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Environmental Protection
Agency

Technical Development Document for the Final Effluent Limitations Guidelines and New Source Performance Standards for the Airport Deicing Category

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ACKNOWLEDGMENTS AND DISCLAIMER

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1. LEGAL AUTHORITY

Effluent limitation guidelines and standards for the Airport Deicing Category are promulgated under the authority of sections 301, 304, 306, 307, 308, and 501 of the Clean Water Act, 33 U.S.C. 1311, 1314, 1316, 1317, 1318, and 1361.

1.1 Clean Water Act

Congress passed the Federal Water Pollution Control Act Amendments of 1972, also known as the Clean Water Act (CWA), to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (section 101(a)). To implement the Act, the United States Environmental Protection Agency (EPA) is to issue effluent limitation guidelines, pretreatment standards, and new source performance standards for industrial dischargers. These guidelines and standards are summarized briefly in the following sections.

1.1.1 Best Practicable Control Technology Currently Available (BPT)

Traditionally, EPA establishes BPT effluent limitations based on the average of the best performances of facilities within the industry, grouped to reflect various ages, sizes, processes, or other common characteristics. EPA may promulgate BPT effluent limits for conventional, toxic, and nonconventional pollutants. In specifying BPT, EPA looks at a number of factors. EPA first considers the cost of achieving effluent reductions in relation to the effluent reduction benefits. The Agency also considers the age of the equipment and facilities, the processes employed, engineering aspects of the control technologies, and required process changes, non-water-quality environmental impacts (including energy requirements), and such other factors as the Administrator deems appropriate. See CWA section 304(b)(1)(B)). If, however, existing performance is uniformly inadequate, EPA may establish limitations based on higher levels of control than are currently in place in an industrial category when based on an Agency determination that the technology is available in another category or subcategory, and can be practically applied.

1.1.2 Best Conventional Pollutant Control Technology (BCT)

The 1977 amendments to the CWA required EPA to identify additional levels of effluent reduction for conventional pollutants associated with BCT technology for discharges from existing industrial point sources. In addition to other factors specified in section 304(b)(4)(B), the CWA requires that EPA establish BCT limitations after consideration of a two-part "cost-reasonableness" test. EPA explained its methodology for the development of BCT limitations in July 1986 (51 FR 24974). Section 304(a)(4) designates the following as conventional pollutants: biochemical oxygen demand over 5 days (BOD_5), total suspended solids (TSS), fecal coliform, pH, and any additional pollutants defined by the Administrator as conventional. The Administrator designated oil and grease as an additional conventional pollutant on July 30, 1979 (44 FR 44501; 40 CFR 401.16).

1.1.3 Best Available Technology Economically Achievable (BAT)

BAT represents the second level of stringency for controlling direct discharge of toxic and nonconventional pollutants. In general, BAT effluent limitation guidelines represent the best economically achievable performance of facilities in the industrial subcategory or category. The factors considered in assessing BAT include the cost of achieving BAT effluent reductions, the age of equipment and facilities involved, the process employed, potential process changes, and non-water quality environmental impacts including energy requirements, and such other factors as the Administrator deems appropriate. The Agency retains considerable discretion in assigning the weight to be accorded these factors. An additional statutory factor considered in setting BAT is economic achievability. Generally, EPA determines economic achievability based on total costs to the industry and the effect of compliance with BAT limitations on overall industry and subcategory financial conditions. As with BPT, where existing performance is uniformly inadequate, BAT may reflect a higher level of performance than is currently being achieved based on technology transferred from a different subcategory or category. BAT may be based upon process changes or internal controls, even when these technologies are not common industry practice.

1.1.4 New Source Performance Standards (NSPS)

NSPS reflect effluent reductions that are achievable based on the best available demonstrated control technology. New facilities have the opportunity to install the best and most efficient production processes and wastewater treatment technologies. As a result, NSPS should represent the most stringent controls attainable through the application of the best available demonstrated control technology for all pollutants (i.e., conventional, nonconventional, and priority pollutants). In establishing NSPS, EPA is directed to take into consideration the cost of achieving the effluent reduction and any non-water quality environmental impacts and energy requirements.

1.1.5 Pretreatment Standards for Existing Sources (PSES)

Pretreatment standards apply to discharges of pollutants to publicly owned treatment works (POTWs) rather than to discharges to waters of the United States. PSES are designed to prevent the discharge of pollutants that pass through, interfere with, or are otherwise incompatible with the operation of POTWs. Categorical pretreatment standards are technology-based and analogous to BAT effluent limitation guidelines. The General Pretreatment Regulations, which set forth the framework for the implementation of categorical pretreatment standards, are found at 40 CFR Part 403. These regulations establish pretreatment standards that apply to all nondomestic dischargers. See 52 FR 1586 (January 14, 1987).

1.1.6 Pretreatment Standards for New Sources (PSNS)

Section 307(c) of the Act calls for EPA to promulgate PSNS at the same time it promulgates NSPS. Such pretreatment standards must prevent the discharge of any pollutant into a POTW that may interfere with, pass through, or may otherwise be incompatible with the POTW. EPA promulgates categorical PSES based principally on BAT technology for existing sources. EPA promulgates PSNS based on best available demonstrated technology for new sources. New indirect discharges have the opportunity to incorporate into their facilities the best available demonstrated technologies. The Agency considers the same factors in promulgating PSNS as it considers in promulgating NSPS.

1.2 Effluent Guidelines Plan

In 2004, EPA issued its biannual effluent guidelines plan under section 304(m) of the CWA. This plan announced the initiation of rulemaking for the Airport Deicing Category (69 FR 53705, September 2, 2004).

2. APPLICABILITY AND SUBCATEGORIZATION

This document presents the information and rationale supporting the effluent limitation guidelines and standards for the Airport Deicing Category. Section 2 highlights the applicability and subcategorization basis of this regulation.

2.1 Applicability of the Regulation

Airports in the scope of this regulation are defined as Primary Commercial Airports that conduct deicing activities.

2.2 Subcategorization

The CWA requires EPA to consider a number of different factors when developing effluent limitation guidelines. For example, when developing limitations that represent the BAT for a particular industrial category, EPA must consider among other factors the following: the age of the equipment and facilities in the category, location, manufacturing processes employed, types of treatment technology to reduce the effluent discharges, costs of effluent reductions, and non-water-quality impacts (CWA section 304(b)(2)(B)). The statute also allows EPA to take into account other factors that the EPA Administrator deems appropriate and requires the BAT model technology chosen by EPA to be economically achievable, which generally involves considering both compliance costs and overall financial condition of the industry.

For this rulemaking, EPA evaluated the characteristics of the Airport Deicing Category to determine their potential to provide the Agency with a means to differentiate effluent quantity and quality among facilities. EPA also evaluated the design, process, and operational characteristics of the different industry segments to determine technology control options that might be applied to reduce effluent quantity and improve effluent quality. Based on this analysis, below are the factors that EPA evaluated to determine whether subcategorizing the Airport Deicing Category would be appropriate:

- Aircraft deicing fluid (ADF) usage;
- Federal Aviation Administration (FAA) classifications; and
- Land availability.

2.2.1 ADF Usage

Ethylene glycols (EG) and propylene glycols (PG) are the main ingredients in ADF. Through EPA's research, it became apparent that the volume of glycol required to deice a single aircraft varied greatly depending on a number of variables including weather conditions, aircraft size, and operator training. EPA reviewed industry questionnaire responses and determined that ADF usage is the best indicator for the volume of deicing operations that occur at an airport. ADF usage can range from zero to hundreds of thousands of gallons per year at airports across the United States.

2.2.2 FAA Classification

The Airport and Airway Improvement Act (AAIA) and the FAA classify airports by size based on the volume of commercial traffic. (Noncommercial airports, commonly known as "General Aviation" airports, are not specifically defined by the AAIA.) EPA utilized this classification system to organize its data collection and analysis of the aviation industry. The AAIA defines airports by categories of airport activities, including Commercial Service (Primary and Nonprimary), Cargo Service, and Reliever. Commercial Service Airports are publicly owned airports that have at least 2,500 passenger boardings each calendar year and receive scheduled passenger service. The definition also includes passengers who continue on an aircraft in international flight that stops at an airport in any of the 50 states for a nontraffic purpose, such as refueling or aircraft maintenance rather than passenger activity. Primary Commercial Service airports have more than 10,000 passenger boardings each year. Primary Commercial Service airports are further subdivided into Large Hub, Medium Hub, Small Hub, and Non-hub classifications, based on the percentage of total passenger boardings within the United States in the most current calendar year ending before the start of the current fiscal year.

Early in the regulatory process, EPA assumed that the majority of the deicing in the United States would occur at Primary Commercial Service airports and particularly those with nonpropeller departures. General aviation aircraft, as well as smaller commercial propeller driven aircraft are expected to suspend flights during inclement weather, whereas commercial aircraft with scheduled service are much more likely to deice to meet customer demands.

2.2.3 Land Availability

EPA is aware that airports across the country have different amounts of land that may be available for facility modifications, such as installing environmental controls. EPA collected some basic information from airports on their current configurations. However, neither the aviation industry nor the FAA has developed a standard definition of land availability.

As part of the public comments on the proposed rule, commenters requested that EPA subcategorize airports that would be prohibited from installing deicing pads due to gate, runway, and taxiway space constraints and lack of available land. EPA did not set a spent ADF collection requirement as part of BAT in the final rule and therefore did not separate these airports into their own subcategory.

2.2.4 Conclusions

EPA concludes that establishing formal subcategories is not necessary for the Airport Deicing Category; rather, EPA structured the applicability of the final rule to address the relevant factors and established a set of requirements that encompasses the range of situations that an airport may encounter during deicing operations.

3. DATA COLLECTION ACTIVITIES

To characterize airport deicing operations and to develop the final effluent limitation guidelines and standards, EPA collected and evaluated technical and economic data from a variety of sources. This section describes the following data sources used for the Airport Deicing Category rulemaking effort:

Section 3.1 – Preliminary Data Summary
Section 3.2 – Site Visits
Section 3.3 – Industry Questionnaires (Surveys)
Section 3.4 – Field Sampling
Section 3.5 – Permit Review
Section 3.6 – Deicing Pad Costs
Section 3.7 – Industry-Supplied Data
Section 3.8 – Literature Reviews
Section 3.9 – Data Collected as Part of Public Comments

3.1 Preliminary Data Summary

EPA's initial source of wastewater discharge information for the aviation industry was the *Preliminary Data Summary (PDS): Airport Deicing Operations,* which was published in August 2000 (USEPA, 2000). This study focused on approximately 200 U.S. airports with potentially significant deicing/anti-icing operations. For the study, EPA collected information from industry questionnaires, engineering site visits, wastewater sampling activities, meetings with industry and regulatory agencies, and technical and scientific literature. See Section 3.0 of the PDS for detailed information on the study's data collection activities.

The questionnaires that EPA reviewed included the 1993 Screener Questionnaire for the Transportation Equipment Cleaning Industry and a set of questionnaires distributed during the study to major and regional airports and airlines, technology vendors, and POTWs.

From September 1997 through March 1999, the Agency conducted 16 airport site visits and six sampling episodes to collect information about deicing processes, deicing equipment, and deicing wastewater generation, collection, handling, and treatment technologies.

EPA met with the FAA, deicing fluid manufacturers and formulators, airlines, industry associations, technology vendors, and other interested parties to discuss environmental and operational issues related to aircraft deicing and anti-icing operations.

Literature searches provided information on the toxicity, industry usage, and mitigation techniques for ADFs. The literature also covered topics such as alternative fluid types, pollution prevention practices, economic and financial data, and environmental impacts.

3.2 Site Visits

Between December 2004 and November 2005, EPA conducted 20 airport site visits to collect current information about aircraft and airfield deicing practices, deicing equipment, deicing stormwater generation, collection, handling, and control. During these site visits, EPA also evaluated potential sampling locations for the sampling program described in Section 3.4.

EPA used information collected from the PDS, updated airport literature searches, and other Agency-supplied data to assess potential airports for site visits. EPA also solicited recommendations from industry trade associations, including the Air Transport Association (ATA), the American Association of Airline Executives (AAAE) and Airports Council International-North America (ACI-NA). EPA considered the following criteria in evaluating which airports to visit:

- Hub size and location of the airport;
- ADF handling practices;
- Deicing stormwater collection and control practices; and
- ADF-contaminated stormwater discharge practices.

In general, EPA visited Medium Hub and Large Hub airports operating in northern climates that conduct aircraft and airfield deicing operations each winter. EPA also visited some Small Hub airports to evaluate potential issues related to an airport's size. The Agency visited airports that use a variety of deicing practices (such as gate deicing, centralized deicing pads (CDPs), deicing trucks and stationary booms, infrared deicing hangars) and various deicing stormwater collection and control technologies (such as dedicated deicing stormwater collection systems, stormwater treatment through biological systems, and glycol recovery systems). Table 3-1 lists the 20 airports visited in 2004 and 2005, the visit dates, and EPA's rationale for selecting each for a site visit. This table also lists a post-proposal site visit conducted at Boston Logan airport.

During the site visits, EPA collected the following information:

- General airport and deicing operations information, including size and age of the airport, permit status, information on the entities that perform deicing operations (both aircraft and airfield), and current airline tenant information;
- Description of the deicing/anti-icing operations conducted at the airport, including the types of equipment used, locations of deicing operations, and information on any pollution prevention or "state-of-the-art" systems in use at the airport that improved their deicing operations;
- Deicing chemicals used, including ADF type (e.g., Type I-IV), pavement deicer type, and any chemical usage information available;
- Description of the deicing stormwater collection and control systems used at the airport, including any glycol recovery or stormwater treatment systems and their effectiveness and any available cost information for these systems; and
- Airport monitoring and discharge of deicing stormwater, including pollutants monitored and frequency of monitoring.

This information is documented in the Site Visit Report (SVR) for each airport visited.

Table 3-1. Airports Visited

Airport Name	Airport Code	Date of Visit	Airport Details
Washington Dulles International	IAD	12/1/2004	Local Large Hub airport, ADF-contaminated stormwater collection and glycol recovery, indirect discharger
Baltimore-Washington International	BWI	12/15/2004	Local Large Hub airport, deicing pads, ADF-contaminated stormwater collection, indirect discharger
Chicago O’Hare International	ORD	1/26/2005	Large Hub airport, ADF-contaminated stormwater collection with indirect discharge, upgrades to system since the PDS site visit
General Mitchell International (Milwaukee)	MKE	1/27/2005	Medium Hub airport, ADF-contaminated stormwater collection and indirect discharge, extensive monitoring data in collaboration with U.S. Geological Survey (USGS)
Detroit Metropolitan Wayne County	DTW	1/28/2005	Large Hub airport, deicing pads, ADF-contaminated stormwater collection with glycol recovery, both direct and indirect discharger
Ronald Reagan Washington National	DCA	2/1/2005	Local Large Hub airport, changes in ADF practices since PDS site visit, ADF-contaminated stormwater collection
Syracuse Hancock International	SYR	2/9/2005	Small Hub airport, deicing pads, aerated stormwater lagoons, indirect discharger
Albany International	ALB	2/10/2005	Small Hub airport, ADF-contaminated stormwater collection with anaerobic and aerobic treatment, direct discharger, upgrades to system since PDS site visit
Pittsburgh International	PIT	2/10/2005	Large Hub airport, deicing pads, glycol recovery and treatment (ultra filtration and reverse osmosis) of ADF-contaminated stormwater, direct discharger
Cincinnati/Northern Kentucky International	CVG	2/11/2005	Large Hub airport, variety of ADF-contaminated stormwater-related activities, recommended by FAA as a site visit location, on-site aerobic treatment, direct and indirect discharger
Richmond International	RIC	2/16/2005	Local Small Hub airport
Minneapolis/St. Paul International/World-Chamberlain	MSP	2/18/2005	Large Hub airport, ADF collection with glycol recovery, direct and indirect discharger
James M Cox Dayton International	DAY	2/25/2006	Small Hub airport, centralized deicing with ADF-contaminated stormwater collection
Portland International (Oregon)	PDX	7/26/2005	Medium Hub northwestern airport, indirectly discharges high-strength deicing stormwater, sends low-strength deicing stormwater to detention pond and then to direct discharge
Seattle-Tacoma International	SEA	7/27/2006	Large Hub northwestern airport, industrial stormwater treatment on site
LaGuardia (New York)	LGA	10/11/2005	Large Hub airport, direct discharger, part of New York City area visits

Table 3-1 (Continued)

Airport Name	Airport Code	Date of Visit	Airport Details
John F. Kennedy International (New York)	JFK	10/11/2005	Large Hub airport with a high percentage of international flights, direct discharger, part of New York City area visits, future plans for infrared deicing
Newark Liberty International	EWR	10/12/2005	Large Hub airport, infrared deicing technology since 1999
Salt Lake City International	SLC	11/8/2005	Large Hub western airport, ADF-contaminated stormwater collection with glycol recovery
Denver International	DEN	11/9/2005	Large Hub western airport, deicing pads, ADF-contaminated stormwater collection with glycol recovery
General Edward Lawrence Logan International	BOS	3/21/2011	Space-constrained airport with no ADF-contaminated stormwater collection and direct discharge

3.3 Industry Questionnaires (Surveys)

EPA distributed three questionnaires to directly support the Airport Deicing rulemaking. Section 3.3.1 discusses the recipient selection process, distribution, and mail-out results for the three airport deicing questionnaires. Section 3.3.2 discusses the organization of and type of technical information requested in each questionnaire.

3.3.1 Recipient Selection and Questionnaire Distribution

EPA distributed a screener questionnaire followed by a detailed airline questionnaire to airlines, and a questionnaire to airports. The overall focus of the questionnaires was on airports and airlines that perform deicing and anti-icing on aircraft and/or airfield pavement. EPA selected airports for the airport questionnaire by airport type (i.e., Large Hub, Medium Hub, Small Hub, and Non-hub), days and amount of snow or freezing precipitation, and the number of departures. EPA performed a census design for large and Medium Hub[1] airports and a stratified random sample design for small and Non-hub airports (see the *Statistical Support Memorandum* DCN AD01208).

EPA selected recipients for the airline screener questionnaire by identifying airlines with greater than 1,000 departures per year at those airports selected for the airport questionnaire. EPA selected airlines for the detailed airline questionnaire based on the airline screener questionnaire responses (which identified whether an airline deiced its aircraft or used some other entity) at the specified airports. To reduce respondent burden, EPA asked the selected

[1]FAA classifies large commercial airports into size categories of “hubs,” based on the number of annual enplanements that occur at the airport. Enplanements represent the number of passengers boarding the plane for departure. Large Hubs are airports that represent more than 1 percent of total U.S. passenger enplanements. Medium Hubs are airports that account for more than 0.25 percent but less than 1 percent of total passenger enplanements. Small Hubs enplane 0.05 to 0.25 percent of the total passenger enplanements. Airports with less than 0.05 percent of the total passenger enplanements but more than 10,000 annual enplanements are considered Non-hub primary airports.

airlines to provide data on a limited subset of the airports they served for which they were expected to use the maximum amount of deicing chemicals.

Table 3-2 summarizes the number of questionnaires distributed in each category and their response rates.

Table 3-2. Deicing Questionnaire Response Rates

Questionnaire Type	Distributed	Returned Undelivered	Returned Completed	Not Returned
Airport Deicing Questionnaire	153	0 (0%)	150 (98%)	3 (2%) [1]
Airline Screener Questionnaire[2]	72	1 (1%)	70 (97%)	1 (1%)
Airline Deicing Detailed Questionnaire	58	0 (0%)	49 (84%)	9 (16%)

[1] EPA determined that one airport recipient was out of scope and removed it from the sample frame.
[2] Information was collected from an additional 22 foreign carriers.

3.3.1.1 Airport Questionnaire

EPA selected 153 airports to receive the airport questionnaire and distributed the questionnaire to these airports in April 2006. Of the 153 airport questionnaires distributed, 150 were completed and returned. EPA removed one of the three nonrespondent airports from the sample frame because it was a city airport operating as a tenant at a military airport. EPA determined that its selection was based on data for the military airport operations, not the city airport, and military airports were not included in the sample frame.

3.3.1.2 Airline Screener Questionnaire

EPA initially selected 72 airlines as recipients of the screener questionnaire. The recipient group comprised a random sample of airlines with greater than 1,000 departures per year operating at the airports selected for the airport questionnaire. In April 2006, the Agency distributed the airline screener questionnaire to the 72 airlines. EPA also identified 22 additional foreign airlines for which information would be useful in developing effluent guidelines, but that were not captured by the random sample. EPA collected aircraft deicing and anti-icing information for these 22 foreign carriers through contacts with airport managers where the carriers operated.

Of the 72 screener questionnaires distributed, 70 were completed and returned to EPA. Of the two not returned, one questionnaire was returned undelivered, as the airline had ceased operations.

3.3.1.3 Airline Detailed Questionnaire

Using the responses from the airline screener questionnaire, EPA selected and sent a more detailed questionnaire to 58 airlines that responded they deice planes at any of the airports that received an airport questionnaire. This questionnaire was distributed in March 2007. The selection included 448 airline/airport combinations. The Agency categorized the airline/airport combinations according to the entity that performed most of the deicing for the 2002/2003, 2003/2004, and 2004/2005 winter seasons as listed below:

- Airline/airport combinations that deice their own aircraft;
- Airline/airport combinations that contract to fixed-base operators (FBOs) for deicing services; or
- Airline/airport combinations that contract to other airlines for deicing services.

Of the 58 airline detailed questionnaires sent, 49 were completed returned and nine were not returned.

3.3.2 Questionnaire Information Collected

EPA designed the questionnaires to collect current information with sufficient detail to support development of effluent guidelines. The questionnaires collected information on deicing operations performed on aircraft and airfield pavement, including deicing stormwater generation, collection, characterization, management, and treatment. The airline screener supported the selection of recipients for the airline detailed questionnaire. This section describes the technical information collected and the purpose of each of the three questionnaires.

3.3.2.1 Airport Questionnaire

EPA divided the airport deicing questionnaire into the following parts and sections:

PART A: TECHNICAL INFORMATION

Section 1: General Airport Information
Section 2: Airport Deicing and Anti-Icing Operations
Section 3: Deicing Stormwater Containment and/or Collection
Section 4: Deicing Stormwater Treatment/Recovery
Section 5: Analytical Data
Section 6: Pollution Prevention Practices

PART B: FINANCIAL AND ECONOMIC INFORMATION

Section 1: Ownership and Management Structure
Section 2: Airport Finances
Section 3: Capital Expenditures
Section 4: Airport Operations

Part A, Section 1 (Questions 1 through 24) requested information to identify the airport and primary contacts, to confirm that aircraft deicing/anti-icing was performed during the three designated winter seasons (2002/2003, 2003/2004, and 2004/2005), and to characterize deicing operations. This information included the destination of deicing/anti-icing stormwater, receiving surface waters, the entity that performed aircraft and/or airfield pavement deicing, and the number of deicing/anti-icing days per winter season. This information helped EPA update the industry profile on airports deicing in the U.S., characterize deicing/anti-icing operations, and determine the proximity and types of ecosystems within and beyond airport boundaries

Part A, Section 2 (Questions 25 through 31) requested detailed information about airport deicing/anti-icing stormwater sources, flows, and destinations as well as deicing/antiicingchemicals, materials, and practices. EPA used this information to develop an industry profile of deicing stormwater generation and collection, to determine baseline loadings using airfield deicing chemical usage, and to develop and evaluate possible regulatory technology options and compliance cost estimates.

Part A, Section 3 (Questions 32 through 39) requested information on the collection, containment, conveyance, discharge and/or disposal methods for deicing stormwater, and pollution prevention and best management practices. EPA used this information to develop an industry profile of deicing stormwater collection/containment/conveyance methods and to evaluate pollution prevention and best management practices.

Part A, Section 4 (Questions 40 through 51) requested information on deicing stormwater treatment technologies and units operated by the airport, including deicing stormwater treatment diagrams, design and operating specifications, sources of wastewater influent, treatment chemical additions, treatment operations and maintenance costs, and discharge practices. EPA used this information to develop control technology options, regulatory options, and compliance cost estimates.

Part A, Section 5 (Questions 52 through 55) requested information concerning the availability of deicing stormwater characterization data, receiving water in-stream monitoring data, and/or data characterizing the effectiveness of treatment of deicing stormwater. EPA used this information to follow up with selected airports to request long-term monitoring data, to estimate pollutant discharge loadings, to characterize behavior of the discharge in the receiving water, to assess deicing stormwater treatment technologies, and to assess environmental impacts.

Part A, Section 6 (Questions 56 through 68) requested information to evaluate the status of pollution prevention practices at each airport and to identify pollution prevention technologies. EPA used this information to identify appropriate practices as regulatory options and to prepare an industry profile of pollution prevention practices.

Part B of the questionnaire requested airport financial and economic information. Section 1 requested information on the ownership and management structure that EPA used to develop the industry profile and to estimate economic impacts of an effluent guideline. Section 2 requested information on operation finances that EPA used to project the potential impacts of the rule. Section 3 requested information on current capital airport expenditures that EPA used to assess the capability of airports to pay for deicing-related capital improvements. Section 4 requested information on the finances for airport operations, including the airport's financial statement, which EPA used to determine the airport's cost of capital.

3.3.2.2 Airline Screener Questionnaire

The airline screener questionnaire included three questions. Question 1 requested the contact information for the airline should EPA need to verify or clarify their response. Question 2 asked who (the airline, another airline, FBO, or private contractor) performed most of the deicing/anti-icing on the respondent's aircraft at specific airports. Question 3 provided an opportunity for the respondent to provide additional information or comment on its responses. EPA used this information to identify potential airline detailed questionnaire recipients and to indicate the potential contribution of FBOs to deicing operations and to the discharge of ADF-contaminated stormwater.

3.3.2.3 Airline Detailed Questionnaire

EPA divided the airline detailed questionnaire into the following parts and sections:

PART A: TECHNICAL INFORMATION

Section 1: General Airline Information
Section 2: Airline Deicing and Anti-Icing Operations (at each airport specified in Section 1)
Section 3: Pollution Prevention Practices (at each airport specified in Section 1)

PART B: DEICING COSTS AND OPERATIONS

Section 1: Airline Deicing Costs and Operations
Section 2: Airport-Specific Deicing Costs and Operations

Part A, Section 1 (Questions 1 through 4) requested verification of the airline name and address and identification of the primary and secondary contacts to clarify or verify the technical questionnaire responses.

Part A, Section 2 (Questions 5 through 18) requested information on deicing/anti-icing operations performed by the airline or for the airline at each specified airport. The Agency used this information to:

- Develop an industry profile of ADF usage and deicing stormwater generation;
- Estimate pollutant loadings;
- Characterize deicing stormwater;
- Evaluate differences in airport deicing stormwater generation and characteristics;
- Identify pollutants of concern; and
- Identify opportunities for pollution prevention through chemical substitution and best management practices.

Part A, Section 3 (Questions 19 through 31) requested information on the airline's pollution prevention practices including a description of each practice and any costs and/or savings from its implementation. The Agency evaluated this information to identify appropriate practices that could become part of regulatory options and to develop an industry profile.

Part B of the questionnaire requested airline financial and economic information. Section 1 requested information on ownership, aircraft deicing costs and operations, and the airline's financial statement, that EPA used to develop the industry economic profile and to conduct the economic analysis. Section 2 requested detailed information regarding airline-specific deicing costs and operations at specific airport locations. The Agency also used this information for the industry economic profile and to determine the economic impacts of the rule.

3.3.3 Questionnaire Review, Coding, and Data Entry

EPA reviewed the screener and the two detailed questionnaires for completeness, accuracy, and consistency of the responses. In some cases, the Agency followed up with the airport or airline by email or telephone to clarify responses or to obtain missing or incomplete information. During the review, EPA coded responses to facilitate entry of data into the airline screener and the airline and airport questionnaire databases.

The Agency developed databases containing the information provided by questionnaire respondents of each questionnaire. After detailed review and coding, EPA entered data from the questionnaires into the appropriate database using a double-key-entry and verification procedure to identify and resolve differences between the two data entry tasks.

3.4 Field Sampling

EPA conducted sampling episodes at six airports from March 2005 through August 2006 to characterize ADF and ADF-contaminated stormwater discharges and to evaluate treatment technologies for stormwater affected by aircraft and airfield deicing practices. EPA used existing industry profile information and information collected during airport site visits to determine the most appropriate locations for sampling. The Agency evaluated the following criteria for selecting sampling sites:

- Size and location of the airport;
- Deicing stormwater collection and control practices; and
- ADF-contaminated stormwater discharge practices.

EPA conducted the episodes to characterize deicing stormwater and assess the capabilities and effectiveness of several different treatment technologies such as anaerobic treatment, aerobic treatment, distillation, reverse osmosis, mechanical vapor recompression, aeration, and chemical addition. Table 3-3 lists the airports selected for EPA sampling, the reason for selection, and the points that were sampled.

3.5 Permit Review

During the regulatory development process, EPA reviewed National Pollutant Discharge Elimination System (NPDES) permits to understand what permit authorities are currently requiring of airports with respect to deicing stormwater control. Using the data gathered during the permit review assisted EPA in:

1. Assessing the current state of deicing stormwater control;
2. Evaluating the effectiveness of various deicing stormwater control measures; and
3. Identifying potential measures that EPA could use to further control deicing stormwater.

Table 3-3. Airports Selected for Sampling and the Reason for Their Selection

Airport Name	Airport Code	Dates of Sampling	Reason for Sampling	Sample Points
Detroit Metropolitan Wayne County Detroit, MI Episode 6508	DTW	3/31/05	Collects highly concentrated ADF for recycling, significant stormwater volumes, direct and indirect discharger	• Untreated deicing stormwater • Effluent from ADF-contaminated stormwater collection pond • Effluent from pavement deicer stormwater collection pond • ADF, as applied • Quality control (QC) samples [1]
Minneapolis/St. Paul International Minneapolis/St. Paul, MN Episode 6509	MSP	4/28/05	On-site collection and recycling facility, direct and indirect discharger	• High concentration ADF-contaminated stormwater storage tank • Low concentration ADF-contaminated stormwater storage tank • Influent to pavement deicer stormwater collection pond • Effluent from pavement deicer stormwater collection pond • ADF, as applied • QC samples [1]
Albany International Albany, NY Episode 6523	ALB	2/5/06-2/10/06	Reported recovery efficiency of 72% of applied ADF through collection and treatment (anaerobic and aerobic) of ADF-contaminated stormwater	• Influent to anaerobic treatment • Effluent from anaerobic treatment • Effluent from aerobic treatment • QC samples [1]
Pittsburgh International Pittsburgh, PA Episode 6528	PIT	2/26/06-3/3/06	Reported recovery efficiency of 60-66% of applied ADF through collection and treatment (ultrafiltration and reverse osmosis (RO)) of ADF-contaminated stormwater	• Influent to RO treatment • Effluent from RO treatment • QC samples [1]
Denver International Denver, CO Episode 6522	DEN	3/26/06-3/31/06	ADF-contaminated stormwater collection with glycol recovery	• Influent to mechanical vapor recompressions (MVRs) • Influent to distillation column • Distillate from MVRs • Overhead from distillation column • Effluent from treatment • QC samples [1]
Greater Rockford Rockford, IL Episode 6529 and 6530	RFD	4/20/06 and 8/29/06	On-site aerated lagoon treatment system (run in batch mode) for its deicing-contaminated stormwater	<u>Spring Sampling</u> • Influent to aerobic pond treatment • QC samples [1] <u>Summer Sampling</u> • Effluent from aerobic pond treatment • QC samples [1]

3.5.1 Airport Selection for Permit Review

For this review, EPA selected the top 50 U.S. airports based on ADF usage. At the time of review, usage estimates from the airline survey were not available; therefore, EPA estimated the airports with the highest usage using a "weighting factor" based on the number of snow or freezing precipitation (SOFP) days and commercial departures as a measure of ADF usage. Table 3-4 displays the results of the weighting factor analysis and lists the 50 airports for which EPA reviewed permits.

3.5.2 Obtaining NPDES Permits

From the list of selected airports for permit review, EPA identified those for which it already had permits. While airports were not required to submit permits as part of their questionnaire response, some airports did so. Furthermore, there were some permits already available in the airport deicing record files. Therefore, as a first step, EPA reviewed available documentation and survey responses to identify in-house permit availability.

As a next step, EPA identified NPDES permit numbers for those permits not available in-house. Some airports reported permit numbers in the airport questionnaire, so in these cases, EPA obtained the data from the questionnaire database. For the remaining airports, EPA searched its Envirofacts search tool by facility name, location, SIC code (4581), or a combination of any of the three to obtain the permit numbers.

After identifying the permit numbers, EPA obtained a copy of the permit from a state or regional permit database. If a permit was not available online, EPA contacted the appropriate regional, state, or local permitting authority to obtain a copy. If still unsuccessful in obtaining the permit, EPA contacted the airport directly to request a copy.

There were a few airports for which EPA could not identify permit numbers from either the questionnaires or Envirofacts. For these airports, EPA searched the Internet or contacted permitting authorities or the airports directly to obtain a copy of the permit.

3.5.3 Permit Review Process

The objectives of the permit review were to answer the following questions:

- What are the monitoring requirements for deicing area outfalls?
- What pollutants are monitored?
- Are there numeric limits listed in the permit for deicing area outfalls?
- What parameters are limited?
- What are the limits for each parameter?
- How were the limits developed?
- Are there deicing operation best management practices (BMPs) required by the permit?
- What BMPs are required?
- When does the permit expire?
- If it is a general permit, are there differences between the permit and the EPA Multi-Sector General Permit (MSGP)?

Table 3-4. Top 50 Airports in the United States with the Highest ADF Usage, Estimated Based on SOFP Days and Total Airport Departures

Rank	Airport ID	Airport Code	Airport Name	State	SOFP Days	Total Airport Departures	Weighting Factor SOFP Days × Departures ÷ 100,000
1	1006	ORD	Chicago O'Hare International	IL	26	467,721	121.6
2	1126	MSP	Minneapolis /St Paul International – Wold-Chamberlain	MN	41	246,286	101.0
3	1138	DTW	Detroit Metropolitan Wayne County	MI	31	250,629	77.7
4	1028	DEN	Denver International	CO	26	264,051	68.7
5	1012	ANC	Ted Stevens Anchorage International	AK	55	88,126	48.5
6	1053	BOS	General Edward Lawrence Logan International (Boston)	MA	26	186,253	48.4
7	1113	CVG	Cincinnati/Northern Kentucky International	KY	17	247,165	42.0
8	1069	CLE	Cleveland – Hopkins International	OH	36	116,569	42.0
9	1142	IAD	Washington Dulles International	DC	17	238,635	40.6
10	1107	PIT	Pittsburgh International	PA	31	125,143	38.8
11	1145	EWR	Newark Liberty International	NJ	16	203,082	32.5
12	1095	MDW	Chicago Midway International	IL	26	108,385	28.2
13	1139	PHL	Philadelphia International	PA	12	227,749	27.3
14	1136	MKE	General Mitchell International (Milwaukee)	WI	31	85,128	26.4
15	1029	LGA	La Guardia (New York City)	NY	12	192,127	23.1
16	1066	SLC	Salt Lake City International	UT	14	160,472	22.5
17	1010	FAI	Fairbanks International	AK	89	24,919	22.2
18	1011	STL	Lambert - St Louis International	MO	17	129,414	22.0
19	1148	MCI	Kansas City International	MO	27	76,016	20.5
20	1021	BUF	Buffalo Niagara International	NY	48	41,916	20.1
21	1089	JFK	John F Kennedy International (New York City)	NY	12	154,606	18.6
22	1024	IND	Indianapolis International	IN	21	83,769	17.6
23	1141	DCA	Ronald Reagan Washington National	DC	12	134,346	16.1
24	1129	BDL	Bradley International (Windsor Locks)	CT	31	51,389	15.9
25	1059	ROC	Greater Rochester International	NY	44	35,726	15.7

Table 3-4 (Continued)

Rank	Airport ID	Airport Code	Airport Name	State	SOFP Days	Total Airport Departures	Weighting Factor SOFP Days × Departures ÷ 100,000
26	1111	CMH	Port Columbus International	OH	26	59,938	15.6
27	1036	BWI	Baltimore - Washington International	MD	12	124,033	14.9
28	1026	DFW	Dallas/Fort Worth International	TX	4	360,933	14.4
29	1065	ALB	Albany International	NY	36	39,324	14.2
30	1080	SYR	Syracuse Hancock International	NY	44	30,840	13.6
31	1140	MEM	Memphis International	TN	8	166,910	13.4
32	1128	CLT	Charlotte/Douglas International	NC	6	214,396	12.9
33	1079	MHT	Manchester	NH	36	34,860	12.5
34	1058	GRR	Gerald R Ford International (Grand Rapids)	MI	48	25,015	12.0
35	1037	IAH	George Bush Intercontinental (Houston)	TX	4	248,339	9.9
36	1123	DAY	James M Cox Dayton International	OH	26	35,709	9.3
37	1020	ATL	Hartsfield - Jackson Atlanta International	GA	2	459,765	9.2
38	1121	PVD	Theodore Francis Green State (Providence)	RI	21	43,671	9.2
39	1147	RDU	Raleigh - Durham International	NC	10	86,302	8.6
40	1068	OMA	Eppley Airfield (Omaha)	NE	26	33,022	8.6
41	1105	GEG	Spokane International	WA	31	27,269	8.5
42	1108	SDF	Louisville International - Standiford Field	KY	12	65,586	7.9
43	1124	DSM	Des Moines International	IA	31	23,951	7.4
44	1074	SBN	South Bend Regional	IN	48	13,722	6.6
45	1153	CAK	Akron - Canton Regional	OH	41	14,911	6.1
46	1109	ILN	Airborne Airpark (Wilmington)	OH	21	25,508	5.4
47	1018	GSO	Piedmont Triad International (Greensboro)	NC	14	38,257	5.4
48	1100	TOL	Toledo Express	OH	36	14,385	5.2
49	1022	FWA	Fort Wayne International	IN	31	16,247	5.0
50	1051	HYA	Barnstable Municipal - Boardman/Polando Field (Hyannis)	MA	26	18,782	4.9

EPA also consulted Envirofacts as necessary to fill in any numeric limit data gaps from the permits and to cross-check for accuracy with the permitted limits.

To facilitate interpreting the results, EPA created a Microsoft® Access database to store the data obtained from the reviews. The database consists of two tables: a General Information table, and a Pollutant-Specific Information table. Table 3-5 and Table 3-6 detail the database table descriptions. A summary of the permit review is presented in the memorandum *Airport Deicing Operations NPDES Permit Review Summary* (ERG, 2007).

Table 3-5. Permit Review General Information Table

Data Element	Data Element Description
AirportID	The airport identification number used for the Airport Questionnaire
Permit_ID	The airport NPDES identification number
Permit_Expiration	The permit expiration date
Permit_BMPs	A checkbox that identifies the presence of BMPs in the permit
Permit_BMPs_Description	A field that allows the BMPs in the permit to be listed
General_Permit	A checkbox that identifies general permits
General_Permit_Difference from MSGP	A field that describes any differences that exist between general permits and the MSGP
Permit_Monitoring	A checkbox that indicates if the permit requires monitoring
Permit_Limits	A checkbox that indicates if the permit has numeric limits
Permit_Limit_Rationale	A field that describes what rationale was used to determine the limits in the permit

Table 3-6. Permit Review Pollutant-Specific Information Table

Data Element	Data Element Description
AirportID	The airport identification number used for the detailed airport questionnaire.
Permit_SamPoint	The outfall/sampling area identifying number.
Permit_Stream_Description	The description of the outfall/sampling area. EPA tried to determine which outfalls receive deicing stormwater and to include only information from those outfalls. If the deicing outfalls cannot be determined, EPA included all outfalls.
Permit_Pollutant	The pollutants that are monitored and/or limited at each outfall, using the following same codes that are used in the questionnaire database: • BOD • COD (chemical oxygen demand) • Fecal coliform • Metal • N (nitrogen) • OG (oil & grease) • ORG (organic pollutants) • pH • TOC (total organic carbon) • TSS • Other
OtherDesc	If a pollutant is monitored/limited that does not have a code, "Other" was selected as the Permit_Pollutant and the pollutant name was entered in this field. This method of tracking pollutants was used to be consistent with the questionnaire database.
PermitTimes PermitFreq	To be consistent with the questionnaire database, the frequency of monitoring for each pollutant and outfall was recorded in the PermitTimes and PermitFreq fields. These fields allow the frequency to be reported in a number/unit manner. For example, a yearly report is entered as PermitTimes = 1 and PermitFreq = Year. Frequency Codes were also used in the PermitFreq field for daily (D), monthly (M), and quarterly (Q) reports.
PermitLimitNumeric	The numeric value of the permit limit for each pollutant and outfall.
PermitLimitUnit	The unit of the permit limit for each pollutant and outfall.
LimitType	Indicates whether the limit is a minimum value, maximum value, average, or simply a reporting requirement. This also incorporates the time span of the limit using the frequency codes as above (e.g., daily maximum = DMAX; weekly average = WAVG).
Season	For deicing outfalls, the limits may vary by season for various parameters. Usually, this field is populated with Summer, Winter, or All (as in year-round).

