Aircraft Deicing Activities
Voluntary Pollution Reduction Program

Phase I Report

March 31, 2015

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I. INTRODUCTION

The aviation industry's major trade associations – 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") – are pleased to present this Phase I Report on our Voluntary Pollution Reduction Program (VPRP). The VPRP builds 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), without compromising their efficacy in maintaining safety of aircraft operations in winter conditions. The VPRP focuses industry leadership on efforts to continue meaningful and substantial pollution reduction progress during the VPRP Period, defined as 2005 through 2017. It helps to provide a framework to facilitate, measure, and document that progress.

The Phase I Report describes industry activities and progress since the initiation of the VPRP and publication of the VPRP's November 30, 2012 Initial Report. These activities included surveys of the types of pollution reduction technologies (PRTs), defined under the VPRP to be inclusive of deicing infrastructure, practices, policies, and procedures, utilized and/or deployed by the Program Partners' members; industry outreach and education activities; data collection on the estimated environmental benefits of technologies; and the development of a metric to express the national, industry-wide pollution reduction goal. A description of the VPRP, the aforementioned Initial Report, Governing Principles, and other documentation are also available on the respective Program Partner websites: www.airlines.org, www.aci-na.org, www.aaae.org, and www.raa.org.

The Phase I Report is the second report documenting industry's implementation of the VPRP. As described in prior program documents, the VPRP milestones are:

September 30, 2012	Establish and Initiate VPRP (completed)
November 30, 2012	Initial Report (completed)
September 30, 2014	Phase I Report (this report)
September 30, 2017	End VPRP (to be done)
November 30, 2017	Phase II Report (to be done)

As the VPRP has evolved, the Program Partners have determined that there is a need for an additional milestone in 2016: publication of a supplement to the Phase I report that will provide additional information regarding specific industry goals and our progress in meeting those goals. The additional milestone is scheduled for March 31st 2016 and explained in greater detail at the end of this Phase I report.

A. The Aviation Industry and Deicing

Aircraft deicing is not typical of other economic or industrial activity. Aircraft deicing is essential to maintaining air safety in winter conditions, As such, it is only undertaken when certain weather events beyond human control (e.g., icing conditions or winter precipitation) occur and require that aircraft be deiced to protect public safety. Consistent with the Congressional mandate that safety must be the "highest aviation priority,"[1] safety is a nonnegotiable imperative for the industry and its chief regulator, the Federal Aviation Administration (FAA). Accordingly, the FAA requires aircraft deicing through regulations, advisory circulars, orders and technical memoranda.

[1] 49 USC §47101(a)(1). *See also* 49 USC §40101(a) ("[T]he Secretary of Transportation shall" . . . "(1) assign[ ] and maintain[ ] safety as the highest priority in aviation").

The industry has worked closely with the FAA to develop strict aircraft deicing programs that require all critical surfaces of an aircraft to be free of ice, frost, snow, and other contaminants prior to flight. Aircraft deicing is accomplished with a combination of physical removal techniques and application of ADF. In certain winter conditions, the safety of aircraft operations can only be ensured through the application of ADF and is mandated by the U.S. Government through the FAA.[2] Thus, this industrial activity is unique in that industry does not control the circumstances that trigger the activity and, once the need is triggered, industry cannot avoid the activity.

A related feature of the activity is that the amount and extent of aircraft deicing needed in any given deicing season will vary depending on the severity, frequency and types of weather conditions experienced during the season and where those conditions occur.

Additional complexity and variability is associated with deicing activity because the underlying air service characteristics that drive deicing activity are themselves variable. Demand for air transportation services, both in terms of the level of demand and the location of the demand, changes over time. Not only does aggregate demand fluctuate with the broader economy, but regional economic changes can shift relative intensity of operations among markets. Dynamics within the airline industry also change, affecting carriers' business plans for efficiently meeting demand, which in turn affects the types of aircraft operated at individual airports (fleet mix) and level of services offered. For example, since the start of the Program Period in 2005, the U.S. aviation industry has undergone significant restructuring. Five mergers of U.S. major carriers took place during this period beginning with US Airways and America West Airlines in 2005, followed by Delta Air Lines and Northwest Airlines in 2008, United Airlines and Continental Airlines in 2010, Southwest Airlines and AirTran Airways in 2010, and American Airlines and US Airways in 2013. These mergers affected air service characteristics and activity levels at numerous U.S. airports. Over the same time period, a severe global recession took place from 2007 to 2009 with lingering effects on the air travel demand that continue to today. All of these events affected demand patterns at U.S. airports and ultimately deicing activity.

