as providing support and participation in ACRP webinars on deicing-related research products. These outreach and dissemination activities help our members

[5] See https://www.faa.gov/airports/acrp/ and http://www.trb.org/ACRP/ACRP.aspx.
[6] See Table 2 in Appendix C. ACRP is funded by revenues generated by the aviation industry, including passenger ticket taxes, segment fees, fuel taxes and air cargo fees (these revenues fund the Airport and Airway Trust Fund, which funds the Airport Improvement Program (AIP), which, in turn, funds ACRP).

more effectively develop and deploy PRTs, as well as evaluate and refine their performance and environmental benefits.

Program Partners also promote research on deicing topics and disseminate the results of that research to the aviation community through the Transportation Research Board's (TRB's) AV030 Impacts of Aviation on the Environment Committee and AV030(3) Water Resources subcommittee. The activities of Program Partner representatives and members in AV030 include holding committee and subcommittee leadership positions, development of technical programs for meetings, attendance and technical presentations on deicing topics at committee meetings and on technical panels at TRB's Annual Meeting, development of problem statements for consideration by ACRP for funding, and participation in peer-reviews of technical papers for the Annual Meeting. Through these activities, the Program Partners directly and indirectly promote the advancement and implementation of deicing PRTs.

In addition to these activities, the work undertaken by the Program Partners to implement the VPRP itself also served to facilitate information exchange, encourage PRT development and deployment, and disseminate information regarding the environmental benefits of PRTs. The Program Partners convened multiple meetings, teleconferences, webinars, etc., including representatives of the associations and their memberships, to carry out the VPRP. These events included meetings of the Steering Group, Advisory Committee, and task-specific Working Groups formed to collect and analyze information and to assist in the drafting and finalization of VPRP reports. For example, our Pollution Reduction Technology Working Group undertook the work to survey the Defined Set of airports and airlines serving those airports to develop a comprehensive list of the types of PRTs in use in the 2005 baseline (PRTs deployed as of the end of the deicing season of 2004 - 2005) and in use currently. We provided a detailed description of this work in our *Phase I Report* and since publication of that report the Program Partners have worked to identify additions to the Inventory. Our updated Inventory of Pollution Reduction Technologies is provided in Appendix C at Table 3.

Our work to establish a Program Goal and to assess our progress towards that goal has greatly improved the aviation industry's understanding of the PRTs deployed across the country, their relative environmental benefits and, perhaps most importantly, their interdependencies. In particular, development of the BOD Management Capacity Index reflects many, many hours of work to understand the various PRTs that are deployed and how they interact with one another and how, ultimately, their cumulative contribution to controlling BOD could be assessed quantitatively and reliably across deicing seasons on a national basis. The work undertaken to categorize PRTs and to create the BOD Management Capacity Index is detailed in both the *Phase I Report* and the *Supplement to Phase I Report*. For convenience, a detailed discussion of the background, rationale, and computational details of the Index are provided in Appendix D.

Similarly, the work to evaluate the national BOD Management Capacity Index in both the 2004-2005 and 2016-2017 deicing seasons also facilitated information exchange regarding the deployment of PRTs, industry practices and industry progress in addressing environmental impacts associated with aircraft deicing. Most centrally, this work involved collecting detailed data on PRT deployment in the 2004-2005 and 2016-2017 deicing seasons. In connection with EPA's development of regulations to address deicing activity at airports, which were codified in 2012 as the "Effluent Limitations Guidelines and New Source Performance Standards for the Airport Deicing Category," both EPA and industry collected data on PRTs and their deployment at airports around the country. To derive a BOD Management Capacity Index value for the 2004-2005 deicing season, the Program Partners organized and assessed this data relevant to the 42 airports included in the Defined Set and the airlines that serve those airports. To derive the value for the 2016-2017 deicing season, the Program Partners undertook extensive work to collect new data from these airports and airlines. This work is described in detail in Appendix D.

III. PROGRESS TOWARDS PROGRAM GOAL

The results of the Program Partners' work to collect data regarding the deployment of PRTs and evaluate the BOD Management Capacity Index for the deicing seasons bracketing the Defined Period, are summarized in the table below:

BOD Management Capacity Index Values and Relative Improvement

Deicing Season	BOD Management Capacity Index
2004 – 2005	3,342
2016 – 2017	4,534
Relative Improvement:	36%

The industry-wide index of BOD management capacity, which includes all categories of PRTs, improved by 36% over the Program Period, far exceeding the Program Goal of at least 20% improvement in the national BOD Management Capacity Index over the Defined Period established in the *Supplement to Phase I Report*.

IV. PUTTING BOD MANAGEMENT CAPACITY RESULTS INTO CONTEXT

As the analysis of the BOD Management Capacity Index reported above indicates, industry made significant progress deploying PRTs during the Defined Period. The Program Partners and our memberships are proud of this record and the commitment to protecting our nation's waters it reflects. It is important to realize, however, that industry had already made significant progress in deploying PRTs prior to the Defined Period. EPA's 2000 study of airport deicing operations[7] reported on industry practices and the significant investments that the industry had already made in PRTs prior to 2000, providing extensive information on industry practices and investments in PRTs. The Program Partners also have gathered and reviewed information regarding PRTs investments made prior to the Program's commencement in 2005. The industry undertook efforts at many airports prior to 2005 to deploy carefully selected systems of PRTs to be consistent with each airport's unique requirements and constraints, including space availability, operational and safety imperatives, and geological and hydrological setting. As a result, many airports in the Defined Set - including, e.g., Denver, Dallas-Ft. Worth, Detroit, Minneapolis-St. Paul, Albany, Cleveland, Bradley, Philadelphia, Portland (Oregon), Pittsburgh, and Cincinnati – had already deployed PRT systems to comprehensively address environmental impacts associated with aircraft deicing prior to 2005.