3.6 Deicing Pad Costs

To evaluate the potential financial impacts of deicing pads for new airports, EPA reviewed deicing pad cost information received from airports. EPA collected deicing pad costs from Pittsburgh International airport and Minneapolis/St. Paul airport during the site visits, and information was provided by Akron-Canton Regional airport via email on May 3, 2007, and from Cleveland-Hopkins International airport as part of comments in its airport questionnaire response.

3.7 Industry-Submitted Data

Based on airport site visits, EPA sampling episodes, and responses to the airport questionnaire, EPA requested costing and long-term analytical data for managing deicing stormwater from specific airports. The Agency used this information to develop control technology options and compliance cost estimates, and to evaluate pollution prevention and best management practices.

Table 3-7 and Table 3-8 list those airports providing data, the type of system used to manage or treat the airport's deicing stormwater, and the costing and/or analytical data submitted by the airport.

Table 3-7. Summary of Costing Data Provided by Industry

Airport	Type of Deicing Stormwater Management	Costing Data Provided
Akron-Canton Regional	Anaerobic ADF-contaminated stormwater treatment system	Capital and operating and maintenance costs for the airport's new anaerobic fluidized bed (AFB) treatment system
Albany International	AFB/aerobic ADF-contaminated stormwater treatment system	Capital and operating and maintenance costs for the airport's AFB/aerobic treatment system
Cincinnati/Northern Kentucky International	Glycol recovery and recycling system	Capital and operating and maintenance costs for glycol collection and treatment
Denver International	Storage, recovery, and recycling; MVR and distillation system	Capital costs for storage and the recycle/recovery system
General Mitchell International	Recovery and recycling; anaerobic digester	Engineering and monitoring-related costs
Minneapolis/St. Paul International –Wold Chamberlain	ADF collection (deicing pads, plug and pump system)	Capital costs for deicing pads and operating and maintenance costs for plug and pump system
Pittsburgh International	ADF collection at deicing pads; ADF-contaminated stormwater recovery and recycling	Operating and maintenance costs for deicing pads
Seattle-Tacoma International	ADF to industrial waste treatment plant	Study costs for determining all known and reasonable technology (AKART) for handling aircraft deicing fluids

Table 3-8. Summary of Long-Term Analytical Data Provided by Industry

Airport	Type of Deicing Stormwater Management	Long-Term Analytical Data Provided
Albany International	Anaerobic/aerobic ADF-contaminated stormwater treatment	Ammonia, COD
Denver International	Storage, recovery, and recycling; MVR/distillation	COD
Detroit Metropolitan – Wayne County	Recycling; distillation and recovery	Ammonia
Pittsburgh International	Ultrafiltration/Reverse Osmosis; ADF-contaminated stormwater recovery and recycling	Ammonia, urea
Salt Lake City International	ADF recovery and recycling	COD

3.8 Literature Reviews

EPA conducted preliminary literature searches during the effluent guideline development process to supplement information acquired from site visits, sampling, and questionnaires. The purpose for the literature searches was three-fold:

- To collect information on current airport deicing practices and trends, and gather information on state-of-the-art deicing stormwater treatment and/or glycol recovery technologies;
- To collect available data from airports currently monitoring wastewater discharges; and
- To obtain studies on the toxicity and environmental impact of current deicing fluids and deicing discharges.

The following sections list the data sources used for each literature search.

3.8.1 Current Deicing Practices and Treatment Technologies

EPA performed keyword searches on three online search engines: 1) Cambridge Scientific Abstracts (CSA); 2) Dialog Version 5.0; and 3) Google™. CSA provides access to over 50 databases published by CSA and its publishing partners, such as Aqualine, Environmental Sciences & Pollution Management Database, and Water Resources Abstracts. Dialog provides access to over 900 databases and handles more than 700,000 searches. The databases in Dialog that contain articles pertaining to airport deicing are BIOSIS Toxicology, Life Sciences Abstracts, Institute for Science Information, ProQuest Info & Learning, Ei Compendex, Enviroline, TGG National Newspaper Index, GeoBase, National Technical Information Service (NTIS), and Wilson Applied Science & Technology Abs.

The keywords for the literature searches included: airport deicing, aircraft, airfield, runway, aircraft deicing, aircraft deicing fluid (ADF), runway deicing, anti-icing, anti-icing fluid, airport stormwater, snow melt, centralized deicing pads, environmental assessment, environmental impact study (EIS), fish mortality, fish kill, and publicly owned treatment works.

EPA also used other online journal databases, such as Science Direct, Scirus, and Infotrak, for subject-specific articles. The treatment technologies featured in the articles found included:

- AFB reactor/ biological treatment;
- Aerated storage tanks;
- Anaerobic co-digestion of ADF and municipal wastewater sludge;
- Batch-loaded AFB reactor;
- Glycol reclamation/recycling and concentration;
- Infrared technology;
- Phytoremediation;
- Plant-enhanced remediation;
- Spray irrigation;
- Subsurface-flow constructed wetlands; and
- Surface detention ponds.

3.8.2 Current Airport Deicing Discharge Data

In addition to sampling and airport questionnaire data, EPA procured airport deicing discharge information from its Permit Compliance System (PCS) database and online journals. EPA downloaded all data reports from PCS for SIC code 4581: Airports, flying fields, and services. Not all airports report this data to their permitting authority, so the scope of discharge data is limited. The pollutant parameters include temperature, dissolved oxygen, BOD, TSS, metals, fecal coliform, aromatic hydrocarbon, pH, and oil and grease. For online searches, EPA procured journals that discussed deicing discharge containing ADF chemicals such as benzotriazole, propylene/ethylene glycol, and alklyphenol ethoxylates. EPA also collected monitoring data during the site visit to the Minneapolis/St. Paul International Airport.

3.8.3 Chemical Information and Environmental Impact Studies

The methodology and databases used for chemical information and environmental impact study findings are similar to those used for the deicing practices and treatment technology search. EPA conducted searches for the following categories:

- **Chemical Properties of ADF Ingredients:** Physical appearance, structure, solubility, reactivity;
- **Human Toxicity:** Inhalation, ingestion, dermal effect, oral rat lethal dose (LD_{50}) values;
- **Aquatic Toxicity:** Aquatic life lethal concentration (LC_{50}) values; and
- **Chemical Fate and Transport:** Soil sorption, fate in river, streams, and estuaries, breakdown pathways in anaerobic and aerobic conditions, and biodegradability.

In addition to journal articles, EPA gathered chemical information from Material Safety Data Sheets (MSDSs), Chemfinder.com, the Pesticides Action Network (PAN) Pesticides Database, and the U.S. Patents Database.

The keywords for the pollutant term search included: PG, PG-based fluids, EG, EG-based fluids, urea, potassium acetate, calcium magnesium acetate (CMA), sodium acetate, sodium formate, dissolved oxygen, biodegradation, BOD, and ADF additives (e.g., tolytriazole, benzotriazole, nonylphenols, nonylphenol ethoxylate, etc.).

3.8.4 Current Deicing Discharge Regulations

In addition to the data sources described above, EPA searched the Internet using Google™ to review regulatory documents that contain guidelines, operation controls, management programs, laws, statutes, and certification requirements related to airport deicing from the United States, Canada, Germany, Norway, and other European countries.

3.9 Data Collected Based on Public Comments

EPA collected and received limited additional information as part of the public comment process. This section summarizes the information EPA collected as part of and in response to public comments on the proposed rule and the types of data provided as part of the public comments. Section 3.9.1 summarizes information that EPA collected to confirm deicing pad use and operations at major airports and data collected to supplement the costing effort in response to comment. Section 3.9.2 summarizes the types of data submitted as part of the public comments to the proposed rule.

3.9.1 EPA-Collected Data

EPA received comments on the proposed regulation that airports that had previously installed deicing pads did not use them for all flights that required deicing. EPA contacted the following airports in early August 2010 to confirm information on the airport's deicing pad use and operations:

- Minneapolis/St. Paul International Airport (MSP);
- Washington Dulles International Airport (IAD);
- Philadelphia International Airport (PHL);
- Detroit Metropolitan/Wayne County Airport (DTW);
- Denver International Airport (DEN);
- Cleveland-Hopkins International Airport (CLE);
- Salt Lake City International Airport (SLC); and
- Pittsburgh International Airport (PIT).

Table 3-9 summarizes the information collected for these airports.

EPA also collected additional post-proposal information as part of revisions to the costing analysis in response to specific public comments. Additional costing information collected by EPA included drainage cover data that it used in conjunction with existing cost data for Glycol Collection Vehicles (GCVs). The supplemental data collected to inform GCV costing is summarized in a memorandum entitled *Estimated Capital and Operation and Maintenance Costs for Glycol Collection Vehicle Operation* (ERG, 2010a). EPA also collected vendor data related to liquid application and storage of airfield deicing chemicals. These data are summarized in the memorandum entitled *Estimated Costs for Transition to Liquid Airfield Deicing Application from Solid Airfield Deicing* (ERG, 2010b). In addition, Section 10 presents the liquid application and storage of airfield deicing chemical cost data used in developing the final rule cost analysis.

Table 3-9. Selected Airport Information Related to Deicing Pad Operations

Airport	Deicing Pad Operations Data
Minneapolis/St. Paul International Airport	1. MSP encourages the use of deicing pads and requires deicing in contained locations only. ADF stormwater is contained through deicing pad use (and its collection system), block and pump, and cover and sweep (using glycol collection vehicles). There are no exceptions to the requirement for contained locations for deicing operations. 2. MSP estimates that 65-70% of ADF fluid used at the airport is sprayed at its deicing pads. The percentage of flights represented by this amount of ADF fluid use is much lower than 65-70%. The deicing pads are typically used for heavy deicing and not for defrost deicing. Delta, previously Northwest Airlines, deices at both the gate and at the deicing pads. Overall, they spray more deicing fluid at the pads than at the gates. This airline does not generally act as an FBO for other airlines but may be used as a deicing provider in a backup situation. The small airlines operating at the airport do not have personnel for deicing pad use. 3. If deicing is not done on the deicing pads, it is done at the gate. 4. Advantages of the MSP deicing pads include putting the deiced aircraft closer to the runway, which lowers the chance of missing ADF holdover times, and freeing up the gates for incoming flights.
Washington Dulles International Airport	1. Approximately 50% of the flights deiced at IAD are deiced on deicing pads. In addition, the airport requires that flights be deiced in areas of capture that may include glycol collection vehicles. 2. There are no specific requirements on where each airline has to deice their planes. The location of where each airline plans to deice is decided between the airlines at winter "snow meetings."
Philadelphia International Airport	1. All commercial aircraft except commuter aircraft (regional jets and turbo-props) must be deiced at the airport deicing pad, as specified in the airport's NPDES permit. 2. Aircraft defrosting is permitted at the gates with a usage limit of 20-40 gallons of ADF, as specified in the airport's NPDES permit. 3. Deicing of the plane is also permitted at the gate with no ADF usage limit, for required weight reduction or visibility enhancement, sufficient to safely taxi the aircraft to the deicing pad for final, pre-take-off ADF application.
Detroit Metropolitan/Wayne County Airport	1. DTW does not have a specific requirement forcing the airlines to deice aircraft at the deicing pads but does strongly encourage deicing pad use. 2. The airport estimates that approximately 90% of the airport traffic that is deiced uses the deicing pads. 3. The airport allows 747s to deice at the gates to free up the deicing pads for smaller aircraft. Airport study of this allowance shows that it achieves a higher net capture of ADF using this approach. The airport collects ADF stormwater from the 747 deicing using a glycol collection vehicle in conjunction with catch basin inserts.

Table 3-9 (Continued)

Airport	Deicing Pad Operations Data
Denver International Airport	1. DEN does not allow full-plane gate deicing, and does not track limited gate deicing operations specifically (other than to enforce the 25-gallon rule discussed in item 3. below). The airport tracks only the volume of fluid used on an airport-wide basis but estimates that 95% of deicing occurs on the dedicated deicing pads. DEN's largest carrier, United Airlines (UAL), does provide DEN (Environmental Services) with its fluid usage data, including by location. UAL's data show approximately 6% of its total fluid used was applied at the gates pursuant to DEN's 25-gallon operational allowance. UAL's data do not provide the number of flights deiced by location. On average, UAL accounts for approximately 27% of the total aircraft deicing fluid applied at DEN. 2. DEN is not aware of any specific instances of deicing outside the designated areas (pads, gates (limited), GA, South Cargo). If it did occur, it would be a very rare occurrence under special circumstances, and would require prior approval from the Manager of Aviation. 3. Limited deicing requirements are stipulated on page 6 of DEN Rule and Regulation Part 190 - Aircraft Deicing Regulations. The language does not specify for what purpose limited deicing may occur, only that "In no event may the total amount of deicing fluid used in a limited deicing exceed 25 gallons neat (undiluted) ADF per aircraft." DEN R&R Part 190 can be accessed directly at http://business.flydenver.com/info/research/rules/index.htm. 4. On a volume-only basis, for the 2008/2009 season, DEN data show approximately 5% of the total amount of deicing fluid used at DEN was applied at South Cargo and General Aviation (combined).
Cleveland-Hopkins International Airport	1. CLE estimates that 90% of deiced flights are deiced at deicing pads and the remaining 10% are deiced at the gate. Most of the air carriers are not allowed to deice at the concourse gates. 2. For those air carriers not allowed to deice at the gate, the airport does allow emergency deicing to unfreeze the wheels or other plane parts to allow the plane to move safely to the deicing pad.
Salt Lake City International Airport	1. At SLC, 95-98% of the deiced flights are deiced on pads and each major airline has its own dedicated deicing pad. 2. All deicing is to occur on the deicing pads except for specific circumstances that are typically delay related.
Pittsburgh International Airport	1. Aircraft deicing at the airport is required by consent decree to occur on deicing pads. Thus, 100% of deiced flights are deiced on the airport's pads unless doing so will result in a total loss of operations (e.g., major delays or if the deicing pad is out of ADF). The airport does allow gate deicing for both defrost and safety purposes. 2. PIT defines defrost deicing as "the removal of contamination (frost) from critical components of the airport that occurs when there is no active precipitation" and defines regular deicing as "the removal of contamination (snow/ice) that occurs when there is or has been active precipitation." 3. When an air carrier conducts gate deicing (instead of using the deicing pads), it must document why the deicing occurred at the gate.

3.9.2 Data Submitted with Public Comments

All comments received on the proposed airport deicing rulemaking are available in the docket. In assessing comments, EPA evaluated, and in some cases used, data or suggestions provided by specific commenters for the final rule analyses. While the data submitted by commenters were useful, in general, commenters provided very little analytical data on treatment or collection performance. Commenters, however, did provide some new data related to the costing analysis and on the feasibility of deicing pads. Section 10 summarizes the data used to develop EPA's final rule costs. As an example, EPA incorporated industry-supplied data on AFB capital costs versus COD loading in its final costing analysis (see Figure 10-1).

Comments by specific airports/port authorities on the proposed rule, including Boston-Logan International Airport and The Port of New York and New Jersey, included documentation supporting a claim that their airports are space-constrained and they would not be able to locate a deicing pad facility to comply with the proposed rule. EPA considered this data in developing the final rule and is no longer requiring collection of spent ADF at existing airports.

3.10 References

ERG. 2007. Memorandum from Jason Huckaby (ERG) to Brian D'Amico and Eric Strassler (U.S. EPA). *Airport Deicing Operations NPDES Permit Review Summary*. (April 16). DCN AD00611.

ERG. 2010a. Memorandum from Steve Strackbein and Mary Willett (ERG) to the Airport Deicing Administrative Record. *Estimated Capital and Operation and Maintenance Costs for Glycol Collection Vehicle Operation*. (October 8). DCN AD01249.

ERG. 2010b. Memorandum from Steve Strackbein and Mary Willett (ERG) to Brian D'Amico and Eric Strassler (U.S. EPA). *Estimated Costs for Transition to Liquid Airfield Deicing Application from Solid Airfield Deicing*. (October 8). DCN AD01252.

USEPA. 2000. *Preliminary Data Summary: Airport Deicing Operations.* U.S. Environmental Protection Agency. Washington, D.C. EPA-821-R-00-016. Available online at http://www.epa.gov/guide/airport . DCN AD00005.

USEPA. 2005. *Supporting Statement: Survey of Airport Deicing Operations.* U.S. Environmental Protection Agency. Washington, D.C. DCN AD00447.

USEPA.2008a. *Airline Screener Questionnaire Database.* U.S. Environmental Protection Agency. Washington, D.C. DCN AD00937.

USEPA. 2008b. *Airline Detailed Questionnaire Database.* U.S. Environmental Protection Agency. Washington, D.C. DCN AD00938.

USEPA. 2008c. *Airport Questionnaire Database.* U.S. Environmental Protection Agency. Washington, D.C. DCN AD00927.

4. Overview of the Industry

This section provides an overview of the airport deicing/anti-icing performed by selected airports and airlines. The overview includes statistics on the number and location of airports and airlines that perform deicing/anti-icing (Section 4.1) and deicing and anti-icing practices performed on airfields and aircraft and methods used to collect and control deicing stormwater (Section 4.2).

4.1 Industry Statistics

Data sources for statistics on the number and types of airports and airlines include responses to EPA's airport and airline questionnaires, the Bureau of Transportation Statistics, FAA, and EPA's *Preliminary Data Summary: Airport Deicing Operations* (PDS) (USEPA, 2000). Data provided in responses to EPA questionnaires are based on deicing/anti-icing operations performed during the winter seasons of 2002/2003, 2003/2004, and 2004/2005, hereafter referred to as the three winter seasons.

4.1.1 Airports

The North American Industry Classification System (NAICS) identification number applicable to airport deicing is 488119: Other Airport Operations. The U.S. Census Bureau describes this industry as establishments primarily engaged in the following: (1) operating international, national, or civil airports or public flying fields, or (2) supporting airport operations, such as runway maintenance services, hangar rental, and/or cargo handling services.

The airport questionnaire data presented in this section are based on the 150 respondents to EPA's airport questionnaire. EPA applied weighting factors to the information provided by selected airport questionnaire recipients to scale up the questionnaire data to represent national estimates.

4.1.1.1 Number and Types of Airports

FAA's general categories of airports include commercial, general aviation, and relievers. *Commercial airports* are public airports receiving scheduled passenger service and having more than 2,500 enplaned passengers (number of passengers boarding a plane for departure) each year. *General aviation* airports have less than 2,500 enplanements per year or do not receive scheduled commercial service. *Relievers* are high-capacity general aviation airports in major metropolitan areas, and provide an alternative for small aircraft using busy commercial airports.

Airports may be further classified into several different categories, depending on the size and activity level of the airport. Often both of these factors can be determined by the number of enplanements or operations (number of arrivals and departures) at the airport in a given year. FAA classifies large commercial airports into "hubs," based on the number of annual enplanements that occur at the airport. Large Hubs are defined as airports with more than 1 percent of total U.S. passenger enplanements. Medium Hubs are defined as airports with more than 0.25 percent but less than 1 percent of total passenger enplanements. Small Hubs account for 0.05 to 0.25 percent of the total passenger enplanements. Airports with less than 0.05 percent of the total passenger enplanements but more than 10,000 annual enplanements are considered

Non-hub primary airports. Nonprimary commercial services are those airports that have 2,500 to 10,000 enplanements a year.

According to FAA 2004 data and the FAA's National Plan of Integrated Airport Systems (NPIAS) Report to Congress, about 3,344 airports operated in the United States in 2004. Table 4-1 identifies the number of airports by type as defined by number of enplanements. For all airport types, excluding general aviation airports, the totals in Table 4-1 represent counts for January through December 2004. FAA's designation of hub status depends on the percentage of total passenger boardings occurring at each airport, causing the number of airports in each hub category to vary from year to year.

Table 4-1. Number of U.S. Airports by Airport Type in 2004

Airport Type	Number of Airports
Large Hub	33
Medium Hub	36
Small Hub	67
Non-hub	231
Other Nonprimary	130
General Aviation [1]	2,573
General Aviation Relievers [1]	274
TOTAL	3,344

[1] General aviation and general aviation reliever airports (open to the public) from the NPIAS Report to Congress (USDOT, 2008a).
Note: Airport counts will differ depending on the source and year of data represented.

EPA distributed the airport questionnaire to 153 airports that included, based on 2004 information, all Large Hub, all Medium Hub, and a statistical sampling of Small Hub and Non-hub airports, as well as judgment sampling of some general aviation/cargo, and other nonprimary airports. EPA determined that one airport recipient was out of scope and removed it from the sample frame. EPA received responses from 150 of these airports. Using the airport responses and their statistical weights and including the cargo airports and Alaskan airport judgment samples, EPA estimated that the number of primary commercial airports nationally that perform deicing and/or anti-icing of airfield pavement and/or aircraft is 334.

4.1.1.2 Geographic Location of Deicing Airports

The location of the airport and its climate have a direct impact on deicing operations. Airport deicing/anti-icing operations occurred in 44 states in the three winter seasons. As shown below, the FAA divides the United States into the following nine regions:

Region	State
Alaskan	AK
Central	IA, KS, MO
Eastern	DE, MD, NJ, NY, PA, VA, WV
Great Lakes	IL, IN, MI, MN, ND, OH, SD, WI
New England	CT, ME, MA, NH, RI, VT
Northwest Mountain	CO, ID, MT, OR, UT, WA, WY
Southern	AL, FL, GA, KY, MS, NC, PR, TN, VI
Southwest	AR, LA, NM, OK, TX
Western-Pacific	AZ, CA, HI, NV, GU, AS, MH

Source: FAA, "FAA Regional Offices," http://www.faa.gov/about/office_org/headquarters_offices/arp/regional_offices/ (U.S. DOT, 2008b).

Table 4-2 summarizes the regions for the airports that reported deicing in the EPA airport questionnaire for the three winter seasons surveyed by EPA. *(Note: these are not national estimates.)* The Great Lakes and Eastern regions reported the highest number of deicing airports.

Table 4-2. Deicing Airports by FAA Region for the Three Winter Seasons

Region	Airports Reporting Deicing and/or Anti-Icing in EPA Airport Questionnaire
Great Lakes	31
Eastern	22
Southern	20
Northwest Mountain	17
Western-Pacific	15
Southwest	14
Alaskan	10
New England	6
Central	5

Source: EPA airport questionnaire database (USEPA, 2008c).

4.1.1.3 Weather Impacts on Airport Deicing/Anti-Icing

Airports conduct deicing/anti-icing operations when weather conditions, such as precipitation and/or temperature, have the potential to cause icing. Precipitation includes snowfall, rainfall, sleet (including freezing rain), and ice. The type of precipitation affects the volume and type of deicing/anti-icing chemicals used on aircraft and airfield pavement. For example, freezing rain requires the most deicing/anti-icing agent usage because the rain freezes on contact and coats the aircraft or airfield pavement to form a solid layer of ice. Dry-weather deicing, performed when the ambient temperature is cold enough to form ice on aircraft wings and surfaces (below 55° F), generally requires only a small volume of ADF.

The duration of the deicing/anti-icing season is also determined by the climate at an airport location. Airfield pavement deicing can begin as early as September and continue through May in colder climates and/or areas with high numbers of snow or freezing precipitation days.

The national estimate of airports performing airfield pavement deicing is 215; this is lower than the national estimate of airports performing deicing operations overall because there are airports that have some aircraft deicing (usually defrost deicing) but no airfield pavement deicing. In general, these airports are located in warm and/or dry weather climates with minimal winter storm events. For months when airfield pavement deicing occurs, December, January, and February have the most occurrences of airfield pavement deicing, and September and May have the lowest. Figure 4-1 presents the percentage of these 215 airports deicing airfield pavement for each month. The time frame during which an airport conducts deicing during a typical winter season ranges from two to nine months, and a majority of airports typically conduct deicing/anti-icing operations for five months a season. For the three winter seasons surveyed by EPA, the average reported number of airfield pavement deicing days among these 215 airports ranges from 0.3 to 240 days.

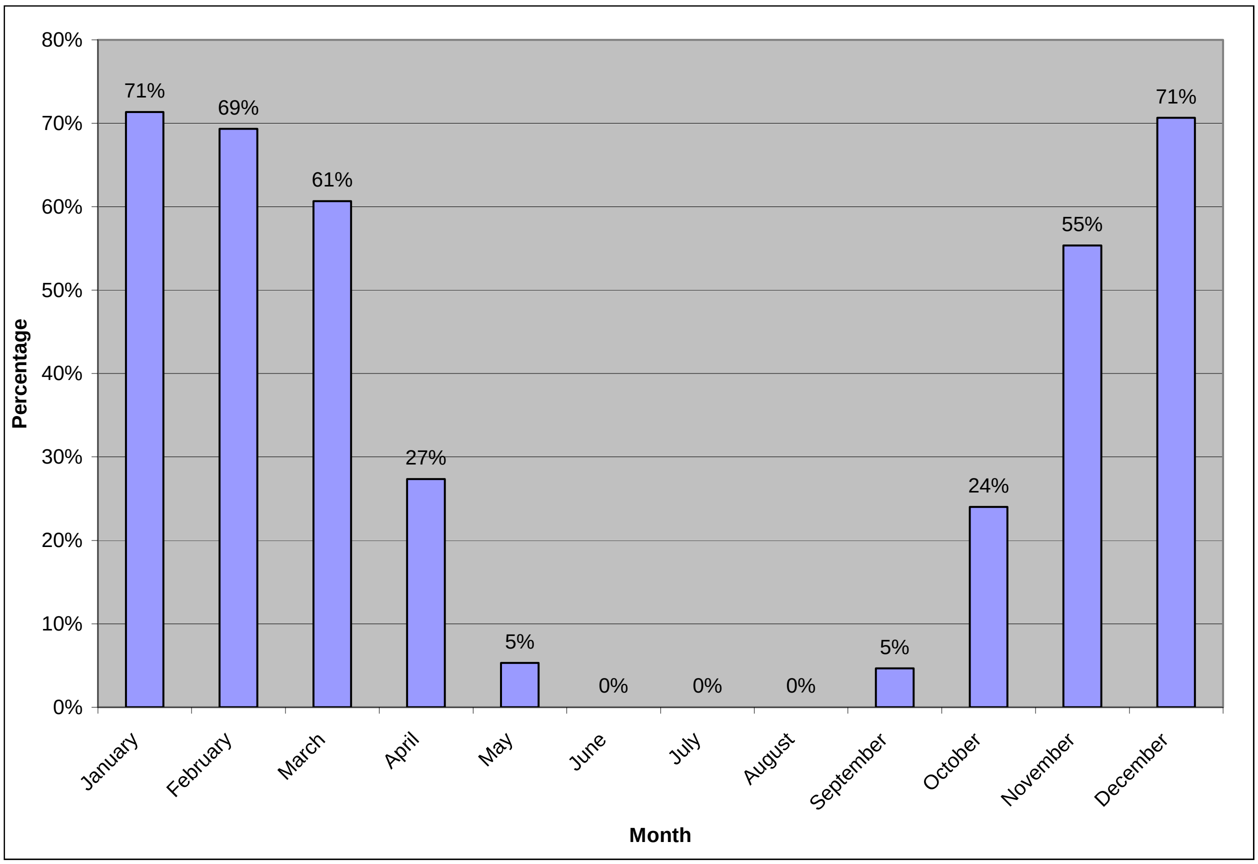


Figure 4-1. Percentage of Airports Deicing Airfield Pavement Each Month

4.1.1.4 Destination of Airport Deicing Stormwater

Airport questionnaire respondents reported direct, indirect, and zero discharge of deicing stormwater. Direct dischargers discharge deicing stormwater directly to U.S. surface waters, such as creeks, rivers, ponds, lakes, or oceans. Indirect dischargers convey deicing stormwater by pipe, conduit, or hauling to a publicly owned or other treatment works. A zero discharger disposes of deicing stormwater using methods other than direct or indirect discharge. Figure 4-2 presents the reported discharge status of airports by destination. Scaling the questionnaire data to a national estimate results in 176 airports discharging to surface water only, 52 airports discharging both directly to surface water and indirectly to a POTW, 10 airports discharging to a POTW only, and 96 airports reporting zero discharge.

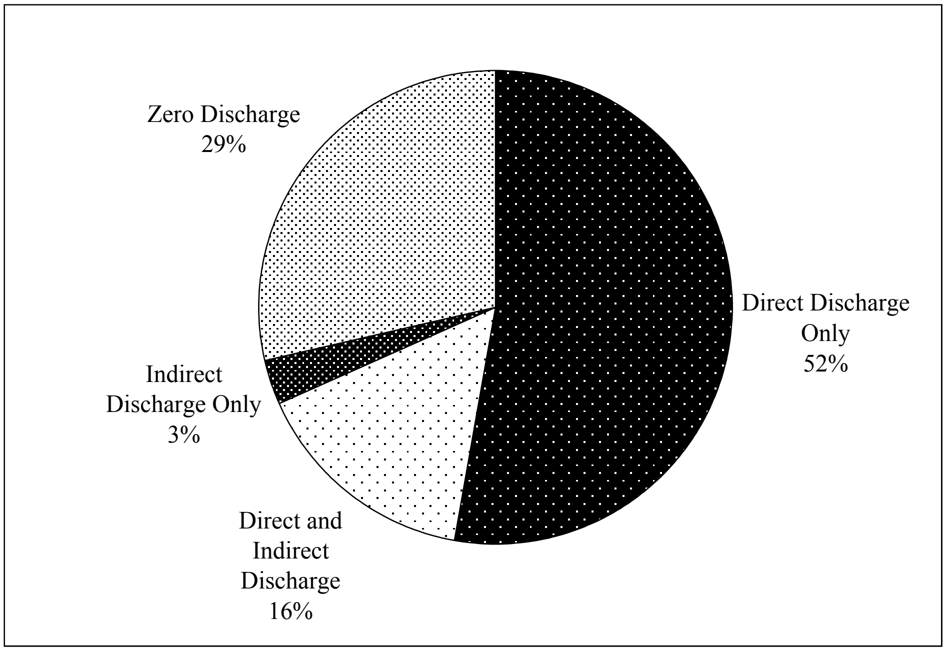


Figure 4-2. Discharge Status of Airports

A majority of the zero dischargers reported conducting aircraft deicing only (i.e., no deicing of airfield pavement). These airports generally are in warm and/or dry weather climates and have minimal dry weather (defrost) deicing. Airports reported various methods for maintaining zero discharge that included evaporation, storage in surface impoundments, contract hauling, and recycle/recovery of deicing stormwater. The most common zero discharge method reported was evaporation followed by discharge to a surface impoundment and the “other” category. The methods identified as “other” zero discharge techniques included, infiltration, discharge to tundra over permafrost, use of drain covers and sorbent material, and use of BMPs.

Even though over 100 airports indicated that they do not have any direct discharge (96 zero discharge and 10 POTW only) of ADF-contaminated stormwater, EPA believes that fugitive ADF emissions from overspray and tracking and dripping, during taxiing and takeoff, are difficult if not impossible to track and will likely result in direct discharges, albeit potentially small ones.

4.1.2 Airlines

The NAICS code for airlines is 481: Air Transportation. Specific NAICS codes for respondents to the airline deicing questionnaires are: (1) 481111: Scheduled Passenger Air Transportation, described by the U. S. Census Bureau as establishments primarily engaged in providing air transportation of passengers or passengers and freight over regular routes and on regular schedules; and (2) 481112: Scheduled Freight Air Transportation, described by the U.S. Census Bureau as establishments primarily engaged in providing air transportation of cargo without transporting passengers over regular routes and on regular schedules.

The airline data presented in this section are based on the 49 respondents to EPA's airline detailed questionnaire and additional information from the 70 respondents to EPA's airline screener questionnaire. Statistics for airlines do not have weighting factors and are based on the actual number of respondents.

4.1.2.1 Types of Airlines

The four classifications of airlines are major, national, regional, and cargo and are based on the type of service they offer and their annual revenues. Classification is based on the economic and financial aspects of each airline's aircraft fleet. Table 4-3 lists the criteria for the four classifications.

Table 4-3. Airline Classifications

Airline Type	Annual Revenues	Type of Service	Aircraft Fleet
Major	>$100 million	Regular schedules	Large jets: >60 seats Payload >18,000 lbs
National	$100 million to $1 billion	Regular schedules	Medium and large jets
Regional:		Limited to single U.S. region	
Large	$20 million to $100 million	Scheduled	>60 seats
Medium	<$20 million	Scheduled	Lesser or greater than 60 seats
Small (commuters)	No revenue cut-off	Scheduled	<30 seats
Cargo	No revenue cut-off	Scheduled	Passenger aircraft with seats removed

Source: *Preliminary Data Summary: Airport Deicing Operations* (Revised) (USEPA, 2000).

There were 20 major airlines in the United States in 2006. Many national airlines typically serve multiple U.S. regions whereas regional airlines are generally limited to a single region of the country.

Small regional airlines are the largest segment of the regional airline business. Regional airlines may be private business carriers, commercial airlines, charter airlines, or provide a combination of these services. Private business carriers represent about 60 percent of regional airline flights. Regional airlines serve all airports served by major airlines as well as smaller airports that are not served by any major airline. They typically operate out of one gate area unless they are affiliates of major airlines and operate at the gates of their affiliate. Regional airlines conduct a disproportionately large number of flight operations per passenger because their aircraft are smaller and carry fewer passengers per operation.

All respondents to the airline detailed questionnaire reported conducting deicing/anti-icing operations on their aircraft at a total of 57 airport locations.

4.1.2.2 Types of Airline/Airport Relationships

The relationship between airports and airlines regarding deicing operations is one of dependency and cooperation. Airports and airlines conduct deicing using chemical and nonchemical methods in the same airfield locations and both contribute pollutants to deicing stormwater. Airlines may conduct deicing on their own aircraft, deicing for other airlines, and/or may also use FBOs. An airline's deicing methods must be approved by the FAA for air safety. Airports provide the collection and control systems to contain and/or treat deicing stormwater generated as a result of aircraft and airfield deicing. However, both airports and airlines implement pollution prevention practices such as evaluating application rates, using alternate chemicals, pretreating pavement and aircraft, and manually removing snow and ice to reduce the quantity of pollutants discharged and the amount of deicing stormwater generated.

4.2 Industry Practices

Airport deicing and anti-icing operations involve chemical and mechanical methods and are conducted at varied locations and by different entities. This section discusses these practices and pollution prevention methods used by airports and airlines as reported by respondents to the airport and airline deicing questionnaires.

4.2.1 Airfield Deicing Practices

Airfield pavement deicing/anti-icing removes or prevents the accumulation of frost, snow, or ice on runways, taxiways, aprons, gates, and ramps. These methods are typically conducted by airport personnel, FBOs, or private contractors using a combination of mechanical methods and chemical deicing/anti-icing agents. To reduce the quantity of pollutants or the amount of deicing stormwater generated, airports also use various pollution prevention measures.

Responses to EPA's airport questionnaire indicated that 67 percent of airports have the primary responsibility for airfield pavement deicing/anti-icing.

4.2.1.1 Chemical Deicing/Anti-Icing

The type of precipitation and temperature affect the volume and type of deicing agents required for deicing/anti-icing. Common pavement deicing/anti-icing agents used at airports include potassium acetate, sand, airside urea, sodium acetate, glycol-based fluids, and sodium formate, as reported by respondents to EPA's airport questionnaire. Potassium acetate and PG-based fluids were reported as the top deicing/anti-icing chemicals (by weight) used on airfield pavement during the three winter seasons surveyed by EPA; some respondents also reported using a mixture of these agents as well as heated sand. Table 4-4 provides national estimates of the number of airports using these agents. Airports purchase primarily ready-to-apply rather than concentrated formulations of these chemicals. See Section 6.1 for a detailed discussion of deicing chemical usage.

Table 4-4. National Estimate of Airports Using Deicing Chemicals or Materials

Deicing/Anti-Icing Chemical or Material	Number of Airports Using Deicing Chemical/Material			Average	Percentage of Airports Using Deicing Chemical/ Material
	2002/2003	2003/2004	2004/2005		
Potassium Acetate	94	104	111	103	31
Sand	103	104	98	102	30
Airside Urea	58	60	59	59	17
Sodium Acetate	39	34	33	35	10
PG-Based Fluids	16	16	16	16	5
Sodium Formate	22	1	23	15	5
EG-Based Fluids	6	6	6	6	2

Source: EPA airport questionnaire responses (scaled to national estimates) (USEPA, 2008c).

4.2.1.2 Mechanical and Nonchemical Deicing/Anti-Icing

Mechanical methods, such as plows, brushes, blowers, and shovels for snow removal, are the primary forms of airfield pavement deicing and may be used in combination with chemical methods. One facility uses heated pavement through pavement temperature sensors to prevent airfield pavement from icing. All of the 215 airports that conduct pavement deicing use some form of chemical, while an estimated 212 (99 percent) use mechanical methods as well on airfield pavement.

4.2.2 Aircraft Deicing Practices

Aircraft deicing involves removing frost, snow, or ice from aircraft. Aircraft anti-icing entails preventing frost, snow, or ice from accumulating on aircraft surfaces. Both chemical and nonchemical deicing/anti-icing methods are conducted on aircraft at varied airport locations and by different entities. The FAA also influences aircraft deicing, as it has approval authority for the deicing/anti-icing practices and procedures selected. Airlines and FBOs also perform pollution prevention practices similar to airports to reduce the quantity of pollutants discharged and/or reduce the amount of deicing stormwater generated.

Aircraft deicing may be conducted by an airline, FBO, or private contractor. Often, larger airline carriers deice their own aircraft and possibly the aircraft of other airlines. In addition, the entity conducting aircraft deicing for an airline may vary depending on the airport location. All of the airline questionnaire respondents reported deicing their own aircraft at one or more of their airport locations. Airline respondents also reported FBOs and/or another airline deiced their aircraft (84 percent and 56 percent, respectively) at some of their airport locations.

Aircraft deicing is conducted at a variety of airport locations and may be conducted at multiple types of locations at the same airport. Aircraft deicing is most commonly performed at deicing pads and terminal gates and apron areas. Airline respondents reported aircraft deicing at the following locations (the percentage of the airline respondents reporting using the specific type of location is in pararentheses):

- Deicing pad (80 percent);
- Passenger terminal gates/apron areas (78 percent);
- Aircraft parking aprons (46 percent);
- Airfield ramps (42 percent);
- Taxiways (24 percent);
- Cargo apron areas (16 percent); and
- Other locations (12 percent) (e.g., hangar).

4.2.2.1 Chemical Deicing/Anti-Icing

The type of precipitation and temperature influences the volume and type of deicing chemicals required to deice/anti-ice aircraft. Two types of aircraft deicing are conducted: wet-weather and dry-weather. Wet-weather deicing is conducted when snow, sleet, or freezing rain accumulates on the aircraft. Dry-weather deicing is conducted when frost or ice forms on the aircraft due to changes in the ambient temperature or when fuel tanks become cooled during high-altitude flight, forming ice at lower altitudes and after landing. Dry-weather deicing requires significantly smaller volumes of ADFs than wet-weather deicing.

Aircraft deicing/anti-icing chemicals are categorized into four classes: Type I, Type II, Type III, and Type IV. Not all types are currently used. Airlines surveyed by EPA reported consistently using only Type I and Type IV fluids. ADFs vary by composition and allowable holdover times (i.e., the amount of time the residual fluid protects aircraft from ice formation). They generally contain either EG or PG, water, and additives to remove or prevent ice and snow. Type I ADF is used to remove ice and snow that has accumulated on aircraft, and Type IV fluids are used for anti-icing to increase holdover times for an aircraft prior to takeoff. Deicing fluids are usually heated prior to application, while anti-icing fluids are typically applied at ambient temperatures.

All fluids are usually applied under pressure using a nozzle, often from mobile deicing trucks (as reported by 31 airlines). Below are additional types of ADF application equipment used, as reported in responses to the airline questionnaire:

- Other equipment (e.g., brooms, ground sprayer and ladder, palletized equipment and fork lift, towed tower, small portable unit, self-contained mobile unit);
- Fixed booms; and
- Handheld bottle/containers.

Table 4-5 identifies the types of ADF fluids purchased by airlines that deiced their own aircraft during the three winter seasons, as well as the average across those seasons, based on the 49 airline respondents to the airline detailed questionnaire. Table 4-6 lists the ADF fluids purchased by an FBO during the three winter seasons and the average across those seasons, as reported in the airline questionnaire. As shown in the tables, Type I and Type IV PG are the most commonly purchased ADF fluids for deicing aircraft, both by airlines that deice their own aircraft and airlines that use FBOs.

Table 4-5. Deicing/Anti-Icing Chemicals Purchased by Airlines that Deiced Their Own Aircraft

Deicing/Anti-Icing Chemical	Number of Airlines Purchasing Chemicals			Average Number of Airlines Purchasing Chemicals
	2002/2003	2003/2004	2004/2005	
Type I PG	29	29	28	29
Type IV PG	22	22	23	22
Type I EG	8	8	8	8
Type IV EG	6	5	4	5
Type II PG	0	0	1	1

Source: EPA airline detailed questionnaire database (USEPA, 2008b).