While the need to deice aircraft is dictated by factors that are complex, safety-related, and largely beyond the industry's control, the industry continues to recognize that it can proactively work to reduce environmental impacts associated with the activity. This is being done through the use of technologies (inclusive of infrastructure, practices, policies and procedures) that (1) reduce the amount of ADF used in deicing activities (without compromising safety) and (2) intercept ADF after it has been applied to aircraft, preventing it from reaching the environment.

Technologies vary because airline businesses and business models vary and airports vary considerably in terms of their size, location, activity levels, geography, hydrology, proximity to water bodies, infrastructure, land availability, climate, weather, and aircraft fleet mix. In addition, multiple parties are involved with deicing activities including airport operators, airlines, fixed-base operators (FBOs), general and business aviation aircraft operators, and third party service providers. In short, every airport is unique in terms of the constraints and opportunities it may present for deployment of technologies designed to reduce deicing-related impacts. As a result, the success of any effort to reduce pollution associated with aircraft deicing depends on preserving and reinforcing industry's ability to select PRTs that are best suited to the unique combination of physical, operational, meteorological, and environmental conditions that exist at each airport and pertain to each deicing operation.

[2] Similarly, airfield pavement surfaces must provide sufficient friction for safe landings, taxiing, and takeoffs during winter weather conditions. To achieve this, airport operators monitor runway friction during winter seasons, apply deicing and anti-icing products to their runways and other airfield surfaces, and mechanically remove winter contaminants using specialized plows and brooms.

The United States Environmental Protection Agency (EPA) has recognized this fundamental reality.[3] After nearly 15-years of study and analysis of the industry, EPA concluded in its final Deicing Effluent Limitation Guideline (ELG) rule that the decisions regarding what measures are appropriate to address runoff related to aircraft deicing activities must be made "on a site-specific basis because such determinations appropriately consider localized operational constraints (*e.g.,* traffic patterns), land availability, safety considerations, and potential impacts to flight schedules." [4] EPA emphasized the importance of this final factor, stating that "[aircraft] delays must be a factor" in considering technology options because "such delays fundamentally affect U.S and international business and recreational interests."[5] In its May 2012 Final Rule, the EPA concluded that site-specific complexities prevented it from identifying a single national technology standard for aircraft deicing operations. As a result, aircraft deicing operations are controlled through NPDES permits through site-specific "best professional judgment" technology-based effluent limits established through individual or general permits. EPA's Multi-Sector General Permit (sector S) is one example.[6]

II. Voluntary Pollution Reduction Program (VPRP)

A. BACKGROUND

The aviation industry has a long history of proactive implementation of practical and effective technologies to reduce pollution associated with ADF use. The industry has spent hundreds of millions on technologies to achieve such reductions, including collection and treatment facilities and other technologies that reduce the amount of ADF needed to maintain safe aircraft operations.

The scope and scale of these efforts are described in detail in the administrative record amassed for the Deicing ELG. In 2011, the Program Partners and their respective memberships began development of the VPRP to further document these industry efforts and share information regarding effective industry practices for reducing ADF pollution at U.S. airports.

The Program Partners adopted the VPRP in 2012.[7] The VPRP is a voluntary initiative and designed to facilitate broad possible participation from the Program Partner memberships. It is energized by the Program Partners' confidence that, just as it has in the past, the industry will continue to grow and, as it grows, improve its environmental performance and maintain its impeccable safety record.

As noted previously, deicing operations are conducted solely to ensure the safe operation of aircraft in weather conditions when ice or snow formation is likely or has already occurred. As an industry, we are committed first and foremost to safe operation of aircraft in these conditions. In accordance with this top priority, the VPRP *does not* impose constraints on ADF usage, aircraft operations, or discharges associated with ADF usage. Just as importantly, the VPRP is not intended to identify any standard, target,

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[3] In August of 2009, EPA published a proposed ELG for aircraft and pavement deicing operations. The proposed rule had been in development for over a decade prior to the publication of the draft. During that time, the aviation industry worked very closely with EPA to inform and educate EPA staff regarding all aspects of aircraft and airfield deicing activities. These efforts built on over 20 years of close coordination with EPA on stormwater permitting issues related to deicing activities.
[4] 77 FR at 29178.
[5] 77 FR at 29178-9.
[6] http://water.epa.gov/polwaste/npdes/stormwater/EPA-Multi-Sector-General-Permit-MSGP.cfm
[7] See Appendix A for the constituting document that created the VPRP. The EPA subsequently recognized its "potential to significantly reduce aircraft deicing discharges in a safe manner." 77 FR 29175. As explained in the VPRP Q&A : "While they address similar subject matter, the Voluntary Program and EPA's Deicing ELG are completely distinct from and unrelated to one another."

benchmark or obligation any for individual airport, airline or other entity involved in aircraft deicing. Rather, the VPRP is focused on proactively facilitating the sharing of information regarding PRTs, fostering their deployment and establishing a robust means of assessing industry progress on an industry-wide, national level.