The Program Partners understood when they committed to the VPRP in 2012 that significant progress had already been achieved at the larger airports at which the majority of aircraft deicing occurs. Indeed, the industry's pre-2005 investments in PRTs are reflected in the already high BOD Management Capacity Index value for 2005. Nevertheless, the Program Partners also predicted that the increased collaboration among the Defined Set airports would help to identify additional opportunities for enhanced PRT deployment, as well as ancillary benefits, such as:

[7] Preliminary Data Summary: Airport Deicing Operations, EPA 821-R-00-016 (2000).

- Reduction in discharges of pollutants that are incidentally captured by runoff control systems (e.g., suspended solids);
- Reduced energy consumption and greenhouse gas emissions from reduced usage of glycol and reuse of recycled glycol instead of using virgin stocks; and
- Generally increased awareness of airport stormwater management among airport and tenant employees.

The “lessons learned” through the VPRP and ACRP projects identified above have achieved benefits beyond those reflected simply by the BOD Management Capacity Index. Valuable PRT information and strategies have been communicated to the many smaller airports outside of the Defined Set that have limited aircraft deicing operations, but can benefit from PRT deployment. Hence, the VPRP both improved information sharing within the Defined Set and enhanced information exchange with airports outside the Defined Set. The result is improved environmental protection, the benefits of which the Program Partners have not attempted to fully quantify.

V. CONCLUSION

The Program Partners are pleased to report the achievement of the Program Goal and the fulfillment of our other voluntary commitments under the VPRP. While the Program is now concluded, the Program Partners remain committed to refining the suite of PRTs as they evolve, building on the industry’s record of reducing environmental impacts related to aircraft deicing operations, and encouraging meaningful and substantial progress into the future.

We welcome feedback on the VPRP and this report. Feel free to forward questions or seek additional information from any of the Program Partners listed below.

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APPENDIX A

References

ACI-NA Industry Deicing Voluntary Pollution Reduction Program
http://www.aci-na.org/content/industry-deicing-voluntary-pollution-reduction-program

Airlines For America: http://airlines.org/protecting-water-quality/

American Association of Airline Executives:
http://www.aaae.org/AAAE/AAAEMemberResponsive/Advocacy/Regulatory_Affairs/Issues/Voluntary Pollution Reduction Program.aspx

Regional Airline Association:
https://c.ymcdn.com/sites/www.raa.org/resource/resmgr/2018_Pubs/AircraftDeicingActivitiesVol.pdf

Documents on these pages include:

- **Program Language**
- **Governing Principles**
- **Questions and Answers**
- **Initial Report – November 30, 2012**
- **Phase I Report – March 31, 2015**
- **Supplement to Phase I Report – March 31, 2016**
- **Phase II Report – November 30, 2017**

APPENDIX B

Defined Set of Airports

Airport Code	Airport Name
ALB	Albany International Airport
ANC	Ted Stevens Anchorage International Airport
ATL	Hartsfield - Jackson Atlanta International Airport
BDL	Bradley International Airport
BOS	General Edward Lawrence Logan International Airport
BUF	Buffalo Niagara International Airport
BWI	Baltimore-Washington International Thurgood Marshall Airport
CAK	Akron-Canton Regional Airport
CLE	Cleveland-Hopkins International Airport
CLT	Charlotte-Douglas International Airport
CMH	John Glenn Columbus International Airport
CVG	Cincinnati/Northern Kentucky International Airport
DAY	James M. Cox Dayton International Airport
DCA	Ronald Reagan Washington National Airport
DEN	Denver International Airport
DFW	Dallas/Fort Worth International Airport
DTW	Detroit Metropolitan Wayne County Airport
EWR	Newark Liberty International Airport
GRR	Gerald R. Ford International Airport
HPN	Westchester County Airport, White Plains Airport

IAD	Washington Dulles International Airport
IND	Indianapolis International Airport
JFK	John F. Kennedy International Airport
LGA	La Guardia Airport
MCI	Kansas City International Airport
MDW	Chicago Midway International Airport
MEM	Memphis International Airport
MHT	Manchester-Boston Regional Airport
MKE	General Mitchell International Airport
MSP	Minneapolis-St Paul International Airport
ORD	Chicago O'Hare International Airport
PDX	Portland International Airport (OR)
PHL	Philadelphia International Airport
PIT	Pittsburgh International Airport
PVD	Theodore Francis Green Airport
RNO	Reno/Tahoe International Airport
ROC	Greater Rochester International Airport
SDF	Louisville International Airport
SEA	Seattle-Tacoma International Airport
SLC	Salt Lake City International Airport
STL	Lambert-St Louis International Airport
SYR	Syracuse Hancock International Airport

A4A and RAA Members

Alaska Airlines, Inc.

American Airlines, Inc.

Atlas Air, Inc.

Federal Express Corporation

Hawaiian Airlines

JetBlue Airways Corp,

Southwest Airlines Co.

United Continental Holdings, Inc.

United Parcel Service Co.

Air Canada*

Air Wisconsin Airlines

Cape Air

CommutAir

Compass Airlines

Empire Airlines

Endeavor Air

Envoy

ExpressJet Airlines

GoJet Airlines

Grand Canyon Airlines/Scenic

Great Lakes Aviation

Horizon Air

Jazz Aviation

Mesa Airlines

New England Airlines

Piedmont Airlines

PSA Airlines

RAVN Alaska

Republic Airlines

Seaborne Airlines

SkyWest Airlines, Inc.