Table 4-6. Deicing/Anti-Icing Chemicals Purchased for Aircraft Deiced by an FBO

Deicing/Anti-Icing Chemical	Number of Airlines for Chemicals Purchased by an FBO			Average Number of Airlines for Chemicals Purchased by an FBO
	2002/2003	2003/2004	2004/2005	
Type I PG	35	36	39	37
Type IV PG	31	35	37	34
Type I EG	17	13	13	14
Type IV EG	13	9	9	10
Type II PG	0	2	1	1
Type II EG	0	0	1	1

Source: EPA airline detailed questionnaire database (USEPA, 2008b).

4.2.2.2 Mechanical and Nonchemical Deicing/Anti-Icing

Mechanical and other nonchemical methods used to deice aircraft include brooms, ropes, hot water, infrared heating, and forced air. Brooms and ropes are not the primary method of aircraft deicing, especially wet-weather deicing, because they are so time- and labor-intensive, but rather are used in combination with chemical deicing. Forced air/hot air systems are used to blow or melt snow and ice from aircraft surfaces. Infrared heating deicing systems consist of an open hangar-type structure with infrared generators suspended from the ceiling. The infrared wavelengths are targeted to heat ice and snow and minimize heating of aircraft components. This system reduces the volume of ADF fluid required, but cannot provide anti-icing protection. Aircraft may also be stored in a hangar to prevent snow or ice from accumulating if a storm event is predicted. The most common mechanical and nonchemical methods of deicing/anti-icing used by airline questionnaire respondents are mechanical methods and hangar storage. Table 4-7 and Table 4-8 summarize the use of these methods for deicing/anti-icing aircraft by airlines and by FBOs, respectively.

Table 4-7. Summary of Mechanical and Nonchemical Aircraft Deicing Methods Used by an Airline

Mechanical/Nonchemical Method	Number of Airlines			Average Number of Airlines
	2003/2004	2003/2004	2004/2005	
Mechanical (e.g., brooms, ropes)	22	21	21	21
Hangar storage	15	16	16	16
Forced air	9	7	7	8
Hot water	5	4	4	4
Infrared heating	1	1	1	1

Source: EPA airline detailed questionnaire database (USEPA, 2008b).

Table 4-8. Summary of Mechanical and Nonchemical Aircraft Deicing Methods Used By FBOs

Mechanical/Nonchemical Method	Number of Airlines			Average Number of Airlines
	2003/2004	2003/2004	2004/2005	
Mechanical (e.g., brooms, ropes)	10	10	10	10
Hangar storage	5	5	5	5
Forced air	4	5	5	5
Hot water	3	4	4	4
Infrared heating	0	0	0	0

Source: EPA airline detailed questionnaire database (USEPA, 2008b).

4.2.3 Airport Deicing Stormwater Collection and Control

Deicing and anti-icing operations are conducted at multiple locations at an airport, and the fluids are widely dispersed during and after application via ramp discharge, taxiway drippage, and residual on aircraft. Deicing stormwater is contained and collected using designated deicing areas, stormwater drainage systems, glycol recovery, storage tanks, containment ponds, and plug and pump systems. Typical sources of deicing stormwater are:

- Terminal gates and aprons/areas;
- Aircraft deicing pads;
- Taxiways;
- Airfield ramps;
- Runways;
- Cargo apron areas;
- Maintenance hangar ramps;
- Aircraft parking areas;
- Military bases; and
- ADF-contaminated snow dumps.

Table 4-9 summarizes the collection and control methods used by airports. Based on responses to the airport questionnaire, an estimated 246 U.S. airports use containment, collection, and/or conveyance measures to control the discharge of deicing stormwaters to surface waters and/or POTWs. Most of the airports use stormwater drainage systems and containment ponds and basins. See Section 9.0 for detailed discussions of deicing stormwater collection and control methods used by the Airport Deicing Category.

Table 4-9. Summary of Airport Collection, Containment, and Conveyance Methods

Collection/Containment/Conveyance Method	Estimated Number of Airports	Percentage of Airports
Stormwater drainage system	211	63
Containment pond/basin	121	36
Aboveground/underground tank	57	17
Glycol collection vehicles/sweepers	54	16
Other (vegetated swales, snow melters, absorbant)	34	10
Plug and pump	29	9

Source: EPA airport questionnaire database (scaled to national estimate) (USEPA, 2008c).

EPA estimates that approximately half (46 percent) of the U.S. airports with deicing operations also operate systems to treat or recover their deicing stormwater. The treatment and recovery technologies reported by airports include equalization (46 percent), oil/water separation (5 percent), sand or other media filtration (4 percent), membrane separation (1 percent), and biological treatment (1 percent). Eight percent of the airports report using other types of treatment technologies, including MVR, aeration, and distillation. Section 7 describes these technologies in detail.

4.2.4 Pollution Prevention Practices

To reduce the quantity of pollutants discharged and the amount of deicing stormwater generated, airports implement various pollution prevention practices that control pollution from airport deicing chemicals (e.g., glycol), thus minimizing pollutant loads by reducing chemical usage. Physical snow removal, specialized employee training, and pretreatment of airfields in advance of precipitation are the most common practices used by airports for airfield pollution prevention. The national estimate of airports implementing one or more pollution prevention practices is 244. Table 4-10 summarizes EPA's national estimates of the number and percentage of airports that used airfield pollution prevention practices. See Section 7.4 for detailed descriptions of the pollution prevention practices used by airports.

Table 4-10. Summary of Airfield Pollution Prevention Practices

Pollution Prevention Practice	Estimated Number of Airports Using Practice	Percentage of Airports Using Practice
Specialized employee training	153	46
Pretreatment of airfield in advance of precipitation	101	30
Runway ice detection system	95	28
Enhanced weather forecasting	77	23
Heated sand	74	22
Evaluation of application rates of deicing fluids	56	17
Use of alternative chemicals	40	12
Use of prewet dry chemical constituents	32	10
Other	88	26

Source: EPA airport questionnaire database (scaled to national estimates) (USEPA, 2000c).

Airlines also implement pollution prevention practices at various airports. These practices control pollution from aircraft deicing chemicals and minimize pollutant loads. Specialized training, implementation of a pollution prevention policy, and physical snow removal are the most common pollution prevention practices used by airlines. Table 4-11 summarizes airline pollution prevention practices reported in response to the airline detailed questionnaire. See Section 7.4 for detailed descriptions of the pollution prevention practices used by airlines.

Table 4-11. Summary of Aircraft Pollution Prevention Practices

Pollution Prevention Practice	Number of Airlines Reporting Practice
Specialized employee training	43
Instituting pollution prevention policy	43
Physical removal of snow or freezing precipitation	31
Overnight pretreatment/storage of aircraft	30
Custom fluid blending	27
Enhanced weather forecasting	25
Evaluation of application rates of deicing fluids	24
Pretreating aircraft with hot water	9
Use of alternative chemicals	2
Other	30

Source: EPA airline detailed questionnaire database (USEPA, 2008b).

4.3 References

USDOT. 2008a. *Report to Congress: National Plan of Integrated Airport Systems (NPIAS) 2009-2013*. U.S. Department of Transportation, Federal Aviation Administration. Washington, D.C. Available online at http://www.faa.gov/airports_airtraffic/airports/planning_capacity/npias/reports/.

USDOT. 2008b. *FAA Regional Offices.* U.S. Department of Transportation, Federal Aviation Administration. Washington, D.C. Available on line at www.faa.gov/about/office_org/headquarters_offices/arp/regional_offices/.

USEPA. 2000. *Preliminary Data Summary: Airport Deicing Operations.* U.S. Environmental Protection Agency. Washington, D.C. EPA-821-R-00-016. DCN AD00005. Available online at http://www.epa.gov/guide/airport.

USEPA. 2005. *Supporting Statement: Survey of Airport Deicing Operations.* U.S. Environmental Protection Agency/Office of Water. Washington, D.C. DCN AD00447.

USEPA. 2008a. *Airline Screener Deicing Questionnaire Database.* U.S. Environmental Protection Agency. Washington, D.C. DCN AD00937.

USEPA. 2008b. *Airline Detailed Deicing Questionnaire Database.* U.S. Environmental Protection Agency. Washington, D.C. DCN AD00938.

USEPA. 2008c. *Airport Deicing Questionnaire Database.* U.S. Environmental Protection Agency. Washington, D.C. DCN AD00927.

5. DEICING CHEMICAL USE AND DEICING STORMWATER CHARACTERIZATION

This section summarizes EPA's estimate of the amount of airfield and aircraft deicing/anti-icing chemicals currently in use by U.S. primary commercial airports and provides information on deicing stormwater pollutant characteristics to the extent possible. Deicing stormwater discharges are "weather-dependent" and they are, by nature, highly variable. In addition, deicing chemical disposition after its intended use is not fully understood. These chemicals may be lost to evaporation, dispersion, or soil absorption; collected; or released into the environment and discharged from the airport, but limited information is currently available on each of these disposition methods. This section presents the information EPA has collected on the types of pollutants present in deicing stormwater and their ranges of concentrations.

5.1 Deicing Chemical Usage

As discussed in Section 4, several deicing chemicals are commonly used at U.S. commercial airports. These chemicals are used for either airfield or aircraft deicing/anti-icing and their usages are described below.

5.1.1 Airfield Chemical Use

Pavement deicing/anti-icing removes or prevents frost, snow, or ice from accumulating on runways, taxiways, aprons, gates, and ramps. Airports use mechanical and chemical methods for this purpose. The more often-used method is mechanical removal, but because ice, sleet, and snow may be difficult to remove by mechanical methods alone, many airports also use sand and/or chemical deicing agents such as potassium acetate, sodium acetate, sodium formate, glycol-based products, or urea. Based on the data collected by EPA in the airport questionnaire, the most common airfield deicing chemical currently used by U.S. airports is potassium acetate (approximately 63 percent of airfield chemical usage by weight). Section 9, Table 9-6 presents the average amount of pavement deicing chemical usage in pounds per year by airport and by deicing chemical.

Table 5-1 lists the total estimated national average airfield chemical usage (based on data for the 2002/2003, 2003/2004, and 2004/2005 deicing seasons) for primary commercial airports in the United States.

Table 5-1. U.S. Commercial Airports – National Estimate of Airfield Chemical Usage

Chemical	Estimated Total Airport Usage (tons/year)	Percentage of Chemical Usage
Potassium acetate	22,538	63
Propylene glycol-based fluids	3,883	11
Airside urea	4,127	12
Sodium acetate	3,100	9
Sodium formate	1,117	3
Ethylene glycol-based fluids	774	2

Source: EPA Airport Deicing Questionnaire Database (USEPA, 2008a)

5.1.2 Aircraft Chemical Use and Purchasing Patterns

There are four types of ADFs manufactured around the world, referred to by the aviation and chemical industries as Types I through IV. Of these, Type I and Type IV are commonly used at U.S. commercial airports. Type I ADF is used to defrost and deice aircraft and Type IV ADF is used to prevent icing from recurring (anti-icing) after initial deicing with a Type I ADF. ADFs contain a primary freezing point depressant (typically PG or EG) and other additives. ADFs work by adhering to aircraft surfaces to remove and/or prevent snow and ice accumulation by virtue of their depressed freezing points. Airports conduct two types of deicing: dry-weather deicing to remove frost and wet-weather deicing and anti-icing during precipitation such as snow, sleet (ice pellets), or freezing rain. Airports may also perform dry-weather deicing on some types of aircraft whose fuel tanks become super-cooled during high-altitude flight, allowingfrost/ice to form on aircraft wings at lower altitudes and after landing. Based on the data collected by EPA in the airline detailed questionnaire, the most common ADF is Type I PG-based fluids (approximately 77 percent of ADF usage). In addition, U.S. airports have been trending towards using more PG-based fluids and less EG-based fluids. Table 9-3 in Section 9 presents EPA's estimates of ADF annual usage by airport based on the airline questionnaire responses and the estimation procedure outlined in that section.

Table 5-2 presents a national estimate of the average aircraft chemical usage by U.S. commercial airports by type of fluid.

Table 5-2. U.S. Commercial Airports – National Estimate of Aircraft Chemical Usage [1]

Chemical	Average Total Airport Usage (million gallons/year) [2]	Percentage of Chemical Usage
Type I PG ADF	19.305	77.1
Type IV PG ADF	2.856	11.4
Type I EG ADF	2.575	10.3
Type IV EG ADF	0.306	1.2

Sources: EPA Detailed Airline Questionnaire (USEPA, 2008b); Airport Deicing Loadings Database (USEPA, 2008c).
[1] EPA used the ADF purchase information to represent usage, per airline industry recommendations.
[2] Total gallons normalized to 100% PG/EG.

5.2 Deicing Stormwater Characterization

EPA evaluated data from a variety of sources to better understand the components of deicing chemicals and ADFs that collect in deicing stormwater. These data include:

- Information on the additives included in ADFs;
- Data collected during sampling of concentrated and diluted ADFs used at the Detroit Metropolitan Wayne County (DTW) and Minneapolis/St. Paul International (MSP) airports during the 2003/2004 deicing season;
- Data collected during sampling of deicing stormwater at the Albany International (ALB), Pittsburgh International (PIT), Denver International (DEN), and Greater Rockford (RFD) airports during the 2004/2005 deicing season;

- Current data for airports included in the PCS database; and
- Deicing stormwater data collected by EPA during the PDS, through site visits, or through industry or permit authority submissions.

Section 6 summarizes the types of pollutants found in deicing stormwater based on these sources.

5.2.1 Airfield Deicing Chemicals and Associated Deicing Stormwater

Most solid airfield deicing chemical products comprise a freezing point depressant (e.g., potassium acetate, sodium acetate) and minimal additives (e.g., corrosion inhibitors). Liquid airfield deicing chemical products comprise a freezing point depressant (e.g., potassium acetate, PG), water, and minimal additives. The airfield deicing products that include salts (i.e., potassium acetate, sodium acetate, and sodium formate) will ionize in water, creating positive salt ions (K^+, Na^+) and BOD load as the acetate or formate ion degrades into carbon dioxide (CO_2) and water.

Urea is typically applied to pavement and runway areas in granular form. Urea degrades by hydrolysis to CO_2 and ammonia, which can be toxic to aquatic organisms even at very low concentrations. Once ammonia is formed, it either remains in solution as ammonia or its ionized form (NH_4^+), biologically converts to other nitrogen forms (e.g., NO_3 or N_2), or volatilizes to the air. The formation of ammonia is dependent on the pH and temperature of the receiving water. The higher the pH and temperature, the more ammonia is formed. Another potentially toxic by-product of urea degradation is nitrous acid, which reacts with secondary amines to form nitrosamines, many of which are known carcinogens.

EPA has limited data on airfield deicing stormwater alone (i.e., stormwater that does not also contain aircraft deicing area stormwater). Most of EPA's stormwater data include both airfield and aircraft deicing components. However, during sampling at DTW, EPA collected samples from the airport's runway and open area ponds (Pond 3 East and Pond 6). These ponds are not expected to contain aircraft deicing stormwater because a separate pond collects wastewater from the gate and deicing pad areas where the stormwater is expected to contain ADF. DTW sometimes uses sand and potassium acetate for runway traction and deicing in addition to their usual mechanical snow removal equipment. It does not use urea-based deicers.

Table 5-3 presents the sampling data from the two airfield/open area runoff ponds.

5.2.2 Aircraft Deicing Chemicals and Associated Deicing Stormwater

ADFs primarily comprise a freezing point depressant (typically PG or EG), additives, and water. Typical additives are thickening agents, wetting agents, corrosion inhibitors, buffer, and dye, which make up 1 to 4 percent of the fluid mass. Type IV fluids have higher concentrations of the freezing point depressant and greater viscosity so that the fluid stays on the aircraft until take-off.

Table 5-3. EPA's Analytical Results for Pond 3E Effluent and Pond 6 Effluent, DTW

Analyte	Unit	Pond 3 East Effluent	Pond 6 Effluent
BOD_5	mg/L	146	43.0
Chloride	mg/L	855	315
COD	mg/L	273	111
Nitrate/Nitrite (NO_2 + NO_3-N)	mg/L	0.0400	0.110
Sulfate	mg/L	50.1	51.0
Total Dissolved Solids (TDS)	mg/L	1,790	833
Total Kjeldahl Nitrogen (TKN)	mg/L	1.51	0.990
TOC	mg/L	813	314
Total Phosphorus	mg/L	0.340	0.280
TSS	mg/L	150	149
Aluminum	µg/L	1,660	2,110
Aluminum, Dissolved	µg/L	ND (50.0)	64.5
Barium	µg/L	92.3	81.8
Barium, Dissolved	µg/L	77.5	66.5
Calcium	µg/L	96,600	69,400
Calcium, Dissolved	µg/L	91,000	63,500
Chromium [1]	µg/L	ND (10.0)	ND (10.0)
Copper [1]	µg/L	ND (10.0)	ND (10.0)
Iron	µg/L	3,630	4,390
Iron, Dissolved	µg/L	407	600
Magnesium	µg/L	20,300	17,400
Magnesium, Dissolved	µg/L	18,200	15,700
Manganese	µg/L	508	411
Manganese, Dissolved	µg/L	462	335
Molybdenum	µg/L	ND (10.0)	ND (10.0)
Molybdenum, Dissolved	µg/L	ND (10.0)	ND (10.0)
Sodium	µg/L	547,000	191,000
Sodium, Dissolved	µg/L	522,000	189,000
Titanium	µg/L	26.2	34.8
Zinc [1]	µg/L	41.4	43.8
Acetone	µg/L	ND (50.0)	ND (50.0)
PG - 1671 [2]	mg/L	ND (10.0)	ND (10.0)
PG - 8015D [2]	mg/L	ND (10.0)	ND (10.0)

Source: Final Sampling Episode Report Detroit Metropolitan Wayne County International Airport (DTW) (USEPA, 2006a).
[1] Pollutant listed by EPA as a priority pollutant. See 40 CFR Part 423, Appendix A.
[2] Number following analyte name refers to analytical method. 1671 is a Clean Water Act method and 8015D is a hazardous waste method promulgated under the Resource Conservation and Recovery Act (RCRA).
ND – Not detected (number in parentheses is reporting limit).

The actual composition of ADFs varies and information on specific additive compounds is usually considered proprietary by ADF manufacturers. EPA believes that typical ADFs most likely include the following components:

ADF Component	Composition (%)
PG or EG	50-88
Surfactant/wetting agent	About 0.5
Corrosion inhibitor/flame retardant	About 0.5
pH buffer	About 0.25
Dyes	<1
Water	Remainder

Source: *Environmental Impact and Benefit Assessment for Proposed Effluent Limitations Guidelines and Standards for the Airport Deicing Category* (ERG, 2009).

Despite limited public information, EPA has identified two main classes of additives widely used among ADF manufacturers. Alkylphenol/alkylphenol ethoxylates (AP/APEO) are nonionic surfactants used to reduce surface tension in aircraft deicers and triethanolamine is used as a pH buffer. (ERG, 2009). At the time of proposal of the rule, EPA also identified methyl-substituted benzotriazole (MeBT) as an ADF additive, which was used as a corrosion inhibitor/flame retardant. In conversations with ADF manufacturers since proposal, EPA has been told that the use of triazole compounds in ADF is being discontinued and that triazole use in European ADFs has been phased out. EPA also has information indicating that high molecular weight, nonlinear polymers may be used as thickening agents in ADFs (see *Aircraft Deicing Fluids* (ERG, 2007b) and various classes of dyes can be used to color the ADF. The classes of dyes identified as potentially used in ADFs include azo, xanthene, triphenyl methane, and anthroquinone dyes (see *Questions Regarding Pylam Dye Use in ADF* (ERG, 2007a).

Analyses conducted by the USGS at General Mitchell International (MKE) airport in Milwaukee, WI, and EPA's sampling programs have confirmed the presence of glycols, triazole compounds, and alkylphenol compounds in deicing stormwater. EPA collected deicing stormwater samples at MSP and DTW during the 2004/2005 winter season. At MSP, EPA collected samples of deicing stormwater from segregated high concentration and low concentration storage tanks. At DTW, Northwest collected its deicing stormwater from a March 24, 2005 deicing event into a portable "frac" tank, which was then sampled by EPA. Table 5-4 lists the constituents detected in these deicing stormwaters and their concentrations. During the 2005/2006 deicing season, EPA collected five consecutive days of samples of influent to and effluent from deicing stormwater treatment at ALB, PIT, DEN, and RFD. The sampled deicing stormwater at these airports, prior to treatment, shows a wide range of constituents and constituent concentrations among the airports, as shown in Table 5-5 and Table 5-6.

Table 5-4. MSP and DTW Grab Sample Data Summary for Collected Deicing Stormwater

Analyte	Unit	MSP High Concentration Storage Tank	MSP Low Concentration Storage Tank	DTW Northwest Frac Tank
Classical Pollutants				
Ammonia as Nitrogen (NH_3-N)	mg/L	ND (0.05)	ND (0.05)	0.790
BOD_5	mg/L	115,000	8,000	140,000
Chloride	mg/L	45.0	27.0	25.0
COD	mg/L	358,000	16,000	332,000
Hexane Extractable Material (HEM)	mg/L	50.0	ND (5.00)	22.0
Nitrate/Nitrite (NO_2 + NO_3-N)	mg/L	0.0950	<0.0600	0.240
Silica Gel Treated HEM (SGT-HEM)	mg/L	17.0	ND (5.00)	ND (6.00)
Sulfate	mg/L	21.2	13.6	20.3
TDS	mg/L	1,370	559	1,440
TKN	mg/L	13.5	5.61	71.1
TOC	mg/L	96,100	5,660	93,100
Total Phosphorus	mg/L	6.49	< 2.10	0.320
Total Recoverable Phenolics	mg/L	0.150	0.0375	<0.007
TSS	mg/L	89.0	19.5	11.5
Total and Dissolved Metals				
Aluminum	µg/L	525	508	ND (500)
Aluminum, Dissolved	µg/L	ND (500)	136	ND (500)
Antimony, Dissolved [1]	µg/L	201	ND (20.0)	ND (200)
Barium	µg/L	114	67.1	52.4
Barium, Dissolved	µg/L	36.4	61.9	46.9
Calcium	µg/L	68,200	35,200	127,000
Calcium, Dissolved	µg/L	59,600	34,500	125,000
Copper [1]	µg/L	ND (100)	37.6	ND (100)
Copper, Dissolved [1]	µg/L	ND (100)	16.4	ND (100)
Iron	µg/L	11,000	7,470	1,410
Iron, Dissolved	µg/L	4,960	6,030	1,370
Magnesium	µg/L	9,230	4,250	12,900
Magnesium, Dissolved	µg/L	8,490	4,080	13,000
Manganese	µg/L	887	317	433
Manganese, Dissolved	µg/L	756	308	423
Mercury [1]	µg/L	ND (40)	ND (2)	45.1
Mercury, Dissolved [1]	µg/L	ND (40)	ND (2)	68.7
Molybdenum	µg/L	19,100	794	15,900
Molybdenum, Dissolved	µg/L	19,000	771	16,000
Sodium	µg/L	48,700	18,700	22,800
Sodium, Dissolved	µg/L	48,100	18,600	19,200
Tin	µg/L	611	32.1	673

Table 5-4 (Continued)

Analyte	Unit	MSP High Concentration Storage Tank	MSP Low Concentration Storage Tank	DTW Northwest Frac Tank
Tin, Dissolved	µg/L	616	32.5	646
Titanium	µg/L	ND (100)	13.5	ND (100)
Zinc [1]	µg/L	492	291	119
Zinc, Dissolved [1]	µg/L	444	277	119
Volatile and Semivolatile Organics				
Acetone	µg/L	1,440	23,700	3,340
PG – 1671 [2]	mg/L	—	—	192,000
PG – 8015D [2]	mg/L	193,000	8,600	170,000
Trichloroethene [1]	µg/L	ND (10)	ND (10)	14.5

Sources: Final Sampling Episode Report Minneapolis/St. Paul International Airport (MSP) (USEPA, 2006b); Final Sampling Episode Report Detroit Metropolitan Wayne County International Airport (DTW) (USEPA, 2006a).
[1] Pollutant listed by EPA as a priority pollutant. See 40 CFR Part 423, Appendix A.
[2] Number following analyte name refers to analytical method. 1671 is a Clean Water Act method and 8015D is a hazardous waste method promulgated under the Resource Conservation and Recovery Act (RCRA).
< – Average result includes at least one nondetect value.
ND – Not detected (number in parenthesis is reporting limit).

Table 5-5. DEN, PIT, and ALB - 5-Day Average Data Summary for Untreated Deicing Stormwater

Analyte	Units	DEN Effluent from Equalization Feed Tank 5-day Average	PIT Influent to Reverse Osmosis (RO) Unit 5-day Average	ALB Influent to Anaerobic Treatment System 5-day Average
Alkalinity	mg/L	706	481	159
NH_3-N)	mg/L	0.448	ND (0.05)	<0.262
BOD_5	mg/L	149,000	16,600	3,400
COD	mg/L	247,000	28,300	5,350
Chloride	mg/L	120	11.6	90.0
Hardness	mg/L	362	542	248
HEM	mg/L	9.20	ND (6.0)	ND (5.0)
NO_3-N + NO_2-N)	mg/L	0.0266	<0.0204	<0.0284
Sulfate	mg/L	60.0	48.1	26.4
TDS	mg/L	NC	1,670	650
TKN	mg/L	6.41	9.04	1.61
TOC	mg/L	89,000	7,720	1,570
Total Orthophosphate	mg/L	<1.03	<0.0196	0.115
Total Phosphorus	mg/L	<2.76	0.0778	0.946
Total Recoverable Phenolics	mg/L	0.0608	0.0187	ND (0.005)
TSS	mg/L	<17.8	<8.40	16.6
Arsenic	µg/L	<81.8	12.7	ND (10)
Barium	µg/L	<13.2	103	42.5
Boron	µg/L	<723	532	ND (100)
Calcium	µg/L	103,000	155,000	48,300
Copper	µg/L	305	ND (10)	ND (10)
Iron	µg/L	1,210	5,870	6,270
Magnesium	µg/L	5,360	6,260	9,990
Manganese	µg/L	156	532	736
Molybdenum	µg/L	11,900	ND (10)	ND (10)
Selenium	µg/L	172	31.8	<5.38
Sodium	µg/L	254,000	54,300	89,600
Tin	µg/L	<258	41.0	ND (30)
Zinc	µg/L	<81.1	71.8	48.3
Acetone	µg/L	4,100	10,900	15,400
Benzoic Acid	µg/L	716	ND (50)	278
Methyl Ethyl Ketone	µg/L	ND (50)	ND (50)	<58.5
Phenol	µg/L	ND (100)	ND (100)	24.5
EG - 1671 [1]	mg/L	<167	<65.6	ND (10)
EG - 8015D [1]	mg/L	<172	<73.6	ND (10)

Table 5-5 (Continued)

Analyte	Units	DEN Effluent from Equalization Feed Tank 5-day Average	PIT Influent to Reverse Osmosis (RO) Unit 5-day Average	ALB Influent to Anaerobic Treatment System 5-day Average
PG - 1671 [1]	mg/L	174,000	15,700	2,570
PG - 8015D [1]	mg/L	173,000	15,900	2,630
Tolyltriazole	µg/L	10,100	7,860	325
Nonylphenol, total	µg/L	ND (5.0)	22.2	ND (12.0)
Nonylphenol-1-Ethoxylate	µg/L	ND (7.4)	130	ND (19.0)
Nonylphenol-2-Ethoxylate	µg/L	ND (21.0)	190	ND (53.0)
Nonylphenol-3-Ethoxylate	µg/L	17.8	59.9	3.90
Nonylphenol-4-Ethoxylate	µg/L	16.4	15.4	3.01
Nonylphenol-5-Ethoxylate	µg/L	21.5	213	5.70
Nonylphenol-6-Ethoxylate	µg/L	50.4	403	12.5
Nonylphenol-7-Ethoxylate	µg/L	60.7	619	15.4
Nonylphenol-8-Ethoxylate	µg/L	86.2	841	24.7
Nonylphenol-9-Ethoxylate	µg/L	79.1	942	24.7
Nonylphenol-10-Ethoxylate	µg/L	92.5	1,050	38.1
Nonylphenol-11-Ethoxylate	µg/L	100	1,040	40.4
Nonylphenol-12-Ethoxylate	µg/L	216	833	33.7
Nonylphenol-13-Ethoxylate	µg/L	167	589	25.2
Nonylphenol-14-Ethoxylate	µg/L	116	386	17.8
Nonylphenol-15-Ethoxylate	µg/L	69.9	222	8.80
Nonylphenol-16-Ethoxylate	µg/L	43.4	107	4.69
Nonylphenol-17-Ethoxylate	µg/L	23.3	53.5	2.27
Nonylphenol-18-Ethoxylate	µg/L	12.4	23.3	1.09
Octylphenol	µg/L	<8.80	ND (0.01)	ND (2.00)
Octylphenol-2-Ethoxylate	µg/L	71.8	ND (0.144)	0.159
Octylphenol-3-Ethoxylate	µg/L	1,460	4.38	2.66
Octylphenol-4-Ethoxylate	µg/L	1,260	ND (2.26)	ND (2.26)
Octylphenol-5-Ethoxylate	µg/L	891	ND (2.93)	ND (2.93)
Octylphenol-6-Ethoxylate	µg/L	441	ND (2.69)	ND (2.69)
Octylphenol-7-Ethoxylate	µg/L	198	ND (2.58)	ND (2.58)
Octylphenol-8-Ethoxylate	µg/L	116	ND (1.85)	ND (1.85)
Octylphenol-9-Ethoxylate	µg/L	44.6	ND (0.636)	ND (0.636)
Octylphenol-10-Ethoxylate	µg/L	22.5	ND (0.636)	ND (0.636)
Octylphenol-11-Ethoxylate	µg/L	12.0	ND (0.267)	ND (0.267)
Octylphenol-12-Ethoxylate	µg/L	8.08	ND (0.113)	ND (0.113)

Table 5-5 (Continued)

Analyte	Units	DEN Effluent from Equalization Feed Tank 5-day Average	PIT Influent to Reverse Osmosis (RO) Unit 5-day Average	ALB Influent to Anaerobic Treatment System 5-day Average
Total Nonylphenol-3-Ethoxylate-Nonlyphenol-18-	µg/L	1,170	7,400	260
Total Octylphenol-2-Ethoxylate-Octylphenol-12-Ethoxylate	µg/L	4,530	ND (16.0)	ND (16.0)

Sources: Draft Sampling Episode Report Denver International Airport (USEPA, 2006c); Draft Sampling Episode Report Pittsburgh International Airport (USEPA, 2006d); Draft Sampling Episode Report Albany International Airport (USEPA, 2006e).
[1] Number following analyte name refers to analytical method. 1671 is a Clean Water Act method and 8015D is a hazardous waste method promulgated under the Resource Conservation and Recovery Act (RCRA).
ND – Not detected (number in parentheses is reporting limit).
NC – Not collected.
< – Average result includes at least one nondetect value.

Table 5-6. RFD - 1-Day Data Summary for Untreated Deicing Stormwater

Analyte	Units	Influent to Aerobic Treatment System, Spring
Alkalinity	mg/L	1,030
NH_3-N	mg/L	59.6
BOD_5	mg/L	603
COD	mg/L	646
Chloride	mg/L	14.0
Hardness	mg/L	112
NO_3-N + NO_2-N)	mg/L	0.0190
Sulfate	mg/L	5.65
TDS	mg/L	384
TKN	mg/L	82.8
TOC	mg/L	137
Total Phosphorus	mg/L	0.330
TSS	mg/L	85.0
Barium	µg/L	20.3
Calcium	µg/L	6,600
Iron	µg/L	108
Magnesium	µg/L	14,700
Manganese	µg/L	164
Sodium	µg/L	4,790
Acetone	µg/L	86.6
Methyl Ethyl Ketone	µg/L	136
PG - 8015D [1]	mg/L	31.0
Tolyltriazole	µg/L	45.3
Bisphenol A	ng/L	ND (12,000)
N-Nonylphenol-2-Ethoxylate	NC	50.0
N-Nonylphenoxyl-2-Carboxylic Acid	NC	41.0
Octylphenol-9-Ethoxylate	µg/L	ND (3.18)

Source: Final Sampling Episode Report Greater Rockford Airport (USEPA, 2006f)
[1] Number following analyte name refers to analytical method. 8015D is a hazardous waste method promulgated under the Resource Conservation and Recovery Act (RCRA).
ND – Not detected (number in parentheses is reporting limit).

5.3 Aircraft and Airfield Deicing Chemical Use and Associated Deicing Stormwater at Alaskan Airports

Deicing operations at Alaskan airports may be different than those commonly seen at other U.S. airports due to the nature of air travel in Alaska and weather conditions. In Alaska, small airports have a relatively high number of commercial aircraft departures (including jet aircraft) for the suite of communities they serve due to their remote locations with no access to the road system. Yet these airports utilize small amounts of ADF and runway deicers because of climate conditions (dry and cold), as well as runway maintenance scheduling. For example, in Kotzebue, a town of 3,120 people, there are about 12,000 annual departures (including passenger and freight jet planes and prop planes) and the fluid usage is only about 1,000 gallons/winter.

In addition, long periods of below-freezing temperatures affect the the timing of deicing stormwater discharges. Deicing materials are not available for collection during freezing temperatures because they are encapsulated within the snow and eventually become runoff during the spring thaw. Thus, the stormwater runoff is not linked to the time of the ADF application. For example, at locations in arctic Alaska such as Bethel Airport (BET), there is no stormwater to collect during the deicing season (October – March) as temperatures rarely, if ever, go above freezing. For these airports, collection strategies may be significantly different than airports located within the lower 48 states. One current practice reported by Ted Stevens Anchorage International Airport (ANC) is gas-and-go cargo operations, which involves anti-icing on landing during certain weather conditions. This allows the airport to avoid deicing prior to departure. This anti-icing procedure also uses less glycol and allows a quicker turnaround.

Due to the remote nature of Alaskan airports and aircraft scheduling, runways are generally prepped for individual flights each day rather than maintaining continuous operation around the clock. Because of this, Alaskan airports rely heavily on mechanical methods for runway deicing. When airfield deicing chemical use is necessary, most airports in Alaska use potassium acetate or urea.

5.4 References

Corsi, S.R., et al. 2003. *Nonylphenol Ethoxylates and Other Additives in Aircraft Deicers, Anti-icers, and Waters Receiving Airport Runoff.* (January 1). DCN AD00083.

ERG. 2007a. Personal communication (telecon) between Mary Willett (ERG) and Bob Reynolds (Pylam Dyes). *Questions Regarding Pylam Dye Use in ADF*. (April 16). DCN AD00686.

ERG. 2007b. Personal communication (telecon) between Mary Willett (ERG) and Jeffery Carey (Noveon). *Aircraft Deicing Fluids*. (April 16). DCN AD00688.

USEPA. 2006a. *Final Sampling Episode Report Detroit Metropolitan Wayne County International Airport (DTW), Episode 6508.* U.S. Environmental Protection Agency. Washington, D.C. (July 12). DCN AD00620.

USEPA. 2006b. *Final Sampling Episode Report Minneapolis/St. Paul International Airport (MSP), Episode 6509*. U.S. Environmental Protection Agency. Washington, D.C. (July 12). DCN AD00622.

USEPA. 2006c. *Final Sampling Episode Report Denver International Airport, Episode 6522.* U.S. Environmental Protection Agency. Washington, D.C. (August 2). DCN AD00840.

USEPA. 2006d. *Final Sampling Episode Report Pittsburgh International Airport, Episode 6528.* U.S. Environmental Protection Agency. Washington, D.C. (November 1). DCN AD00841.

USEPA. 2006e. *Final Sampling Episode Report Albany International Airport, Episode 6523.* U.S. Environmental Protection Agency. Washington, D.C. (July 19). DCN AD00842.

USEPA. 2006f. *Final Sampling Episode Report Greater Rockford Airport, Sampling Episode 6529* (April 20, 2006) *and Sampling Episode 6530* (August 29, 2006, January 18, 2008). U.S. Environmental Protection Agency. Washington, D.C. DCN AD00839.

USEPA. 2008a. *Airport Deicing Questionnaire Database.* U.S. Environmental Protection Agency. Washington, D.C. DCN AD00927.

USEPA. 2008b. *Airline Questionnaire Database.* U.S. Environmental Protection Agency. Washington, D.C. DCN AD00938.

USEPA. 2008c. *Airport Deicing Loadings Database.* U.S. Environmental Protection Agency. Washington, D.C. DCN AD00857.

USEPA. 2009. *Environmental Impact and Benefit Assessment for Proposed Effluent Limitation Guidelines and Standards for the Airport Deicing Category.* (July 1). EPA 821-R-09-005. DCN AD01197.

6. POLLUTANTS OF CONCERN

EPA identified pollutants in stormwater associated with deicing activities for potential control. Pollutants of concern may include pollutants directly associated with deicing chemicals, by-products from deicing activities (e.g., metals), and/or pollutant parameters that are influenced by deicing chemicals (e.g., BOD and COD).

EPA reviewed its deicing stormwater sampling data as well as the information available through NPDES permits to identify conventional, nonconventional, and priority pollutants present in airport deicing stormwater. This section presents the results of EPA's evaluation and identifies potential pollutants of concern and those chosen for regulation.

6.1 Identification of Airport Deicing/Anti-icing Stormwater Pollutants

Airport deicing stormwater is generated when airfield deicing chemicals and ADFs mix with stormwater (either directly or because of snowmelt). Because deicing stormwater is weather-dependent, it is highly variable in nature and pollutant concentrations may vary greatly. In addition, other airport-related activities, including aircraft fueling and maintenance activities, may contribute pollutants to stormwater that is also contaminated with deicing chemicals. Because of the inherent difficulties in characterizing pollutants resulting solely from deicing activities, EPA evaluated pollutants detected in deicing stormwater, pollutants present in source water, and pollutants that are present in ADFs and airfield deicers prior to use to determine the pollutants likely to be present in deicing stormwater.

EPA considered multiple sources of information to identify potential pollutants of concern associated with deicing stormwater including the following:

- EPA sampling data from the PDS;
- NPDES permits for airports to determine pollutants that are currently monitored or limited at airports;
- EPA sampling data collected during the 2004/2005 and 2005/2006 deicing seasons to identify pollutants present in untreated deicing stormwater;
- EPA sampling data collected during the 2004/2005 and 2005/2006 deicing seasons to determine pollutants present in source water;
- EPA sampling data collected during the 2004/2005 deicing season, current research, and expert sources to determine ADF constituents; and
- Responses to the airport questionnaire.

Airport Deicing Operations PDS

For the PDS, EPA sampled:

- Type I ADFs;
- Lagoon stormwater from Albany International Airport;
- Untreated deicing stormwater from Kansas City International Airport;
- Untreated deicing stormwater from Bradley International Airport;
- Untreated deicing stormwater from Greater Rockford Airport; and
- Stormwater outfalls from Bradley International Airport.

The pollutants detected in one or more of these samples were summarized in Table 8-4 of the *Preliminary Data Summary: Airport Deicing Operations* report (USEPA, 2000) and are presented in Table 6-1 of this report.

NPDES Permits

EPA reviewed NPDES individual and general stormwater permits for airports that are estimated to have significant deicing operations in the United States. The permit review is summarized in the *Airport Deicing Operations NPDES Permit Review Summary* memorandum (ERG, 2007a). Table 6-1 lists pollutants that have monitoring and limit requirements in current airport NPDES permits.

Pollutants Present in Untreated Deicing Stormwater

Under this rulemaking effort, EPA collected samples at the following six airports during the 2004/2005 and 2005/2006 deicing seasons:

- Detroit Metropolitan Wayne County (DTW) airport;
- Minneapolis/St. Paul International (MSP) airport;
- Albany International (ALB) airport;
- Greater Rockford (RFD) airport;
- Pittsburgh International (PIT) airport; and
- Denver International (DEN) airport.

Table 6-1 lists pollutants detected in untreated deicing stormwater from these locations.

Pollutants Present in Source Water

Table 6-1 also lists pollutants detected in source water samples at the airports EPA sampled at during the 2004/2005 and 2005/2006 deicing seasons.

Deicing/Anti-Icing Fluid Constituents

EPA does not have sufficient information on all of the constituents of airfield chemicals and ADFs to fully characterize them. However, EPA's airport questionnaire does identify which chemicals and brand-name products are commonly used, which can help to define the pollutants expected to be in deicing stormwater.