Two features of the VPRP deserve additional emphasis. First, the VPRP is national in scope. As EPA found in its Deicing ELG, a nationally-standardized technology-based approach to pollution reduction associated with ADF usage is neither appropriate nor feasible given the many unique characteristics of the aviation industry and associated challenges. Accordingly, the VPRP is designed to encourage and to quantify pollution reduction benefits nationwide, recognizing that the contributions of individual airports will necessarily vary according to their site- and winter season-specific circumstances.

Second, the VPRP is focused on measuring the adoption of PRTs, which include both Pollution Prevention Technologies (technologies that reduce the amount of ADF needed to maintain air safety) and Stormwater Management Technologies (technologies that intercept and treat used ADF). By focusing on the adoption and deployment of PRTs, the industry leverages the best available means of continuing progress in reducing pollution related to deicing activities.

Importantly, this approach does not depend on monitoring airport discharges or ADF usage but instead focuses on overall, national technology deployment.

B. IMPLEMENTATION

Initiated September 30, 2012, the VPRP is being implemented in three phases. In the initial phase, the Program Partners committed to identifying a “Defined Set of Airports,” to include the airports at which, collectively on a national basis approximately 80% of ADF typically is applied. This phase concluded with the publication of our ***Initial Report,*** issued November 30, 2012, which provides the list of the 42 airports included in the Defined Set.

This ***Phase I Report*** marks the culmination of the current phase of the VPRP, which has centered on our voluntary commitment to develop a Quantitative Pollution Reduction Goal (the “Program Goal”). In addition, this ***Phase I Report*** also provides a summary of Industry activities that have been conducted or planned from the time the Initial Report was filed to (a) further facilitate information exchange and outreach; and (b) encourage the development, testing and, as commercially appropriate, deployment of PRTs.

The third phase will be completed in 2017 when the Program Partners will publish a Phase II Report in which we will report on our progress towards the VPRP Goal.

III. Industry Outreach Efforts

A. Program Partner Outreach

The VPRP includes outreach activities to facilitate exchange of information about PRTs. These activities continue to involve all industry stakeholders, including airports, airlines, fluid manufacturers, deicing contractors, etc. The Program Partners have 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. Table 1 shows the events at which formal presentations and discussions were held regarding the VPRP in 2013 and 2014.

Table 1-Industry Outreach Activities

Program Partner	Meeting/Conference	Date	Location
RAA	RAA 38th Annual Convention	May 6-9, 2013	Montreal, Quebec
A4A/RAA	Joint Environment Council Meeting	May 8, 2013	Montreal, Quebec
SAE G-12	Deicing Meeting	May 9, 2013	New Orleans, LA
ACI-NA	Environmental Affairs Spring Conference	May 13-16, 2013	Halifax, NS
AAAE	National Aviation 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
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

In addition to these events, the process of surveying the Defined Set of Airports (see the following section for additional details) and participating airlines included informal outreach and education efforts too numerous to list above. Participants in such discussions included not only association representatives, but also airport and airline managers, industry consultants, and other academic/government experts. The Program Partners and their members also conducted a number of other outreach activities: updates on the Voluntary Program are provided on the majority of ACI-NA Environmental Affairs Committee monthly Steering Group calls; Program Partners have also made presentations and engaged in discussions of best practices at each other's conferences.

B. Voluntary Program Working Groups

The Program Partners convened three working groups to gain actual industry-specific input from airport and airline representatives and inform the Program Partners in developing critical aspects of the VPRP, as follows:

- Defined Airports Workgroup, which was tasked with developing the "defined set of airports" to serve as the basis for national assessments, as described in the November 30, 2012 Initial Report
- Pollution Reduction Technologies (PRT) Workgroup, which was tasked with identifying and verifying PRTs that have been utilized nationwide
- Environmental Benefits Workgroup, which was tasked with assembling information regarding the estimated environmental benefits of PRTs identified by the PRT Workgroup

These groups, composed of airport and airline volunteer representatives, participated on weekly conference calls and meetings for varying durations to complete their work.