Trans States Airlines

*Associate A4A Member

APPENDIX C

Table 1: Industry Outreach Activities 2012-2017

Program Partners	Meetings/Conference	Date	Location
ACI-NA	ACI-NA Environmental Affairs Committee Annual Meeting	September 8-9, 2012	Calgary, Canada
AAAE	National Aviation Environmental Management Conference	October 14-16, 2012	Dallas, TX
A4A	A4A Environmental Council Meeting	November 12-13, 2012	Chicago, IL
AAAE	Basics of Airport Law Workshop and 2012 Legal Update	October 7-9, 2012	Washington, DC
A4A / ACI	SAE G-12 Aircraft Ground Deicing Committee Meeting	October 29, 2012	Montreal, QC
RAA	RAA 38th Annual Convention	May 6-9, 2013	Montreal, QC
A4A/RAA	Joint Environment Council Meeting	May 8, 2013	Montreal, QC
A4A	SAE G-12 Aircraft Ground Deicing Steering Committee	May 13-15, 2013	New Orleans, LA
ACI-NA	Environmental Affairs Spring Conference	May 13-16, 2013	Halifax, NS
AAAE	National Environmental Management Conference	June 23-25, 2013	Cleveland, OH
AAAE	Large Hub Winter Operations & Deicing Conference	July 21-23, 2013	Denver, CO
ACI-NA / A4A	2013 Deicing and Stormwater Management Conference	July 31-August 1, 2013	Arlington, VA
ACI-NA	Environmental Affairs Committee Annual Conference	September 21-22, 2013	San Jose, CA
A4A	Environment Council Meeting	December 4-5, 2013	Washington, DC

ACI-NA	Environmental Affairs Spring Conference	April 14-16, 2014	Baltimore, MD
A4A	Environment Council Meeting	May 6-7, 2014	Washington, DC
RAA	RAA Annual Convention	May 12-14, 2014	St. Louis, MO
ACI-NA	Environmental Affairs Committee Annual Conference	September 6-7, 2014	Atlanta, GA
AAAE	Environmental Services Committee Meeting at National Airport Conference	September 30, 2014	Portland, OR
RAA	RAA Board of Directors Meeting	November 5-6, 2014	Atlanta, GA
ACI-NA	Environmental Affairs Spring Conference	March 22-25, 2015	Vancouver, BC
ACI-NA / A4A	2015 Deicing and Stormwater Management Conference	May 19-20, 2015	Arlington, VA
A4A	Environment Council Meeting	June 10-11, 2015	Washington, DC
AAAE	Environmental Services Committee Meeting	June 8, 2015	Philadelphia, PA
AAAE	Environmental Services Committee Meeting	September 21, 2015	Savannah, GA
ACI-NA	Environmental Affairs Committee Annual Conference	October 3-4, 2015	Long Beach, CA
RAA	RAA Board of Directors Meeting	October 28-29, 2015	Washington, DC
A4A	Environment Council Meeting	March 8, 2016	Washington, DC
A4A	SAE G-12 Aircraft Ground Deicing Committee Meeting	May 9, 2016	Savannah, GA

ACI-NA	Environmental Affairs Spring Conference	April 18-21, 2016	Austin, TX
RAA	RAA Annual Convention	May 10-12, 2016	Charlotte, NC
AAAE	AAAE/Great Lakes Chapter AAAE Environmental Management Conference	June 5-7, 2016	Detroit, MI
ACI-NA	Environmental Affairs Committee Annual Conference	September 23-25, 2016	Montreal, QC
AAAE	Environmental Services Committee Meeting	October 3, 2016	Orlando, FL
A4A	Environment Council Meeting	November 11, 2016	Dallas, TX
RAA	RAA Board of Directors Meeting	November 29-30, 2016	Ft. Lauderdale, FL
ACI-NA	Environmental Affairs Spring Conference	March 26-30, 2017	Las Vegas, NV
RAA	RAA Board Meeting & Congressional Fly-In	May 3-4, 2017	Washington, DC
AAAE	Environmental Services Committee Meeting	May 8, 2017	Long Beach, CA
A4A	Environment Council Meeting	May 17, 2017	Dallas, TX
ACI-NA / A4A	2017 Deicing and Stormwater Management Conference	May 18-19, 2017	Arlington, VA
ACI-NA	Environmental Affairs Committee Annual Conference	September 16-17, 2017	Fort Worth, TX