Table 6-1. Pollutants Under Consideration as Potential Pollutants of Concern

Analyte	Pollutants Identified in the PDS Sampling	Pollutants Monitored in NPDES Permits	Pollutants Identified in Raw ADF in Research or 2004-2006 EPA Sampling	Pollutants Identified in Untreated Stormwater in 2004-2006 EPA Sampling	Pollutants Identified in Source Water in 2004-2006 EPA Sampling
Classicals/Conventionals					
Alkalinity				X	X
NH_3-N	X	X		X	X
BOD_5	X	X	X	X	
COD		X	X	X	
Chloride			X	X	X
Dissolved Oxygen		X			
Hardness				X	X
Oil & Grease		X			
SGT-HEM	X			X	
HEM	X		X	X	
NO_3-N + NO_2-N			X	X	X
Sulfate			X	X	X
TDS				X	X
TKN			X	X	X
TOC	X		X	X	X
Total Orthophosphate				X	X
Total Phosphorus			X	X	X
Total Petroleum Hydrocarbons (TPH)		X			
Total Recoverable Phenolics			X	X	
TSS		X		X	
Metals					
Aluminum	X			X	
Antimony	X		X	X	
Arsenic	X	X		X	
Barium	X			X	X
Boron	X			X	

Table 6-1 (Continued)

Analyte	Pollutants Identified in the PDS Sampling	Pollutants Monitored in NPDES Permits	Pollutants Identified in Raw ADF in Research or 2004-2006 EPA Sampling	Pollutants Identified in Untreated Stormwater in 2004-2006 EPA Sampling	Pollutants Identified in Source Water in 2004-2006 EPA Sampling
Cadmium	X				
Calcium	X		X	X	X
Chromium	X		X		
Copper	X	X	X	X	X
Iron	X		X	X	X
Lead	X	X			
Magnesium	X		X	X	X
Manganese	X			X	
Mercury	X		X		
Molybdenum			X	X	
Potassium	X				
Selenium	X			X	
Silver	X				
Sodium	X		X	X	X
Thallium	X				
Tin	X		X	X	
Titanium	X				
Vanadium	X				
Zinc	X	X	X	X	X
Organics					
Acetone			X	X	
Benzene, toluene, ethylbenzene, xylene (BTEX)	X	X			
Benzoic Acid				X	
Bis(2-Ethylhexyl) Phthalate	X				
Di-n-butyl Phthalate	X				
Diethylene Glycol	X				

Table 6-1 (Continued)

Analyte	Pollutants Identified in the PDS Sampling	Pollutants Monitored in NPDES Permits	Pollutants Identified in Raw ADF in Research or 2004-2006 EPA Sampling	Pollutants Identified in Untreated Stormwater in 2004-2006 EPA Sampling	Pollutants Identified in Source Water in 2004-2006 EPA Sampling
N-Dodecane	X				
EG	X	X		X	
N-Hexadecane	X				
Methyl Ethyl Ketone				X	
Naphthalene		X			
Phenol	X			X	
PG	X	X	X	X	
N-Tetradecane	X				
1,2,4- Trimethylbenzene		X			
Trichloroethene				X	
Tolyltriazole				X	
Benzotriazole					
5-Methyl-1H-benzotriazole	X				
Alkylphenols					
Nonylphenol, total			X	X	
Nonylphenol-1-Ethoxylate			X	X	
Nonylphenol-2-Ethoxylate			X	X	
Nonylphenol-3-Ethoxylate			X	X	
Nonylphenol-4-Ethoxylate			X	X	
Nonylphenol-5-Ethoxylate			X	X	
Nonylphenol-6-Ethoxylate			X	X	
Nonylphenol-7-Ethoxylate			X	X	
Nonylphenol-8-Ethoxylate			X	X	
Nonylphenol-9-Ethoxylate			X	X	
Nonylphenol-10-Ethoxylate			X	X	
Nonylphenol-11-Ethoxylate			X	X	
Nonylphenol-12-Ethoxylate			X	X	X

Table 6-1 (Continued)

Analyte	Pollutants Identified in the PDS Sampling	Pollutants Monitored in NPDES Permits	Pollutants Identified in Raw ADF in Research or 2004-2006 EPA Sampling	Pollutants Identified in Untreated Stormwater in 2004-2006 EPA Sampling	Pollutants Identified in Source Water in 2004-2006 EPA Sampling
Nonylphenol-13-Ethoxylate			X	X	X
Nonylphenol-14-Ethoxylate			X	X	X
Nonylphenol-15-Ethoxylate			X	X	X
Nonylphenol-16-Ethoxylate			X	X	X
Nonylphenol-17-Ethoxylate			X	X	X
Nonylphenol-18-Ethoxylate			X	X	X
Octylphenol			X	X	
Octylphenol-2-Ethoxylate			X	X	
Octylphenol-3-Ethoxylate			X	X	
Octylphenol-4-Ethoxylate			X	X	
Octylphenol-5-Ethoxylate			X	X	
Octylphenol-6-Ethoxylate			X	X	
Octylphenol-7-Ethoxylate			X	X	
Octylphenol-8-Ethoxylate			X	X	
Octylphenol-9-Ethoxylate			X	X	
Octylphenol-10-Ethoxylate			X	X	
Octylphenol-11-Ethoxylate			X	X	
Octylphenol-12-Ethoxylate			X	X	
Total Nonylphenol-3-Ethoxylate-Nonlyphenol-18-Ethoxylate			X	X	X
Total Octylphenol-2-Ethoxylate-Octylphenol-12-Ethoxylate			X	X	

Note: Octylphenol and nonylphenol should have a higher toxicity than the alkylphenol ethoxylates.

The commonly used airfield deicing and anti-icing chemicals are listed below, along with the approximate percentage of total airfield deicing chemical usage they comprise:

- Potassium acetate (64 percent);
- Propylene glycol-based fluids (12 percent);
- Urea (11 percent);
- Sodium acetate (9 percent);
- Sodium formate (3 percent); and
- Ethylene glycol-based fluids (2 percent).

EPA has two sources of data on the constituents of ADF. First, EPA collected and analyzed samples of unused, or "raw," ADF during the sampling episodes at DTW and MSP. Table 6-1 lists the chemical compounds for which EPA analyzed the raw ADF samples. Second, EPA reviewed research conducted by USGS to determine potential ADF constituents. Steven Corsi of USGS conducts research and sampling on ADF and deicing stormwater at General Mitchell International Airport in Milwaukee, WI. He has published several papers presenting his research and sampling results and has identified the following pollutants in ADF stormwater and snowmelt:

- BOD_5;
- COD;
- PG and EG;
- AP and APEO; and
- Benzotriazole (BT) and its methylated derivatives (MeBT).

6.2 Pollutants of Concern Selection Criteria

Having identified pollutants that are likely to be present in airport deicing stormwater, EPA then considered which pollutants should be pollutants of concern. EPA considered the following criteria in assessing potential pollutants of concern for the airport deicing industry:

- Whether the pollutant can be directly linked to deicing/anti-icing chemicals;
- Whether the pollutant is detected in the effluent from a small number of airports and is uniquely related to those facilities; or
- Whether the pollutant can be analyzed using an EPA-approved or other established method.

After considering the criteria listed above, EPA developed a list of those pollutants that are considered potential pollutants of concern.

6.3 Identification of Potential Pollutants of Concern

EPA compared the pollutants detected in deicing stormwater to ADF and airfield deicer constituents and determined that many pollutants present in the stormwater are not present in ADF or airfield deicers. Stormwater contains pollutants from sources other than ADF and airfield deicers; these sources may include, but are not limited to, the following:

- Source water pollutants (present in the water used at the airport facility);
- Pollutants from aircraft and vehicle fueling;

- Pollutants from maintenance-related operations; or
- Pollutants from roof runoff.

EPA also considered the other criteria listed in Section 6.2 to assess potential pollutants of concern. Below is a summary of EPA's evaluation of potential pollutants of concern by the following analytical categories: classical/conventional parameters, metals, and organic pollutants.

Classical/Conventional Parameters

The major components of both airfield deicing chemicals and ADFs are organic and degrade in the environment after their release. Because of this, COD and BOD_5 concentrations are generally high in deicing stormwater. Both of these pollutant parameters are also good indicators of the amount of acetates, urea, glycols, and formates in deicing stormwater.

EPA believes that those airports with discharge permits requiring monitoring and control of ammonia, TKN, and nitrate/nitrite are likely doing so to monitor discharges of urea. Information collected during EPA's airport site visits seemed to indicate that airports have been phasing out the use of urea for airfield deicing. However, EPA's analysis of urea use from the airport questionnaire showed an increase during the 2002/2003 through 2004/2005 deicing seasons, with approximately the same number of airports using urea in each of those seasons.

Several of the classical parameters detected in deicing stormwater are from nondeicing stormwater, dilution water, or other airport operations. Based on information on airfield deicers and analysis of raw ADF, EPA concludes these pollutants are not present in ADF or airfied deicers but are present in deicing stormwater. Pollutants from airport sources aside from ADF/airfied deicers include alkalinity, hardness, oil and grease, TDS, and TSS.

Other classical/conventional parameters (including chloride, TOC, and total phosphorus) are found in source water, which is used to dilute ADF/airfield deicers prior to application. Therefore, EPA concluded these pollutants are not present in ADF/airfield deicers.

Finally, while total recoverable phenolics are present in EPA sampling results, the phenols in ADF are widely reported as alkylphenols and octylphenols; therefore, EPA chose the analyte-specific results and not the bulk parameter as the more appropriate indicator of phenols in ADF.

Metals

Multiple metals have been detected in samples of airport deicing stormwater. Some of these metals were also detected in the ADF samples collected by EPA. Many of these metals are not original components of deicing products (e.g., aluminum and seleniun); they are present as background concentrations from the stormwater or source water used for ADF dilution or they are metals picked up by stormwater runoff from aircraft maintenance/operation areas or building roofs.

Nonyl/Octyl-Phenol-Ethoxylates

EPA sampling data shows the presence of both nonylphenol and octylphenol ethoxylates. EPA decided to use the total octylphenol and total nonylphenol ethoxolates as the indicator for all ethoxolates.

Organic Pollutants

Organic pollutants present in deicing stormwater include PG, EG, triazole compounds, alkylphenols, and alkylphenol ethoxylates. Other organics may also be present from the breakdown of glycols, urea, acetates, and formates.

Pollutants of Concern

Based on this evaluation of available data, EPA identified the following as potential pollutants of concern for the Airport Deicing Category:

- COD;
- BOD5;
- EG;
- PG;
- Benzotriazole;
- 5-Methyl-1H-benzotriazole;
- Nonylphenol, total;
- Octylphenol, total;
- Total nonylphenol-3-ethoxylate-nonlyphenol-18-ethoxylate;
- Total octylphenol-2-ethoxylate-octylphenol-12-ethoxylate;
- Ammonia as nitrogen;
- Nitrate/Nitrite;
- TKN;
- Aluminum;
- Antimony;
- Boron;
- Cadmium;
- Chromium;
- Iron;
- Lead;
- Magnesium;
- Mercury;
- Molybdenum;
- Potassium;
- Selenium;
- Thallium;
- Tin;
- Titanium;
- Vanadium;
- Zinc; and
- Acetone.

6.4 Selection of Regulated Pollutants

Table 6-2 lists the potential pollutants of concern identified in Section 6.3, along with an explanation of whether EPA selected the pollutants for regulation. Based on the documented environmental impacts from stormwater contaminated with airport deicing materials, EPA focused on regulating those pollutants exerting oxygen demand and contributing toxicity to receiving water bodies. EPA found that the impacts of slug loads of ADF stormwater on the dissolved oxygen of receiving streams, as well as color and odor issues associated with high ADF concentrations in stormwater discharge, are well documented. The main component of ADF is glycol, which exhibits significant oxygen demand. Research by Corsi (Corsi et al., 2006) also identified potential toxicity concerns that may be linked to ADF additives, specifically triazoles and alkylphenols. ADF manufacturers have told EPA that the use of triazole compounds in ADF is being discontinued and that triazole use in European ADFs has been phased out. Alkylphenols and their ethoxylates have also been identified as potential toxic components of ADF. EPA's sampling data have confirmed the presence of these compounds; however, EPA believes that insufficient information is currently available to fully characterize the extent to which these compounds are present in deicing stormwater and their impact. In addition, there is not currently an approved EPA method (in 40 CFR Part 136) for these compounds.

For stormwater discharges from airfield deicing operations, EPA focused on the continued use of urea. Urea breaks down into ammonia, and the resulting ammonia toxicity in receiving streams has helped to discourage urea use as an airfield deicing chemical in the past. When inadequately treated, urea-contaminated wastewater also may contribute to nitrogen enrichment and eutrophication of receiving waters. Alternative airfield deicing chemicals, predominantly comprising a salt ion (potassium or sodium) and either acetate or formate, are available that are less toxic than ammonia.

Based on the known environmental impacts from deicing stormwater discharges, EPA has selected COD and ammonia (as N) for regulation. COD is a good indicator parameter to monitor the overall oxygen demand resulting from the discharge of glycol-based ADFs and any other organic constituents present in the stormwater. Ammonia as N is selected for regulation to ensure that airports cease using urea as an airfield deicer, since other less toxic products are available.

EPA evaluated the impacts of the airport deicing collection and treatment scenarios on both BOD_5 and COD discharges. EPA selected COD for regulation and not BOD_5 for the following reasons:

- COD analyses are simple to conduct and can be measured in real time compared to a 5-day test for BOD;
- COD eliminates the need to consider receiving water temperature when evaluating water quality concerns; and
- Toxic ADF additive compounds in deicing stormwater may have a negative and variable affect on the acclimation of the active cultures used in BOD analysis, making the method less robust than COD analysis for these wastewaters.

Table 6-2. Potential Pollutants of Concern Selected for Regulation

Potential Pollutant of Concern	Selected for Regulation	Explanation of Selection or Nonselection for Final Rule
BOD_5		COD as surrogate
COD	X	Selected for regulation
Ethylene glycol		COD as surrogate
Propylene glycol		COD as surrogate
Benzotriazole		Limited data available to support selection; potential discontinued use
5-Methyl-1H-benzotriazole		Limited data available to support selection; potential discontinued use
Nonylphenol, Total		Limited data available to support selection; no current EPA-approved method for analysis
Octylphenol, Total		Limited data available to support selection; no current EPA-approved method for analysis
Total nonylphenol-3-ethoxylate-nonlyphenol-18-ethoxylate		Limited data available to support selection; no current EPA-approved method for analysis
Total octylphenol-2-ethoxylate-octylphenol-12-ethoxylate		Limited data available to support selection; no current EPA-approved method for analysis
Ammonia as nitrogen	X	Selected for regulation to monitor urea use
Nitrate/Nitrite		Ammonia as nitrogen as surrogate for urea use
TKN		Ammonia as nitrogen as surrogate for urea use
Aluminum		Limited impact data for metals; insufficient data to support ADF as sole source of metal contamination
Antimony		Limited impact data for metals; insufficient data to support ADF as sole source of metal contamination
Boron		Limited impact data for metals; insufficient data to support ADF as sole source of metal contamination
Cadmium		Limited impact data for metals; insufficient data to support ADF as sole source of metal contamination
Chromium		Limited impact data for metals; insufficient data to support ADF as sole source of metal contamination
Iron		Limited impact data for metals; insufficient data to support ADF as sole source of metal contamination
Lead		Limited impact data for metals; insufficient data to support ADF as sole source of metal contamination
Magnesium		Limited impact data for metals; insufficient data to support ADF as sole source of metal contamination
Mercury		Limited impact data for metals; insufficient data to support ADF as sole source of metal contamination
Molybdenum		Limited impact data for metals; insufficient data to support ADF as sole source of metal contamination
Potassium		Limited impact data for metals; insufficient data to support ADF as sole source of metal contamination
Selenium		Limited impact data for metals; insufficient data to support ADF as sole source of metal contamination

Table 6-2 (Continued)

Potential Pollutant of Concern	Selected for Regulation	Explanation of Selection or Nonselection for Final Rule
Thallium		Limited impact data for metals; insufficient data to support ADF as sole source of metal contamination
Tin		Limited impact data for metals; insufficient data to support ADF as sole source of metal contamination
Titanium		Limited impact data for metals; insufficient data to support ADF as sole source of metal contamination
Zinc		Limited impact data for metals; insufficient data to support ADF as sole source of metal contamination
Acetone		COD as surrogate

EPA is not regulating metals in the final airport deicing rule. Given the potential for background interference from airport operations, EPA does not have sufficient data to support metals as a unique pollutant from ADF alone.

6.5 References

Corsi, S.R., et al. 2000. "Aircraft and Runway Deicers at General Mitchell International Airport, Milwaukee, Wisconsin, USA. Biochemical Oxygen Demand and Dissolved Oxygen in Receiving Streams." (November 22). DCN AD00081.

Corsi, S.R., et al. 2003. "Nonylphenol Ethoxylates and Other additives in Aircraft Deicers, Anti-icers, and Waters Receiving Airport Runoff." *Environmental Science & Technology*, 37:4031-4037. DCN AD00083.

Corsi, S.R., et al. 2006. "Characterization of Aircraft Deicer and Anti-icer Components and Toxicity in Airport Snowbanks and Snowmelt Runoff." *Environmental Science & Technology.* DCN AD00326.

ERG. 2006. Memorandum from Steve Strackbein and Cortney Itle (ERG) to Brian D'Amico and Eric Strassler (U.S. EPA). *Airport Deicing Operations SWPPP and Permit Review.* (November 8). DCN AD00859.

ERG. 2007a. Memorandum from Jason Huckaby (ERG) to Brian D'Amico and Eric Strassler (U.S. EPA). *Airport Deicing Operations NPDES Permit Review Summary*. (April 16). DCN AD00611.

ERG. 2007b. Memorandum from Maureen Kaplan (ERG) to Mary Willett (ERG). *Toxic Weighting Factors (TWFs) for Nonylphenol, Octylphenol, and Alkyl Phenol Ethoxylate*. (March 30). DCN AD00862.

USEPA. 2000. Preliminary Data Summary: Airport Deicing Operations. U.S. Environmental Protection Agency. Washington, D.C. EPA-821-R-00-016. (August). http://www.epa.gov/guide/airport.

USEPA. 2006. *Toxic Weighting Factor Development in Support of CWA 304(m) Planning Process.* U.S. Environmental Protection Agency. Washington, D.C. (June). DCN AD00861.

USEPA. 2007. Ecotoxicology ("ECOTOX") Database. U.S. Environmental Protection Agency. Washington, D.C. Available online at www.epa.gov/ecotox/.

USGS. 2004. *Data Summary for Monitoring and Assessment of Changes in Water Quality Due to Deicer Management Water Years 1997-2004*. General Mitchell International Airport and U.S. Geological Survey. (September). DCN AD00085.

7. COLLECTION AND TREATMENT TECHNOLOGIES APPLICABLE TO AIRPORT DEICING OPERATIONS

The NPDES permit program, along with the emergence of problems such as fish kills and odor reports, have prompted airports and airlines to investigate a wide range of pollution prevention and treatment practices. These practices are designed to eliminate or minimize the environmental impact of ADF without compromising safety. This section summarizes the common techniques used to collect deicing stormwater and the treatment steps implemented prior to discharge. This section also discusses pollution prevention practices used by U.S. airports and airlines.

Each method of collection, treatment, or pollution prevention selected by an airport or airline often depends on a variety of airport-specific or airline-specific factors, including climate, amount of deicing and anti-icing agents applied, number of airlines operating at a particular airport, aircraft fleet mix, number of aircraft operations, costs, presence of existing infrastructure, availability of land, and effect on aircraft departures. EPA recognizes that some of the practices discussed in this section may not be practical or economically feasible for all U.S. airports.

EPA evaluated whether regulation of airfield deicing stormwater was practical or cost-effective. Because airfield deicing stormwater losses tend to occur over large areas and the volumes of dilute stormwater may be very high, at this time EPA could not identify an “economically achievable” means to regulate airfield deicing stormwater other than to encourage a complete transition away from urea use. Therefore, the technologies presented in this section are primarily used to collect and treat ADF-contaminated stormwater.

Section 7.1 discusses deicing stormwater collection, Section 7.2 describes deicing stormwater treatment, Section 7.3 discusses glycol recycling, and Section 7.4 presents pollution prevention (e.g., product substitution) practices.

7.1 Deicing Stormwater Collection

The collection of deicing stormwater from aircraft deicing/anti-icing operations helps prevent or minimize discharges at stormwater outfalls. Airports currently use a variety of collection and conveyance methods, including designated aircraft deicing pads, gate and ramp area drainage collection systems, plug and pump systems, and specially designed glycol collection vehicles (GCVs), each of which is discussed in Section 7.1.1. Individual airports often rely on a combination of these collection strategies to effectively collect ADF-contaminated stormwater.

Section 7.1.2 presents common methods for storing and discharging deicing stormwater, including detention ponds or constructed wetlands, retention ponds, permanent storage tanks or frac tanks, discharge to a POTW, trucking waste off site, or any combination of these methods. The following sections describe in detail the various wastewater collection methods used by the industry.

7.1.1 Deicing Stormwater Collection and Conveyance

This section describes the various wastewater collection and conveyance methods commonly used by airports. Airport stormwater collection systems are designed to collect deicing stormwater from several different locations at which deicing operations are performed, including aircraft deicing at CDPs, at the gates, or at parking or cargo aprons. Collection systems may collect stormwater from airfield deicing locations including ramps, taxiways, and runways. Common methods of collecting and conveying deicing stormwater include deicing pad collection systems, gate and ramp area drainage collection systems, plug and pump systems, and GCVs.

Deicing Pads

A CDP is a facility on an airfield built specifically for aircraft deicing operations. It is typically a paved area adjacent to a gate area, taxiway, or runway, and constructed with a drainage system separate from the airport's main storm drain system. It is usually constructed of concrete with sealed joints to prevent the loss of sprayed ADF through the joints. The pad's collection system is typically connected to a stormwater storage facility, from which the spent ADF may be sent to an on-site or off-site treatment facility.

Deicing pads restrict aircraft deicing to a confined area, allowing the deicing stormwater to be captured at the point of generation and thereby minimizing the volume of sprayed deicing fluid discharged in an uncontrolled manner. Aircraft deicing pads also centralize deicing activities, which allows airports to more easily collect high-concentration ADF-contaminated stormwater. Transporting ADF-contaminated stormwater off site to wastewater treatment plants or POTWs is also more economical when the amount of deicing stormwater is minimized.

One benefit of deicing departing aircraft on deicing pads instead of at the gates is that it frees the gates for use by arriving aircraft. Another benefit is that pads are commonly located near the heads of runways, where planes can be deiced just prior to takeoff, potentially reducing the amount of Type IV anti-icing fluid necessary due to shorter holdover times and the amount of glycols transferred from the deicing pad or released into the air. Figure 7-1 shows an example of a CDP with fixed boom sprayers.

Figure 7-1. Deicing Pad Equipped with Fixed Deicing Booms at Pittsburgh Airport

Gate and Ramp Area Drainage Collection Systems

Other than deicing pads, the most common areas for deicing operations are passenger terminal gates and aircraft parking or cargo ramps/aprons. To collect wastewater generated at these locations, some airports have installed collection systems or modified existing stormwater drainage systems. The typical collection system consists of graded concrete pavement with trench or square drains that convey wastewater to a storage facility or discharge point through a diversion box. Gate and ramp collection systems generally generate low-concentration ADF-contaminated stormwater because more stormwater is mixed in with the ADF and because there are increased fugitive losses due to vehicle traffic around the planes. For some stormwater drainage systems, a diversion box allows uncontaminated stormwater to be diverted to stormwater outfalls.

Plug and Pump Systems

Plug and pump collection systems generally comprise devices and equipment that alter an airport's existing storm drain system to contain and collect ADF-contaminated stormwater to prevent ADF-contaminated stormwater from entering the storm drain system. These systems include, but are not limited to, temporary blocking devices at storm drain inlets and/or shutoff valves in the storm sewer system. Some airports use storm drain inserts or plugs to close the drains and allow the ADF-contaminated stormwater to collect within the existing airport stormwater drainage system. When aircraft are undergoing deicing/anti-icing, the inserts are installed to force contaminated stormwater to pool in drainage piping until it can be vacuumed or pumped out. This practice prevents manholes and stormwater piping from overflowing. Once deicing/anti-icing activity ends and the contaminated stormwater is removed, the storm drain inserts can be removed, or deactivated allowing uncontaminated stormwater to pass through the drain. Plug and pump collection systems are applicable to airports that deice at the gate and may be utilized to convert ramp areas (e.g., cargo, feeder, taxiways) into deicing areas. One benefit of deicing at the gate is that the components of the existing collection system infrastructure (i.e., existing storm sewers) can be incorporated into the plug and pump collection system, reducing the costs associated with deicing control.

Minneapolis/St. Paul International (MSP) airport is one example of an airport using a plug and pump collection system. At MSP airport, 30 percent of deicing operations takes place in the airport's 16 plug and pump containment areas. During the deicing season, the plug and pump areas are fitted with compression plugs in the storm sewers to prevent contaminated or potentially contaminated stormwater from being discharged. The stormwater plugs convert the stormwater sewer pipes and manholes into individual stormwater retention systems that can each retain between 5,000 to 42,000 gallons of stormwater. These individual stormwater retention systems are monitored during the day to determine how full they are (to prevent overflow) and to determine how to manage the ADF-contaminated stormwater based on its composition and strength. Contaminated stormwater is pumped or vacuumed from the sewer pipes and tested to determine the glycol concentration. Based on the glycol concentration of the wastewater, it is stored in either a low-concentration storage tank or a high-concentration storage tank prior to being shipped off site (USEPA, 2008a).

GCVs

GCVs are specially designed vehicles that remove stormwater contaminated with deicing materials from airport deicing pads and gate locations by vacuuming liquid from pavement surfaces. GCVs help prevent ADF losses through evaporation and/or direct discharge and allow ADF-contaminated stormwater to be collected for treatment or disposal. Drain covers that bond to surfaces to quickly seal off drains are often used in conjunction with GCVs in the area where aircraft are deiced to allow the GCVs to collect high-concentration spent deicing fluid.

Commercial GCVs have two basic designs: truck chassis or trailer mounted. The truck chassis designs are adapted from the street sweeper concept, with a vacuum unit, vacuum/sweeper head, and storage tank all mounted on a single self-propelled vehicle. Typically, a separate engine powers the vacuum system. Trailer-mounted designs have the vacuum unit, collection head, and storage tank on a towed platform with power provided by either an engine mounted on the trailer chassis or a power take-off from the tow vehicle, typically a tractor. Figure 7-2 shows an example of a GCV. GCVs help prevent ADF-contaminated stormwater from reaching unpaved areas where infiltration could occur and from contaminating surrounding waterways.

Once ADF-contaminated wastewater is vacuumed from airport surfaces, it is typically transported to an on-site storage facility (either temporary or permanent) where the airport can then treat and discharge or ship the waste off site. In addition, some airports with collection and conveyance or plug and pump systems will have a designated area where the GCV can discharge into the collection system, allowing the existing infrastructure to convey the material to final storage.

Figure 7-2. GCV

Plug and Pump with GCV

Commonly, a plug and pump system is operated in conjunction with GCVs or a tanker truck with pumps that collect the deicing stormwater that builds up behind the drainage block during the deicing event. Additionally, GCVs may be used outside of the blocked area to collect ADF-contaminated stormwater to enhance what can be collected through the plugging operation alone.

7.1.2 Deicing Stormwater Storage

This section describes the various stormwater storage methods commonly used by airports. Airport stormwater storage systems are designed to retain deicing stormwater from several different locations around an airport, accommodate highly variable flows and volumes, and may retain/store stormwater that contains pollutants from both airfield and aircraft deicers. Common methods of stormwater storage at airports include detention ponds, equalization ponds, retentions ponds, and storage or frac tanks.

Detention Ponds/Lagoons and Equalization Ponds

Detention ponds/lagoons are open-water ponds that collect deicing stormwater from runways and other airport property. Detention ponds and lagoons are designed to temporarily hold deicing stormwater anywhere from one day to two months and allow solids to settle while reducing oxygen demand through surface oxygenation and volatilization prior to discharge to receiving waters. Detention ponds and lagoons can be lined or gravel-filled and may contain microscopic bacteria that biodegrade deicing and anti-icing materials. Pump stations are commonly implemented to pump metered wastewater to discharge or further treatment. Detention basins often use aeration to increase dissolved oxygen levels. Lagoons may be equipped with a floating cover.

Equalization ponds are detention ponds designed to thoroughly mix ADF-contaminated stormwater so that consistent concentrations of pollutants can be pumped from the pond to treatment operations or to other disposal. Equalization ponds may contain moving parts, such as mixers, to ensure the liquid in the pond is completely mixed.

Retention Ponds

Retention ponds are designed to hold collected deicing stormwater indefinitely. Usually the pond is designed to allow overflow to drain to another location (e.g., a second retention pond or other overflow structure) when the water level gets above the pond capacity. Retention ponds can also be used to treat deicing stormwater as part of a batch process (using chemical addition and/or aeration) prior to discharge. With retention ponds, airports can collect ADF-contaminated stormwater throughout a deicing season and have the option of trucking it off site for treatment or treating it on site in the retention pond.

Advantages and Disadvantages of Ponds in Treating ADF-Contaminated Stormwater

Ponds require large areas for installation and their wastewater normally requires treatment for many months after the end of the annual deicing season before it can be discharged.

FAA discourages airports from installing new stormwater retention ponds, as they can be a lure for birds, which are a safety hazard for aircraft (FAA, 2007). For airports with existing retention ponds and adequate storage capacity, aerated pond systems may be able to provide efficient treatment. See section 7.2.1 for further discussion of aerated pond systems. Figure 7-3 shows an example of an airport pond used for deicing stormwater storage.

Figure 7-3. Pond for Deicing Stormwater Storage

Storage Tanks

Airports that treat ADF-contaminated stormwater often use tanks to store the stormwater prior to on-site treatment or transfer off site. These types of tanks can be constructed as aboveground tanks or underground tanks. Collecting and storing deicing stormwater in storage tanks allows an airport to equalize pollutant concentrations and flow the stormwater at a consistent flow rate into an on-site treatment system, which is important to ensuring consistent treatment results. Portable storage tanks, called frac tanks, can be placed on the airport property (while empty) and provide temporary storage of collected deicing stormwater. These types of tanks may also be connected by a hose or pipeline to an alternative area. Figure 7-4 shows an example of two frac tanks.

Figure 7-4. Frac Tanks

7.2 Treatment

This section describes the various means of treating stormwater contaminated with deicing chemicals. The technologies described within this section are typically used to control ADF-related pollutants; however, stormwater with pollutants from airfield deicing operations may also be routed into these systems.

7.2.1 Biological Treatment

This section describes the treatment of ADF-contaminated stormwater through biological processes. Biological treatment consists of two types of processes, aerobic or anaerobic, and can take place on site at an airport or off site at POTWs or other treatment facilities.

POTW Treatment of ADF-Contaminated Stormwater

Where practical, airports discharge their deicing stormwater to a POTW for biological treatment. POTW systems generally use activated sludge in an aerobic biological treatment system and may also incorporate anaerobic digestion of the sludge generated. In aerobic treatment systems, microorganisms consume the organic matter and convert it to water, carbon dioxide, and additional biomass in the presence of oxygen. To maintain the microorganism population in the treatment process, POTWs using an activated sludge process will use an aerated treatment tank followed by a sludge settling tank. Part of the settled sludge is recycled back into the aerated treatment tank and the remainder is removed for further processing or disposal.

Airports may be prevented from discharging ADF-contaminated stormwater to a local POTW for one or more or the following reasons: (1) limited hydraulic or loading capacity at the POTW, (2) high POTW wastewater treatment and/or conveyance fees, (3) inability of the local POTW to handle highly variable pollutant loadings, and/or (4) airport infrastructure constraints.

Aerated Ponds

Aerated ponds used on site at airports are effective for treating low-concentration ADF-contaminated stormwater. These are ponds that are open to the atmosphere, though open-topped tank systems may also be used. Aerated ponds are not generally used for high-concentration ADF-contaminated stormwater because the ponds do not have sufficient oxygen transfer to completely convert the ADF pollutants into water, carbon dioxide, and biomass compared to an activated sludge system. Treatment ponds may range in size and are usually operated as a batch process.

Aeration in lagoons and ponds increases the level of dissolved oxygen in the water, which is needed to decompose organic matter such as glycols. In addition, oxygen helps to oxidize certain elements that are suspended in the water, and oxidation causes some materials to become heavier so that they will settle out of the water column quicker. Without proper aeration, bacteria cannot decompose the organic matter in a pond quickly or efficiently. Aeration devices are used to agitate the lagoon or pond surface, which helps to transfer atmospheric oxygen into the wastewater to promote biological treatment processes, vent carbon dioxide and other gaseous elements from the water, and increase the amount of wastewater exposed to ambient air, allowing other volatile organics to oxygenate and evaporate.

The Greater Rockford airport is an example of an airport operating an aerated pond treatment system for deicing stormwater. Greater Rockford airport collects ADF-contaminated stormwater throughout the deicing season into a 16-million-gallon aerated detention pond. Its aerobic digestion system consists of the aerated detention pond, a settling pond, a re-circulating pump, and a chemical addition building. The biodegradation of glycol is temperature-dependant and predominantly occurs during the spring and early summer months when ambient temperatures are higher. Airport personnel monitor the process, adding nutrients, antifoaming agents, and pH adjustment chemicals as needed. When the BOD_5 concentration of the pond has been reduced to less than 30 mg/L, airport personnel discharge the treated stormwater from the settling pond to Rock River (USEPA, 1999).

Figure 7-5 shows an aerated pond installation at Portland Airport (Oregon).

Figure 7-5. Aerated Pond Installation at Portland Airport

Anaerobic Treatment

Anaerobic treatment systems can effectively treat ADF-contaminated stormwater with a range of glycol concentrations. This type of treatment usually occurs in a closed tank in which microscopic bacteria in an oxygen-deficient environment biodegrade deicing and anti-icing materials. In anaerobic treatment systems, microorganisms consume the organic matter and convert it to methane and carbon dioxide in the absence of oxygen, which creates much less sludge than an aerobic system.

AFB treatment is a demonstrated technology for addressing ADF-contaminated stormwater at both the Albany, New York (ALB) and Akron/Canton, Ohio (CAK) airports. Additionally, Portland completed construction of an AFB in 2011 and testing is slated to be complete in 2012. TF Green Airport (Providence, RI) is designing an AFB system, estimated to be operational in 2015. (Rhode Island Airport Corporation, 2011). The AFB treatment system uses a vertical, cylindrical tank in which the ADF- contaminated stormwater is pumped upwards through a bed of granular activated carbon at a velocity sufficient to fluidize, or suspend, the media. A thin film of microorganisms grows and coats each granular activated carbon particle, providing a vast surface area for biological growth. The anaerobic microorganisms that develop occur naturally in sediment, peat bogs, cattle intestines, and even brewer's yeast. Breakdown products from the AFB treatment system include methane, carbon dioxide and new biomass. Effluent from the AFB can be discharged to a local POTW or, in most cases, directly to surface water. Figure 7-6 presents a diagram showing the major components of a typical AFB treatment system (Source: US Department of Defense, 2003).

Treating wastes using an anaerobic biological system compared to an aerobic system offers several advantages. Because it does not require aeration, the anaerobic system requires less energy and produces less than 10 percent of the sludge of an aerobic process. In addition, because the biological process is contained in a sealed reactor, odors are eliminated. EPA evaluated AFB biological treatment as it represents the best technology currently in use by airports to treat deicing stormwater prior to direct discharge.

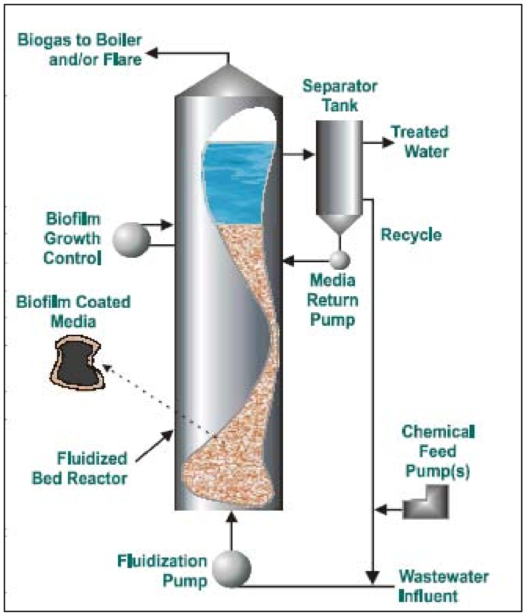


Figure 7-6. Typical Anaerobic Fluid Bed Treatment System for Treatment of ADF-Contaminated Stormwater

Land Application and Constructed Wetlands

Low-concentration deicing stormwater may also be treated on site at an airport using either land application or discharge through constructed wetlands. Land application involves spraying deicing stormwater onto a land surface for infiltration and biological degradation within the soil. As an example, Salt Lake City International (SLC) airport uses land application to dispose of batch volumes of low-concentration deicing stormwater on a periodic basis. The system sprays approximately 300,000 to 400,000 gallons of stormwater over nutrient-enriched land using agricultural wheels. The application is sprayed at a rate of about 1 gallon per square foot over a two-day period. The sprayed glycol then degrades in the soil over a week to month-long period (USEPA, 2008b). Because glycol-based ADFs readily degrade in both high clay and sandy soil systems, this type of system can be effective for low concentrations and limited volumes. Biodegradation occurs in the soil through carbon respiration of soil microbes, which consume oxygen and release carbon dioxide. Zurich International Airport, Switzerland, also uses a spray irrigation system for ADF treatment. At that airport, a heated sprinkler system applies ADF-contaminated stormwater to a 20 ha (49.4 acre) area (Jungo Engineering Ltd, 2005).

Constructed wetlands are artificial marshes or swamps placed inline with stormwater drainage at airports. The wetlands act as biofilters and help remove sediments and pollutants such as heavy metals from the wastewater. Physical, chemical, and biological processes combine in wetlands to remove contaminants from the wastewater. The discharge from constructed wetlands can also be collected and treated if it cannot meet discharge permit limits or it can be discharged to a POTW or surface water.

7.2.2 Physical Separation

This section describes physical separation processes that are used to treat ADF-contaminated stormwater. Physical separation consists of four types of processes: filtration, MVR, membrane separation, and distillation. The treatment can take place on site at an airport or off site at other treatment facilities.

Filtration

Primary filtration, which removes solids greater than 10 microns, is commonly the first step in glycol treatment systems because it removes suspended solids and prevents subsequent processing units from plugging. This technology is typically used in combination with other technologies. Popular primary filters used in glycol treatment are made of either polypropylene cartridges or bag filters.

MVR

MVR is an evaporation method that uses mechanically driven compressors or blowers to increase the pressure of the vapor produced. The increase in pressure causes the vapor's temperature to increase, which allows it to heat the liquid being concentrated. Benefits of using MVR in glycol treatment include:

- Low specific operating costs;
- Low specific energy consumption;
- Short residence times of the product; and
- Simplicity of the process.

EPA conducted a site visit and subsequent sampling episode at Denver International (DEN) airport, which operates MVRs in the following manner. MVRs concentrate the deicing pad storage tank influent, which ranges from 1 to 12 percent PG, to a final concentration of 50 to 55 percent glycol. Each MVR has a capacity of 3,250 gallons per day. The effluent from the MVRs goes to a storage tank where it is stockpiled prior to being sent to a distillation system (USEPA, 2007b). The evaporative process may also generate a condensate, which in most cases requires further treatment prior to indirect discharge. Typically, this is managed via an RO system, with the concentrated material returned to the treatment process and the RO permeate discharged to a POTW.

Membrane Separation

Membrane separation is an efficient one- or two-step process that incorporates ultrafiltration (UF) and/or RO to increase the ADF concentrations of ADF-contaminated stormwater. In an UF/RO process, fluid is filtered at a high temperature (75º C) using an ultrafiltration membrane as stage one. Next, the deicing fluid (ultrafiltration filtrate) can be dewatered using an RO membrane as stage two. The UF membrane is effective at removing contaminants such as turbidity, color, and odor, and RO stage two is used for dewatering and glycol separation. The combined UF/RO process produces a final glycol concentration of approximately 10 percent from an original concentration ranging between 0.5 and 4 percent. Pittsburgh International (PIT) airport uses this type of system. The PIT system first treats ADF-contaminated stormwater through an UF unit to remove suspended solids. At this point, the stormwater is 0.5 to 4 percent PG. The stormwater is next treated through an RO unit. Following RO, the stormwater is split into two outputs: 1) concentrate that is approximately 10 percent PG, and 2) permeate that has a very low glycol concentration. The concentrated PG is transported off site for further processing and the permeate containing small amounts of glycol, CBOD, and COD is sent to the POTW for further processing (USEPA, 2006).

Distillation

Distillation can effectively treat ADF-contaminated stormwater by separating the water from the glycol. A potential drawback of distillation is that it creates a distillate that requires further treatment. Depending on whether the distillation system is operated in a batch or continuous mode, the majority of the distillate can be discharged to the local POTW without further processing. In a batch mode, there is a "mid-cut" water/glycol mixture, which marks the transition from water removal and product; this volume is redirected to the process feed. However, depending on system design and applicable limits, distillate may be able to be directly discharged. Distillation columns may be larger and more expensive than other technologies to operate, and because distillation is energy-intensive, it is generally not cost-effective to distill waste glycol solutions at low concentrations (less than15 percent). Design variables for this technology include temperature, distillation column height, and reflux ratio. This process is commonly done in batches to ensure proper distillation and desired results.

EPA conducted site visits at SLC and DEN airports, both of which operate distillation columns.