The Defined Airports Workgroup's efforts were summarized in the November 30, 2012 Initial Report. Thereafter, the PRT Working Group was tasked with developing a baseline inventory of technologies in use at the Defined Set of Airports and by airlines serving those airports in 2005 and a current inventory (as of 2012 - 2013). In this effort, airport operators and airlines provided information on both historical and current practices, to the extent that information was available. The PRT Working Group also conducted outreach to association members and deicing service providers to develop common definitions of the technologies in use.

Based in part on this work, the Environmental Benefits Working Group developed an extensive survey to collect information regarding the estimated performance and possible environmental benefits for the suite of technologies. The Working Group held multiple webinars and conference calls to educate airport staff about the survey and encourage participation, while also reaching out to each airport individually to assist airport representatives in responding to the survey.

IV. Pollution Reduction Technologies (PRTs)

Pollution Reduction Technologies, or PRTs, include infrastructure, practices, policies, and procedures that are used by the airports, airlines, and deicing service providers to both (1) reduce the amount of ADF necessary to maintain the safety of aircraft operations in winter conditions and (2) increase the amount of spent ADF that is intercepted and/or treated. Together, these technologies reduce the pollutants that may enter the environment as the result of aircraft deicing. As noted previously, technologies in the first category of PRTs are termed “Pollution Prevention Technologies”, while those in the second category are termed “Stormwater Management Technologies”.

Pollution Prevention Technologies include ADF application equipment and facilities, alternative ADF application methods and procedures, improved weather forecasting, and other policies and procedures. Pollution Prevention Technologies are most frequently employed by airline operators, but can be employed by other entities that conduct aircraft deicing operations, which can include airports and third party providers (including contractors, often referred to as Fixed Base Operators (FBOs)).

Stormwater Management Technologies include infrastructure such as deicing pads, stormwater collection systems (including stormwater conveyance and storage facilities), water treatment systems, and glycol recycling facilities and equipment such as glycol recovery vehicles. They also include stormwater management policies and procedures as well as program documentation, data collection and reporting, and quality assurance/review that help airport operators and their tenants assess the utilization and effectiveness of their stormwater management programs. Stormwater Management Technologies, are most frequently implemented by airport operators, but can also be implemented by the airlines or other third parties.

The aviation industry is highly complex with many integrated participants. Furthermore each airport operation is unique, and aircraft deicing operations, particularly when facing the challenges associated with winter storm events, fully reflect the industry’s complex interactions and pressures. Deicing operations can involve multiple stakeholders including airports, airlines, and third parties. In terms of deploying Stormwater Management Technologies multiple variables must be assessed to determine the mix of technologies best suited for the management of stormwater laden with spent deicing fluid, including: geography, airport location, climate, space constraints, ground operations, availability of publicly owned treatment works (POTWs), local water quality, among other factors.

The imperative to ensure the safety of aircraft operations not only impels the need to deice aircraft in the first place, it is also an elemental design criterion for airport facilities, including facilities that support aircraft deicing both on and near airports. For example, stringent clearance and separation standards constrain the design of both areas dedicated to aircraft deicing operations and stormwater collection, storage and treatment facilities. These standards include airspace, aircraft separations, FAA Technical Operations facilities critical areas, and Airport Traffic Control Tower (ATCT) and line-of-sight criteria. Aircraft operations are supported by many different types of ground support equipment and vehicles, including catering trucks, baggage tows, fueling trucks, etc. – in winter weather conditions more ground vehicles (e.g., deicing trucks and glycol recovery vehicles) may be introduced to the aircraft operating area. Thus, airport facilities must be designed to provide for vehicle safety zones and adhere to other strict safety criteria.

Safety requirements also must be met in the selection and deployment of PRTs. The imperative is to ensure that an aircraft is free of contamination (e.g., frost, ice or snow) to protect safety of flight. Aircraft deicing specifications are very prescriptive and several factors must be assessed prior to deicing aircraft including air temperature, fluid type, and where the aircraft can be deiced. Aircraft deicing technologies have improved and continue to improve, with a major benefit being more precise deicing application and appropriate fluid mixes based on real time information.

In addition to safety, the effect of deicing technologies on the efficiency of aircraft operations is also a key concern. Industry, the FAA[8], EPA[9] and U.S. Congress[10] all acknowledge the central importance of

[8] FAA, *2009-2013 Flight Plan* at 5.

efficiency in the operation of the National Air Transportation System (NAS). Accordingly, infrastructure to accommodate aircraft deicing and address runoff also must be designed to ensure the efficiency of aircraft operations is not compromised.