Table 2: ACRP Deicing Research Projects and Products

Project Number	Report No.	Project or Report Title	Year Published	Research Cost
02-01	WOD #3	Formulations for Aircraft and Airfield Deicing and Anti-Icing: Aquatic Toxicity and Biochemical Oxygen Demand	2008	$600,000
	WOD #8	Alternative Aircraft Anti-Icing Formulations with Reduced Aquatic Toxicity and Biochemical Oxygen Demand	2010	
02-02	Report 14	Managing Runoff From Aircraft and Airfield Deicing and Anti-Icing Operations	2009	$265,000
11-02/10	N/A	Estimate of National Use of Aircraft and Airfield Deicing Materials	2008	$100,000
02-13	Report 43	A Guidebook for Improving Environmental Performance at Small Airports	2011	$200,000
10-01	Report 45	Optimizing the Use of Aircraft Deicing and Anti-Icing Fluids	2011	$450,000
02-14	Report 72	Guidebook for Selecting Methods to Monitor Airport and Aircraft Deicing Materials	2012	$150,000
02-19	Report 81	Winter Design Storm Factors for Airport Stormwater Management	2012	$250,000
02-29	Report 99	Guidance for Treatment of Deicing-Impacted Airport Stormwater	2013	$500,000
02-32	Report 115	Understanding Microbial Biofilms in Receiving Waters Impacted by Airport Deicing Activities	2014	$300,000
10-15	Report 123	Guidebook for Airport Winter Operations	2015	$400,000
09-08	Report 125	Balancing Airport Stormwater and Bird Hazard Management	2015	$249,200
02-39	Report 134	Applying Whole Effluent Toxicity Testing to Airport Deicing Runoff	2015	$339,600
02-53	Report 166	Interpreting Airport Water Monitoring Results	2017	$250,000
02-61	Report 169	Clean Water Act Requirements for Airports	2017	$30,000
02-61	WebResource #3	Airport Stormwater Resource Library and Training Materials	2017	$459,000
02-71	On-going	Guidebook and Decision Tool for Managing Airport Stormwater Containing Deicers	2018 (expected)	$400,000
02-75	On-going	Benefit-Cost Analyses Guidebook for Airport Stormwater	2018 (expected)	$325,000
			Total:	**$5,267,800**

Table 3: Inventory of Pollution Reduction Technologies

In order to create and update the national inventory of deicing technologies, the Deicing Technology Working Group, composed of volunteers from the airport and airline stakeholder community, developed a list of Pollution Reduction Technologies (PRTs) in use in the baseline year and at the end of the Program Period. The technology inventory informed the development of the BOD Management Capacity goal metric. The table below contains a comprehensive list of technologies deployed nationally and their common definitions.

Technology	Common Definition
Preventive Anti-Icing	Preventive anti-icing is the application of glycol-based anti-icing fluid prior to the start of icing conditions or a storm event to limit ice and snow build-up and facilitate its removal
Anti-Icing Fluid Dilutions	75/25 anti-icing fluids
Forced-Air Aircraft Deicing Systems	A high-pressure air jet to blast ice and snow from aircraft surfaces
Non-Glycol Freeze Point Depressant Fluids	Fluid formulated with freeze point depressants other than propylene, ethylene, and diethylene glycol
Computer-Controlled Fixed-Gantry Aircraft Deicing Systems	Self-contained “car wash style” aircraft deicing systems
Hot Water Aircraft Deicing	Aircraft to be deiced using hot water followed by the application of an anti-icing fluid when ambient air temperatures are above 27 degrees F
Blend to Temperature (Varying Glycol Content to Ambient Air Temperature)	Type I fluid in concentrated form and diluted to a glycol concentration appropriate to the local weather conditions
Enclosed-Basket Deicing Trucks	An enclosed-basket design that improves operator working conditions by enabling operators to get closer to the aircraft, the enclosed basket reportedly reduces over-spray and helps to minimize the volume of fluid used to deice aircraft
Mechanical Methods	Use of brooms, squeegees, and ropes to remove ice and snow from aircraft surfaces
Aircraft Deicing Using Solar Radiation	Use of sunlight
Hangar Storage	Pull aircraft into hangar during a storm event
Aircraft Covers	Covers or blankets put over the aircraft
Thermal Blankets for MD-80s and DC-9s	Blankets are bonded to the wing surface and consist of nickel-plated carbon fibers sandwiched between fiberglass layers
Ice-Detection Systems	Sensors, either wing mounted or remote, that detect ice on the wings

Technology	Common Definition
Airport Traffic Flow Strategies and Departure Slot Allocation Systems	Airport management plans and better communication during storm events that help avoid unnecessary repeated application of ADF
Personnel Training and Experience	Training using existing methods or simulators to more efficiently spray aircraft
Warm Fuel	Use of warmed fuel to protect wings against precipitation and frost contamination
Nozzles	Use of special nozzles that reduced the amount of fluid sprayed
Deicing Trucks	The typical equipment includes a cherry picker or lift truck, tank, pump, and hose pressure sprayer. The deicer is lifted high above the airplane, where chemical deicer can be sprayed over the iced body of the aircraft. The truck has either an open or closed lift bucket, which is raised into the correct position for deicing.
Enhanced Weather Forecasting	Use of NCAR Weather Support for Deicing Decision Making (WSDDM), SITA Met Office or similar systems that allow for better forecasting of oncoming weather and allow for better deicing planning
Liquid Water Equivalent Test (LWET)	The use of automated weather measurement systems that determine the water equivalent precipitation rate to allow for more accurate determination of holdover or check times
ADF Collection Systems for Ramps and Passenger Terminal Gate Areas	Fluid flows via grooved pavement and/or trench drains to a wastewater collection area
Temporary Aircraft Deicing Pads	Temporary aircraft deicing pads are specially designed platforms used to collect contaminated wastewater generated during aircraft deicing and anti- icing operations. They are constructed from reinforced rubber or polypropylene mats and sometimes use inflatable air or foam berms to contain contaminated wastewater
Storm Drain Inserts	Storm drain inserts or plugs are used by some airports to close storm drains and prevent glycol-contaminated wastewater from entering storm water drainage systems
Glycol Vacuum Vehicles	Vacuum vehicles collect wastewater generated by aircraft deicing/anti-icing operations
Mobile Pumping Station with Fluid Concentration Sensor	Trailer-mounted, computer-controlled pumping unit capable of measuring the glycol concentration of the wastewater and diverting it, based on glycol content, to one of three designated storage tanks