- At DEN airport, the distillation system runs 24 hours a day for a three-week cycle and processes about 225,000 gallons of PG before the system is halted for cleaning and maintenance. The distillate from the distillation column is discharged to the airport's storage ponds. The distillation column bottoms compile sludge that is classified as specialized nonhazardous waste. The 98 to 99 percent PG from the distillation column is pumped to a polisher (USEPA, 2007b).
- At SLC airport, 40 to 45 percent glycol-concentrated stormwater is passed through a finisher (one stage of evaporation) to increase the concentration to approximately 70 to 80 percent glycol and then discharged to a storage tank. The stored concentrate is sent to a distillation column where it is heated to 250 to 260 degrees Fahrenheit to produce a final product of 100 percent glycol. Distillate from the distillation column is discharged to a storage tank prior to RO treatment and indirect discharge. The column bottoms (residual solids) are disposed of at an off-site facility landfill (USEPA, 2008b).

7.3 Recycling

Recycling glycol from ADF-contaminated stormwater decreases the amount of ADF-contaminated stormwater that reaches and potentially impairs surface and ground waters. The process to recover glycol from ADF-contaminated stormwater may take several steps and can be conducted both on site at the airport and/or off site at a regional treatment facility. The recycle and recovery technologies currently in use by U.S. airports include filtration, MVR, membrane separation, and distillation (discussed in Section 7.2). On-site recycling typically includes some combination of these technologies, configured as an integrated treatment train to meet specific requirements of the airport where it is located. Most commonly, an on-site facility initiates the process to increase the glycol concentration to make transport to a regional facility for final processing more cost-effective.

Recovered glycol is generally sold to help recover expenses associated with ADF application, collection, and control. On-site recycling was successful and economically viable at the airports visited by EPA that collected large enough volumes of high-concentration ADF-contaminated stormwater. However, recovery systems may also be able to handle lower concentration ADF stormwaters (with glycol concentrations in the 1-2 percent range), and small- and medium-hub airports may be able to recover and recycle glycol using off-site recycle/recovery facilities. Off-site facilities can recycle ADF-contaminated stormwater from airports not generating sufficient volumes to warrant on-site recycling and treatment. Glycol recycling vendors offer a variety of recycle/recovery related services to accommodate different airport sizes and configurations. Services commonly provided by glycol recycle/recovery vendors include supplying drain blocks, leasing portable storage tanks, on-call trucking services, and tote (fluid container) pickups. Key criteria for determining the appropriate recycle/recovery program include the type of ADF being collected, glycol concentration of the stormwater, total consumption of ADF per season, and peak ADF volume application rates. Other factors to consider are the number of deicing days per season at an airport and future air traffic plans.

7.4 Pollution Prevention and Product Substitution Practices

Pollution prevention practices reduce the generation or discharge of pollutants produced during aircraft/airfield deicing operations. Pollution prevention practices implemented throughout the aviation industry include infrared deicing, forced-air deicing, product substitution practices, and BMPs.

Infrared Deicing

Infrared heating involves transmitting energy using electromagnetic waves or rays. Infrared energy is invisible and travels at the speed of light in straight lines from the heat source (the emitter) to all surfaces and objects (the receivers) without significantly heating the space (air) through which it passes. This heating process is much faster than convection or conduction heating mechanisms used by conventional deicing, where the deicing fluid spray is cooled by ambient air.

Figure 7-7 shows a picture of the infrared hangar at John F. Kennedy (JFK) airport.

Figure 7-7. Infrared Hangar at JFK

Infrared-based aircraft deicing systems offer two advantages over traditional glycol-based deicing methods. From an environmental standpoint, they can greatly reduce the amount of glycol-based fluids used for aircraft deicing, while from an operational standpoint, they are relatively inexpensive to operate, as they use natural gas or propane as fuel.

Any infrared deicing facility must take into account the physical characteristics of all aircraft that will use the system. For example, an infrared system design factors in the maximum tail height, the shape of tails, maximum wingspans, and differences in the length and width of the fuselage. The site selected for an infrared deicing system must comply with the same FAA regulations that apply to glycol-based aircraft deicing facilities, including aircraft separation rules, airport traffic control tower line-of-sight criteria, and requirements to not interfere with radar signals, navigational aids, and airport lighting. FAA issued a new Advisory Circular in 2005 specifically for infrared deicing facilities (FAA, 2005). As with traditional aircraft deicing facilities, an infrared deicing facility must provide taxiways that allow aircraft to bypass the deicing facility.

While EPA encourages the use of this technology, industry practice has shown that it may not be applicable at all airports and it appears to be best used in conjunction with other more conventional deicing operations (ERG, 2004; Belcher-Hoppe Associates, Inc., 2004).

Forced Air Deicing

Forced air deicing uses large volumes of air at low pressure to remove loose accumulations of snow and ice from an aircraft prior to chemical deicing. Aircraft deicing trucks or fixed booms equipped with forced air nozzles help reduce the amount of glycol that is used during deicing and defrosting operations. In light snow conditions, forced air may completely replace the need for deicing fluid. For light frost and light deicing events, fluid-injected forced air can be used to reduce the amount of deicing fluid by up to 75 percent. For heavy deicing events, a fluid forced air technique is used. This technique requires the ADF application rate sprayed from the boom to be reduced from 60 gallons per minute (gpm) to 40 gpm to achieve a 25-percent reduction in deicing fluid per aircraft. Forced air deicing can reduce operational expenses, environmental impacts, and subsequent environmental monitoring or remediation expenses (Icewolf product flyer; IDS, 2006).

Aircraft Deicing/Anti-Icing Product Substitution Practices

One solution to the environmental problems associated with glycol-based ADF is replacing such fluids with more environmentally friendly products. ADFs need to meet FAA's Aerospace Material Specification (AMS) 1424 for Type I fluids and AMS 1428 standards for Type IV fluids. These standards require a specified level of product performance and compatibility and any alternative product must meet the same standards. To be economically viable, alternative products must also be comparably priced and be at least as effective in maintaining air safety as the glycol-based fluids they replace and less harmful to the environment.

EPA is aware of one non-glycol, plant-derived product currently being marketed by Cryotech Deicing Technology. A new Type I ADF product called "DF Sustain" uses 1,3-propanediol rather than PG, and is manufactured by a fermentation process using cornstarch. The manufacturer claims performance equal or better than PG- or EG-based deicers.

Table 7-1 lists other aircraft deicing alternatives that EPA is aware of based on literature reviews, industry meetings, and site visits. In addition, the airport and airline industry associations as well as U.S. Air Force have conducted and are continuing to conduct research into other potential substitutes for PG- and EG-based fluids.

Table 7-1. ADF Alternatives

Alternative	Comments
PG	ADF usage data indicates a trend towards greater PG use as an alternative to EG use.
Hot Air, Forced Air, and Tempered Steam Deicing	The use of hot air, forced air, or tempered steam when deicing aircraft is an alternative to typical deicing fluid application techniques using deicing trucks with conventional spray nozzles alone. These alternatives can provide more effective deicing than conventional spraying technologies and result in lower ADF usage.
Infrared Deicing	Infrared deicing is an alternative to conventional ADF usage and can greatly reduce (though not eliminate) the use of ADFs for deicing and anti-icing.
Cryotech Bio-PDO™	This bio-based product is currently being marketed as an alternative to conventional PG-based Type I fluids.
Warm Fuel for Wing Deicing	This type of deicing is an alternative to defrost deicing with ADF.

Airfield Deicing Product Substitution Practices

Environmental problems associated with past airfield deicing products like urea led to the development of the alternative airfield deicing chemicals used today. Potassium acetate has replaced urea as the primary airfield deicer at many U.S. airports. The U.S. Armed Forces no longer purchases airfield deicers that contain urea and instead use potassium acetate, sodium acetate, and sodium formate. These airfield deicers are highly effective at low temperatures, exert much lower oxygen demand than urea, and offer less environmental impact.

The aviation industry is currently evaluating the impact of common airfield deicing chemicals on the environment, runway infrastructure, and chemical corrosion of aircraft carbon brakes. Based on the results of this work, EPA anticipates that alternative airfield deicing chemicals will be identified and ultimately incorporated into practice. EPA is aware of one such product, Cryotech's Bio-PDO™[2], which is currently being used as an additive for potassium acetate runway deicers. The Cyrotech BX36 runway product performs similarly to its widely-used E36 product, but with reductions in electrical conductivity and potassium content (reducing carbon brake issues), and a bio-based material composition of 75 percent, allowing for easy degradation.

BMPs

BMPs are techniques used to limit the amount of ADF applied or allowed to mingle with stormwater. EPA defines a BMP as a "technique, measure or structural control that is used for a given set of conditions to manage the quantity and improve the quality of stormwater in the most cost-effective manner." This section describes the following aircraft/airfield deicing-related BMPs:

- Application rates and deicing fluid dilution;
- Airfield prewetting;
- Ice detection systems;
- Enhanced weather forecasting;
- Heated sand;
- Separation of contaminated snow;
- Annual employee training;
- Mechanical deicing and snow removal;
- Yearly inspections of deicing equipment and infrastructure; and
- Type IV anti-icing.

Application Rates and Deicing Fluid Dilution

Deicing personnel can minimize the amount of deicing fluid used at an airport by varying deicing fluid application rates and the ADF dilution mix to best match each deicing event condition. Application rates are commonly evaluated every time deicing is required. However, ADF is usually premixed to a set 55 percent or 45 percent glycol concentration. Systems that allow for ADF dilution adjustment based on the weather conditions can use less. Ice thickness, ambient temperatures, and plane size all determine application rates and fluid dilution requirements. Small planes with small amounts of frost can require as little as 50 gallons of ADF while large planes with thick ice accumulations can take up to 2,000 gallons to deice. Application rates controlled by chemical metering systems installed to deicing trucks or booms allow the applicator to control the distribution of chemicals and maintain a consistent application rate at all times. Using a chemical metering system also allows the operator to change the application rate in mid-application based on changing weather conditions.

[2] Mention of Cryotech products should not be construed as an endorsement from EPA.

Airfield Prewetting

Airfield prewetting involves applying a dry chemical followed by a light coating of liquid deicer to airfield pavement. During icy conditions, a granular deicer is generally used to penetrate ice and increase surface area prior to using a liquid deicer (generally PG) to help the solid deicer stick to the pavement and prevent dry pellets from blowing off. Responses to EPA's airport questionnaire indicated that prewetting is common and helps lower the cost of materials by increasing the rate at which the liquid deicer contacts icy surfaces and by minimizing wind losses of solid deicer. Following prewetting, snow and ice are generally removed from airfield areas using mechanical equipment (such as plows and brooms).

Ice Detection Systems

Ice detection systems include sensors installed on runways and taxiways that transmit constant surface and subsurface temperature readings to deicing control personnel. These sensors indicate whether there is a potential for ice to form on the paved surfaces. Airports can then use the information provided by individual deicer manufacturers to determine whether to apply deicing/anti-icing chemicals.

Enhanced Weather Forecasting

Many of the larger U.S. airports use enhanced weather forecasting systems to help determine when they will require deicing activities. A popular weather forecasting product on the market is the Weather Support to Deicing Decision Making (WSDDM) software program. This system is a "nowcasting" system that is used to confirm National Weather Service data and forecasts. WSDDM provides forecasts, monitors storms and provides real-time storm information, and estimates and detects precipitation. WSDDM can provide the following services to the user:

1. Real-time snow gauge data (updated every minute) of the liquid equivalent snowfall rate at the airport and two to three sites 10 to 20 kilometers (km) away from the airport;

2. Real-time radar reflectivity from radars depicting current locations of precipitation and snow;

3. Meteorological data at the airport and two to three sites 10 to 20 km away from the airport updated every minute and displayed in text and time line form, with the time line going back two hours;

4. Thirty-minute nowcast of radar reflectivity based on a cross-correlation technique on the radar reflectivity data updated every six minutes; and

5. Thirty-minute nowcast of liquid equivalent snowfall rate at the airport and the off-site snow gauge locations by applying a real-time snow gauge-radar reflectivity calibration algorithm at each of the snow gauge sites, updated every six minutes.

WSDDM can improve pollution prevention by pinpointing when deicing operations are actually needed, which lowers the amount of ADFs used to keep departing aircraft free of ice and snow at takeoff and lowers the amount of anti-icing chemicals used to prevent ice and snow from bonding to aircraft and taxiways (ERG, 2005).

Heated Sand

Sand trucks can be parked in a heated garage with heat piped to the truck. Heating sand trucks accomplishes two things. First, heating the truck prevents the moisture in the sand from freezing and clumping, which would prevent the sand from being efficiently disbursed when applied. Second, applying heated sand to icy surfaces can melt ice and the sand provides needed traction when the surfaces refreeze, which minimize the need to use pavement deicers.

Separation of Contaminated Snow

Airports often segregate glycol-contaminated snow (commonly called “pink snow”) and haul it to a designated area where the snow melt can be collected. Deicing pads often contain designated areas to store contaminated snow so that the snow melt can be commingled with other deicing stormwater.

Annual Employee Training

Training and experience of personel performing aircraft deicing/anti-icing operations affects the efficiency of aircraft deicing/anti-icing. Well-trained and experienced deicing/anti-icing personnel improve the efficiency of aircraft deicing/anti-icing operations and minimize the volume of ADF used. The training and experience of airport personnel may also affect the efficiency of airfield deicing operations. Airport personnel are typically responsible for clearing taxiways, gate areas, ramps, aprons, and deicing pads. When these areas are not adequately cleared, snow and ice accumulate on the undercarriage and the underside of aircraft during taxing and must be removed prior to takeoff.

Many airports conduct annual operations and maintenance training, with specialized winter operations training usually conducted prior to the deicing season. This specialized training can include but is not limited to proper use of equipment, application of chemicals, and location of snow melt areas. Staff may also be trained in environmental awareness detailing the requirements of airport permits and BMPs associated with airport deicing/anti-icing operations.

Mechanical Deicing and Snow Removal

The amount of ADF required to deice aircraft can be minimized by mechanically deicing the aircraft prior to chemical deicing. Mechanical deicing is generally economical only for small aircraft because mechanical deicing of large aircraft is labor-intensive and time consuming. A drawback of mechanical deicing is that aircraft (e.g., aircraft antennae and sensors) risk being damaged by incorrect mechanical deicing methods. Despite the risk of aircraft damage, many airlines use brooms, squeegees, and ropes, among other items, to remove ice and snow from aircraft surfaces. These methods are more effective at removing snow rather than ice.

Snow is commonly mechanically removed on airfield pavement, including passenger ramps, gate positions, taxiways, and runways, prior to ADF being applied, to prevent contamination of the snow. The following types of equipment are used to remove snow from airfield surfaces: self-propelled snow brooms, high speed snow blowers and snow plows, and utility trucks or tractors fitted with snow brooms or plows. Physical means are generally used to remove snow rather than ice.

Yearly Inspections of Deicing Equipment and Infrastructure

Inspections are conducted to ensure that equipment used for deicing operations is working properly and to determine where maintenance may be needed. Storage tanks are inspected to ensure there are no leaks. ADF application equipment is inspected to determine if gauges are working properly and that fluid is not being spilled. Trench or square drains are inspected to ensure there is no clogging and that water conveyed through the drain does not escape. Other equipment and airport infrastructure may require yearly inspections to make certain that deicing chemicals are applied with properly functioning equipment and collected with suitable infrastructure.

Type IV ADF Anti-icing

Type IV ADF protects aircraft from ice, snow, or slush accumulations on cleaned aircraft surfaces. Type IV fluids form a protective film on treated surfaces, protecting against ice formation and/or snow accumulation. Pretreating aircraft with Type IV fluid is sometimes used when ice is in the forecast and an aircraft is expected to remain on the ground for an extended period of time. This type of anti-icing treatment can reduce the amount of deicing fluid needed for an aircraft by reducing the amount of ice that forms on the aircraft.

7.5 References

Becher-Hoppe Associates, Inc. 2004. *Airport Facilities - Rhinelander - Oneida County Airport*. (December 6). DCN AD00097.

CASQA. 2003. *Vegetated Swale*. (January 1). California Stormwater Quality Association, Menlo Park, CA. DCN AD01137.

ERG. 2004. *Aircraft Deicing using an Infrared System called Ice-Cat.* (December 13). DCN AD00095.

ERG. 2005. Memorandum from Steve Strackbein (ERG) to Project File: Summary of *Weather Support to Deicing Decision Making (WSDDM). A Winter Weather Nowcasting System.* (January 3). DCN AD00185.

ERG. 2007. Memorandum from Juliana Stroup and Mary Willett (ERG) to Brian D'Amico (U.S. EPA). *Aircraft Deicing Stormwater Control Technologies and Their Removal Efficiencies*. (December 17). DCN AD00855.

FAA. 2005. Federal Aviation Administration Advisory Circular 120-89. "Ground De-Icing using Infrared Energy. (December 13). DCN AD01139.

FAA. 2007. Federal Aviation Administration Advisory Circular No. 150/5200-33B. "Hazardous Wildlife Attractants on or Near Airports." (August 28). DCN AD01138.

Icewolf. *The Evolution of Aircraft Deicing Systems, Icewolf,* Product Flyer. DCN AD00096.

IDS. 2006. *Deicing the IDS Way*, Product Flyer. (January 4). DCN D00077.

Jungo Engineering Ltd. 2005. *Disposal of De-icing Effluent by Irrigation.* (June 6-8). DCN AD01200.

Rhode Island Airport Corporation. 2011. *RIDEM and RIAC Reach Agreement*. (December 21). www.dem.ri.gov/programs/benviron/water/permits/ripdes/pdfs/riacprelim.pdf. DCN AD01286.

US Department of Defense. 2003. ESTCP, Mineralization of TNT, RDX, and By-Products in an Anaerobic Granular Activated Carbon Fluidized Bed Reactor, (April). DCN AD00898.

USEPA. 1999. Final Engineering Site Visit Report for Greater Rockford International Airport. U.S. Environmental Protection Agency. Washington, D.C. DCN T10402.

USEPA. 2006. *Final Engineering Site Visit Report for Pittsburgh International Airport.* U.S. Environmental Protection Agency. Washington, D.C. (November 1). DCN AD00774.

USEPA. 2007a. *Final Engineering Site Visit Report for Seattle - Tacoma International Airport.* U.S. Environmental Protection Agency. Washington, D.C. (July 1). DCN AD00778.

USEPA. 2007b. *Final Engineering Site Visit Report for Denver International Airport*. U.S. Environmental Protection Agency. Washington, D.C. (November 4). DCN AD00779.

USEPA. 2008a. *Final Engineering Site Visit Report for Minneapolis-St. Paul International Airport.* U.S. Environmental Protection Agency. Washington, D.C. (January 24). DCN AD00793.

USEPA. 2008b. *Final Engineering Site Visit Report for Salt Lake City International Airport*. U.S. Environmental Protection Agency. Washington, D.C. (January 24). DCN AD00792.

8. PERFORMANCE OF CONTROL AND TREATMENT SCENARIOS

EPA evaluated the performance of the selected control and treatment scenarios based on their ability to collect and treat ADF-contaminated stormwater and/or their ability to reduce pollutant loadings. EPA used airport-specific estimates of Type I and IV ADF to calculate the volumes of *applied* and *available* ADF at each of these airports (ERG, 2011a). EPA then evaluated the collection ranges of both the data collected by EPA and the data available in the Transportation Research Board (TRB) manual (TRB Airport Cooperative Research Program, 2009), combined with best engineering judgment to estimate the collection efficiency of each of the technologies below.

8.1 Deicing Pad Collection

EPA reviewed data on the performance of centralized deicing pads from a number of larger airports across the United States and Europe including DEN, DAY, PHL, CVG, DTW, PIT, and Oslo. These airports reported a collection range from 42 to 90 percent of their spent and/or applied ADF.

Additionally, the TRB Airport Cooperative Research Program Report No. 14, *Deicing Planning Guidelines and Practices for Stormwater Management Systems,* detailed airport collection efficiencies ranging from 44 to 86 percent of applied glycol (TRB Airport Cooperative Research Program, 2009).

EPA reviewed the airport-specific ADF usage data and determined that the collection of 42 to 90 percent of spent and/or applied ADF is equivalent to 61 to 90 percent of *available* ADF (ERG, 2011b). At proposal of this rule, EPA estimated the collection efficiency of deicing pads to be 60 percent. Based on the Agency's new analysis, this estimate represents the lower range of collection efficiency. As a result, EPA estimates deicing pads will collect at least 60 percent of the available ADF.

8.2 Plug and Pump Collection with GCV

EPA reviewed performance data from General Mitchell International (MKE) airport because its collection system matches the plug and pump with GCV collection system EPA costed for this rule. MKE reported a collection range between 22.5 and 33 percent of applied ADF.

Additionally, the TRB Airport Cooperative Research Program Report No. 14 reported collection efficiencies between 20 and 35 percent of applied ADF for plug and pump systems (TRB Airport Cooperative Research Program, 2009).

At proposal, EPA estimated a plug and pump with GCV collection system would collect 40 percent of available ADF. When adjusted for rounding, the mean of the data above is approximately 40 percent. As such, EPA has determined that a well-operated plug and pump system (in conjunction with GCVs) should be able to collect 40 percent of the available ADF. DCN AD01270 contains further details on these calculations.

8.3 GCV Collection

EPA did not identify nor did commenters provide collection efficiency data on GCVs alone. Gerald R. Ford International airport, which uses two tow-behind glycol collection units in conjunction with catch basin inserts to collect aircraft deicing contaminated stormwater around the terminal gates and apron, reported collecting 29 percent of all *applied* glycol during the 2005/2006 deicing season. Mass balance data on glycol usage and collection at Theodore Francis Green State airport between 2002 and 2006 indicate that its GCV-based system annually collects between 26 and 48 percent of all *applied* glycol. Overall, collection efficiencies of applied glycol from these airports ranged from 26 to 48 percent, although these systems also used some combination of catch basin inserts, plug and pump technology, and/or apron systems.

EPA's data points are similar to those summarized in the TRB Airport Cooperative Research Program Report No. 14. The report described collection efficiencies between 23 to 48 percent for glycol collection vehicles (TRB Airport Cooperative Research Program, 2009), although these systems, like those EPA referenced, also used some combination of catch basin inserts, plug and pump technology, and/or apron systems.

The ranges presented in the literature provide higher collection efficiencies than those associated with a plug and pump system; however, all of these data points include technologies that would have higher collection efficiencies than a GCV alone. While EPA is unable to document the efficiency of a GCV alone, it stands to reason that the collection efficiency of a GCV alone would be less than that of a plug and pump with a GCV. For the purposes of today's regulation, on a national basis, EPA assumes that a GCV is able to achieve approximately half the collection of a plug and pump with a GCV, or 20 percent of the available ADF.

8.4 AFB Treatment Performance

EPA collected data on the effectiveness of AFB treatment systems through literature review, its own sampling efforts, and industry-supplied data. These systems have demonstrated effective treatment for targeted pollutants, including COD, BOD_5, and glycol. Based on EPA's sampling data from Albany International airport, COD was reduced by greater than 97 percent, BOD_5 was reduced by greater than 98 percent, and glycol was reduced by greater than 99 percent (ERG, 2007).

Influent COD concentrations that can be efficiently treated by an AFB system range from approximately 2,000 to 128,000 mg/L and an AFB system can manage brief excursions outside of this range. (See Airport Council International – North America comments on EPA's Proposed Rule for Effluent Guidelines for the Airport Deicing Category). EPA selected AFB as the best technology for on-site treatment of ADF-contaminated stormwater because of the technology's superior ability to destroy the pollutants of concern and to handle a range of influent concentrations. An evaluation of AFB treatment for other industrial wastewaters that have high COD content, such as distillery, textile, dairy, and brewery wastewaters, shows COD removals in the 50 to 98 percent range (ERG, 2010).

8.5 References

ERG. 2007. Memorandum from Juliana Stroup and Mary Willett (ERG) to Brian D'Amico (U.S. EPA). *Aircraft Deicing Stormwater Control Technologies and Their Removal Efficiencies*. (December 17). DCN AD00855.

ERG. 2010. Memorandum from Cortney Itle (ERG) to Brian D'Amico (U.S. EPA). *Summary of Anaerobic Fluidized Bed Applications.* (August 31). DCN AD01262.

ERG. 2011a. Memorandum from Cortney Itle and Mary Willett (ERG) to Brian D'Amico (U.S. EPA). *ADF Collection and Control Efficiency Review.* (June 15). DCN AD01270.

ERG.2011b. Memorandum from Steve Strackbein and Mary Willett (ERG) to Brian D'Amico (U.S. EPA). *Centralized Deicing Pad ADF Collection Efficiency*. (July 12). AD01271.

TRB Airport Cooperative Research Program. 2009. Deicing Planning Guidelines and Practices for Stormwater Management Systems ACRP Report No. 14. DCN AD01191.

Williams, M. 2006. *Baltimore-Washington International Airport Deicing Mass Balance*.

9. POLLUTANT LOADINGS AND POLLUTANT LOAD REDUCTION ESTIMATES

Pollutant loadings from airport deicing operations are highly variable and airport-specific. Because the use of deicing and anti-icing chemicals is weather-dependent, the pollutant loadings at each airport vary from year to year based on weather conditions and also based on each airport's climate. In addition, the amount of applied chemical that is discharged to surface water depends on the existing stormwater separation, collection, and/or containment system present at each airport.

Due to the variations of the pollutant discharges, EPA determined that it would not be appropriate to develop baseline pollutant loadings using end-of-pipe monitoring data. Monitoring data on an airport's deicing stormwater outfall(s) provides only a "snap shot" of a single point in time, during a monthly monitoring event or, in some cases, a single storm event. In addition, these data are available only for a select number of airports and are airport-specific. Although these data provide information on the types of pollutants present in airport deicing stormwater and the range of concentrations that may reach outfall points, there is insufficient basis for extrapolating or transferring the data across large time frames (e.g., an entire winter season) or to other airports.

Therefore, EPA developed a pollutant loading estimation methodology for individual airports based on the use of ADF and airfield chemicals at the airports surveyed by EPA. The methodology takes into account EPA's existing data sources and provides a better estimate of the loadings than those based on sporadic monitoring data alone. The Agency used a model-site approach to estimate loads for the Airport Deicing Category. A model airport is an operating airport whose deicing chemical usage and unit operation and treatment information were used as parameters for the loadings model. EPA selected an airport-by-airport approach to estimate baseline loadings and loading removals from the model airports, as opposed to a more generalized approach, to better characterize the current control and treatment systems in place for ADF-contaminated stormwater and to account for current site conditions and airport operations.

This section discusses the data sources available to EPA to support its pollutant loadings and loading reduction estimates (Section 9.1), provides an overview of EPA's pollutant loading methodology (Section 9.2), and describes the calculation steps that compose EPA's loading methodology (Sections 9.3 through 9.6). Section 9.7 summarizes EPA's approach for estimating loading reductions associated with the discontinued use of urea as an airfield deicing chemical.

9.1 Data Sources

EPA considered the following available data when developing the pollutant loadings estimation methodology for airport deicing operations (see Section 3 for more information about the data sources):

- Pavement deicing chemical usage information for the 2002/2003, 2003/2004, and 2004/2005 deicing seasons, as reported by airport personnel in the airport questionnaire;
- ADF purchase information for the 2002/2003, 2003/2004, and 2004/2005 deicing seasons, as reported by airline personnel in the airline detailed questionnaire;
- Standard airport information available from the FAA, including the number of operations and departures by airport;

- Weather information for each airport from the National Oceanic and Atmospheric Administration (NOAA), including temperature, freezing precipitation, and snowfall data;
- Existing airport stormwater collection and containment systems, as reported by airport personnel in the airport questionnaire or during EPA site visits;
- Standard chemical information about ADF and pavement deicing chemicals, including molecular formulas and densities; and
- Analytical data from EPA sampling episodes of airport deicing operations.

9.2 Aircraft Deicing Pollutant Loading

This section presents EPA's methodology for estimating ADF pollutant loads using airline questionnaire data on ADF usage and the theoretical oxygen demand associated with various deicing fluids.

9.2.1 Estimate the Amount of Applied Deicing Chemical

EPA requested the purchase amount, concentration, and brand name in the airline detailed questionnaire for the 2002/2003, 2003/2004, and 2004/2005 deicing seasons for the following ADF chemicals:

- EG Type I;
- EG Type II;
- EG Type IV;
- PG Type I;
- PG Type II;
- PG Type III;
- PG Type IV; and
- Isopropyl Alcohol-Based Fluid.

Questionnaire responses provided sufficient data to estimate ADF usage at 56 model airports. In some cases, data were not available for every airline operating at a model airport. In these instances, EPA extrapolated the amount of ADF used at the reporting airlines to estimate the total amount of ADF used by the entire airport, based on the number of airport operations (departures) at the reporting airlines and the total amount of airport operations. Table 9-1 presents the ADF estimates based on airline questionnaire responses. No airports reported purchasing EG Type II, EG Type III, PG Type II, PG Type III, or isopropyl alcohol-based fluid.

In addition to the ADF data reported in the airline detailed questionnaire, 10 airports reported their estimates of total annual ADF usage to EPA in the comment section of the airport questionnaire (see Table 9-2). These ADF data were combined with the ADF data reported in the airline detailed questionnaires, resulting in 66 airports with total PG/EG (gallons) usage estimates. EPA used the airport's estimate of ADF usage from the airport questionnaires because those data came from a certified questionnaire response.

Table 9-1. ADF Estimates Based on Airline Detailed Questionnaire Responses

Airport ID	Airport Name	Estimated PG/EG Use (GPY)	PG Type I (%)	PG Type IV (%)	EG Type 1 (%)	EG Type IV (%)
1003	Ketchikan International	18,182	0	0	100	0
1006	Chicago O'Hare International	1,516,626	80	20	0	0
1010	Fairbanks International	83,335	0	0	100	0
1011	Lambert - St Louis International	325,122	23	1	70	6
1012	Ted Stevens Anchorage International	420,735	0	0	100	0
1013	Wiley Post-Will Rogers Mem	3,056	9	0	91	0
1021	Buffalo Niagara International	281,836	92	9	0	0
1022	Fort Wayne International	50,412	92	8	0	0
1024	Indianapolis International	452,155	91	9	0	0
1026	Dallas/Fort Worth International	166,790	43	12	38	7
1028	Denver International	1,043,138	87	10	4	0
1029	La Guardia	485,157	75	22	2	1
1036	Baltimore - Washington International	323,623	90	10	0	0
1037	George Bush Intercontinental Airport/Houston	10,242	82	18	0	0
1043	Ralph Wien Memorial	2,500	27	0	73	0
1047	Sacramento Mather	1,282	100	0	0	0
1053	General Edward Lawrence Logan International	995,249	82	17	0	0
1058	Gerald R Ford International	98,156	86	13	0	0
1059	Greater Rochester International	229,158	91	9	0	0
1065	Albany International	125,775	93	7	0	0
1066	Salt Lake City International	570,540	22	6	52	20
1069	Cleveland - Hopkins International	582,321	90	10	0	0
1074	South Bend Regional	29,586	75	25	0	0
1079	Manchester	177,307	87	13	0	0
1080	Syracuse Hancock International	186,351	97	3	0	0
1089	John F Kennedy International	560,031	82	18	0	0
1095	Chicago Midway International	293,834	88	12	0	0
1100	Toledo Express	46,449	64	5	29	2
1103	Juneau International	48,014	0	0	100	0
1104	Nome	3,047	15	0	85	0
1105	Spokane International	67,984	92	8	0	0
1107	Pittsburgh International	943,982	88	12	0	0
1109	Airborne Airpark	432,416	74	26	0	0
1110	Aniak	476	100	0	0	0
1111	Port Columbus International	288,374	92	8	0	0
1113	Cincinnati/Northern Kentucky International	715,836	24	5	61	11

Table 9-1 (Continued)

Airport ID	Airport Name	Estimated PG/EG Use (GPY)	PG Type I (%)	PG Type IV (%)	EG Type 1 (%)	EG Type IV (%)
1117	Cherry Capital	11,524	75	0	0	25
1118	Bethel	4,897	40	0	60	0
1123	James M Cox Dayton International	90,580	89	11	0	0
1124	Des Moines International	79,658	84	14	3	0
1126	Minneapolis/ St Paul International/Wold - Chamberlain	1,456,537	93	7	0	0
1128	Charlotte/Douglas International	143,572	81	19	0	0
1129	Bradley International	427,068	88	12	0	0
1136	General Mitchell International	152,944	90	9	0	1
1138	Detroit Metropolitan Wayne County	2,152,292	93	7	0	0
1139	Philadelphia International	979,983	88	12	0	0
1140	Memphis International	199,174	88	12	0	0
1141	Ronald Reagan Washington National	219,533	81	16	3	0
1142	Washington Dulles International	1,076,083	77	22	1	0
1145	Newark Liberty International	1,123,057	86	14	0	0
1148	Kansas City International	203,726	75	8	17	0
1149	Fort Worth Alliance	1,522	97	3	0	0
1150	Greater Rockford	146,856	79	21	0	0
1151	Kalamazoo/Battle Creek International	22,002	84	16	0	0
1152	Duluth International	68,168	96	4	0	0
1153	Akron - Canton Regional	60,246	90	10	0	0

Source: Airport Deicing Operations ADF Usage Database (USEPA, 2008).
Note: PG/EG gallons represent total usage normalized to 100 percent glycol. Values may not sum to 100 due to rounding.
GPY – Gallons per year.

Table 9-2. ADF Data Reported in the Airport Questionnaire

Airport ID	Airport Name	PG/EG Usage (GPY)
1115	Jacksonville International	1,000
1062	Birmingham International	5,000
1072	Gillette-Campbell County	880
1060	Williamson County Regional	150
1096	Santa Fe Municipal	1,108
1097	Lovell Field	4,148
1025	Tupelo Regional	820
1143	San Francisco International	105
1001	Montgomery Regional (Dannelly Field)	232
1019	Ontario International	35

Source: Airport Deicing Operations ADF Usage Database (USEPA, 2008).
GPY – Gallons per year.

Using the airline and airport questionnaire data on ADF purchases, airport departures, and climate, EPA correlated the estimate of the amount of ADF used to the climate and size of each airport. EPA created an "ADF Factor" to estimate the relative amount of deicing occurring at each airport based on the airport's climate and number of departures. EPA calculated the ADF Factor by multiplying the 30-year annual average number of SOFP days by the average number of annual departures at each airport during 2004-2006 (USEPA, 2008a). EPA graphed the total gallons of PG/EG purchased with the ADF factor and determined the equation of the line. During this analysis, EPA noted a difference in the relationship of ADF Factor and ADF usage for Alaskan airports compared to other airports. Due to this difference, EPA developed a separate graph and equation for Alaskan airports. Figure 9-1 shows the graph for non-Alaskan airports and Figure 9-2 presents the graph for Alaskan airports.

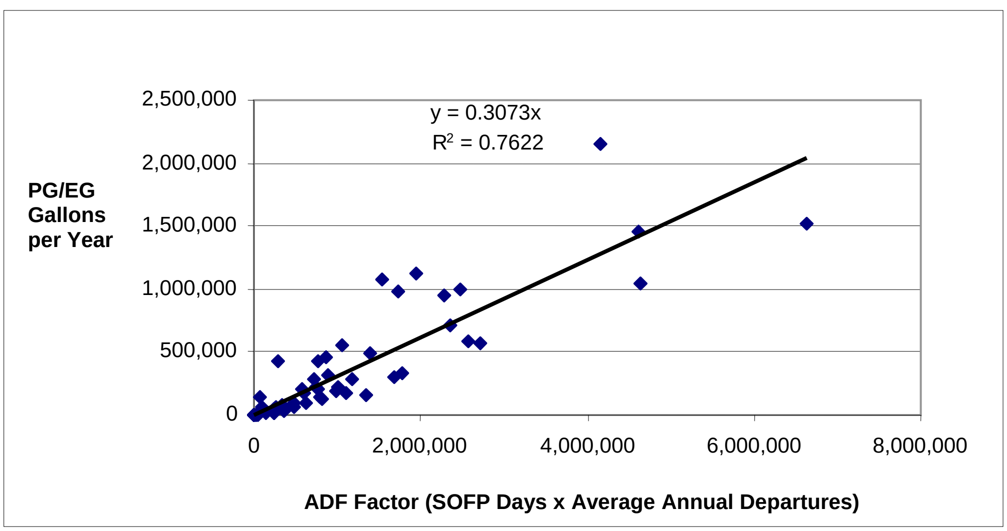


Figure 9-1. ADF Factor vs. PG/EG Gallons for U.S. Airports (excluding Alaska)

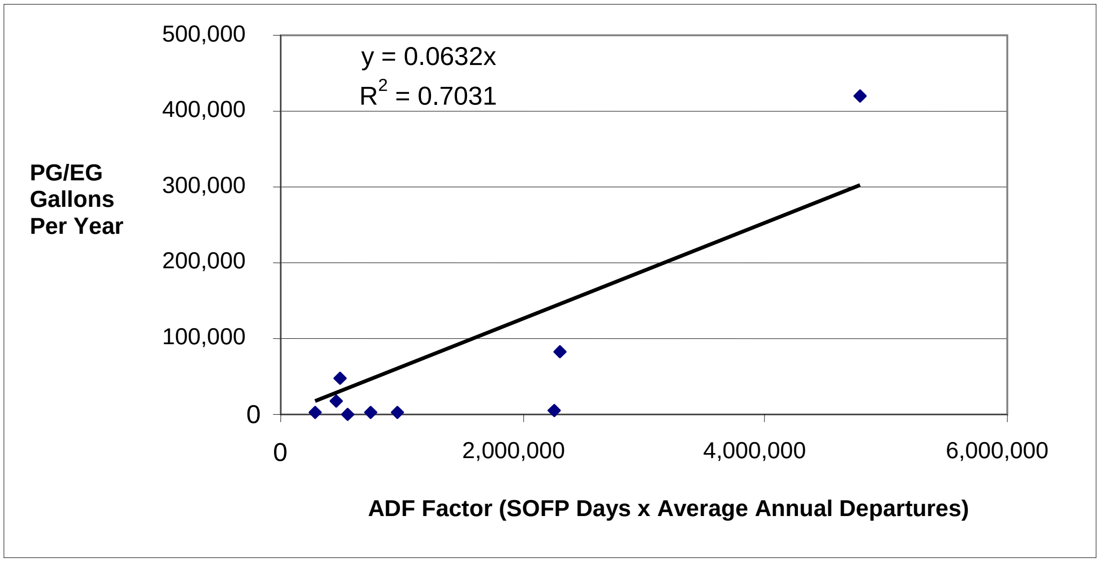


Figure 9-2. ADF Factor vs. PG/EG Gallons for Alaskan Airports

EPA used the line equations to estimate the total gallons of ADF used at model airports that did not have available ADF data in the airport or airline detailed questionnaires. Based on the estimated total gallons of ADF used at an airport, EPA calculated the distribution of different types of ADF (PG/EG, Type I/Type IV) based on the average percent distribution of the reported ADF amounts. See the *Airport Deicing Loadings Calculations* memorandum (ERG, 2008b) for more detail. Table 9-3 presents the final estimates of ADF usage for airports in the scope of the final rule.