A. EPA and TRB Technology Assessments

In developing its Deicing ELG, EPA conducted a review of pollution prevention technologies and EPA's assessment of those technologies is based on information the Agency collected.[11] EPA, in its Technical Development Document (TDD) summarized its technology review of the industry as follows:

> EPA has identified several technologies that are available to collect and manage portions of the ADF waste stream. Some of these collection technologies are more effective than others. EPA has also identified several pollution prevention (P2) approaches that may be used to minimize the amount of ADF applied. However, no single technology or P2 approach is capable of collecting or eliminating all applied ADF, as a portion of the fluid is designed to adhere to the aircraft until after takeoff, in order to ensure safe operations.[12]
>
> With respect to aircraft deicing discharge controls, EPA's record demonstrates that ADF collection and associated treatment technologies are technically feasible for many airports. Data supplied from the industry through EPA's nationally representative survey of airports indicates that dozens of airports currently use GCVs and plug and pump collection systems, in addition to a myriad of P2 technologies and practices, ranging from alternative means of applying ADF such as forced air nozzles, to alternate deicing technologies such as IR deicing. In addition, many airports also employ a variety of treatment technologies to treat collected ADF prior to discharge.[13]

EPA concluded that the industry has a significant number of different technology options for mitigating the pollutants associated with aircraft deicing activities. However, as indicated above, EPA also concluded that "best available technology determinations should continue to be made on a site-specific basis because such determinations appropriately consider localized operational constraints (e.g., traffic patterns), land availability, safety considerations, and potential impacts to flight schedules."[14]

Another resource that assesses various aircraft deicing control technologies is ACRP Report 14, *Deicing Planning Guidelines and Practices for Stormwater Management Systems* (2009), (http://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_014.pdf). The Transportation Research Board describes ACRP Report 14 as follows:

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[9] *See*, 77 Fed. Reg. at 29178-79 ("EPA agrees that [operational] delays must be a factor in considering today's possible requirements and recognizes that such delays fundamentally affect U.S and international business and recreational interests.")
[10] *See,* § 47101(a): "It is the policy of the United States – . . . (7) that construction and improvement projects that increase the capacity of facilities to accommodate passenger and cargo traffic be undertaken to the maximum feasible extent so that safety and efficiency increase and delays decrease." *See also e.g.,* 49 U.S.C. § 40101(a)(4), (6), (7), (10) and (11).
[11] *Technical Development Document for the Final Effluent Limitations Guidelines and New Source Performance Standards for the Airport Deicing Category,* EPA-821-R-12-005, April 2012, http://water.epa.gov/scitech/wastetech/guide/airport/upload/Technical-Development-Document-for-the-Final-Effluent-Limitations-Guidelines-and-New-Source-Performance-Standards-for-the-Airport-Deicing-Category.pdf.
[12] 77 FR 29172.
[13] 77 FR 29178.
[14] Ibid.

ACRP Report 14: Deicing Planning Guidelines and Practices for Stormwater Management Systems represents one of the first references on deicing operations. This document provides practical technical guidance to airports; aircraft operators; consultants and designers; and local, state, and federal regulators. The guidelines address a wide array of practices for the practical, cost-effective control of runoff from aircraft and airfield deicing and anti-icing operations.

The EPA TDD and ACRP's related efforts helped to serve as a foundation for the VPRP's more specific look at available and new technologies.

B. Creation of National Pollution Reduction Technology Inventory

Under the VPRP, the Program Partners convened a Pollution Reduction Technology Working Group comprised of association members, industry stakeholders and Program Partners to survey the Defined Set of Airports and airlines to develop a comprehensive list of the types of PRTs in use in the baseline year (2005) and in use currently (as of 2012 – 2013).

First, a baseline technology inventory was developed by the working group using information obtained from the EPA's 2004 industry survey, which was conducted in support of its ELG rulemaking. This inventory was enhanced from member surveys sent out as part of the VPRP work effort and from working group members' own institutional knowledge. Common definitions for each technology were obtained from ACRP Report 14. The VPRP builds on and enhances the information provided in EPA's TDD and ACRP Report 14 by collecting the most current technology development and implementation information from the defined set of airports to create a compendium of technologies in use at those airports. See Appendix A for the current National Pollution Reduction Technology Inventory.

The Program Partners will update the inventory again at the end of the VPRP in 2017. Because of the difficulties in determining in which intervening year certain technologies were added by individual airports or airlines (for example because of service changes, mergers, etc.), and the exact frequency or coverage of a technology or practice's use, the inventory does not attempt to make a full account of where, when or how often a particular technology or practice is used. The inventory demonstrates that there are a wider range of solutions available now (with new and improved technologies continuously under development), and airports and airlines are using a variety of combinations of technologies designed to best suit their site-specific needs.