Technology	Common Definition
Pink Snow Management (Containment and Collection Practices for Snow Containing Aircraft Deicing/Anti-Icing Fluids)	Management plans related to plowed snow containing aircraft deicing fluid and/or pavement deicing materials
Snow Melters – Fixed	These units are holes in the ground that have heating elements into which the snow is pushed or loaded
Snow Melters - Mobile	An above-ground unit on a trailer that can be moved with a melting vat, heat/BTU generator, fuel storage, and discharges the water into a storm drain
Publicly-Owned Treatment Works (POTWs)	Publicly owned treatment works, as defined at 40 CFR 403.3(o)
On-Site Treatment	Various onsite wastewater treatment technologies to support discharge of treated effluent to either surface waters or a POTW for further treatment.
Glycol Recycling	Recovery and recycling of glycol from ADF-contaminated wastewater

APPENDIX D

BOD Management Capacity Index

Description and Methodology

Introduction

The BOD Management Capacity Index (BMC Index) quantifies the aggregate capacity of Pollution Reduction Technologies (PRTs) to manage Biochemical Oxygen Demand (BOD) associated with aircraft deicing activities at the Defined Set of airports.[1] The BMC Index is a composite derived by assigning relative values to PRTs and using weighting and implementation factors to reflect their deployment across the Defined Set of Airports. Because it is a composite of values measured in different units, the BMC Index is dimensionless, with higher values indicating a greater capacity to manage BOD. Accordingly, the BMC Index is to be understood as a reasonable and credible indicator of industry's BOD management capacity rather than a precise measurement of that capacity. The BMC Index is consistent with similar indices, such as EPA's DRASTIC index, which serves as an indicator rather than a precise measurement of geographical areas' vulnerability to ground-water contamination.

Objective

This document describes the derivation and application of the BMC Index, including a description of the assumptions made in developing the index and the methodology and data used to calculate the index value.

Parameters

The following parameters were defined to develop the BMC Index.

- PRTs: technologies and practices that reduce the discharge of aircraft deicers to the environment.
- PRT Ratings: values assigned to PRTs based on a scale that reflects their relative importance in contributing to BOD Management Capacity, with a higher score indicating increased importance in BOD management.
- Weighting Factors: the following are applied to adjust for relative importance or significance:
    - PRT Category Weighting Factor: PRT categories are weighted to reflect relative importance of the categories to BOD management
    - Airport Weighting Factor: airports are assigned a weighting factor to reflect relative magnitude of deicing activity at airports within the Defined Set
    - Implementation Weighting Factors: reflect level of implementation of PRTs
- Data collected by both airports and air carriers and analysis of the data supports definition of PRT Ratings and Weighting Factors

Description of the BMC Index

The BMC Index uses a numerical scoring system to quantify the aggregate BOD Management Capacity of the Defined Set airports resulting from PRTs deployed by both aircraft operators and airports. The national BMC Index value is a composite, reflecting a summation of deployment of PRTs using PRT Ratings and Weighting Factors to measure their contribution to the industry's capacity to manage BOD across the National PRT Complex. The scoring system and its application are described in the following paragraphs.

[1] The Defined Set of airports consists of 42 airports which the Program Partners previously determined represent approximately 83% of aircraft deicing fluid (ADF) usage in the nation.

PRT Categories. The PRT categories reflect the fundamental means available to industry to manage BOD associated with aircraft deicing operations. These categories are:

Source Reduction	These PRTs reduce the amount of BOD needed to maintain flight safety (through application of aircraft deicing fluid (ADF)) in winter conditions. Typically, but not exclusively, aircraft operators or their service providers implement these PRTs.
Collection and Management	These PRTs increase the amount of applied BOD (BOD which has been applied to ensure flight safety) that is intercepted and prevented from entering waters of the U.S. (through containment, collection, storage). Typically, but not exclusively, these PRTs are implemented by airport operators.
Supporting Activities	These PRTs are not an integral part of either Source Reduction or Collection and Management but can contribute significantly to improve/enhance BOD management capacity. Some examples include:

- Data collection and evaluation to characterize BOD capacity performance and identify opportunities for improvements
- Training and awareness programs that go beyond what would normally be implemented
- Environmental Management Systems or similar record-keeping practices that facilitate management and tracking of data and other information on deicing program operations
- System automation

Specific PRTs, as catalogued previously in Table 3, were identified for inclusion in the BMC Index based on their potential significance in reducing discharges of deicers and availability of quantitative information on their deployment. Consideration of only a subset of all possible PRTs in the calculations results in a conservative assessment of industry's progress in addressing pollution associated with use of ADF. The following table summarizes the PRTs used to calculate the BMC Index:

Category / PRT	Description
Source Reduction	
Forced Air/Glycol + Blend to Temperature	Deicing practice that combines forced air/glycol and blend to temperature technologies.
Forced Air/Glycol (Alone)	A high-pressure air jet to blast ice and snow from aircraft surfaces used in combination with ADF.
Blend to Temperature (On-Board and Stationary)	Type I fluid diluted to a glycol concentration appropriate to the local weather conditions.
Low-Flow Nozzles	Use of special nozzles that reduced the amount of fluid sprayed.