Table 9-3. ADF Annual Usage Estimates for In-scope Airports

Airport ID	Airport Name	PG Type I (gallons)	PG Type IV (gallons)	EG Type I (gallons)	EG Type IV (gallons)
1001	Montgomery Regional (Dannelly Field)	166	22	41	3
1003	Ketchikan International	0	0	18,182	0
1004	Norfolk International	22,084	2,938	5,451	402
1006	Chicago O'Hare International	1,213,301	303,325	0	0
1007	Yeager	35,450	4,715	8,750	646
1008	Tucson International	1,675	223	413	31
1010	Fairbanks International	0	0	83,335	0
1011	Lambert-St Louis International	74,778	3,251	227,586	19,507
1012	Ted Stevens Anchorage International	0	0	420,735	0
1014	Albuquerque International Sunport	46,107	6,133	11,380	840
1015	Gulfport-Biloxi International	1,109	148	274	20
1017	Austin Straubel International	44,442	5,912	10,969	810
1018	Piedmont Triad International	49,169	6,540	12,136	896
1019	Ontario International	25	3	6	0
1020	Hartsfield - Jackson Atlanta International	259,100	34,465	63,950	4,720
1021	Buffalo Niagara International	259,289	25,365	0	0
1022	Fort Wayne International	46,379	4,033	0	0
1023	Seattle-Tacoma International	112,631	14,982	27,799	2,052
1024	Indianapolis International	411,461	40,694	0	0
1026	Dallas/Fort Worth International	71,720	20,015	63,380	11,675
1028	Denver International	907,530	104,314	41,726	0
1029	La Guardia	363,868	106,735	9,703	4,852
1031	Richmond International	42,442	5,646	10,476	773
1032	Austin-Bergstrom International	17,198	2,288	4,245	313
1033	Mc Carran International	7,613	1,013	1,879	139
1034	Metropolitan Oakland International	0	0	0	0
1035	San Diego International	0	0	0	0
1036	Baltimore-Washington International	291,261	32,362	0	0
1037	George Bush Intercontinental Airport/Houston	8,399	1,844	0	0
1040	Louis Armstrong New Orleans International	0	0	0	0
1041	Glacier Park International	27,578	3,668	6,807	502
1043	Ralph Wien Memorial	675	0	1,825	0
1044	Roanoke Regional/Woodrum Field	23,552	3,133	5,813	429
1045	Norman Y. Mineta San Jose International	10	0	0	0
1046	Long Island Mac Arthur	31,135	4,141	7,685	567
1050	Aspen-Pitkin Co/Sardy Field	10,742	1,429	2,651	196
1052	Wilmington International	1,556	207	384	28

Table 9-3 (Continued)

Airport ID	Airport Name	PG Type I (gallons)	PG Type IV (gallons)	EG Type I (gallons)	EG Type IV (gallons)
1053	General Edward Lawrence Logan International	816,104	169,192	0	0
1054	Jackson Hole	24,413	3,247	6,026	445
1057	Will Rogers World	35,409	4,710	8,740	645
1058	Gerald R. Ford International	84,414	12,760	0	0
1059	Greater Rochester International	208,534	20,624	0	0
1061	William P Hobby	10,134	1,348	2,501	185
1062	Birmingham International	3,578	476	883	65
1063	Evansville Regional	14,412	1,917	3,557	263
1065	Albany International	116,971	8,804	0	0
1066	Salt Lake City International	125,519	34,232	296,681	114,108
1067	Helena Regional	13,147	1,749	3,245	240
1068	Eppley Airfield	79,386	10,560	19,594	1,446
1069	Cleveland-Hopkins International	524,089	58,232	0	0
1070	City of Colorado Springs Municipal	54,230	7,214	13,385	988
1074	South Bend Regional	22,189	7,396	0	0
1075	Pensacola Regional	592	79	146	11
1078	Nashville International	65,479	8,710	16,161	1,193
1079	Manchester	154,257	23,050	0	0
1080	Syracuse Hancock International	180,760	5,591	0	0
1081	Bob Hope	0	0	0	0
1083	Tampa International	0	0	0	0
1084	Bismarck Municipal	15,018	1,998	3,707	274
1086	Palm Beach International	732	97	181	13
1087	El Paso International	11,608	1,544	2,865	211
1088	Outagamie County Regional	41,375	5,504	10,212	754
1089	John F Kennedy International	459,225	100,806	0	0
1090	Boise Air Terminal/Gowen Fld	51,086	6,795	12,609	931
1091	Rochester International	24,717	3,288	6,101	450
1094	Boeing Field/King County International	3,688	491	910	67
1095	Chicago Midway International	258,574	35,260	0	0
1097	Lovell Field	2,968	395	733	54
1099	Sacramento International	0	0	0	0
1100	Toledo Express	29,728	2,322	13,470	929
1101	Portland International	80,173	10,664	19,788	1,461
1102	John Wayne Airport-Orange County	0	0	0	0
1103	Juneau International	0	0	48,014	0
1104	Nome	457	0	2,590	0
1105	Spokane International	62,545	5,439	0	0

Table 9-3 (Continued)

Airport ID	Airport Name	PG Type I (gallons)	PG Type IV (gallons)	EG Type I (gallons)	EG Type IV (gallons)
1107	Pittsburgh International	830,704	113,278	0	0
1108	Louisville International-Standiford Field	91,849	12,217	22,670	1,673
1111	Port Columbus International	265,304	23,070	0	0
1113	Cincinnati/Northern Kentucky International	171,801	35,792	436,660	78,742
1114	Stewart International	23,086	3,071	5,698	421
1115	Jacksonville International	716	95	177	13
1116	Reno/Tahoe International	53,382	7,101	13,176	973
1117	Cherry Capital	8,643	0	0	2,881
1118	Bethel	1,959	0	2,938	0
1119	Rickenbacker International	7,661	1,019	1,891	140
1120	Rapid City Regional	18,185	2,419	4,488	331
1121	Theodore Francis Green State	107,383	14,284	26,504	1,956
1122	Southwest Florida International	680	90	168	12
1123	James M Cox Dayton International	80,616	9,964	0	0
1124	Des Moines International	66,913	11,152	2,390	0
1126	Minneapolis/St Paul International/Wold-Chamberlain	1,354,580	101,958	0	0
1128	Charlotte/Douglas International	116,293	27,279	0	0
1129	Bradley International	375,820	51,248	0	0
1130	San Antonio International	9,119	1,213	2,251	166
1131	Wilkes-Barre/Scranton International	30,426	4,047	7,510	554
1133	Phoenix Sky Harbor International	0	0	0	0
1135	Lafayette Regional	1,065	142	263	19
1136	General Mitchell International	137,650	13,765	0	1,529
1137	Dallas Love Field	26,622	3,541	6,571	485
1138	Detroit Metropolitan Wayne County	2,001,632	150,660	0	0
1139	Philadelphia International	862,385	117,598	0	0
1140	Memphis International	175,273	23,901	0	0
1141	Ronald Reagan Washington National	177,822	35,125	6,586	0
1142	Washington Dulles International	828,584	236,738	10,761	0
1143	San Francisco International	75	10	19	1
1144	Central Wisconsin	31,203	4,151	7,702	568
1145	Newark Liberty International	965,829	157,228	0	0
1146	Northwest Arkansas Regional	22,013	2,928	5,433	401
1147	Raleigh-Durham International	73,281	9,748	18,087	1,335
1148	Kansas City International	152,794	16,298	34,633	0

Source: Airport Deicing Operations ADF Usage Database (USEPA, 2008).
Note: Values may not sum to total usage amounts due to rounding.

9.2.2 Calculate the Amount of Pollutant Load Associated with the Applied ADF

As aircraft deicing chemicals break down in the environment, they increase COD and BOD. EPA calculated the amount of COD and BOD (presented as-5 day BOD, or BOD_5) associated with the degradation of the applied deicing/anti-icing chemicals.

EPA considered two approaches to estimate the amount of COD and BOD_5 associated with deicing chemicals. The first approach involved using laboratory empirical COD and BOD_5 data for deicing chemicals. The second approach involved using standard chemical information and stoichiometric equations to estimate COD and BOD_5 for each chemical.

EPA determined it would not be suitable to use empirical data to estimate loadings for three main reasons. First, empirical COD and BOD_5 data were not readily available for all deicing/anti-icing chemicals. Second, the available empirical data were outdated and brand-specific. Finally, chemical formulations vary significantly over time and by brand, so it is inappropriate to apply any given set of empirical data to all airports and chemicals.

EPA selected the second approach, calculating loadings based on standard chemical information and stoichiometric equations. The advantage of this methodology over using empirical data is that it can be used for all deicing chemicals. In addition, this methodology allows the calculations and assumptions used to be clearly presented. EPA checked the validity of the COD and BOD_5 concentrations for PG and EG calculated using this methodology against the available empirical data and found a good match.

Calculate the Total Mass of Each Pollutant

First, EPA estimated the total mass of each chemical based on the airline and airport questionnaire responses (which specified varying formulations of ADF and deicing products). To calculate the total mass of applied chemical, EPA multiplied the reported mass of each chemical by the reported percentage of the pollutant in the ADF formulation, by the density of the pollutant.

Determine the Theoretical Oxygen Demand of Each Chemical

Next, EPA determined the theoretical oxygen demand (ThOD) associated with the degradation of each of the deicing chemicals. The ThOD estimate was based on the molecular formula of the chemical and the stoichiometric equation of the breakdown of the chemical to the end products of carbon dioxide and water. Table 9-4 lists the calculated ThOD for each chemical in aircraft deicers.

Table 9-4. Theoretical Oxygen Demand Calculations for Aircraft Deicing Chemicals

Deicing Compound	Molecular Formula	Stoichiometric Formula	ThOD (Moles of O_2 per Mole of Deicing Compound)
PG	$C_3H_8O_2$	$C_3H_8O_2 + 4\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$	4.0
EG	$C_2H_6O_2$	$2[C_2H_6O_2] + 5\ O_2 \rightarrow 4\ CO_2 + 6\ H_2O$	2.5

Determine the COD of Each Chemical

EPA next determined the COD loading associated with the chemical's degradation. EPA assumed that the chemical would completely degrade in the environment over time and therefore the calculated ThOD load would be equivalent to the COD load. EPA estimated the COD load associated with each reported chemical based on the calculated mass of the chemical purchased, the molecular weight of the chemical, the ThOD, and the molecular weight of oxygen, using the equation below:

$$\begin{aligned}\text{COD Load (pounds)} &= \text{Chemical (pounds)} \times \frac{434\ \text{grams}}{\text{pound}} \times \text{Chemical Molecular Weight}\left(\frac{\text{moles of chemical}}{\text{grams of chemical}}\right) \\ &\times \text{ThOD}\left(\frac{\text{moles of O}_2}{\text{moles of chemical}}\right) \times \text{O}_2\ \text{Molecular Weight}\left(\frac{\text{grams of O}_2}{\text{moles of O}_2}\right) \times \frac{\text{pound}}{434\ \text{grams}}\end{aligned} \quad (9\text{-}1)$$

Determine the BOD_5 of Each Chemical

EPA calculated the BOD_5 loading of ADF based on the estimated COD loading in ADF. EPA developed an industry-specific relationship between COD and BOD_5 using analytical data for untreated deicing stormwater from the EPA sampling episodes at Albany International airport, Pittsburgh International airport, and Denver International airport. The average COD/BOD_5 ratio was 1.67. This relationship was used to calculate the BOD_5 associated with the degradation of the deicing chemical. See the *Airport Deicing Loading Calculations* memorandum (ERG, 2008b) for more information.

9.2.3 Estimate the Amount of Baseline Pollutant Load that is Discharged Directly

The amount of applied chemical that is discharged directly is airport-specific and dependent upon the existing stormwater collection/treatment system present at each airport. Typically, ADF is applied at a number of specific locations at the airport, including gates, deicing pads, and/or aprons.

In estimating the direct discharge amount of ADF, EPA first estimated the amount of applied ADF that would be available for discharge. EPA assumed that 75 percent of applied Type I ADF falls onto the pavement at the deicing area and is available for discharge; the remaining 25 percent is lost to evaporation, wind, or tire tracking, or adheres to the plane and is later sheared off during taxiing and takeoff (Switzenbaum, et al., 1999). EPA assumed that 10 percent of Type IV ADF falls to the pavement in the deicing area and is available for discharge; the remaining 90 percent adheres to the plane. The Agency multiplied the total amount of applied ADF by the appropriate percentage available for discharge to determine the amount of ADF that is available for discharge.

Next, EPA determined the percentage of available ADF that would be directly discharged at each airport, depending on the airport's current control and treatment systems (ERG, 2011). EPA estimated collection and control percentages of available ADF for each airport based on information provided during EPA site visits and in the airport questionnaire. If the airport did not provide an ADF collection and control percentage estimate, EPA personnel reviewed the airport's questionnaire responses and the reported collection and control percentage of similar systems to determine an estimate for the airport.

The COD load associated with each ADF chemical applied at an airport was reduced by EPA's estimate of the airport's current collection and control percentage to estimate the amount of COD directly discharged. These estimates represent the baseline amount of ADF discharged to the environment. Table 9-5 in Section 9.2.5 presents EPA's estimate of the baseline COD load (in pounds) directly discharged by each airport.

9.2.4 Estimate Pollutant Loading Discharges for Each ADF Collection/Control Scenario

Two of EPA's regulatory options require a specific collection and treatment percentage of available ADF. For the final rule, EPA evaluated the following scenarios as discussed in Section 11:

- 20% Collection and Control Scenario: collection and treatment of 20 percent of available ADF; and
- 40% Collection and Control Scenario: collection and treatment of 40 percent of available ADF.

EPA estimated the direct discharge COD load of each collection and control scenario accounting for the following two components:

- The COD load associated with the applied ADF, minus any reductions achieved by the collection and control practices implemented; and
- The COD load that would be discharged from AFB biological treatment of the collected treatment.

EPA estimated the amount of COD load that would be discharged from treatment for each airport that had load reductions in a scenario. Using analytical data from its sampling episodes, EPA determined that AFB systems remove 97.5 percent of COD. Therefore, EPA assumed that 97.5 percent of the COD load going to treatment would be removed and 2.5 percent would be discharged.

9.2.5 Estimate Pollutant Loading Reductions for Each ADF Collection/Control Scenario

After estimating the loads for each scenario, EPA estimated the loading reductions as compared to baseline. Table 9-5 lists the ADF COD baseline loads and reductions for each control and treatment scenario EPA evaluated for those airports in the scope of the final rule.

Table 9-5. ADF COD Baseline Loads and Loading Reductions for Each Control and Treatment Scenario, by In-Scope Airport

Airport ID	Airport	Airport Weighting Factor	Current ADF Collection (%)	Baseline COD Load (pounds)	COD Load Reduction for 20% Collection and Control Scenario (pounds)	COD Load Reduction for 40% Collection and Control Scenario (pounds)
1001	Montgomery Regional (Dannelly Field)	6.7013	0	2,214	432	863
1003	Ketchikan International	1.0000	NA	0	0	0
1004	Norfolk International	1.0000	20	235,637	0	57,436
1006	Chicago O'Hare International	1.0000	40	8,204,552	0	0
1007	Yeager	2.1508	40	283,685	0	0
1008	Tucson International	2.9997	20	17,873	0	4,357
1010	Fairbanks International	1.0000	≥60	299,205	0	0
1011	Lambert-St Louis International	1.0000	≥60	1,154,584	0	0
1012	Ted Stevens Anchorage International	1.0000	40	2,265,902	0	0
1014	Albuquerque International Sunport	1.0000	20	491,959	0	119,915
1015	Gulfport-Biloxi International	5.8413	≥60	0	0	0
1017	Austin Straubel International	2.3269	40	355,646	0	0
1018	Piedmont Triad International	1.0000	0	655,787	127,879	255,757
1019	Ontario International	1.0000	0	334	200	200
1020	Hartsfield - Jackson Atlanta International	1.0000	≥60	1,382,287	0	0
1021	Buffalo Niagara International	1.0000	40	1,718,928	0	0
1022	Fort Wayne International	1.9682	0	511,705	102,341	204,682
1023*	Seattle-Tacoma International	1.0000	0	1,502,208	292,931	585,861
1024	Indianapolis International	1.0000	40	2,728,125	0	0
1026	Dallas/Fort Worth International	1.0000	≥60	557,682	0	0
1028	Denver International	1.0000	≥60	104,244	0	0
1029	La Guardia	1.0000	0	4,216,728	822,262	1,644,524
1031	Richmond International	1.0000	40	339,643	0	0
1032	Austin-Bergstrom International	1.0000	40	137,629	0	0
1033	Mc Carran International	1.0000	40	60,923	0	0
1034	Metropolitan Oakland International	1.0000	≥60	0	0	0
1035	San Diego International	1.0000	≥60	0	0	0
1036	Baltimore-Washington International	1.0000	≥60	1,289,506	0	0
1037	George Bush Intercontinental Airport/Houston	1.0000	40	56,571	0	0
1040	Louis Armstrong New Orleans International	1.0000	≥60	0	0	0

Table 9-5 (Continued)

Airport ID	Airport	Airport Weighting Factor	Current ADF Collection (%)	Baseline COD Load (pounds)	COD Load Reduction for 20% Collection and Control Scenario (pounds)	COD Load Reduction for 40% Collection and Control Scenario (pounds)
1041	Glacier Park International	3.1409	0	367,815	71,724	143,448
1043	Ralph Wien Memorial	1.0000	0	23,743	4,630	9,260
1044	Roanoke Regional/Woodrum Field	2.1921	0	314,124	61,254	122,508
1045	Norman Y. Mineta San Jose International	1.0000	10	0	0	0
1046	Long Island Mac Arthur	1.9985	≥60	166,102	0	0
1050	Aspen-Pitkin Co/Sardy Field	4.7500	40	85,963	0	0
1052	Wilmington International	6.0388	0	20,756	4,047	8,095
1053	General Edward Lawrence Logan International	1.0000	0	9,147,072	1,783,679	3,567,358
1054	Jackson Hole	4.3500	≥60	0	0	0
1057	Will Rogers World	1.0000	0	472,260	92,091	184,181
1058	Gerald R. Ford International	1.5862	40	563,544	0	0
1059	Greater Rochester International	1.0000	50	1,152,208	0	0
1061	William P Hobby	1.0000	≥60	0	0	0
1062	Birmingham International	2.8410	0	47,717	9,305	18,610
1063	Evansville Regional	5.1042	0	192,217	37,482	74,965
1065	Albany International	1.0000	≥60	25,771	0	0
1066	Salt Lake City International	1.0000	≥60	1,687,338	0	0
1067	Helena Regional	4.2000	≥60	0	0	0
1068	Eppley Airfield	1.0000	0	1,058,801	206,466	412,933
1069	Cleveland-Hopkins International	1.0000	40	3,480,467	0	0
1070	City of Colorado Springs Municipal	1.7414	40	433,971	0	0
1074	South Bend Regional	2.1417	≥60	0	0	0
1075	Pensacola Regional	3.9341	≥60	0	0	0
1078	Nashville International	1.0000	≥60	349,329	0	0
1079	Manchester	1.0000	0	1,715,962	334,613	669,225
1080	Syracuse Hancock International	1.0000	≥60	791,854	0	0
1081	Bob Hope	1.0000	≥60	0	0	0
1083	Tampa International	1.0000	≥60	0	0	0
1084	Bismarck Municipal	3.8679	0	200,305	39,059	78,119
1086	Palm Beach International	1.0000	≥60	0	0	0
1087	El Paso International	3.0457	≥60	0	0	0
1088	Outagamie County Regional	2.4841	0	551,842	107,609	215,218

Table 9-5 (Continued)

Airport ID	Airport	Airport Weighting Factor	Current ADF Collection (%)	Baseline COD Load (pounds)	COD Load Reduction for 20% Collection and Control Scenario (pounds)	COD Load Reduction for 40% Collection and Control Scenario (pounds)
1089	John F Kennedy International	1.0000	0	5,155,239	1,005,272	2,010,543
1090	Boise Air Terminal/Gowen Fld	1.5043	≥60	272,543	0	0
1091	Rochester International	3.1749	40	197,799	0	0
1094	Boeing Field/King County International	5.8985	40	29,510	0	0
1095	Chicago Midway International	1.0000	≥60	0	0	0
1097	Lovell Field	4.9996	0	39,586	23,752	23,752
1099	Sacramento International	1.0000	20	0	0	0
1100	Toledo Express	2.0917	20	359,704	0	87,678
1101	Portland International	1.0000	20	855,437	0	208,513
1102	John Wayne Airport-Orange County	1.0000	≥60	0	0	0
1103	Juneau International	1.0000	0	430,969	84,039	168,078
1104	Nome	1.0000	0	28,231	5,505	11,010
1105	Spokane International	1.5192	≥60	0	0	0
1107	Pittsburgh International	1.0000	≥60	3,689,998	0	0
1108	Louisville International-Standiford Field	1.0000	≥60	490,009	0	0
1111	Port Columbus International	1.0000	0	2,927,149	570,794	1,141,588
1113	Cincinnati/Northern Kentucky International	1.0000	≥60	415,766	0	0
1114	Stewart International	2.8661	40	184,745	0	0
1115	Jacksonville International	1.0000	≥60	0	0	0
1116	Reno/Tahoe International	1.0000	20	569,580	0	138,835
1117	Cherry Capital	3.5400	≥60	0	0	0
1118	Bethel	1.0000	0	47,733	9,308	18,616
1119	Rickenbacker International	4.3659	0	102,180	19,925	39,850
1120	Rapid City Regional	3.1082	0	242,540	47,295	94,591
1121	Theodore Francis Green State	1.0000	≥60	572,884	0	0
1122	Southwest Florida International	1.0000	≥60	0	0	0
1123	James M Cox Dayton International	1.0000	≥60	357,499	0	0
1124	Des Moines International	1.6211	40	460,483	0	0
1126	Minneapolis/St Paul International/Wold-Chamberlain	1.0000	≥60	5,968,923	0	0
1128	Charlotte/Douglas International	1.0000	0	1,308,047	255,069	510,138
1129	Bradley International	1.0000	≥60	1,669,398	0	0

Table 9-5 (Continued)

Airport ID	Airport	Airport Weighting Factor	Current ADF Collection (%)	Baseline COD Load (pounds)	COD Load Reduction for 20% Collection and Control Scenario (pounds)	COD Load Reduction for 40% Collection and Control Scenario (pounds)
1130	San Antonio International	1.0000	0	121,626	23,717	47,434
1131	Wilkes-Barre/Scranton International	2.6815	0	405,801	79,131	158,262
1133	Phoenix Sky Harbor International	1.0000	20	0	0	0
1135	Lafayette Regional	6.6425	0	14,201	8,521	8,521
1136	General Mitchell International	1.0000	44	852,970	0	0
1137	Dallas Love Field	1.0000	40	213,039	0	0
1138	Detroit Metropolitan Wayne County	1.0000	≥60	0	0	0
1139	Philadelphia International	1.0000	≥60	1,436,522	0	0
1140	Memphis International	1.0000	0	1,946,410	379,550	759,100
1141	Ronald Reagan Washington National	1.0000	40	1,229,789	0	0
1142	Washington Dulles International	1.0000	40	5,686,802	0	0
1143	San Francisco International	1.0000	≥60	0	0	0
1144	Central Wisconsin	3.0156	0	416,170	81,153	162,306
1145	Newark Liberty Intl	1.0000	0	10,762,687	2,098,724	4,197,448
1146	Northwest Arkansas Regional	1.8782	0	293,595	57,251	114,502
1147	Raleigh-Durham Intl	1.0000	0	977,382	190,589	381,179
1148	Kansas City Intl	1.0000	40	1,200,632	0	0

NA – Ketchikan was sent an airport questionnaire but did not respond.
Sources: Airport Deicing Loadings Database. (USEPA, 2010); ADF Capture and Control Efficiency Review Memorandum. (ERG, 2011)
* The airport post-questionnaire has installed deicing pads; high BOD stormwater is sent to a POTW.

For each scenario, EPA estimated no load reductions for the airport if it collects and controls more than the required percentage of available ADF (e.g., for the 20 percent efficiency scenario, if an airport currently collects and controls 20 percent or more of available ADF, no load reductions were estimated for the airport). Model airports that currently collect the required percentage of available ADF either treat it to the required discharge levels, discharge the collected ADF to a POTW, or send it off-site and are assumed to be in compliance with any numeric effluent limitation.

EPA assumed that airports that used small quantities of ADF (less than 5,000 gallons of normalized ADF), as described below in Section 10.1, would collect and haul away the required percentage of ADF instead of collecting it for on-site treatment. For more information, refer to the *Airport Deicing Loadings Calculations* memorandum (ERG, 2008b).

9.3 Airfield Deicing Pollutant Loading

This section presents EPA's methodology for estimating airfield deicing pollutant loads using airport questionnaire data on airfield chemical use.

9.3.1 Estimate the Amount of Applied Deicing Chemical

In the airport questionnaire, EPA requested that airport personnel report the usage amount, concentration, and brand name of the following pavement deicing materials for the 2002/2003, 2003/2004, and 2004/2005 deicing seasons:

- Urea;
- Potassium Acetate;
- CMA;
- Sodium Acetate;
- Sand;
- Sodium Formate;
- EG-Based Fluids;
- PG-Based Fluids; and
- Other: (Specify).

EPA evaluated the data provided for each reported chemical to determine the most appropriate way to estimate the average amount used over the three winter seasons reported. In addition, EPA read the comments provided by the airport personnel to determine any extenuating circumstances that affect chemical use. For example, airport personnel may have reported that urea was replaced with potassium acetate at the airport during the three years reported. In this case, EPA used the potassium acetate average in the loadings estimate and did not use any of the urea data to better represent the airport's current practices. Ninety airports reported pavement deicing chemical usage values to EPA in their questionnaire responses.

Table 9-6 shows the three-year average pavement deicing chemical usage EPA calculated from the reported data (normalized to pure chemical) by airport and chemical. In the questionnaire, airports reported pounds or gallons of pavement deicing chemical used along with the concentration of the chemical. If airport personnel reported a volume of chemical in the airport or airline detailed questionnaire, EPA multiplied the reported volume by the reported deicing chemical strength and the chemical density.

No airports reported using CMA. Multiple airports reported using sand, but these data are not included in Table 9-6, because sand was not included in the loads analysis. Only one airport reported using granular potassium acetate. Potassium acetate (in the liquid form) is the most commonly used pavement deicing chemical.

Table 9-6. Three-Year Average Amount of Pavement Deicing Chemical Usage, in Pounds

Airport ID	Airport Name	EG-Based Fluids	Granular Potassium Acetate	Potassium Acetate	Sodium Acetate	Sodium Formate	PG-Based Fluids	Urea
1006	Chicago O'Hare Intl	0	0	655,284	0	0	4,681,462	0
1007	Yeager	0	0	0	2,560	0	11,540	27,517
1010	Fairbanks Intl	0	0	197,024	0	0	0	332,000
1011	Lambert - St Louis Intl	0	0	5,119,502	0	0	0	0
1012	Ted Stevens Anchorage Intl	0	0	1,266,417	0	0	0	2,514,900
1013	Wiley Post-Will Rogers Mem	0	0	0	0	0	0	20,000
1014	Albuquerque Intl Sunport	0	0	4,586	0	0	0	0
1016	Tri - State/Milton J Ferguson Field	0	0	27,089	0	0	0	56,000
1017	Austin Straubel Intl	0	0	38,121	0	0	0	44,860
1018	Piedmont Triad Intl	0	0	53,938	0	0	0	92,667
1020	Hartsfield - Jackson Atlanta Intl	0	0	314,456	0	0	0	0
1021	Buffalo Niagara Intl	0	0	0	0	7,760	0	0
1022	Fort Wayne Intl	0	0	268,772	0	0	0	285,544
1023	Seattle - Tacoma Intl	0	0	97,914	696	0	0	0
1024	Indianapolis Intl	0	0	783,038	470,667	0	0	0
1026	Dallas/Fort Worth Intl	0	0	18,179	0	0	0	0
1028	Denver Intl	0	0	3,526,704	0	0	0	0
1029	La Guardia	0	0	1,118,145	1,676	0	442,700	0
1031	Richmond Intl	0	0	284,770	17,000	0	0	0
1032	Austin - Bergstrom Intl	0	0	17,483	0	0	0	0
1036	Baltimore - Washington Intl	0	0	1,178,861	257,280	156,800	0	0
1041	Glacier Park Intl	0	0	0	0	0	0	333
1043	Ralph Wien Memorial	0	0	38,870	0	0	0	10,000
1044	Roanoke Regional/Woodrum Field	0	0	109,044	0	0	0	0
1050	Aspen - Pitkin County/Sardy Field	0	17,000	46,732	0	0	0	0
1052	Wilmington Intl	0	0	0	0	0	0	0
1053	General Edward Lawrence Logan Intl	1,217,300	0	0	0	0	0	10,217

Table 9-6 (Continued)

Airport ID	Airport Name	EG-Based Fluids	Granular Potassium Acetate	Potassium Acetate	Sodium Acetate	Sodium Formate	PG-Based Fluids	Urea
1057	Will Rogers World	0	0	49,603	2,910	0	0	0
1058	Gerald R Ford Intl	0	0	66,341	0	8,568	0	0
1059	Greater Rochester Intl	0	0	294,634	0	0	0	0
1063	Evansville Regional	0	0	29,065	0	0	0	0
1065	Albany Intl	0	0	196,535	148,500	0	0	0
1066	Salt Lake City Intl	0	0	173,169	0	0	0	1,121,232
1068	Eppley Airfield	0	0	289,288	9,474	0	0	0
1069	Cleveland – Hopkins Intl	0	0	2,456,657	190,055	6,117	0	0
1070	City of Colorado Springs Municipal	0	0	224,598	0	0	0	0
1071	Tweed - New Haven	0	0	0	291	0	0	0
1074	South Bend Regional	0	0	0	0	0	0	32,440
1078	Nashville Intl	0	0	163,779	0	0	0	0
1079	Manchester	0	0	398,780	0	0	0	36,833
1080	Syracuse Hancock Intl	0	0	11,792	0	0	0	0
1082	Trenton Mercer	0	0	12,393	0	4,704	0	0
1084	Bismarck Municipal	0	0	16,114	0	0	0	0
1085	Waterloo Municipal	0	0	0	0	0	0	6,000
1088	Outagamie County Regional	0	0	229,290	0	0	0	0
1089	John F Kennedy Intl	0	0	170,330	3,460,831	0	224,792	0
1090	Boise Air Terminal/Gowen Field	0	0	98,582	0	0	0	269,901
1094	Boeing Field/King County Intl	0	0	10,255	0	0	0	0
1095	Chicago Midway Intl	0	0	1,397,274	0	0	0	0
1098	Aberdeen Regional	0	0	17,489	0	0	0	0
1100	Toledo Express	0	0	240,209	0	0	0	0
1101	Portland Intl	0	0	256,478	10,292	211,183	0	0
1103	Juneau Intl	0	0	0	0	0	0	478,000

Table 9-6 (Continued)

Airport ID	Airport Name	EG-Based Fluids	Granular Potassium Acetate	Potassium Acetate	Sodium Acetate	Sodium Formate	PG-Based Fluids	Urea
1104	Nome	0	0	39,307	0	0	0	0
1105	Spokane Intl	0	0	240	0	0	951	498,000
1107	Pittsburgh Intl	0	0	1,198,425	13,333	89,507	0	0
1108	Louisville Intl - Standiford Field	0	0	762,020	0	109,760	0	0
1109	Airborne Airpark	0	0	1,916,877	0	1,809,373	0	0
1110	Aniak	0	0	0	0	0	0	2,400
1111	Port Columbus Intl	0	0	623,773	0	7,161	0	0
1112	Deadhorse	0	0	12,229	0	0	0	20,000
1113	Cincinnati/Northern Kentucky Intl	0	0	3,050,218	0	4,000	0	0
1114	Stewart Intl	0	0	78,614	2,520	0	0	151,800
1116	Reno/Tahoe Intl	0	0	42,583	0	0	0	11,186
1117	Cherry Capital	0	0	63,909	0	0	0	0
1118	Bethel	0	0	0	0	0	0	67,333
1119	Rickenbacker Intl	0	0	71,919	0	37,782	0	0
1120	Rapid City Regional	0	0	0	0	0	6,484	0
1121	Theodore Francis Green State	0	0	160,532	0	0	0	0
1123	James M Cox Dayton Intl	0	0	174,912	0	0	0	0
1124	Des Moines Intl	0	0	340,660	139,033	0	0	0
1126	Minneapolis /St Paul Intl/Wold - Chamberlain	0	0	1,273,019	82,667	0	0	0
1128	Charlotte/Douglas Intl	0	0	109,356	0	0	0	149,883
1129	Bradley Intl	0	0	443,282	223,150	0	0	16,748
1136	General Mitchell Intl	0	0	1,275,038	0	127,400	0	0
1137	Dallas Love Field	0	0	218	0	0	0	0
1138	Detroit Metropolitan Wayne County	0	0	1,851,138	0	0	0	0
1139	Philadelphia Intl	0	0	0	0	0	809,829	0

Table 9-6 (Continued)

Airport ID	Airport Name	EG-Based Fluids	Granular Potassium Acetate	Potassium Acetate	Sodium Acetate	Sodium Formate	PG-Based Fluids	Urea
1140	Memphis Intl	0	0	496,699	74,325	0	0	0
1141	Ronald Reagan Washington National	0	0	319,347	34,000	0	0	78,000
1142	Washington Dulles Intl	0	0	2,430,542	619,868	0	0	0
1144	Central Wisconsin	1,858	0	59,419	0	0	0	123,440
1145	Newark Liberty Intl	0	0	2,657,040	6,143	0	0	0
1146	Northwest Arkansas Regional	243,723	0	0	0	0	0	18,000
1147	Raleigh - Durham Intl	0	0	0	0	0	0	63,333
1148	Kansas City Intl	0	0	597,465	4,573	0	0	0
1149	Fort Worth Alliance	0	0	5,241	0	0	0	0
1150	Greater Rockford	0	0	311,914	0	0	0	680,267
1151	Kalamazoo/Battle Creek Intl	0	0	0	4,000	0	0	0
1153	Akron - Canton Regional	0	0	20,073	162	0	0	21,333

Source: Airport Deicing Loadings Database (USEPA, 2010).

9.3.2 Calculate the Amount of Pollutant Load Associated with the Applied Chemical

As airfield deicing chemicals break down in the environment, they (like aircraft deicers) result in increased COD and BOD discharges. EPA calculated the amount of COD associated with the degradation of the applied pavement deicing chemicals. Because pavement deicers containing urea will also break down into ammonia, EPA also calculated the amount of ammonia associated with the degradation of these deicers.

As with the aircraft deicers, EPA determined it would not be suitable to use empirical data to estimate loadings and decided to calculate loadings based on standard chemical information and stoichiometric equations.

Determine the ThOD of Each Chemical

As with aircraft deicers, the ThOD estimate was based on the molecular formula of the chemical and the stoichiometric equation of the breakdown of the chemical to the end products of carbon dioxide and water. Table 9-7 lists the calculated ThOD for each chemical in airfield deicer.

Table 9-7. ThOD Calculations for Airfield Deicing Chemicals

Deicing Compound	Molecular Formula	Stoichiometric Formula	ThOD (Moles of O_2 per Mole of Deicing Compound)
EG	$C_2H_6O_2$	$2[C_2H_6O_2] + 5\ O_2 \rightarrow 4\ CO_2 + 6\ H_2O$	2.5
Urea	N_2H_4CO	$N_2H_4CO + 4\ O_2 \rightarrow 2\ HNO_3 + CO_2 + H_2O$	4.0
Potassium acetate	$KC_2H_3O_2$	$[C_2H_3O_2]^{-} + 1.75\ O_2 \rightarrow 2\ CO_2 + 1.5\ H_2O$	1.75
Sodium acetate	$NaC_2H_3O_2$	$[C_2H_3O_2]^{-} + 1.75\ O_2 \rightarrow 2\ CO_2 + 1.5\ H_2O$	1.75
Calcium magnesium acetate	$C_8H_{12}CaMgO_8$	$[C_8H_{12}O_8]^{4-} + 7\ O_2 \rightarrow 8\ CO_2 + 6\ H_2O$	7.0
Sodium formate	$NaHCO_2$	$2[HCO_2]^{-} + 0.5\ O_2 \rightarrow 2\ CO_2 + H_2O$	0.25

Determine the COD of Each Chemical

EPA next determined the COD loading associated with the chemical's degradation. EPA assumed that the chemical would completely degrade in the environment over time and therefore the calculated ThOD load would be equivalent to the COD load. EPA estimated the COD load associated with each reported chemical based on the calculated mass of the chemical purchased, the molecular weight of the chemical, the ThOD, and the molecular weight of oxygen, using the equation below:

$$\begin{aligned}\text{COD Load (pounds)} &= \text{Chemical (pounds)} \times \frac{434\text{ grams}}{\text{pound}} \times \text{Chemical Molecular Weight}\left(\frac{\text{moles of chemical}}{\text{grams of chemical}}\right) \\ &\times \text{ThOD}\left(\frac{\text{moles of O}_2}{\text{moles of chemical}}\right) \times \text{O}_2\text{ Molecular Weight}\left(\frac{\text{grams of O}_2}{\text{moles of O}_2}\right) \times \frac{\text{pound}}{434\text{ grams}}\end{aligned} \quad (9\text{-}1)$$

9.3.3 Estimate the Amount of Baseline Pollutant Load that is Discharged Directly

As pavement deicing chemicals are applied at a large variety of areas at an airport, the amount of pavement deicers being directly discharged could range from close to 100 percent on pavement areas near outfall drains, to nearly 0 percent for chemicals that may fall onto grassy areas and infiltrate into the ground during a thaw. Estimating a percentage of direct discharge release of pavement deicers at a particular airport is difficult without performing a detailed study of each airport. Therefore, EPA assumed 100 percent direct discharge of pavement deicers to represent the maximum possible amount of discharge.

9.3.4 Estimate Pollutant Reductions for Each EPA Collection/Control Scenario

Urea COD Load Reduction

As described in section 9.3.2, EPA calculated the COD load associated with urea use at the surveyed airports. EPA then evaluated the amount of potassium acetate that would be required to replace the current average urea use using a comparison of application rates under varying winter conditions (see EPA's Urea/Potassium Acetate memorandum (ERG, 2010) for the details of this analysis). Based on the COD load associated with the equivalent potassium acetate use, EPA determined the potential reductions in COD load. Table 9-8 presents by airport the COD load associated with urea use, the COD load associated with a switch to potassium acetate use, and the potential COD load reduction that would result from airfield product substitution.

Urea Ammonia Load Reduction

Because ammonia is not associated with potassium acetate use, the amount of ammonia reduction from a urea product substitution is equal to the amount of ammonia associated with urea usage.

The following equation expresses the breakdown of urea to ammonia:

$$N_2H_4CO + H_2O \rightarrow 2\ NH_3 + 2\ H_2O + CO_2$$

EPA estimated the ammonia load associated with urea based on the equation above, the mass of urea use, and the molecular weights of urea and ammonia, using the equation below:

$$\text{Ammonia Load (pounds)} = \text{Urea (pounds)} \times \frac{434\ \text{grams}}{\text{pound}} \times \text{Urea Molecular Weight}\left(\frac{\text{mole of urea}}{\text{grams of urea}}\right) \quad (9\text{-}2)$$
$$\times \left(\frac{2\ \text{moles of ammonia}}{\text{mole of urea}}\right) \times \text{Ammonia Molecular Weight}\left(\frac{\text{grams ammonia}}{\text{mole of ammonia}}\right) \times \frac{\text{pound}}{434\ \text{grams}}$$

Table 9-8 presents by airport the potential ammonia load reduction that would result from airfield product substitution.

Table 9-8. Baseline Ammonia and COD Load and Potential Load Reduction Associated with the Discontinued Use of Urea as an Airfield Deicing Chemical for In-Scope Airports

Airport ID	Airport	Airport Weighting Factor	Urea Load (lbs of COD)	Equivalent Potassium Acetate Load (lbs of COD)	Potential Load Reduction (lbs of COD)	Potential Load Reduction (lbs of Ammonia)
1007	Yeager	2.1508	58,644	16,172	42,471	15,572
1010	Fairbanks Intl	1.0000	707,559	195,127	512,432	187,883
1012	Ted Stevens Anchorage Intl	1.0000	5,359,760	1,478,087	3,881,674	1,423,212
1017	Austin Straubel Intl	2.3269	95,606	26,366	69,240	25,387
1018	Piedmont Triad Intl	1.0000	197,491	54,463	143,028	52,441
1022	Fort Wayne Intl	1.9682	608,551	167,823	440,728	161,593
1041	Glacier Park Intl	3.1409	710	196	514	189
1043	Ralph Wien Memorial	1.0000	21,312	5,877	15,435	5,659
1053	General Edward Lawrence Logan Intl	1.0000	21,774	6,005	15,769	5,782
1066	Salt Lake City Intl	1.0000	2,389,572	658,984	1,730,588	634,519
1074	South Bend Regional	2.1417	69,136	19,066	50,070	18,358
1079	Manchester	1.0000	78,499	21,648	56,851	20,844
1090	Boise Air Terminal/Gowen Field	1.5043	575,214	158,629	416,584	152,740
1103	Juneau Intl	1.0000	1,018,715	280,936	737,779	270,506
1105	Spokane Intl	1.5192	1,061,339	292,690	768,648	281,824
1114	Stewart Intl	2.8661	323,516	89,218	234,299	85,905
1116	Reno/Tahoe Intl	1.0000	23,840	6,574	17,265	6,330
1118	Bethel	1.0000	143,501	39,574	103,927	38,105
1128	Charlotte/Douglas Intl	1.0000	319,432	88,091	231,340	84,821
1129	Bradley Intl	1.0000	35,692	9,843	25,849	9,478
1141	Ronald Reagan Washington National	1.0000	166,234	45,843	120,391	44,141
1144	Central Wisconsin	3.0156	263,076	72,550	190,526	69,856
1146	Northwest Arkansas Regional	1.8782	38,362	10,579	27,782	10,186
1147	Raleigh - Durham Intl	1.0000	134,976	37,223	97,753	35,841

Source: Airport Deicing Loadings Database. (USEPA, 2010).

9.4 References

ERG. 2008a. Memorandum from Steve Strackbein (ERG) to Brian D'Amico and Eric Strassler (U.S. EPA). *The Development of Snow and Freezing Precipitation (SOFP) Days and the Aircraft Deicing and Anti-icing Fluid (ADAF) Factor*. (January 16). DCN AD00856.

ERG. 2008b. Memorandum from Cortney Itle (ERG) to Brian D'Amico (U.S. EPA). *Airport Deicing Loadings Calculations.* (April 17). DCN AD001140.

ERG. 2010. Memorandum from Steve Strackbein and Mary Willett (ERG) to Brian D'Amico and Eric Strassler (U.S. EPA). *Estimated Costs for Transition to Liquid Airfield Deicing Application from Solid Airfield Deicing*. (October 8). DCN AD01252.