The Program Partners collected publicly available information when possible on the technologies included in the national PRT inventory. Information on the environmental benefits and performance of specific technologies can be found in ACRP Report 14 and the list of technologies appears in Appendix A.

C. Ongoing Research and Possible Future Technologies

Another important element of the VPRP is to review and encourage additional research and development of new and improved PRTs for aircraft deicing activities. The Program Partners reviewed existing and ongoing research to understand the possible future technologies coming online which might benefit our members and contribute to continued pollution reduction achievements. One example is low biochemical oxygen demand (BOD) ADFs consisting of blends of propylene glycol and glycerin are currently undergoing research and testing. Research into advanced materials that are resistant to ice formation—involving liquid infused nanostructured surfaces—is also underway. It is envisioned that these materials could be applied to aircraft in the form of a coating as well as to airfield pavements as either a coating or pavement additive.

Recent technologies that are being assessed look at weather preparation, fluids and fluid applications. Weather preparation has advanced tremendously with weather models that are much more accurate. This coupled with airport surface management systems allow for better planning related to aircraft flow during a winter event. This has the potential to save fluid by reducing the number of aircraft that have to deice multiple times when the holdover times have been exceeded.

Another example of technologies under development involves ADF application nozzles. These nozzles are advancing not only with regard to 'blend to temperature' capabilities at the nozzle, but also with the addition of proximity sensors on the nozzles that allow more efficient application of the aircraft deicing fluid, thereby reducing the amount of fluid overspray. This type of technology is currently being tested at several airports. The Program Partners will continue to monitor and encourage the testing and development of commercially appropriate technologies like these and to the extent they become available to Voluntary Program participants, will be reflected in future technology inventories.

V. Challenges in Assessing the Benefits of Pollution Reduction Technologies

PRTs—whether Pollution Prevention Technologies employed to reduce the amount of ADF required for safe aviation operations or Stormwater Management Technologies used to reduce the amount of pollutants associated with spent ADF from reaching the environment—can and do provide substantive environmental benefits when employed by industry. Industry's commitment to pollution reduction is reflected in the hundreds of millions that airports, airlines and others in the aviation community have invested in these technologies since 2005.

The Program Partners found that reliable measurement and comparison across time of environmental benefits associated with PRTs in terms of reduced discharges is fundamentally thwarted by the types of factors discussed in Section 1.A. above. These factors include variability from winter season to winter season in weather conditions (e.g., the timing, type, and volume of winter precipitation), demand for aircraft deicing operations system-wide and at particular airports, and aircraft fleet mixes and flight schedules. These variations can also affect the efficiency and efficacy of specific PRTs.

Another factor that confounds attempts to assess the benefits of PRTs in terms of reduced discharges is the unique physical and operational factors associated with individual airport facilities and operations. As has been noted earlier in this report, no two airports are the same. Each airport has its own unique physical, meteorological, activity, and operational characteristics that make it impossible to compare PRT performance across airports, compare performance at individual airports across time or to reliably extrapolate data from individual airports to quantify nationwide trends.

Finally, the effectiveness of particular PRTs is often dependent, in part, on the deployment of other PRTs. Perhaps most illustratively, deployment of PRTs that reduce the amount of ADF used and, therefore, the amount of spent ADF available for collection and treatment, can significantly impact the effectiveness of ADF collection and treatment technologies. The mix of PRTs at individual airports shifts over time, even as other factors described above simultaneously affect the level and intensity of deicing activity, rendering a meaningful comparison of the benefits of the PRTs (stated in terms of reduced discharges) impossible.

As a result, just as EPA concluded in the context of promulgating the Deicing ELG that these challenges precluded identification of a uniform, technology-based standard for controlling discharges associated with aircraft deicing activities, the Program Partners found these challenges precluded identification of a meaningful metric for assessing PRT benefits in terms of discharges.

To follow through on the commitments made in this Voluntary Program, the Program Partners have developed an alternatative approach for assessing the benefits conferred through deployment of PRTs. As detailed in the next Section, the Program Partners believe this revised approach provides a clear measure of technology deployment and an effective means of assessing the benefits of those technologies.