Category / PRT	Description
Low BOD ADF	Fluid formulated with freeze point depressants other than propylene, ethylene, and diethylene glycol and having a lower BOD.
Liquid Water Equivalent Test (LWET)	The use of automated weather measurement systems that determine the water equivalent precipitation rate to allow for more accurate determination of holdover or check times.
Advanced Weather Forecasting	The use of weather monitoring systems which provide accurate information on current weather conditions as well as short and long-term forecast to allow better scheduling of deicing operations.
Collection and Disposal	
Central Deicing Facilities	Deicing pads or designated areas where deicing operations are concentrated and deicing runoff is contained for subsequent storage and disposal.
Apron Drainage Management	Apron drainage systems designed to isolate and divert runoff from aircraft deicing to separate storage and disposal.
Cover and Sweep	Storm drain inserts, plugs, or covers used in conjunction with vacuum vehicles to collect runoff from aircraft deicing/anti-icing operations.
Block and Pump	In-line storm sewer plugs or valves used to isolate and temporarily store runoff from aircraft deicing/anti-icing operations for subsequent pump-out and disposal.
Pink Snow Management	Isolation of plowed snow containing aircraft deicers/anti-icers to allow containment and disposal of resulting melt water.
Supporting Activities	
Data Collection and Evaluation	Routine collection and evaluation of data on deicing operations and collection and disposal PRTs for the purposes of assessing performance and identifying opportunities for improvement.
Training & Awareness	Annual programs for training staff involved in deicing operations and deicing runoff management.
Environmental Management Systems	Formal system for the management of data, processes and related compliance activities.
System Automation	Use of sensors, motorized valves, telemetry, and other automated technology to optimize the efficiency of deicing operations and/or the effectiveness of deicing runoff isolation and collection.

PRT Category Weighting Factors. Each PRT category is assigned a relative weight on a scale[2] with the highest value being considered most significant in contributing to Management Capacity potential and the lowest being considered least significant (Table 1).

Table 1. Assigned Weights for PRT Categories

PRT Category	WEIGHT
Source Reduction (SRw)	Highest
Collection/Management(CMw)	Highest

[2] Component PRTs within each PRT Category are rated on a 1-to-5 scale.

Supporting Activities (SAw)	Lowest

Individual PRT Ratings. Each PRT category covers a variety of component PRTs[3] that can contribute to BOD management capacity. Within any given category, some of the component PRTs will be more effective than others. For that reason, ratings are defined to reflect the relative BOD management capacity potential of each PRT. A relative rating on a scale is assigned to each component PRT, with the highest value being considered most significant relative to contribution to Management Capacity and the lowest value being considered least significant. Tables 2, 3, and 4 illustrate the PRTs and ratings for Source Reduction, Collection and Disposal, and Supporting Activities respectively.[4] Again, reflecting the reality that the effectiveness of PRTs in managing BOD can and do vary depending on the context in which they are deployed, these ratings are intended to provide a relative ranking of PRTs in contributing to the management of BOD rather than a precise reflection of their relative effectiveness.

Table 2. PRTs and ratings for Source Reduction.

PRT	Rating
Forced Air/Glycol Application with Blend to Temperature	Highest
Forced Air/Glycol Application (Alone)	Mid
Blend to Temperature (Alone)	Mid –
Low-Flow Nozzles	Mid –
Variable Flow Nozzles	Low+
Low Volume Wand / Frost Nozzles	Lowest
Stationary Blend to Temperature	Low+
Other Technologies (Liquid Water Equivalent HOT, Telemetry, Advanced Weather Forecasting)	Lowest
New Fluid Formulations (Lower BOD)	Lowest

Table 3. Ranges and ratings for Collection and Management.

PRT	Rating
Central Deicing Facilities (Pads)	Highest
Apron Drainage Management	High –
Cover and Sweep (GRVs)	Middle
Block and Pump	Middle
Pink Snow Management	Lowest

Table 4. Ranges and ratings for Supporting Activities.

PRT	Rating
Data Collection and Evaluation	Highest
Training & Awareness	Middle
Environmental Management Systems	Lowest
System Automation	Lowest
Other supporting activities not otherwise listed	Lowest

It should be noted that PRTs within a category are not mutually exclusive. That is, more than one PRT may be implemented at an airport or by an air carrier.

[3] For example, Collection and Management PRTs actually represent systems of technologies that work in concert rather than as individual technologies.
[4] Currently, PRT components within the Categories are rated on a 1-to-5 scale.

PRT Implementation Weighting Factor. Because PRTs deployed at an airport are not necessarily applied to all aircraft deicing that occurs at that airport, an Implementation Weighting Factor is defined to reflect the estimated fraction of all deicing activity to which each PRT is applied. Because this fraction varies from season to season, Implementation Weighting Factors are defined based on ranges, as shown in Table 5.

Table 5: PRT Implementation Weighting Factors for Source Reduction and Collection and Management

Fraction of All Aircraft Deicing Activity to Which PRT is Applied	Implementation Factor
80% - 100%	0.9
60% - 79%	0.7
40% - 59%	0.5
20% - 39%	0.3
>0% and <20%	0.1

For example, if 75% of all deicing activity at an airport takes place at deicing pads, the Implementation Weighting Factor for Central Deicing Facilities will be 0.7. If 15% of deicing activity takes place where Cover and Sweep Operations collect the runoff, an Implementation Weighting Factor of 0.1 would be applied to the rating value for that PRT. Thus, if the ratings adopted for Central Deicing Pads and Cover and Sweep Operations are 5 and 3, the overall Collection and Management rating value would be calculated as follows:

$$\begin{aligned} CM &= (5)(0.7) + (3)(0.1) \\ &= 3.5 + 0.3 \\ &= 3.8 \end{aligned} \quad (1)$$

The same implementation factors are applied to the Source Reduction PRT category, except the implementation factor is based on the percent of operations for each carrier based on the US DOT T-100 database.

The Supporting Activities category has a different set of implementation factors, reflecting the fact that these activities are not readily characterized as being directly associated with the level of aircraft deicing activity. Two levels of implementation are defined.

Table 6. PRT Implementation Factors for Supporting Activities.