ERG. 2011. Memorandum from Cortney Itle and Mary Willett (ERG) to Brian D'Amico (U.S. EPA). *ADF Collection and Control Efficiency Review.* (June 15). DCN AD01270.

Switzenbaum, et al. 1999. Workshop: Best Practices for Airport Deicing Stormwater. DCN AD00893.

USEPA. 2008. *Airport Deicing Operations ADF Usage Database.* U.S. Environmental Protection Agency. Washington, D.C. DCN AD001141.

USEPA. 2010. *Airport Deicing Loadings Database.* U.S. Environmental Protection Agency. Washington, D.C. DCN AD01257.

10. TECHNOLOGY COSTS

This section presents EPA's estimates of costs for the Airport Deicing Category to implement the control and treatment technologies EPA considered as technology bases for existing airports in the final rule. EPA estimated the compliance costs for each control and treatment technology to determine potential economic impacts on the industry. EPA also weighed these costs against the pollutant load reduction benefits resulting from the control and treatment technologies.

This section discusses the following information:

- Section 10.1 – EPA's costing approach using airport-specific data as model airports;
- Section 10.2 – EPA's methodology for estimating aircraft deicing costs associated with the collection and treatment of ADF-contaminated stormwater, including an overview of EPA's cost model and example calculations showing how the model estimates costs;
- Section 10.3 – EPA's methodology for estimating airfield deicing costs associated with urea substitution;
- Section 10.4 – Other compliance-related costs; and
- Section 10.5 – A summary of EPA's annualized costs evaluated for the final rule.

10.1 Costing Approach

The Agency used a model-site approach to estimate costs for the Airport Deicing Category. A model airport is an operating airport for which EPA estimated site-specific compliance costs. In general, these include sites for which EPA has questionnaire responses. EPA selected an airport-by-airport approach to estimate compliance costs based on a comparison of information from the model airports, as opposed to a more generalized approach, to better characterize the current control and treatment systems in place for ADF contaminated stormwater and to account for current site conditions and airport operations.

For each model airport, EPA developed both capital and operating and maintenance costs to reduce pollutant discharges from aircraft deicing and from airfield deicing. EPA combined these costs for each model airport to estimate total costs of each regulatory option evaluated. EPA then applied a weighting factor to the costs for each airport to estimate national costs for each option. A description of the weighting factors for the Airport Deicing Category is in DCN AD01234.

EPA estimated compliance costs for the model airports using information provided in the airport questionnaire, the detailed airline questionnaire, and from individual airports and vendors. For any given model airport, the estimated costs may deviate from those that the airport would actually incur. However, EPA considers the compliance costs to be accurate when aggregated on an industry-wide basis. These compliance costs are generally broken down into three categories, costs associated with aircraft deicing, costs associated with airfield deicing, and costs with documenting compliance with today's regulation.

10.2 Aircraft Deicing Costs

This section describes the general methodology for estimating costs for ADF collection and treatment, including the Airport Deicing Cost Model design and the development of cost equations that use model-airport-specific inputs. Components of the aircraft deicing costs include collection, containment and storage, and treatment costs. EPA estimated capital and annual operating costs for each of these costing components, which were then amortized to generate model-airport-specific annualized costs.

10.2.1 Overview of the ADF Collection and Treatment Airport Deicing Cost Model

Managing ADF-contaminated stormwater is a multistep process. EPA developed an Airport Deicing Cost Model to estimate deicing stormwater control costs for each of these steps and the various alternatives within each step. Costs for each selected alternative are combined for each airport included in the costing effort to develop cost estimates for the different EPA control and treatment technology options considered for the final rule. For example, regulatory costs at an airport may include a combination of alternatives from the collection, containment and storage, and treatment categories.

The EPA regulatory options were based on requiring an airport to collect and control deicing stormwater through a variety of mechanisms. Based on information provided in the airport questionnaire and data gathered during EPA's engineering site visits to various airports, EPA decided to estimate costs for three collection technologies. Those collection technologies included GCVs alone, a combination of plug and pump system with GCVs, and use of CDPs. Each collection alternative is expected to provide a different level of collection efficiency for ADF-contaminated stormwater. In the final rule, EPA decided to estimate costs for only two of these technologies, GCVs and plug and pump with GCV, in part due to concerns that space-constrained airports may not be able to incorporate CDP because of FAA requirements on their design and siting. EPA estimates that using only GCVs to collect ADF-contaminated stormwater from areas within the airport where aircraft are deiced will collect 20 percent of the available ADF. Adding a plug and pump system in combination with GCVs to the existing stormwater drainage system is expected to collect 40 percent of the available ADF.

Once ADF-contaminated stormwater has been collected, the airport has a variety of alternatives for control, including disposal at a POTW, off-site recycle and recovery, on-site recycle and recovery, or on-site treatment and disposal. Each of these alternatives should be considered by an airport when selecting the appropriate method to manage collected ADF. For the airport deicing rulemaking option analysis, EPA selected the AFB reactor treatment system as the basis of costs because of its demonstrated capability to destroy glycols and generate an effluent suitable for direct discharge. Although AFB treatment systems may be more expensive to install and operate when compared to other treatment alternatives, EPA's basis of all treatment conducted via AFB should provide a conservative cost estimate for individual airports to treat spent ADF. For costing purposes, EPA assumed that all model airports requiring improvement to meet the collection requirements, except for low ADF usage airports, would install an AFB system. For airports that occasionally deice aircraft primarily to remove frost, installing permanent collection and treatment equipment for ADF would not be practical. Instead, EPA assumes these airports would use contractors to provide deicing stormwater collection and removal services.

EPA assumed that all airports that are required to collect additional ADF will need on-site containment or storage for the collected deicing stormwater prior to treatment in an AFB system. The final rule does not require nor is it based on collecting the full volume of wastewater generated in a deicing season. Rather, storage is included as part of the technology basis for flow and/or pollutant equalization to support the AFB treatment system. In these cases, containment and storage selections can include ponds, underground storage tanks, aboveground storage tanks, or temporary storage tanks (e.g., frac tanks). EPA decided to estimate costs for aboveground storage tanks in the final rule because they will have less of an impact on subsurface utilities for which EPA does not have site-specific information. In addition, FAA discourages airports from installing new stormwater retention ponds, as they can be a lure for birds, which are a safety hazard for aircraft. Airports may also require additional stormwater piping to transfer collected ADF-contaminated stormwater from aircraft application areas to storage tanks.

The airport deicing cost model considers each of these alternatives to develop a costing scheme for collecting and containing ADF-contaminated stormwater at each model airport. The Airport Deicing Cost Model also takes into account the effectiveness of each model airport's current control and treatment program for ADF-contaminated stormwater to determine if additional costing is requiredto comply with the regulatory options considered for the final rule.

In general, EPA's approach to develop costs for the model airports consists of the following steps:

- **Step 1:** Develop cost equations for each collection, storage, and treatment alternative evaluated for the final rule;
- **Step 2:** Estimate an airport's current level of ADF-contaminated stormwater collection based on information provided in the airport questionnaire;
- **Step 3:** Apply the collection and treatment cost equations for the various components to those airports that currently collect and manage less than the control and treatment scenario percentage being evaluated to determine airport-specific capital and annual costs for that scenario and each component; and
- **Step 4:** Estimate total airport-specific annualized costs for each component of the airport scenario for each control and treatment scenario.

10.2.2 Airport Deicing Cost Model Equation Development

Based on the available data, EPA developed cost equations for the collection, storage, and treatment technologies that could be applied to those model airports not currently achieving the required collection percentage. In general, the Agency developed cost equations using cost data from the BAT model airports representing their entire system rather than attempting to estimate costs for individual components. EPA believes using system wide costs is a better way to estimate costs for this regulatory effort because all installed capital and annual operating costs are rolled under a single value, eliminating the concern that specific components may not have been included and allowing for more robust estimates. For example, EPA did not prepare costs for individual components within the AFB treatment system such as reaction vessels, piping, pumps, flow meters, and buildings, but instead estimated costs for the entire treatment system.

EPA used the cost data from the model airports and information supplied by equipment vendors along with airport-specific information to develop normalized cost equations that could then be projected to other airports based on common variables. The sections below describe the development of the normalized cost equations for the collection, transfer and storage, and treatment system alternatives evaluated by EPA.

10.2.2.1 ADF Collection

Airports use ADF-contaminated stormwater collection alternatives to achieve the targeted ADF collection percentage. Collection alternatives that EPA selected for costing include developing a winter operations plan to help manage ADF use and maximize recovery of available ADF, using glycol collection vehicles to collect ADF from surfaces following aircraft deicing, and using a plug and pump system to collect ADF. EPA estimates that airports using GCVs can collect 20 percent of the available ADF, and airports using plug and pump in combination with GCVs can collect 40 percent of the available ADF. Airports with deicing pads are expected to collect more than 40 percent of the available ADF and would therefore comply with the control alternatives evaluated for this final rule.

Winter Operations Plan

A large number of airports currently have a Stormwater Pollution Prevention Plan (SWPPP) that includes deicing operations during the winter months. However, these SWPPPs may not provide specific guidance for achieving the regulatory requirements considered for the final deicing rule. Therefore, EPA envisions that airports will supplement their SWPPP with a specific winter operations plan that includes information such as methods to verify the percentage of ADF collection, standard operating procedures for ADF collection technology systems, and training information for system operators. Once airports have assessed specific winter operations to collect and control deicing stormwater, they can implement a control and treatment strategy to decrease the amount of ADF leaving the airport through stormwater outfalls.

Costs to develop a winter operations plan will likely vary depending on the type of ADF collection system. EPA assumed that airports targeting 20 percent collection using GCVs would require 120 hours of engineering labor to prepare the plan and those airports targeting 40 percent ADF collection using a combination of GCVs with plug and pump would requireapproximately 240 hours of engineering labor. Based on an engineering rate of $100/hour obtained from the airport questionnaire, the one-time costs to prepare a winter operations plan for 20 percent and 40 percent ADF capture would be $12,000 and $24,000, respectively.

GCVs

Airports use GCVs to collect ADF-contaminated stormwater from various locations including gate and apron areas, taxi areas, and centralized deicing areas. GCVs can be either truck-mounted systems or tow-behind units. Drain covers that bond to surfaces to quickly seal off drains are often used in conjunction with GCVs in the area where aircraft are deiced to allow the GCVs to collect high-concentration spent deicing fluid.

To estimate total capital costs for purchasing GCVs and annual operating and maintenance (O&M) costs for operating GCVs, EPA used information provided by airports in the airport questionnaire.

All airports that provided costing information, regardless of hub size, maintained three or less GCVs. EPA used the information presented in Table 10-1 to estimate the number of GCVs by airport hub size. The Agency assumes that Non-hub, Small Hub, and Medium Hub airports can operate effectively and efficiently with two GCVs and that Large Hub airports can operate effectively and efficiently with three GCVs. Additional details regarding costs for GCVs is provided in a memorandum entitled *Estimated Capital and O&M Costs for Glycol Collection Vehicle Operation* (ERG, 2010).

Control of drainage while operating GCVs will vary by airport. For purposes of estimating GCV costs, EPA assumed that airports use drain covers in combination with the GCV operation. Variables that could impact drainage control costs include the size of drain covers and number of drains to be covered. Because these variables are airport-specific and details are not available, EPA was unable to develop a specific approach to estimate the cost of drain covers and the labor needed to install them. EPA has instead incorporated a cost increase factor of 20 percent to the annual O&M cost for using GCVs. EPA assumes that a 20 percent increase in O&M costs for GCVs will cover costs to purchase and replace drain covers and labor to install and remove the drain covers as needed.

Table 10-1. GCV Capital and O&M Costs

Site ID	Hub Size	Estimated ADF Usage (gal/yr)	Number of GCVs	Total GCV Capital Costs	Capital Cost Base Year	2007 GCV Capital Cost	Total GCV Annual Cost	Annual Cost Base Year	2007 GCV Annual Cost ($/yr)	Unit Capital Cost ($/GCV)	Annual O&M Cost ($/yr)
1136	Medium	152,944	1	$361,355	2001	$415,558	$15,268	2004	$16,184	$415,558	$16,184
1012	Medium	420,735	1	$273,840	2001	$314,916	$80,000	2005	$82,400	$314,916	$82,400
1113	Large	722,995	1	$250,000	1997	$317,500	$5,000	2005	$5,150	$317,500	$5,150
1066	Large	570,540	1	$353,000	2004	$374,180				$374,180	
1101	Medium	112,086	2	$700,000	1996	$910,000	$43,236	2004	$45,831	$455,000	$45,831
1021	Medium	284,654	2	$530,000	2001	$609,500			$0	$304,750	
1036	Large	323,623	1	$283,463	2006	$283,463	$214,516	2004	$227,387	$283,463	$227,387
1065	Small	125,775	1	$325,000	2005	$334,750	$45,000	2005	$46,350	$334,750	$46,350
1031	Small	59,337	2	$518,300	2001	$596,045	$35,000	2005	$36,050	$298,023	$36,050
AVERAGE										**$344,238**	$59,773

Plug and pump with GCVs

Two airports provided sufficient information to estimate costs for a plug and pump type collection system. During the 2005 deicing season, the first airport used sewer balloons at eight locations, storm sewer shutoff valves at four locations, and two catch basin inserts. In addition, this airport utilized two GCVs for ancillary glycol collection; one is a traditional truck-based GCV and the other is a GCV unit (a V-Quip Ramp Ranger) that is towed behind a tractor. The estimated capital cost for this airport's plug and pump system (including the GCVs) is approximately $790,000. The plug-and-pump system operated at this airport prevents ADF-contaminated stormwater from discharging through three deicing stormwater outfalls (USEPA, 2006a).

The second airport operates 16 plug and pump locations that prevent ADF-contaminated stormwater from leaving the airport through a maximum of five outfalls. These plug and pump operations include plugging the associated drainage pipes and pumping out these drains with dedicated pumping trucks. According to the airport, the annual budget to operate the plug and pump system is approximately $1,300,000. This cost includes permit monitoring, glycol management, the pumping contractor, plus other miscellaneous costs (ERG personnel communication, May 3, 2007). Because the glycol collection system at this airport is contracted to a third party, all costs to the airport are reoccurring annual costs. Therefore, these O&M costs are likely over estimates compared to airports that do not contract out their glycol collection system operation.

To estimate both capital and annual O&M costs for other airports where plug and pump collection may be applicable, EPA normalized the costs based on the number of deicing outfalls. EPA assumed that the number of deicing outfalls is related to the number of areas where aircraft deicing occurs, so that in general an airport that has a greater number of discontiguous deicing areas will have a greater number of deicing outfalls. EPA estimated that more deicing areas would indicate the need for additional costs associated with removing ADF from those areas. Table 10-2 presents the normalized capital and annual O&M costs for the plug and pump collection system at the airports for which EPA had costing data.

Table 10-2. Normalized Capital and O&M Costs for the Plug and Pump Collection System

Airport	Deicing Outfalls	Total Capital Cost (2006 $)[1]	Annual O&M Cost (2006 $)	Normalized Capital Cost ($/outfall)	Normalized Annual O&M Cost ($/outfall)
Airport 1	3	$790,000	NA	$263,400	NA
Airport 2	5	NA	$1,300,000	NA	$260,000

NA – Data not available.

Contract Hauling of ADF-Contaminated Stormwater

For airports that occasionally deice aircraft primarily to remove frost, installing permanent collection and treatment equipment for ADF-contaminated stormwater would not be practical. Instead, EPA assumes these airports would contract out deicing stormwater collection and removal and their costs would not vary between the 20 percent and 40 percent collection/ control scenarios. This costing approach impacts the following airports:

- Ontario International airport in California;
- Birmingham International Airport in Alabama;
- Montgomery Regional airport in Alabama;
- Sacramento Mather airport in California;
- Lovell Field airport in Tennessee; and
- Lafayette Regional airport in Louisiana.

These airports reported that they do some deicing, but all reported or are estimated to use 5,000 gallons/year or less normalized ADF, had less than 100 percent capture of ADF-contaminated stormwater, indicated that they discharged ADF-contaminated stormwater to surface waters, but reported no typical deicing months. Specific details regarding the costs for occasional removal of ADF-contaminated stormwater by a local contractor is included in a memorandum entitled *Estimated Annual Costs for Airports with Limited ADF Use* (ERG, 2008).

10.2.2.2 AFB Treatment System

EPA based the proposed COD discharge limitation on AFB treatment. As such, when applicable, EPA determined costs for in-scope facilities to treat collected ADF through an AFB system. EPA also included costs for associated storage and transfer piping.

Transfer Piping

Piping costs to transfer collected stormwater to holding tanks prior to either on-site or off-site ADF management will vary for each airport. Variables that could impact transfer piping costs include existing subsurface utilities, soil types, elevation changes, and anticipated peak precipitation events. Because each of these variables is airport-specific and the details are not available, EPA estimated costs for each airport to construct 10,000 linear feet of new subsurface stormwater conveyance piping from various areas around the airport. EPA modified this estimate from the proposal’s 1,000 linear feet after considering public comment.

Elements of a stormwater piping system include subsurface concrete piping, manholes and catch basins throughout the system to control the direction of flow. EPA obtained costs for individual elements within the system from RSMeans (RS Means, 2010) and adjusted the costs to 2006 dollars. The Agency added cost factors for plumbing and site work to the direct costs to obtain total installed direct costs. Indirect costs for engineering, permits, scheduling, performance bonds, and contractor markups were added to the total installed direct costs. Table 10-3 shows the estimated installed capital cost for 10,000 linear feet of a new stormwater conveyance piping system at an airport is approximately $1,140,000. Details regarding capital costs plus indirect cost factors are provided in a memorandum entitled *Estimated Capital and O&M Costs for Additional Stormwater Piping* (ERG, 2010c).

Table 10-3. Estimated Cost for 10,000 Linear Feet of Stormwater Piping

Description	Total Cost
Trenching for stormwater piping	$59,000
Backfill and compact trench after piping	$38,000
Concrete stormwater piping (18-inch diameter)	$310,200
Manholes/catch basins	$137,400
Manhole frames and covers	28,800
Plumbing (connectors, extra labor, etc.)	$187,500
Site work (clearing, grading, surveying)	$80,300
Engineering	$67,300
Permits	$16,800
Scheduling	$6,700
Performance bonds	$21,000
Insurance (risk, equipment floater, public liability)	$19,300
Contractor markup (handling, procuring, subcontracting, change orders, etc.)	$84,000
Overhead and profit	$84,000
Total Installed Capital Cost for 10,000' of Stormwater Piping	**$1,140,000**

Source: RS Means Heavy Construction Cost Data, 64th Edition, 2010.

Annual O&M costs for the piping and conveyance system include periodic inspections to verify integrity of the piping system. To estimate labor costs for TV inspection of the 18" sewer, EPA made a conservative assumption that an airport would inspect 20 percent of the storm sewer system annually (2,000 linear feet), at a rate of $1,400 per day (2006 basis). Based on engineering experience, a sewer TV crew of two to three persons can inspect approximately 500 feet of piping per day. At a rate of $1,400/day, the annual airport inspection cost would be approximately $5,600.

Storage Tanks for ADF-Contaminated Stormwater

The AFB system that forms the basis for today's COD limitation include storage to provide both flow and concentration equalization. Storage tanks are used at airports to equalize either flow and/or concentration of ADF-contaminated stormwater prior to treatment in the AFB system. The actual size of the storage tank depends primarily on the amount of ADF-impacted stormwater generated during precipitation events, the area from which deicing stormwater is collected, and the rate the stormwater can be discharged to the AFB. For costing purposes, EPA selected aboveground rather than underground storage tanks due to constraints such as existing underground utilities or high ground water levels at individual airports.

EPA obtained storage tank volumes and capital costs when available from five airports in the airport questionnaire (USEPA, 2006b). Using normalized ADF usage data for each of these airports, EPA normalized tank volumes and costs to the annual ADF use per year to provide an equation that could be used to estimate storage tank sizes and costs at other airports. EPA's normalized ADF usage amounts represent ADF amounts without any water dilution. EPA chose ADF usage as the costing basis for tank storage because the amount of tank storage needed is directly related to the amount of ADF applied for aircraft deicing, which is a function of the frequency, duration, and intensity of precipitation events at a particular airport during a deicing season. In addition, the storage tanks at each of these airports are used to contain ADF-contaminated stormwater prior to treatment, and therefore the hydraulic capacity has likely been designed with equalization requirements (e.g., maximum flow and equalized pollutant concentrations) in mind.

The data in Table 10-4 indicate the volume of storage tanks at the five airports ranges between 1.5 million gallons and 8 million gallons, with the average being approximately 4.6 million gallons. The average unit cost for storage tanks calculated from the data in Table 10-4 is $1.67/gallon. The normalized storage tank volume, calculated from the data provided in Table 10-4, is 11.4 gal/gal ADF use/yr. The basis of the 11.4 gal/gal ADF use/yr factor includes storage of ADF-contaminated stormwaters from a variety of collection technologies (including GCVs, diversion systems, and deicing pads) that were identified as having glycol concentrations greater than 1 percent or in one case greater than 1,000 mg/l BOD. EPA believes that this factor will provide sufficient storage volume for those airports required to meet either a 20 or 40 percent available ADF collection requirement because the airports forming the basis of the factor have an ADF collection percentage greater than the considered requirement.

Table 10-4. Storage Tank Volumes and Installed Capital Cost for Various Airports

Airport	ADF Use (gal/yr)	Total Storage Tank Volume (gal)	Storage Tank Volume per ADF Use (gal/gal/yr)	Installed Capital Cost (2006 $)	Storage Tank Capital Cost ($/gal)
1	1,043,138	6,520,000	0.4	$795,000 [1]	$1.89
2	943,982	5,140,000	2.6	NA	NA
3	715,836	8,000,000	11.2	$9,440,000	$1.18
4	112,086	2,000,000	17.8	NA	NA
5	60,246	1,500,000	24.9	$2,890,000	$1.93
AVERAGE			**11.4**		**$1.67**

NA – Not available.
[1] Cost provided for one 420,000-gallon storage tank.

To determine if the unit cost for aboveground storage tanks was reasonable, EPA compared the $1.67/gallon unit cost to the cost for permanent storage tanks reported in the ACRP Fact Sheets (ARCP Fact Sheets). According to Fact Sheet 30, aboveground permanent storage tank costs range from $1.25 to $1.75/gallon for tanks ranging in size from 500,000 gallons to 1 million gallons. Unit costs for storage tanks between 1 million and 2 million gallons range from $1.00 to $1.50/gallon. Based on the data in the fact sheets, EPA believes the $1.67/gallon unit cost factor should provide a conservative estimate of tank costs.

The airport questionnaire responses provided limited data to determine the annual O&M cost for storage tanks. One airport reported annual O&M costs for its storage tanks ranged between $50,000 and $100,000. Using ADF usage information for this airport (281,836 gal/yr) and the reported annual O&M cost for the airport ($75,000/yr), EPA calculated the normalized annual O&M cost for storage tanks to be $0.27 per gallon of ADF used per year ($75,000/281,836).

AFB Treatment Systems

In the proposed rule, EPA used a linear relationship between ADF use and ADF percent collection to predict AFB costs. Public comments raised the issue that such a relationship does not consider minimum capital costs for small systems or the economy of scale for larger systems. All AFB treatment systems, regardless of size, will require basic components such as chemical dosing systems, gas handling systems, sludge handling systems, storage tanks, in-line monitoring equipment, and process control systems. For many of these components, cost is independent of treatment system size.

To assist EPA with developing costs for AFB treatment, industry developed a cost curve that shows a general relationship between cost and COD load for systems designed to treat between 500 and 7,000 lbs/day of COD. As shown in Figure 10-1, the cost per pound of COD removal decreases rapidly for larger load removal systems because of the economy of scale with the reactor and separator system, and the cost for support buildings and facilities is relatively constant and not tied to COD loading.

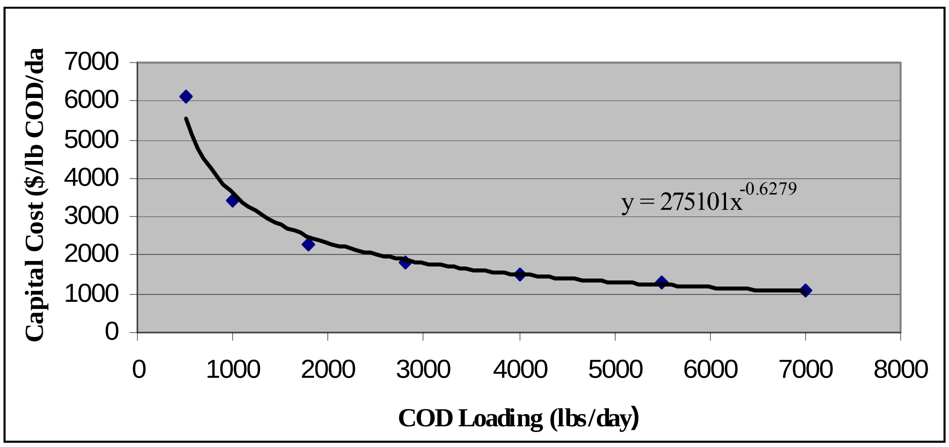


Figure 10-1. AFB Reactor Capital Cost for Treating ADF-Contaminated Stormwater

Using the equation in Figure 10-1 developed from industry comments (See Airport Council International – North America comments on EPA's Proposed Rule for Effluent Guidelines for the Airport Deicing Category), EPA can estimate the installed capital cost for an AFB reactor (excluding storage, transfer piping, and possible land costs) if the COD loading is known. To test the accuracy of this equation, EPA compared calculated costs to those provided by Albany International Airport (Albany) for their AFB treatment units. According to Albany airport staff, the installed cost for their AFB treatment system is approximately $8.1 million dollars (2006 $). This cost does not include equalization tanks or ponds prior to the AFB, additional stormwater piping to transfer ADF-contaminated stormwater from areas of generation to storage, or purchase of additional land to accommodate the AFB treatment reactors or storage. Based on Albany's design COD loading of 5,200 lbs/day, the equation in Figure 10-1 would predict an AFB installed cost of $6.6 million dollars (2006 $). Because the estimated cost for the Albany AFBs, using industry's equation, is within $\pm$ 20 percent of the actual cost provided by Albany, EPA concludes the equation shown in Figure 10-1 can be used to predict AFB costs for all airports.

Both the Albany and Akron-Canton (Akron) airports provided annual O&M costs for their treatment reactors. According to Albany, its annual O&M cost is approximately $510,000/year. Akron has recently constructed its AFB and did not have actual operating data at the time of EPA's costing analysis but did provide estimated annual O&M costs of $195,000/year (McQueen, R. and Arendt, T.). Because annual operating costs for an AFB system are directly related to the annual amount of ADF use and the collection percentage, EPA normalized annual AFB reactor annual operating costs to these two factors. Table 10-5 shows the AFB reactor annual O&M costs normalized to annual ADF usage for Albany and Akron.

Table 10-5. Normalized Annual O&M Costs for the AFB Reactors

	Annual ADF Use (gal/yr)	Estimated Percent Capture [1]	Annual ADF Captured	Annual O&M Cost (2006 $/yr) [1]	Normalized Annual O&M Cost ($/gal ADF recovered)
Albany	125,775	92	115,713	$510,000	$4.40
Akron	60,264	60	36,200	$195,000	$5.39
AVERAGE					**$4.90**

[1] Airport deicing loadings database.

Land Costs

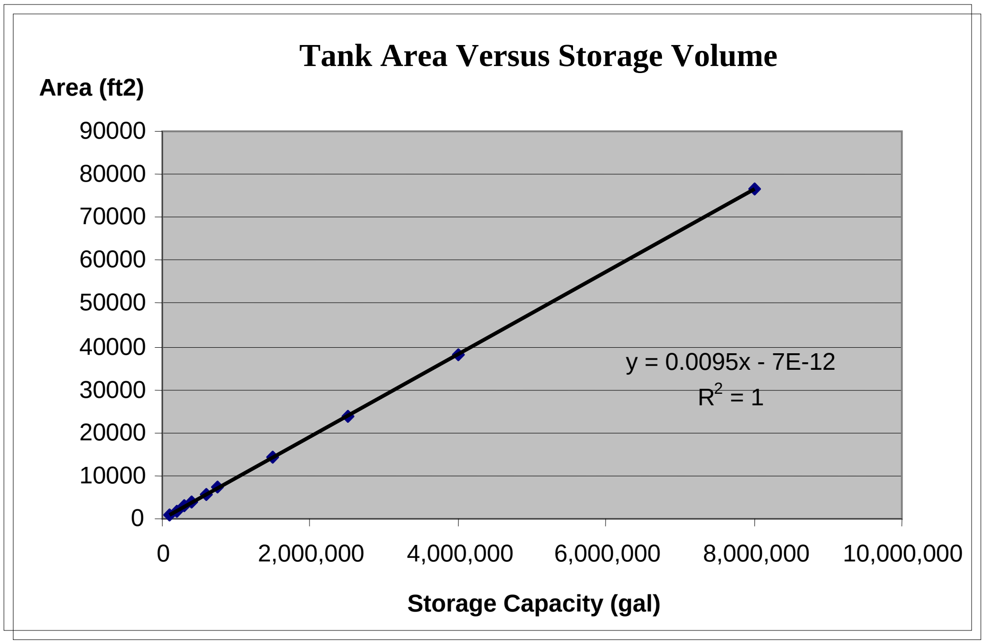
EPA has included the opportunity cost of land use for both storage and treatment of ADF-contaminated stormwater. EPA's approach to estimating this cost is to first estimate the amount of land needed for storage tanks and the AFB treatment system and then apply an opportunity cost per square foot. The opportunity cost assumes the land could potentially be leased for some other use by an airport tenant if not being used for the treatment and storage system.

To estimate the area of land associated with the AFB treatment system, EPA obtained information on the footprint of the AFB systems at Albany using Google Earth (Google Earth, 2007). Based on a review of the Google Earth images, EPA estimates the footprint for the AFB treatment system is approximately 2.4 acres or 104,544 sq.ft. This area would include the reactors, associated buildings, pump houses, roadways and parking areas, etc.

To predict the amount of land needed for storage tanks, EPA used the following equation developed for predicting storage tank costs:

$$\text{Volume of Required Storage Capacity (gal)} = \text{ADF Use gal/yr} \times 13.1 \text{ gal/gal/yr}$$

Combining this equation with the one developed from the figure below allows EPA to estimate the minimum footprint for storage tanks at individual airports based on ADF use. The equation shown in the figure below is based on storage tanks with a 14-foot sidewall depth.



Because storage tanks require a barrier-free area of approximately 20 feet around the entire tank for maintenance as well as access roads to the tanks, EPA decided to increase the minimum tank footprint by 20 percent.

EPA believes that siting of AFB and deicing stormwater storage systems will require that they be placed away from the terminal and main runway area. To estimate the value of this land if leased by an airport, EPA obtained leasing information from a number of airports. Based on the leasing cost data obtained from these airports, EPA selected an estimated $1.00/sq.ft. cost for purposes of the costing model. Additional information on land costs is included in a memorandum entitled *Estimated Land Requirements and Opportunity Costs for the Anaerobic Fluid Bed Treatment System and ADF Stormwater Storage Tanks* (ERG, 2010d).

10.2.3 Development of Airport Deicing Cost Model Inputs

The key inputs to EPA's Airport Deicing Cost Model include airport operations data and site-specific precipitation and physical feature data for the model airports.

10.2.3.1 Airport Operations Data

The primary source of airport operations data used in the calculation of collection and treatment costs were responses to the Agency's 2006 airport questionnaire (U.S. EPA, 2006b). EPA entered data from all questionnaire responses into an electronic database that it used to determine if any ADF-contaminated stormwater collection and treatment technologies were currently utilized and to access reported operations data needed to estimate costs for additional collection and treatment. EPA used the following specific data from the questionnaire responses: geographical location, aircraft deicing chemical usage, manner/frequency of deicing discharges, deicing, and ADF collection operations.

EPA required the following additional airport operating data not requested in the airport questionnaire to estimate costs: annual ADF use and the number of annual nonpropeller aircraft departures. EPA collected data on annual ADF usage in its airline detailed questionnaire (U.S. EPA 2006). EPA evaluated annual nonpropeller aircraft departures using data from the Bureau of Transportation Statistics (BTS).

10.2.3.2 Precipitation Data and Site Characteristics

Estimating costs to collect and treat ADF-contaminated stormwater partially depends upon the volume of the stormwater. To predict the annual volume of ADF-impacted stormwater generated at an airport, EPA used precipitation data along with airport site characteristics and assumed ADF-impacted stormwater would be collected from areas where ADF is applied and possibly from areas where ADF may drip from the aircraft during taxi and takeoff. EPA obtained precipitation data from 1976 to 2006 (30 years) from NOAA for each airport questionnaire respondent and then averaged the data by airport to estimate an airport-specific monthly average. EPA uses these data, combined with the number of deicing months taken from the questionnaire responses, to estimate the average annual amount of precipitation that may be contaminated by ADF.

10.2.4 Airport Deicing Cost Model Design

This section describes how the Airport Deicing Cost Model uses the capital and annual cost equations, in combination with the model input data, to predict costs for each model airport.

10.2.4.1 Airport Deicing Cost Model Description

EPA developed the Airport Deicing Cost Model using Microsoft® Access. The model uses various tables structured from the airport questionnaire responses to provide input to the design equations. EPA designed the model to use a series of "Yes – No" statements and its assessment of the current collection efficiency achieved by an airport to build costs, as appropriate, based on the appropriate types of collection alternatives needed to achieve the target collection efficiency.

The Airport Deicing Cost Model provides output costs in Microsoft® Excel for each selected collection alternative, and the treatment system (piping, storage tanks, and AFB treatment system). The outputs include both installed capital cost and annual O&M costs. Airport Deicing Cost Model outputs for each airport that is currently not achieving the analyzed percent control and treatment of ADF-contaminated stormwater are then used to calculate annualized costs by airport. Section 10.2.5 provides more detail regarding cost annualization. The Airport Deicing Cost Model collection and control cost output is $0 for those airports which EPA estimates are achieving the analyzed option for collection and control of available ADF. EPA's assessment of each airport's current collection and control percentage is provided in the memorandum entitled *ADF Capture and Control Efficiency Review* (ERG, 2011).

10.2.4.2 Summary of Airport Deicing Cost Model Equations

The Airport Deicing Cost Model uses capital and annual cost equations in combination with various input parameters to estimate costs for each option's collection and treatment technology at each airport. Table 10-6 summarizes the cost equations used by the model, the input variables, and any assumptions used by the model to estimate costs. The equations in Table

10-6 are based on an airport collecting ADF-contaminated stormwater with glycol concentrations greater than 0.5 percent.

10.2.4.1 Example Cost Calculation

The following example shows how the Airport Deicing Cost Model uses the equations in Section 10.2.2 along with an airport's questionnaire response to estimate costs. The example below is designed to more clearly illustrate the Airport Deicing Cost Model.

Example Airport Capital and Annual Costs

Airport A has six deicing outfalls and currently has no collection or control equipment in place for ADF-contaminated stormwater. The estimate of airport normalized ADF usage is approximately 490,000 gallons per year of Type 1 and Type IV ADF. The airport has 23 deicing days per year spanning a five-month period (150 days). The airport does not discharge to a POTW or contract haul ADF to an off-site recovery/recycle facility. Based on the final rule, the airport will collect 40 percent of the available ADF using a plug and pump system with GCVs. Collected ADF contaminated stormwater will be treated by an AFB treatment system.

<u>Winter Operations Plan Development</u>

Engineering Labor: 240 hours × \$100/hr = \$24,000

<u>Plug and pump Collection System</u>

Plug and Pump Capital Cost: = 6 × \$263,400 = \$1,580,400

Plug and Pump Annual O&M Cost (\$/yr) = 6 × \$260,000 = \$1,560,000/yr

Table 10-6. Airport Deicing Cost Model Equations, Input Variables, and Assumptions

Calculation Description	Equation	Input Variables	Assumptions
Estimates costs for airports to prepare a one-time winter operations plan as a supplement to the current SWPPP.	Winter Operations Plan ($) 20% ADF collection: 120 hours × $100/hr 40% ADF collection: 240 hours × $100/hr	Target ADF collection percentage	Labor costs assume airport will contract with an outside consultant to prepare the winter operations plan.
Estimates costs to purchase and operate GCVs to collect 20% of available ADF. Includes a 20% factor on the O&M costs for drainage control.	GCV Capital Cost ($) = $344,238 × number of GCVs GCV Annual Cost($/yr) = $59,773 × number of GCVs × 1.2	Airport hub status	Small, medium and Non-hub airports require 2 GCVs. Large Hub airports require 3 GCVs
Estimates costs to install and operate a block-and pump collection system with GCVs to collect 40% of available ADF.	Plug and Pump Capital Cost ($) = $263,400 × outfall number Plug and Pump Annual Cost ($/yr) = $260,000 × outfall number	Number of stormwater deicing outfalls from the airport questionnaire	The number of deicing outfalls relates to the number and size of deicing areas requiring controls.
Estimates costs to install and operate an AFB bioreactor treatment system.	AFB COD Load (lbs/day) = ADF Use × 14.28 × Collect % / 100 × 1/operating days AFB Unit Capital Cost ($/lb/day): 275,101 × (COD Load)$^{-0.6279}$ AFB Capital Cost ($): AFB Unit Capital Cost × COD Load AFB Annual Cost ($/yr) = ADF Use × Collect % / 100 × $4.90	ADF use from airline detailed questionnaire Treatment system operating period based on deicing months from airline detailed questionnaire Collection % from selected collection technology	Ultimate COD is 14.28 lbs COD/gal Type I ADF.
Estimated costs to install storage tanks to equalize collected ADF - contaminated stormwater.	Storage Tank Capital Cost ($) = ADF Use × 11.4 × $1.67 Storage Tank Annual Cost ($/yr) = ADF Use × $0.27	ADF use from airline detailed questionnaire	Storage tank volume requirement is 11.4 gal per gal of ADF used per year.

Table 10-6 (Continued)

Calculation Description	Equation	Input Variables	Assumptions
Estimated costs to install an additional 10,000 linear feet of stormwater piping to convey ADF-contaminated water from collection to treatment.	Piping Capital Cost ($) = $1,140,000 Piping Annual Cost ($/yr) = $5,600	None	Based on 10,000 linear feet of 18" diameter subsurface piping.
Estimated cost for land to install storage tanks and an AFB treatment system.	AFB Treatment System Annual Land Cost ($/yr) = $104,544	None	AFB treatment system can be installed on 2.4 acres and the lease cost for land is $1/ft^{2}.
	Storage Tank Annual Land Cost ($/yr) = 1.2 × (ADF Use gal/yr × 13.1 gal/gal/yr × 0.0095 ft^2/gal) × $1/ft^2	ADF use from airline detailed questionnaire	Lease cost for land is $1/ft^{2}.

AFB Biological Treatment System

AFB COD Loading = 490,000 gal/yr × 14.38 lbs COD/gal ADF × 0.4 × 1/150 days/yr = 18,789 lbs/day

AFB Unit Capital Cost ($/lb/day): 275,101 × $(18{,}789)^{-0.6279}$ = $570/lb COD/day

AFB Capital Cost ($): 18,789 lbs/day COD × $570/lb COD/day = $10,711,000

AFB Annual O&M Cost ($/yr): 490,000 × 0.4 × $4.90 = $960,000/yr

Piping System

Piping system capital cost: $1,140,000
Piping system annual O&M cost: $5,600/yr

Storage Tank(s)

Storage Tank Capital Cost ($) = 490,000 × 11.4 × $1.67 = $9,329,000
Storage Tank Annual O&M Cost ($/yr) = 490,000 × $0.27 = $132,300

Land

AFB Cost ($/yr) = $104,544
Storage Tanks ($/yr) = $1.2 × 490,000 gal/yr × 13.1 gal/gal/yr × 0.0095 ft^2/gal × $1/$ft^2$ = $60,980

The total capital and O&M costs are therefore:

Cost Category	Capital Costs ($)	O&M Costs ($/year)
Winter Operations Plan	24,000	
Plug and Pump Collection System	1,580,400	1,560,000
AFB Treatment System	10,711,000	960,000
Piping	1,140,000	5,600
Storage	9,329,000	132,300
Land Opportunity Costs – For AFB Treatment System	–	104,544
Land Opportunity Costs – For Storage	–	60,980
Total	**22,784,400**	**2,823,424**

The capital costs are then amortized and added to the annual O&M costs to assess an overall annualized cost for the facility.

10.2.5 Annualized Costs for ADF Collection and Treatment Alternatives

Table 10-7 presents the annualized costs by airport developed for the two control and treatment scenarios evaluated by EPA for the final rule. See the Economic Development document (USEPA, 2012; DCN AD01280) for a more detailed analysis of annualized costs.