VI. Voluntary Program Goal Metric

The Program Partners' designed this Program to reflect the ambition and expectation that their voluntary evaluation and adoption of PRTs will continue to improve the industry's ability to reduce the environmental impacts associated with aircraft deicing, an activity critical to ensuring safety of aircraft operations in winter conditions. An important objective of the VPRP is to document and encourage industry's consideration and adoption of PRTs. As noted, these technologies include both Stormwater Management Technologies that intercept deicing runoff before it can enter surface waters (inclusive of technologies to collect and treat/recycle stormwater), and Pollution Prevention Technologies that reduce the amount of deicing fluid necessary to assure the safe operation of aircraft. Together, these PRTs contribute to the industry's capacity to manage discharges of aircraft deicing fluid and the impacts of these discharges on the environment.

At the outset of this program, Program Partners determined to establish a Program Goal that would express this progress on a national basis. This Program Goal was 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 extensive information review reinforced to the Program Partners that the need for aircraft deicing activities and performance of specific technologies varies significantly depending on the highly variable factors previously discussed in this Report. Therefore the Program Partners have adopted a goal that is stated in terms of increased capacity to manage BOD (a measure of oxygen demand) rather than in terms of absolute reductions in oxygen demand.

The Program Partners have developed the following VPRP 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.**

In this Phase I Report the details for quantifying BOD Management Capacity have not been established. The management capacity approach represents an alternative means of quantifying benefits from the deployment of PRTs for aircraft deicing runoff. As a result, the Program Partners recognized the need to develop additional experience working with this metric before assigning a target. The Program Partners recognize, however, the importance of defining and announcing the quantitative goal prior to submission of the Phase II Report in 2017. Therefore, the Program Partners have committed to announce the goal one year from the completion of the Phase I Report.

A brief description of the terms used in the Goal statement above will provide additional context.

A. "BOD Management Capacity"

The Program Partners define "BOD Management Capacity" to be the aggregate capacity (1) to capture, treat, recycle and otherwise manage aircraft deicing runoff and (2) to reduce the amount of aircraft deicing fluid required for safe flight across the Defined Set of Airports. Under this approach, each of these components will be assessed and aggregated to provide a measurement how management capacity has changed during the VPRP Period.

Management capacity was selected as the VPRP Goal's fundamental metric for the following reasons:

1. Most fundamentally, this approach ensures a full accounting of PRTs. As is well known, the effectiveness of particular PRTs often can depend on the various types of PRTs with which it is deployed. For example, deployment of a technology that reduces fluid usage (i.e., a Pollution Prevention Technology) may reduce the concentration of spent deicing fluid in stormwater runoff, which can reduce the amount of spent fluid available for collection by fluid collection technologies (i.e. Stormwater Management Technology). As a result, when measured in terms of end-of-pipe BOD discharge avoided, the deployment of one type of technology can mask the deployment of another PRT. Using a discharge-based approach would thus actually fail to meet the central purpose of the VPRP, which is to measure deployment of PRTs fully.

2. The "BOD Management Capacity" metric, in contrast, enables full accounting of PRT deployment. For example, where all of the aircraft deicing runoff is captured and treated, 'perfect' management capacity for collection would be achieved because all of the available runoff is prevented from reaching surface waters. If, at the same time, technology that eliminated the need to use deicing fluid entirely (e.g., ice-phobic aircraft coatings) a "perfect" management capacity for fluid use is achieved. In such circumstances, the BOD Management Capacity metric will fully account for the contribution of each component of the PRT complex. In contrast, an approach that measures deployment of PRT relative to the reduction in discharge cannot account fully for the deployment of each type of technology. In the preceding example, deployment of a technology reducing deicing fluid use to zero would not be accounted for at all, because deployment of the pollution collection technology would already have reduced discharges to zero or vice versa. While this extreme example is used for illustrative purposes, it reflects an unacceptable consequence of using a discharge metric for measuring deployment of technologies.

   Each deployment of a PRT constitutes a step forward, either by providing additional capacity to manage existing aircraft deicing discharges or by providing capacity that is available to accommodate increased demand for air travel. The BOD Management Capacity metric will, consistent with the intent of the VPRP, account for all such technology deployments.

3. BOD Management Capacity provides a practical means of reflecting the effects of technology adoption. It is extraordinarily difficult to quantify the interdependencies among PRTs even on a site-specific basis and impossible to do on a national basis. The BOD Management Capacity metric will provide a measure of the industry's ability to address BOD that does not depend on resolving the intractable interdependency problem. In this respect it provides a

transparent and valid measure of industry's progress in deploying PRTs and enables a credible national-level measure of progress in addressing BOD.