Supporting Activity Implemented?	Implementation Factor
Yes	1.0
Limited	0.6
No	0.0

Because more than one PRT in a category can be employed in a given deicing operation, implementation factors are not constrained to summing to 1.0.

Airport Weighting Factor. The BMC Index also includes a weighting factor that reflects the relative scale of deicing operations at the 42 airports included in the Defined Set. Generally speaking, factors are assigned to preferentially weight PRTs deployed at airports where large volumes of ADF are used relative to PRTs deployed at smaller airports with lower volumes of ADF used. The basis for this composite weighting is the relative volume of ADF usage associated with each airport compared to the total amount of ADF used at the national level.

The Airport Weighting Factors are held constant across time for a number of reasons. First, annual usage data may not be tracked and available at the same level of detail at each of the airports in the Defined Set. More important, relative ADF usage at airports in the Defined Set changes from year to year due to variations in weather and demand for air transportation, which affects the level of aircraft operations and fleet mix. This is a primary reason that an index approach was selected for the purposes of the VPRP; it expresses the capacity of the industry to manage BOD in terms of deployment of PRTs independent of year-to-year variables. As a result, a temporally integrated expression of relative ADF usage is used as the basis for composite weighting. Such an expression is available in estimates of average annual usage at airports for the 2002 – 2003, 2003 – 2004, and 2004 – 2005 deicing seasons developed under ACRP Project 11- 02 (Task 10). These values are a snapshot in time, and don't precisely reflect current or future ADF usage. They nonetheless are generally representative of the distribution of ADF usage among airports in the Defined Set and can be used to define ranges of relative ADF usage for the purposes of establishing Airport Weighting Factors.

The Airport Weighting Factor is similar in principle to the PRT Implementation Factor in that a single weighting factor is defined for airports within a defined range of ADF usage. Table 5 shows the defined ranges and, using a scale of 1-5 in this example, the associated Airport Weighting Factor applied to airports in the range. For example, the four airports in the highest range of ADF usage are assigned a weighting factor of 5, the six airports in the next range are assigned a weighting factor of 4, etc. The final column in the table shows the total share of ADF usage at the airports in the ranges as a percent of total ADF used nationally.

Table 7. Airport Weighting Factors for Defined Set of Airports.

Airport Rank in Total National ADF Usage*	Airport Weighting Factor	Fraction of National ADF Usage Represented by Airports in Range
1 – 4	5	36.7%
5 – 10	4	22.2%
11 – 18	3	20.1%
19 – 26	2	11%
27 – 42	1	10.1%

*Based on average annual ADF usage estimated by ACRP Project 11-02 (Task 10).

The application of the Airport Weighting Factors puts greater weight in the BMC Index on the PRTs implemented at the airports with relatively more intensive airport deicing operations (using ADF usage as a proxy), and the least weight on PRTs deployed at airports with least intense airport deicing operations. Thus, the contribution of PRTs to the index value is scaled to reflect the magnitude of BOD Management Capacity contributed to the national aggregate.

BMC Index Value. The BOD management capacity across the National PRT Complex is the sum of the index values of each discrete PRT deployed within the National PRT Complex. A "discrete PRT" is a single PRT deployed at a single airport. For example, deicing pads deployed at MSP and DTW are each discrete PRTs. The PRT index values for each discrete PRT ("PRT_d") are calculated by applying the relevant PRT Category Rating, Individual PRT Rating, Implementation Weighting Factor and Airport Weighting Factor relevant to where each PRT was deployed. The BOD Management Capacity Index for the National PRT Complex can be expressed as follows:

$$BMC\ Index\ National\ PRT\ Complex\ = \sum_{i=1}^{n} BMC\ \mathrm{PRT}i$$

Where:

n = Total number of discrete PRTs in the national PRT Complex

BMC PRTi = BMC Index value for i^{th} discrete PRT deployment

= (PRT_i Category Rating) * (PRT_i PRT Rating) * (PRT_i Implementation Factor) * (PRT_i Airport Weighting Factor)

Data Collection and Evaluation

The Program Partners collected information from their member organizations to support calculation of a national BMC Index value at two points in time: 1) the end of the 2004 – 2005 deicing season, and 2) the end of the 2016 – 2017 deicing season. The 2004 – 2005 season represents a point in time when nationwide assessments had been conducted by both the industry and the EPA as part of its development of what would become the "Effluent Limitations Guidelines and New Source Performance Standards for the Airport Deicing Category." These assessments provided a source of previously collected data and other information relevant to the VPRP. The 2016 – 2017 deicing season represents the last season before the end of the VPRP Program Period.

The Defined Set of 42 airports served as the sample population for collecting data on PRT implementation by both aircraft operators and airports. Based on usage data collected in conjunction with the 2004 – 2005 deicing season, these airports collectively represent approximately 83% of all ADF that is typically applied on a national basis.

Data Collection from Airports

Data collection on PRT implementation by airports was accomplished through a survey sent to the Defined Set airports. The survey requested the following information for the two deicing seasons:

- PRTs deployed
- Percent of total ADF usage associated with each Collection and Management PRT
- Percent of total ADF usage associated with each Source Reduction PRT (if airport is responsible for aircraft deicing)
- Implementation levels for Supporting Activity PRTs

Several webinars and live sessions at conferences were conducted for representatives from the surveyed airports to educate them about the BOD Management Capacity Index, explain the survey and what was required of them to complete it, and answer any questions. The survey responses were reviewed for completeness and consistency, and the respondents were contacted to resolve any questions or possible discrepancies.

Responses were received from 37 of the 42 airports surveyed. The remaining airports were unable to respond to the survey for various reasons, including lack of data and records, and resource constraints. However, these five airports are smaller facilities where ADF usage volumes are relatively low compared to the airports where data were available. The airports that did respond to the survey represent approximately 80% of all ADF usage in the nation. As a result, the absence of the five airports from Defined Set did not significantly affect the overall conclusions of the analysis.

Data Collection from Aircraft Operators

Data collection on PRT implementation by the air carriers serving the Defined Set airports was accomplished through a survey of source control technologies implemented by each air carrier at each airport for the 2004 – 2005 and 2016 – 2017 deicing seasons. The following specific information was collected during this effort:

- Percent of operations associated with each carrier at the Defined Set airport
- Percent of aircraft operations associated with each Source Reduction PRT
- Percent of aircraft operations associated with each Collection and Management PRT (if aircraft operators conduct independent collection and management operations)
- Implementation levels for Supporting Activity PRTs

The survey was limited to Airlines for America (A4A) member airlines, but covered the vast majority of PRTs deployed to service regional carrier operations as well, as these often operate under contract with major carriers. The survey was discussed in detail at several A4A meetings and teleconferences to ensure data needs were understood and any ambiguities clarified. Responses accounted for approximately 81% of the operations at the Defined Set airports. Upon receipt of the carrier responses, the data were reviewed and follow-up phone calls were conducted to clarify and confirm understanding of the information provided.

Complexities had to be addressed in applying the available data from the aircraft operators to the BMC Index calculations. Specifically, the BMC Index depends on the aircraft operators providing data with respect to PRTs for two deicing seasons separated by over ten years at the Defined Set. PRTs associated with Source Reduction are generally mobile and can be relocated from one station to another between deicing seasons. The list of participating aircraft operators is subject to change over time, being subject to consolidation, airlines departing the market, and new airlines entering the market.

Although data are available regarding current PRTs, there is limited information regarding historical deployment of PRTs. To address this issue, the following approach was utilized.

- If data for a specific carrier at a Defined Set station were available indicating the date of deployment of the PRT (i.e., age of deicing truck), these data were utilized directly.

- If no data were available, a default estimate of a 10% increase in PRTs from 2005 to 2015 was utilized. This was based on an analysis of available data which indicated an increase in blend to temperature or forced air PRTs ranging between 14% and 19%. Based on this, a conservative industry-wide increase of 10% in PRT deployment was assumed for situations in which site-specific data were not available.

Observations Regarding Data Collection and Evaluation of BOD Management Capacity Indices

Several observations are worth noting regarding the data compilation and analysis that supported calculating the BMC Index for the two reference years.

Limited Data on PRT Inventory Available for Early Program Years

As noted previously, there were a number of industry assessments conducted for the 2004 – 2005 deicing season that made it advantageous as a reference year. Nonetheless, data specifically needed to describe PRT implementation at some stations during that winter were limited for various reasons.

At a few Defined Set airports, data availability for that winter were limited by lack of specific records, departure of key staff who were familiar with the details of the program at that time, or availability of staff resources to research the files. The VPRP spent a significant amount of time with staff at these airports to assist in reconstructing and accurately describing their past programs as best as possible within those constraints.

Similarly, information on Source Reduction technologies implemented by each air carrier at the Defined Set airports for the 2004 – 2005 deicing season was also limited at several airports by lack of specific records, personnel changes, and airline consolidations. Information such as current A4A member acquisition/consolidation history and historical winter operations plans were utilized to determine carrier make-up in 2004 – 2005. Where specific data was lacking, information on PRTs deployed in 2004 – 2005 was obtained through the use of winter operation plans and equipment inventory records. One source of uncertainty is the fact that deicing trucks can be and are relocated to different stations depending on need. Thus, changes in PRT deployment at a specific station are not unusual and add to the complexity of estimating PRTs for 2004 – 2005.

Airport Service Level Changes / Market Forces

Another observation is that economic and market factors significantly impacted aircraft operations at some airports between the two reference seasons. The most dramatic example of this situation was at Pittsburgh International Airport (PIT), where annual passenger traffic declined 37% between 2004 and 2016. The implication to the analysis is that the Airport Weighting Factor assigned to PIT was based on the 2004 – 2005 deicing season operations, while a lower factor would probably have more accurately reflected operations in 2016 – 2017. However, there are significant challenges in adjusting Airport Weighting Factors between the two reference seasons. Most importantly, adjusting Airport Weighting Factors for each airport to reflect market shifts between the two reference seasons would also reflect differences in weather in the two deicing seasons, introducing a significant source of variability the analysis was specifically designed to avoid. In addition, the implementation of significant source reduction PRTs also reduces ADF usage. Adjusting weighting factors across seasons would therefore actually mask the behavior the Index is designed to evaluate: deployment of PRTs. Similarly, changes in operations at an individual airport such as changes in individual air carrier operations and relocation of equipment due to those changes in operations affect the source reduction scores.

Some Airports Do Not Have Staff Available to Assist

At a few Defined Set airports, staff resources are very limited and, as a result, they were not able to respond to the data collection survey. As noted previously, this resulted in no data being available for five of the 42 Defined Set airports.

Variability in Winter Conditions Impacts PRT Deployment

The BMC Index can be affected by shifts in the balance between more and less aggressive collection PRTs in response to variations in winter weather and changing aircraft operations across deicing seasons. For example, it was observed that milder winter weather could increase aircraft deicing activity at gates (where, typically Block and Pump Collection is used) relative to activity at Central Deicing Pads (where typically the fraction of spent ADF is higher).