4. The "BOD Management Capacity" metric also will facilitate identification and assessment of the non-discharge benefits of technology adoption. These benefits include reductions in the energy usage and other resource savings associated with reduced demand for the manufacture, transport, collection and/or treatment of aircraft deicing materials that have been eliminated from the system. Increasingly, these and similar life-cycle costs have been recognized as important measures of industrial efficiency and sustainability. The adopted metric enables the industry to begin recognizing these contributions to the sustainability of the air transportation industry.

5. The details of how the BOD Capacity Management metric will be quantified are under development. These details will be finalized prior to the establishment of the quantitative goal value. The intent under this approach is to assess progress in terms of the national implementation of structural and non-structural PRTs that reduce the risk of discharge of BOD to the environment (through both source reduction and improved interception of spent fluid).

B. The "National PRT Complex"

A second term used in the VPRP Goal is the "National PRT Complex." The National PRT Complex refers to the PRTs estimated by the Program Partners to have occurred between January 1, 2005 and September 30, 2017 (the "Program Period") at the Defined Set of Airports.

Thus, the VPRP Goal is a reflection of the improvement in the industry's capacity to manage BOD on a nationwide basis and does not reflect the performance of individual deicing operations. It is important to understand that the Goal reflects the improvement of the National PRT Complex over the VPRP Period (i.e., from January 1, 2005 to September 30, 2017).

C. Application of Program Goal to "Any Given Deicing Season"

Third, as noted in the statement of the VPRP Goal itself, the goal is stated in terms that do not refer to any actual year. That is, the goal is independent of the intensity and distribution of storm activity in any specific winter, as well as any winter-specific level of demand for winter air transportation and the distribution of that demand across the nation. These variables prevent actual, end-of-pipe performance from being compared from one year to the next at individual sites, and also for one year to the next across the aviation industry. Instead, the VPRP Goal is stated in terms of a percent increase in BOD Management Capacity that will be available in <u>any year</u> compared to the management capacity had no additional PRTs been deployed between January 1, 2005 and September 30, 2017. This approach also ensures the goal reflects the difference in PRTs deployed in those years, rather than changes in the distribution of aircraft deicing activity across airports due to variations unrelated to deployment of PRTs, e.g., shifts in geographical distribution of winter weather events (both in terms of intensity and type) and shifts in demand for air transportation services.

D. Increase in BOD Management Capacity

Finally, the VPRP Goal will identify an increase over time in the BOD Management Capacity for aircraft deicing runoff that has been provided by PRTs deployed over the life of the VPRP. This projected increase will be established based on the industry's best estimates of the BOD management capabilities of each of those PRTs. In some cases, these estimates may be developed based on empirical data from a specific site or operation. In other cases, they may constitute engineering estimates of the efficacy of specific technologies. In still other cases, they may reflect a national estimate of technology deployment and a national estimate of those technologies' efficacy based on publicly available materials.

VII. Conclusion

The Program Partners are pleased to report the adoption of the VPRP Goal metric and the fulfillment of our other voluntary commitments under our Voluntary Program. Establishing the Defined Set of Airports, the VPRP Goal metric, and conducting industry outreach have provided a solid foundation for addressing the next challenges under the VPRP. During the next two and a half years we will be working to continue to fulfill our commitments, developing and announcing the quantitative target of our VPRP Goal by March 31st, 2016, and looking forward to providing the Phase II Report by November 30, 2017. Our focus and goal remains to build on the industry's record of reducing environmental impacts related to aircraft deicing operations and to encourage 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

Inventory of Pollution Reduction Technologies

In order to create and update the national inventory of deicing technologies, the Deicing Technology Working Group (Working Group), composed of volunteers from the airport and airline stakeholder community, developed a list of pollution reduction technologies in use in the baseline year and at the end of the program period. The technology inventory will inform the further development of the "Management Capacity" goal metric. The following is a list of technologies deployed nationally and their common definitions is listed below:

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
Infrared Aircraft Deicing Technology	Infrared deicing tents/hangars that use infrared technology to melt the snow and ice off the aircraft.
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.
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
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
Tempered Steam	A mixture of water vapor and hot air to deice aircraft surfaces
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 and 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
Aircraft Deicing Facilities	Deicing pads or areas that contain deicing fluid either in storage for treatment or recycling, or send to a POTW

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
Containment and Collection Practices for Snow Contaminated with Aircraft Deicing/Anti-Icing Fluids	Management plans related to plowed snow contaminated with aircraft deicing fluid and/or pavement deicing materials.
Publicly owned treatment works (POTWs)	Publicly owned treatment works, as defined at 40 CFR 403.3(o).
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
Glycol Recycling	Recovery and recycling of glycol from ADF-contaminated wastewater