Table 10-7. Annualized Costs by Model Facility for Control and Treatment [1]

Airport ID	Airport	Current ADF Collection	Annualized Cost for 20% Control and Treatment Scenario (2006 $)	Annualized Cost for 40% Control and Treatment Scenario (2006 $)
1001[2]	Montgomery Regional (Dannelly Field)	0	$1,168	$1,168
1003[3]	Ketchikan International	NA	$0	$0
1004	Norfolk International	20	$0	$2,235,548
1006	Chicago O'Hare International	40	$0	$0
1007	Yeager	40	$0	$0
1008	Tucson International	20	$0	$1,069,305
1010	Fairbanks International	≥60	$0	$0
1011	Lambert-St Louis International	≥60	$0	$0
1012	Ted Stevens Anchorage International	40	$0	$0
1014	Albuquerque International Sunport	20	$0	$6,269,926
1015	Gulfport-Biloxi International	≥60	$0	$0
1017	Austin Straubel International	40	$0	$0
1018	Piedmont Triad International	0	$1,090,753	$8,121,534
1019[2]	Ontario International	0	$1,110	$1,110
1020	Hartsfield - Jackson Atlanta International	≥60	$0	$0
1021	Buffalo Niagara International	40	$0	$0
1022	Fort Wayne International	0	$991,516	$3,272,310
1023*	Seattle-Tacoma International	0	$1,560,687	$3,863,913
1024	Indianapolis International	40	$0	$0
1026	Dallas/Fort Worth International	≥60	$0	$0
1028	Denver International	≥60	$0	$0
1029	La Guardia	0	$2,976,443	$6,286,465
1031	Richmond International	40	$0	$0
1032	Austin-Bergstrom International	40	$0	$0
1033	Mc Carran International	40	$4,216	$4,216
1034	Metropolitan Oakland International	≥60	$0	$0
1035	San Diego International	≥60	$0	$0
1036	Baltimore-Washington International	≥60	$0	$0
1037	George Bush Intercontinental Airport/Houston	40	$4,099	$4,099
1040	Louis Armstrong New Orleans International	≥60	$0	$0
1041	Glacier Park International	0	$1,037,252	$1,266,155
1043	Ralph Wien Memorial	0	$605,365	$707,178
1044	Roanoke Regional/Woodrum Field	0	$943,332	$4,095,087
1045[2]	Norman Y. Mineta San Jose International	10	$0	$0

Table 10-7 (Continued)

Airport ID	Airport	Current ADF Collection	Annualized Cost for 20% Control and Treatment Scenario (2006 $)	Annualized Cost for 40% Control and Treatment Scenario (2006 $)
1046	Long Island Mac Arthur	≥60	$0	$0
1050	Aspen-Pitkin Co/Sardy Field	40	$0	$0
1052	Wilmington International	0	$654,946	$3,131,737
1053	General Edward Lawrence Logan International	0	$4,860,377	$6,659,582
1054	Jackson Hole	≥60	$0	$0
1057	Will Rogers World	0	$986,385	$2,675,571
1058	Gerald R. Ford International	40	$0	$0
1059	Greater Rochester International	50	$0	$0
1061	William P Hobby	≥60	$0	$0
1062[2]	Birmingham International	0	$2,675	$2,675
1063	Evansville Regional	0	$846,931	$1,609,927
1065	Albany International	≥60	$0	$0
1066	Salt Lake City International	≥60	$0	$0
1067	Helena Regional	≥60	$0	$0
1068	Eppley Airfield	0	$1,250,502	$2,132,279
1069	Cleveland-Hopkins International	40	$0	$0
1070	City of Colorado Springs Municipal	40	$0	$0
1074	South Bend Regional	≥60	$0	$0
1075	Pensacola Regional	≥60	$0	$0
1078	Nashville International	≥60	$0	$0
1079	Manchester	0	$1,600,420	$1,995,084
1080	Syracuse Hancock International	≥60	$0	$0
1081	Bob Hope	≥60	$0	$0
1083	Tampa International	≥60	$0	$0
1084	Bismarck Municipal	0	$770,509	$1,215,970
1086	Palm Beach International	≥60	$0	$0
1087	El Paso International	≥60	$0	$0
1088	Outagamie County Regional	0	$1,011,102	$2,412,516
1089	John F Kennedy International	0	$3,215,317	$10,136,241
1090	Boise Air Terminal/Gowen Fld	≥60	$0	$0
1091	Rochester International	40	$0	$0
1094	Boeing Field/King County International	40	$0	$0
1095	Chicago Midway International	≥60	$0	$0
1097[2]	Lovell Field	0	$3,745	$3,745
1099[2]	Sacramento International	20	$0	$0
1100	Toledo Express	20	$0	$1,767,861
1101	Portland International	20	$0	$2,792,934

Table 10-7 (Continued)

Airport ID	Airport	Current ADF Collection	Annualized Cost for 20% Control and Treatment Scenario (2006 $)	Annualized Cost for 40% Control and Treatment Scenario (2006 $)
1102	John Wayne Airport-Orange County	≥60	$0	$0
1103	Juneau International	0	$957,795	$2,343,519
1104	Nome	0	$618,441	$1,904,296
1105	Spokane International	≥60	$0	$0
1107	Pittsburgh International	≥60	$0	$0
1108	Louisville International-Standiford Field	≥60	$0	$0
1111	Port Columbus International	0	$2,029,946	$4,321,331
1113	Cincinnati/Northern Kentucky International	≥60	$0	$0
1114	Stewart International	40	$0	$0
1115	Jacksonville International	≥60	$0	$0
1116	Reno/Tahoe International	20	$0	$1,614,875
1117	Cherry Capital	≥60	$0	$0
1118	Bethel	0	$643,331	$1,936,511
1119	Rickenbacker International	0	$710,969	$1,433,955
1120	Rapid City Regional	0	$838,073	$4,548,952
1121	Theodore Francis Green State	≥60	$0	$0
1122	Southwest Florida International	≥60	$0	$0
1123	James M Cox Dayton International	≥60	$0	$0
1124	Des Moines International	40	$0	$0
1126	Minneapolis/St Paul International/Wold-Chamberlain	≥60	$0	$0
1128	Charlotte/Douglas International	0	$1,574,890	$2,111,996
1129	Bradley International	≥60	$0	$0
1130	San Antonio International	0	$780,240	$5,064,195
1131	Wilkes-Barre/Scranton International	0	$971,556	$1,476,180
1133[2]	Phoenix Sky Harbor International	20	$0	$0
1135[2]	Lafayette Regional	0	$1,536	$1,536
1136	General Mitchell International	44	$0	$0
1137	Dallas Love Field	40	$0	$0
1138	Detroit Metropolitan Wayne County	≥60	$0	$0
1139	Philadelphia International	≥60	$0	$0
1140	Memphis International	0	$1,740,377	$3,651,474
1141	Ronald Reagan Washington National	40	$0	$0
1142	Washington Dulles International	40	$0	$0
1143	San Francisco International	≥60	$0	$0

Table 10-7 (Continued)

Airport ID	Airport	Current ADF Collection	Annualized Cost for 20% Control and Treatment Scenario (2006 $)	Annualized Cost for 40% Control and Treatment Scenario (2006 $)
1144	Central Wisconsin	0	$952,550	$1,451,583
1145	Newark Liberty Intl	0	$5,366,144	$9,674,611
1146	Northwest Arkansas Regional	0	$873,730	$1,644,615
1147	Raleigh-Durham Intl	0	$1,294,323	$4,254,332
1148	Kansas City Intl	40	$0	$0

[1] Treatment includes installation and operation of an AFB biological treatment system.
[2] Airport is in a warm climate and uses either no ADF or less than 5,000 gal/yr.; EPA assumes the airport will contract out all ADF removal and disposal operations.
[3] Airport was sent an airport questionnaire but did not respond.
*The airport post-questionnaire has installed deicing pads. High BOD stormwater is sent to a POTW.

10.3 Airfield Deicing Costs

This section describes EPA's cost evaluation for model airports to discontinue using urea as an airfield deicing chemical. Information collected by EPA during the rulemaking effort indicated that use of urea as an airfield deicing chemical is being phased out due to concerns with its environmental impacts and the availability of less harmful alternatives. Responses to EPA's airport questionnaire indicated that potassium acetate was by far the predominant airfield deicing chemical in use from 2002 to 2005, representing about 80 percent of all airfield deicing chemical use; therefore, EPA assumed that airports would switch to this chemical to deice their pavement. However, approximately 35 of the surveyed airports continued to use urea for airfield deicing during the 2002/2003, 2003/2004, and 2004/2005 deicing seasons. EPA did not estimate capital or operating costs associated with airfield deicing control for model airports that did not report urea usage.

10.3.1 Urea and Potassium Acetate Chemical Costs and Application Rates

EPA evaluated the chemical cost of using urea compared to the chemical cost to use potassium acetate in evaluating costs for controlling discharges associated with pavement deicing. This section presents information on the chemical, mechanical, and storage costs to replace urea with potassium acetate. Additional details on urea and potassium acetate use is included in a memorandum entitled *Estimated Costs for Transition to Liquid Airfield Deicing Application from Solid Airfield Deicing* (ERG, 2010a).

Based on responses to the airport questionnaire (USEPA. 2006b), 19 of the airports that used urea also used potassium acetate. EPA attempted to contact these airports to obtain their unit costs for both chemicals and were able to get unit cost data from eight of these airports. Table 10-8 presents the average cost for urea and potassium acetate during the 2002-2005 time frame for these eight airports.

Table 10-8. Average Cost for Urea and Potassium Acetate, 2002-2005

Year	Average Urea Cost	Average Liquid Potassium Acetate Cost
2002	$268.17/ton	$2.81/gallon
2003	$280.57/ton	$2.86/gallon
2004	$297.90/ton	$2.86/gallon
2005	$300.21/ton	$2.92/gallon

Potassium acetate is applied at different rates depending on the weather conditions and the thickness of the ice layer at the time of application. Table 10-9 shows the typical deicing, anti-icing, and prewetting application rates for four commercial potassium acetate runway deicers.

Table 10-9. Typical Application Rates for Potassium Acetate

Brand Name	Deicing Application Rates	Anti-Icing Application Rates	Prewetting Application Rates
Safeway® KA Runway Deicing Fluid	1 gal/1000 ft^2	0.4gal/1000ft^2	70% solid and 30% liquid
Cryotech E-36® LRD	1 gal/1000 ft^2 (thin ice) and 3 gal/1000 ft^2 (2.5cm thick ice)	0.5 gal/1000ft^2	85-95% solid and 5-15% liquid, or 130g/kg of solid deicer, 1.25gal/100lbs. solid deicer
IceClear RDF	1 gal/1000 ft^2 (thin ice) and 3 gal/1000 ft^2 (1in. thick ice)	0.5 gal/1000ft^2	
PEAK® PA	1 gal/1000 ft^2	0.4 gal/1000ft^2	70% solid and 30% liquid

Although it could not obtain actual application rates for urea at individual airports, EPA did obtain airfield application rates for sodium acetate; therefore, the Agency used sodium acetate rates as a surrogate to estimate urea application rates. The amount of sodium acetate required to provide the same protection as urea is between 66 and 70 percent (Transport Canada, 1998). EPA used this relationship to calculate the corresponding urea application rates. Table 10-10 lists typical application rates for Cryotech NAAC®, a commercial sodium acetate deicer and the corresponding urea application rate based on the relationship between sodium acetate and urea.

Table 10-10. Application Rates for Sodium Acetate and Urea

Sodium Acetate, Cryotech NAAC®, Application Rate	Urea Application Rate
Near 32°F on thin ice = 3-5 lbs/1000 ft^2	Near 32°F on thin ice = 4.3-7.1 lbs/1000 ft^2
Less than 10°F on 1 inch ice = 10-25 lbs/1000 ft^2	Less than 10°Fb on 1 inch ice = 14.3-35.7 lbs/1000 ft^2

Using the information in Table 10-10, EPA estimated the application costs for urea and potassium acetate based on the 2005 average unit costs ($/1,000 ft2), as shown in Table 10-11.

Table 10-11. Cost for Application of Urea and Potassium Acetate, per 1000 Square Feet

Chemical	Deicing Application Cost (per 1000 ft^2)	Anti-Icing Application Cost (per 1000 ft^2)
Urea	\$0.65-\$1.07, Near 32°F on thin ice	
Potassium Acetate	\$2.92 (thin ice) and \$8.76 (thick ice)	\$1.17-\$1.46

10.3.2 Mechanical Application Equipment and Storage of Potassium Acetate

Airports that change from urea to potassium acetate for airfield deicing will need new application equipment to apply a liquid rather than a solid as well as liquid storage tanks to contain potassium acetate during the deicing season. The following sections discuss the costs for mechanical application equipment and storage tanks for liquid potassium acetate.

10.3.2.1 Mechanical Application Equipment

Airports require application equipment to spread chemical deicers on the airside pavement. A change from solid to liquid chemicals will require an airport to purchase or retrofit equipment to properly apply liquid chemical deicers. EPA requested liquid chemical application equipment costs from vendors across the country that offer a variety of different application equipment options and obtained costs from three vendors. EPA requested information on equipment of various sizes to assess costs by a large vs. small/medium coverage area.

Based on information provided by the vendors, EPA assumed that new trucks with a large coverage area operated with 100-foot spraying booms and at least 2,500 gallons of tank space. For truck retrofits or trailers, EPA assumed a large coverage area for units that operated with at least 75-foot booms and at least 2,000 gallons of tank space. EPA assumed that new trucks with a small/medium coverage area operated with 50-foot spraying booms and at least 1,100 gallons of tank space. For truck retrofits or trailers, EPA assumed a small/medium coverage area for units that operated with booms of 50 feet or a different type of spreading mechanism. EPA used this information to estimate liquid application equipment costs for those airports that currently use solid urea.

Table 10-12 provides costing information for small/medium and large liquid deicer application equipment. Equipment is presented for two types of installations: new sprayer trucks and truck retrofits/towed sprayers. Costs are presented as a total capital cost and are averaged by equipment type and size.

EPA assumed that small, medium, and Non-hub airports would be required to purchase a medium-size spreader truck and a medium-size truck retrofitted with a tow unit for application of potassium acetate. EPA assumed Large Hub airports would purchase a large-size spreader truck and a large-size truck retrofitted with a towed unit. Based on these equipment assumptions and the relationship between urea and potassium acetate amounts, EPA estimated small, medium and Non-hub airports would be required to spend approximately \$203,000 for a potassium acetate application system and large airports would be required to spend approximately \$348,000. EPA assumed that airports using both urea and potassium acetate have sufficient application equipment available to apply only potassium acetate and those airports were not assigned application equipment costs.

10.3.2.1 Potassium Acetate Storage Tanks

Users of liquid pavement deicers can purchase the chemicals in various size carboys or in bulk. The actual size of bulk liquid storage tanks needed will depend primarily on the amount of deicing chemical purchased each deicing season. EPA used tank cost data from fact sheets contained in ARCP Report 14 (ARCP Fact Sheets) to estimate liquid pavement deicer storage costs for airports that currently use solid urea for airfield deicing and would need to convert to a non-urea-containing deicing chemical.

Table 10-12. Application Equipment Costs for Liquid Pavement Deicer

Installation Type	Large Coverage	Deicing Unit	Medium/Small Coverage	Deicing Unit
Full Truck	$160,000	Tyler Ice AD Series – 4,000 Gallons with 100' Booms (Eagle)	$130,000	Tyler Ice AD Series – 2,000 Gallons with 75' Booms (Eagle)
	$280,000	4,000-5,000-gallon units (Tyler ICE)	$197,500	2,000-3,000-gallon unit (Tyler ICE)
	$245,000	ASP nozzle sprayer spraying width 45 Meter. Tank content 10,000 liter (Schmidt)		
Average Cost [1]	**$228,000**		**$163,000**	
Installation Type	**Large Coverage**	**Deicing Unit**	**Medium/Small Coverage**	**Deicing Unit**
Truck Retrofit/ Spreader	$110,000	3,500 2T 5M Towed Spreader (Eagle)	$35,000	Smart Tote 125, 8-25' spray width (Eagle)
			$35,000	Epoke PC Compact , Drop behind spreader (Eagle)
	$130,000	Tyler Ice TAD Series, 2,000 gallons with 75' booms (Eagle)	$60,000	Tyler Ice TAD Series, 500 gallons with 12-36' boomless spray (Eagle)
			$20,500	Small Tote Sprayer, 8-50' booms (Tyler ICE)
			$50,000	ASPT nozzle sprayer spraying width of 15 meters. Tank content 3,000 liters (Schmidt)
Average Cost [1]	**$120,000**		**$40,000**	

[1] – Yearly cost was calculated assuming a 6% interest rate and a 20 year loan term.
Sources:
Eagle – Mr. Trevor Winn, CA, CFO at Eagle Airfield (a division of Team Eagle Ltd). http://www.team-eagle.ca/.
Tyler ICE Div. of Wausau Equipment – Mr. Mark Kreutzfeldt. http://www.wausau-everest.com/
Schmidt – Mr. Rene Wender - Product Manager Airport equipment. http://www.aebi-schmidt.com.

Table 10-13 provides capital costs for potassium acetate storage tanks. Costs for three types of storage tanks are presented: portable (frac), modular, and permanent. For smaller storage needs, EPA assumed that an airport could use the chemical tote provided with the liquid deicer purchase. EPA assumed that O&M costs for liquid storage are about the same as those for solid storage. EPA assumes that a modular tank with a 50,000-gallon storage capacity will be the best option for airports that use between 1,000 and 50,000 gallons of liquid airfield deicing chemical each deicing season. A modular tank with a 100,000-gallon storage capacity will be the best option for airports that use greater than 50,000 gallons of deicing chemical each season. EPA assumed that airports using both urea and potassium acetate have sufficient liquid storage available and therefore no costs for tanks are assigned to these airports.

Table 10-13. Storage Tank Capital Costs for Liquid Pavement Deicer

Tank Type	Size (gallon)	Transaction Type	Cost	Cost for 2/3 of a year rental
Portable (Frac)	21,000	Rental	$45/day	$10,980
Portable (Frac)	21,000	Rental	$1,350/month	$10,800
Average Portable (Frac) Tank Cost				**$10,890/yr**
Tank Type	**Size (gallon)**	**Transaction Type**	**Cost**	**Cost per gallon**
Modular	50,000	Purchase	$40,000	$0.80
Modular	100,000	Purchase	$50,000	$0.50
Modular	245,000	Purchase	$80,000	$0.33
Modular	500,000	Purchase	$130,000	$0.26
Modular	1,000,000	Purchase	$225,000	$0.23
Modular	2,000,000	Purchase	$375,000	$0.19
Average Modular Tank Cost				**$0.38**
Tank Type	**Size (gallon)**	**Transaction Type**	**Average Cost**	**Cost per gallon**
Permanent	2,000,000	Purchase	2,000,000	$0.90
Permanent	4,000,000	Purchase	4,000,000	$0.70
Average Permanent Tank Cost				**$0.80**

The national average use of urea, based on EPA's airport questionnaire (U.S. EPA, 2006b) data for the three deicing seasons between 2002 and 2005, was 7,075,900 pounds per year. Using the available range of application rates (small coverage area and large coverage area for the same amount of urea) and statistical airport weighting values as determined by EPA, the Agency estimated both capital costs for equipment (application equipment and storage tanks) and chemical costs for a national switch from urea to potassium acetate. Table 10-14 lists the annualized capital costs for application equipment and storage plus the annual cost for potassium acetate for those airports in the scope of the final rule that indicated they use urea. Note that airports that currently use potassium acetate for a portion of airfield deicing are assumed to have both application equipment and storage available and therefore no capital costs are required.

Table 10-14. Annualized Costs for In-Scope Airports to Change from Urea to Potassium Acetate for Airfield Deicing

Airport ID	Annualized Capital Equipment Cost [1] ($/yr 2006)	Predicted Potassium Acetate Annual Cost ($/yr 2006)	Total Annualized Cost ($/yr 2006)
1007	$30,654	$10,487	$41,141
1010	$0	$150,844	$150,844
1012	$0	$657,442	$657,442
1017	$0	$16,346	$16,346
1018	$0	$38,826	$38,826
1022	$0	$105,445	$105,445
1041	$27,125	$131	$27,256
1043	$0	$3,935	$3,935
1053	$49,879	$2,243	$52,122
1066	$0	$577,406	$577,406
1074	$30,654	$12,765	$43,419
1079	$0	$8,854	$8,854
1090	$0	$159,636	$159,636
1103	$31,536	$199,901	$231,436
1105	$31,536	$251,319	$282,855
1114	$0	$59,734	$59,734
1116	$0	$2,848	$2,848
1118	$30,654	$25,971	$56,625
1128	$0	$91,667	$91,667
1129	$0	$6,590	$6,590
1141	$0	$24,660	$24,660
1144	$0	$33,209	$33,209
1146	$30,654	$10,625	$41,278
1147	$30,654	$35,153	$65,807

[1] Cost includes both application equipment and storage tanks.

10.4 Other ADF-Compliance-Related Costs

In addition to the costs associated with ADF stormwater collection and control and airfield deicing chemical substitution, EPA also analyzed potential monitoring and reporting costs for airports to comply with the various options. Specifically, EPA costed the model airports to:

- Assess ADF usage (in some instances, EPA assumed that the airport would not need to assess usage);
- Perform an engineering review of airport operations to determine and document compliance with the percent ADF collection standard (for those that are in scope of the analyzed collection requirements);

- Perform annual ADF collection equipment/system inspections(for those who are in scope of the analyzed collection requirements); and
- Perform COD monitoring from an on-site treatment system (such as AFB treatment) to demonstrate compliance with the COD standards (for those facilities that are in scope of the analyzed option).

EPA's assumptions and methodology for estimating these costs are described below along with a summary of the in-scope airports which EPA projected would incur these costs. Table 10-15 presents these other compliance-related costs for each of the model airports determined to be in the scope of the final rule.

10.4.1 Assessing ADF Usage from Airport Tenants

EPA assumed that many airports using ADF during typical winter seasons will need to collect and compile ADF usage information from the airlines operating at the airport. EPA is assuming that airport personnel will collect ADF usage data monthly from airport tenants and will collate that data into a spreadsheet, which can be totaled each season to assess an annual ADF usage for the entire airport. EPA is assuming that this activity will require 8 hours per month and that ADF usage data is collected for 6 months of the year on average (based on airports' reported deicing months). Costs associated with assessing ADF usage will therefore be:

$$8 \text{ hours/month} \times 6 \text{ deicing months/year} \times \$35\text{/hour labor rate} = \$1{,}680\text{/year}$$

The labor rate shown in the equation above is based on an average reported labor rate of $33/hour obtained from responses to the airport questionnaire and an escalation rate of 7 percent to adjust costs to a 2006 basis[3]. EPA adjusted the labor rate so that the labor costs for the compliance activity will be on a similar-year basis as the other costs assessed by EPA.

EPA is assuming that only those airports that use less than 80,000 gallons of normalized ADF per year would need to collect and assess total airport annual ADF. Rather than collect and tabulate ADF usage, airports that use more than 80,000 gallons would likely certify that their usage is above the cutoff specified in the analyzed option.

10.4.2 Determination of ADF Stormwater Collection Percentage

As part of the options evaluated by EPA in the final rule, airports with normalized ADF use of ≥60,000 gallons/year would need to demonstrate that they achieve the analyzed collection requirement. Airports would meet the collection requirement using the technologies costed by EPA or through other means. EPA is assuming that airports would hire an engineering consultant or firm to evaluate the airport's ADF usage data to calculate its available normalized ADF. The engineering consultant would also evaluate information on the airport's pollution prevention, deicing stormwater collection, and on-site treatment or alternative disposal.

[3] From Bureau of Labor Statistics, Producer Price Index industry data for the airport industry. Increase from 2004 to 2006.

Table 10-15. Other Compliance-Related Costs by Airport

Airport ID	Airport	Total Annualized Compliance-Related Costs ($/yr 2006)
1001	Montgomery Rgnl (Dannelly Field)	$1,680
1003	Ketchikan Intl	$1,680
1004	Norfolk Intl	$1,680
1006	Chicago O'Hare Intl	$9,279
1007	Yeager	$1,680
1008	Tucson Intl	$1,680
1010	Fairbanks Intl	$9,279
1011	Lambert-St Louis Intl	$9,279
1012	Ted Stevens Anchorage Intl	$9,279
1014	Albuquerque Intl Sunport	$21,333
1015	Gulfport-Biloxi Intl	$1,680
1017	Austin Straubel International	$10,959
1018	Piedmont Triad International	$21,333
1019	Ontario Intl	$1,680
1020	Hartsfield - Jackson Atlanta Intl	$9,279
1021	Buffalo Niagara Intl	$9,279
1022	Fort Wayne International	$1,680
1023	Seattle-Tacoma Intl	$19,653
1024	Indianapolis Intl	$9,279
1026	Dallas/Fort Worth International	$9,279
1028	Denver Intl	$19,653
1029	La Guardia	$19,653
1031	Richmond Intl	$1,680
1032	Austin-Bergstrom Intl	$1,680
1033	Mc Carran Intl	$1,680
1034	Metropolitan Oakland Intl	$1,680
1035	San Diego Intl	$1,680
1036	Baltimore-Washington Intl	$9,279
1037	George Bush Intercontinental Arpt/Houston	$1,680
1040	Louis Armstrong New Orleans Intl	$1,680
1041	Glacier Park Intl	$1,680
1043	Ralph Wien Memorial	$1,680
1044	Roanoke Regional/Woodrum Field	$1,680
1045	Norman Y. Mineta San Jose International	$1,680
1046	Long Island Mac Arthur	$1,680
1050	Aspen-Pitkin Co/Sardy Field	$1,680
1052	Wilmington Intl	$1,680
1053	General Edward Lawrence Logan Intl	$19,653
1054	Jackson Hole	$1,680
1057	Will Rogers World	$1,680
1058	Gerald R. Ford International	$9,279
1059	Greater Rochester International	$9,279
1061	William P Hobby	$1,680
1062	Birmingham Intl	$1,680
1063	Evansville Regional	$1,680
1065	Albany Intl	$19,653
1066	Salt Lake City Intl	$9,279
1067	Helena Regional	$1,680
1068	Eppley Airfield	$19,653

Table 10-15 (Continued)

Airport ID	Airport	Total Annualized Compliance-Related Costs ($/yr 2006)
1069	Cleveland-Hopkins Intl	$9,279
1070	City of Colorado Springs Municipal	10,959
1074	South Bend Regional	$1,680
1075	Pensacola Regional	$1,680
1078	Nashville Intl	$19,653
1079	Manchester	$19,653
1080	Syracuse Hancock Intl	$9,279
1081	Bob Hope	$1,680
1083	Tampa Intl	$1,680
1084	Bismarck Municipal	$1,680
1086	Palm Beach Intl	$1,680
1087	El Paso Intl	$1,680
1088	Outagamie County Regional	$1,680
1089	John F Kennedy Intl	$19,653
1090	Boise Air Terminal/Gowen Fld	$10,959
1091	Rochester International	$1,680
1094	Boeing Field/King County Intl	$1,680
1095	Chicago Midway Intl	$9,279
1097	Lovell Field	$1,680
1099	Sacramento International	$1,680
1100	Toledo Express	$1,680
1101	Portland Intl	$19,653
1102	John Wayne Airport-Orange County	$1,680
1103	Juneau Intl	$1,680
1104	Nome	$1,680
1105	Spokane Intl	$10,959
1107	Pittsburgh International	$9,279
1108	Louisville Intl-Standiford Field	$9,279
1111	Port Columbus Intl	$19,653
1113	Cincinnati/Northern Kentucky International	$9,279
1114	Stewart Intl	$1,680
1115	Jacksonville Intl	$1,680
1116	Reno/Tahoe International	$21,333
1117	Cherry Capital	$1,680
1118	Bethel	$1,680
1119	Rickenbacker International	$1,680
1120	Rapid City Regional	$1,680
1121	Theodore Francis Green State	$9,279
1122	Southwest Florida Intl	$1,680
1123	James M Cox Dayton Intl	$9,279
1124	Des Moines Intl	$9,279
1126	Minneapolis/St Paul Intl/Wold-Chamberlain	$9,279
1128	Charlotte/Douglas Intl	$19,653
1129	Bradley Intl	$9,279
1130	San Antonio Intl	$1,680
1131	Wilkes-Barre/Scranton Intl	$1,680
1133	Phoenix Sky Harbor Intl	$1,680
1135	Lafayette Regional	$1,680

Table 10-15 (Continued)

Airport ID	Airport	Total Annualized Compliance-Related Costs ($/yr 2006)
1136	General Mitchell International	$9,279
1137	Dallas Love Field	$1,680
1138	Detroit Metropolitan Wayne County	$9,279
1139	Philadelphia Intl	$9,279
1140	Memphis Intl	$19,653
1141	Ronald Reagan Washington National	$9,279
1142	Washington Dulles International	$19,653
1143	San Francisco International	$1,680
1144	Central Wisconsin	$1,680
1145	Newark Liberty Intl	$19,653
1146	Northwest Arkansas Regional	$1,680
1147	Raleigh-Durham Intl	$19,653
1148	Kansas City Intl	$9,279

EPA has estimated 264 hours and $28,424 total costs for a consulting firm to develop and document an engineering assessment using airport-specific data. These costs include time for project management, data analysis and evaluation of airport drawings, calculation of airport-specific ADF collection, and preparation of a report. EPA developed the project elements and estimated the average hourly rate for consulting engineers at $85/hour based on best professional judgment. This cost is assumed to occur once each permit cycle (i.e., once every five years). EPA assumed that all airports with ≥60,000 gallons/year normalized ADF usage would be required to perform this analysis of the airport's ADF collection percent.

10.4.3 Annual ADF Collection Equipment/System Inspections

As part of the options evaluated by EPA for the final rule, airports could document annual compliance with the collection standard by demonstrating that their selected BAT system was properly maintained and operated. Airports could demonstrate that they were using those technologies properly by annually inspecting the collection equipment and documenting that the equipment was being maintained and used per the manufacturer's specifications.

EPA assumed that an annual inspection of ADF stormwater collection equipment/systems would occur prior to the airport's deicing season and would include the following types of activities as applicable:

- Inspection of GCVs to ensure that they are maintained and ready for use as well as any inspection of the vehicle vacuum system recommended by the manufacturer (e.g., inspection of the vacuum pressure and/or nozzles); and
- Inspection of the plug and pump or drainage diversion system to ensure that system components are in good condition and working order (e.g., inspection and exercising of shut-off values, inspection of balloon inserts).

EPA assumed that 2 weeks of labor (80 hours total) would be required to perform these activities on an annual basis:

$$80 \text{ hours/season} \times \$35\text{/hour labor rate} = \$2{,}800\text{/year}$$

EPA included these costs for all airports with ≥60,000 gallons/year normalized ADF usage when evaluating the options with a collection standard in the final rule.

10.4.4 COD Monitoring of On-Site Treatment Systems

For this costing effort, EPA assumed that airports requiring additional ADF stormwater collection and control to comply with the analyzed options, would treat the stormwater through an on-site AFB treatment system. In addition, airports that were already achieving compliance with the collection standard that use on-site treatment prior to direct discharge would need to monitor compliance with the COD limitation. Most of the airports that currently collect ADF-contaminated stormwater send it to a POTW or to off-site glycol recovery. However, for the costing effort, EPA did not assume either POTW discharge or transfer to an off-site glycol recovery facility would be a viable option for those airports requiring additional collection and control. In assessing national costs, EPA assumed that airports requiring additional collection and control would need to conduct ongoing monitoring of the effluent discharge point of the on-site treatment system to ensure permit compliance.

To estimate AFB discharge monitoring costs, EPA assumed the following:

- Airports would collect a daily 24-hour composite sample of treatment system effluent for analysis of COD for each day the treatment system is operating;
- Treatment systems would be operated continuously for 26 weeks per year (6 months);
- Approximately 1 hour of labor is associated with sample collection and delivery of the sample to the laboratory;
- Labor costs for sample collection are $35/hr;[4] and
- Cost for COD analysis by the laboratory is $22/sample[5] and includes the cost of the sample container.

Using the assumptions above, EPA calculated the annual cost for monitoring the effluent from an airport treatment system to be $10,374/year as follows:

- Sample Analysis Cost ($/yr): 1 sample/day × 7 days/wk × 26 wks/yr × $22/sample = $4,004;
- Labor Cost ($/yr): 1 hr/day × 7 days/wk × 26 wks/yr × $35/hr = $6,370; and
- Total Cost ($/yr): $4,004 + $6,370 = $10,374

EPA assumed that all model airports with normalized ADF use ≥60,000 gallons/year, costed for additional collection and on-site treatment of ADF stormwater would monitor for COD at the effluent discharge point from the on-site treatment system. In addition, EPA

[4] Average labor costs from the airport questionnaire escalated to 2006 year basis.

[5] Sample analysis costs obtained from EPA for analysis of COD samples by contract laboratory.

evaluated all of the other model airports estimated as having ≥60,000 gallons/year normalized ADF usage to determine which of those airports treat ADF stormwater on site and discharge the effluent directly to U.S. surface waters. As a result, EPA also evaluated monitoring costs for the following airports:

- Washington Dulles International Airport;
- Denver International Airport;
- Albany International Airport; and
- Nashville International Airport.

EPA assumed that all of the other model airports that would be required to meet the collection standard do not directly discharge the available ADF required for collection.

10.5 Summary of Annualized Costs

Table 10-16 summarizes EPA's annualized costs for ADF collection and treatment, other compliance-related costs, and urea substitution costs.

Table 10-16. Summary of EPA's Annualized Costs for ADF Collection and Treatment, Airfield Deicing Urea Substitution, and Other Compliance-Related Costs

Airport ID	Airport	Airport Weighting Factor	Annualized Cost for 20% Control and Treatment Scenario (2006 $)	Annualized Cost for 40% Control and Treatment Scenario (2006 $)	Total Annualized ADF-Compliance-Related Costs ($/yr 2006)	Urea Substitution Total Annualized Cost ($/yr 2006)
1001[1]	Montgomery Regional (Dannelly Field)	6.7013	$1,168	$1,168	$1,680	$0
1003[2]	Ketchikan International	1.0000	NC	NC	$1,680	$0
1004	Norfolk International	1.0000	$0	$2,235,548	$1,680	$0
1006	Chicago O'Hare International	1.0000	$0	$0	$9,279	$0
1007	Yeager	2.1508	$0	$0	$1,680	$41,141
1008	Tucson International	2.9997	$0	$1,069,305	$1,680	$0
1010	Fairbanks International	1.0000	$0	$0	$9,279	$150,844
1011	Lambert-St Louis International	1.0000	$0	$0	$9,279	$0
1012	Ted Stevens Anchorage International	1.0000	$0	$0	$9,279	$657,442
1014	Albuquerque International Sunport	1.0000	$0	$6,269,926	$21,333	$0
1015	Gulfport-Biloxi International	5.8413	$0	$0	$1,680	$0
1017	Austin Straubel International	2.3269	$0	$0	$10,959	$16,346
1018	Piedmont Triad International	1.0000	$1,090,753	$8,121,534	$21,333	$38,826
1019[1]	Ontario International	1.0000	$1,110	$1,110	$1,680	$0
1020	Hartsfield - Jackson Atlanta International	1.0000	$0	$0	$9,279	$0
1021	Buffalo Niagara International	1.0000	$0	$0	$9,279	$0
1022	Fort Wayne International	1.9682	$991,516	$3,272,310	$1,680	$105,445
1023	Seattle-Tacoma International	1.0000	$1,560,687	$3,863,913	$19,653	$0
1024	Indianapolis International	1.0000	$0	$0	$9,279	$0
1026	Dallas/Fort Worth International	1.0000	$0	$0	$9,279	$0
1028	Denver International	1.0000	$0	$0	$19,653	$0
1029	La Guardia	1.0000	$2,976,443	$6,286,465	$19,653	$0
1031	Richmond International	1.0000	$0	$0	$1,680	$0
1032	Austin-Bergstrom International	1.0000	$0	$0	$1,680	$0
1033	Mc Carran International	1.0000	$4,216	$4,216	$1,680	$0
1034	Metropolitan Oakland International	1.0000	NC	NC	$1,680	$0
1035	San Diego International	1.0000	NC	NC	$1,680	$0
1036	Baltimore-Washington International	1.0000	$0	$0	$9,279	$0

Table 10-16 (Continued)

Airport ID	Airport	Airport Weighting Factor	Annualized Cost for 20% Control and Treatment Scenario (2006 $)	Annualized Cost for 40% Control and Treatment Scenario (2006 $)	Total Annualized ADF-Compliance-Related Costs ($/yr 2006)	Urea Substitution Total Annualized Cost ($/yr 2006)
1037	George Bush Intercontinental Airport/Houston	1.0000	$4,099	$4,099	$1,680	$0
1040	Louis Armstrong New Orleans International	1.0000	NC	NC	$1,680	$0
1041	Glacier Park International	3.1409	$1,037,252	$1,266,155	$1,680	$27,256
1043	Ralph Wien Memorial	1.0000	$605,365	$707,178	$1,680	$3,935
1044	Roanoke Regional/Woodrum Field	2.1921	$943,332	$4,095,087	$1,680	$0
1045[1]	Norman Y. Mineta San Jose International	1.0000	NC	NC	$1,680	$0
1046	Long Island Mac Arthur	1.9985	$0	$0	$1,680	$0
1050	Aspen-Pitkin Co/Sardy Field	4.7500	$0	$0	$1,680	$0
1052	Wilmington International	6.0388	$654,946	$3,131,737	$1,680	$0
1053	General Edward Lawrence Logan International	1.0000	$4,860,377	$6,659,582	$19,653	$52,122
1054	Jackson Hole	4.3500	$0	$0	$1,680	$0
1057	Will Rogers World	1.0000	$986,385	$2,675,571	$1,680	$0
1058	Gerald R. Ford International	1.5862	$0	$0	$9,279	$0
1059	Greater Rochester International	1.0000	$0	$0	$9,279	$0
1061	William P Hobby	1.0000	$0	$0	$1,680	$0
1062[1]	Birmingham International	2.8410	$2,675	$2,675	$1,680	$0
1063	Evansville Regional	5.1042	$846,931	$1,609,927	$1,680	$0
1065	Albany International	1.0000	$0	$0	$19,653	$0
1066	Salt Lake City International	1.0000	$0	$0	$9,279	$577,406
1067	Helena Regional	4.2000	$0	$0	$1,680	$0
1068	Eppley Airfield	1.0000	$1,250,502	$2,132,279	$19,653	$0
1069	Cleveland-Hopkins International	1.0000	$0	$0	$9,279	$0
1070	City of Colorado Springs Municipal	1.7414	$0	$0	10,959	$0
1074	South Bend Regional	2.1417	$0	$0	$1,680	$43,419
1075	Pensacola Regional	3.9341	$0	$0	$1,680	$0
1078	Nashville International	1.0000	$0	$0	$19,653	$0
1079	Manchester	1.0000	$1,600,420	$1,995,084	$19,653	$8,854
1080	Syracuse Hancock International	1.0000	$0	$0	$9,279	$0
1081	Bob Hope	1.0000	NC	NC	$1,680	$0
1083	Tampa International	1.0000	NC	NC	$1,680	$0

Table 10-16 (Continued)

Airport ID	Airport	Airport Weighting Factor	Annualized Cost for 20% Control and Treatment Scenario (2006 $)	Annualized Cost for 40% Control and Treatment Scenario (2006 $)	Total Annualized ADF-Compliance-Related Costs ($/yr 2006)	Urea Substitution Total Annualized Cost ($/yr 2006)
1084	Bismarck Municipal	3.8679	$770,509	$1,215,970	$1,680	$0
1086	Palm Beach International	1.0000	$0	$0	$1,680	$0
1087	El Paso International	3.0457	$0	$0	$1,680	$0
1088	Outagamie County Regional	2.4841	$1,011,102	$2,412,516	$1,680	$0
1089	John F Kennedy International	1.0000	$3,215,317	$10,136,241	$19,653	$0
1090	Boise Air Terminal/Gowen Fld	1.5043	$0	$0	$10,959	$159,636
1091	Rochester International	3.1749	$0	$0	$1,680	$0
1094	Boeing Field/King County International	5.8985	$0	$0	$1,680	$0
1095	Chicago Midway International	1.0000	$0	$0	$9,279	$0
1097[1]	Lovell Field	4.9996	$3,745	$3,745	$1,680	$0
1099[1]	Sacramento International	1.0000	NC	NC	$1,680	$0
1100	Toledo Express	2.0917	$0	$1,767,861	$1,680	$0
1101	Portland International	1.0000	$0	$2,792,934	$19,653	$0
1102	John Wayne Airport-Orange County	1.0000	NC	NC	$1,680	$0
1103	Juneau International	1.0000	$957,795	$2,343,519	$1,680	$231,436
1104	Nome	1.0000	$618,441	$1,904,296	$1,680	$0
1105	Spokane International	1.5192	$0	$0	$10,959	$282,855
1107	Pittsburgh International	1.0000	$0	$0	$9,279	$0
1108	Louisville International-Standiford Field	1.0000	$0	$0	$9,279	$0
1111	Port Columbus International	1.0000	$2,029,946	$4,321,331	$19,653	$0
1113	Cincinnati/Northern Kentucky International	1.0000	$0	$0	$9,279	$0
1114	Stewart International	2.8661	$0	$0	$1,680	$59,734
1115	Jacksonville International	1.0000	$0	$0	$1,680	$0
1116	Reno/Tahoe International	1.0000	$0	$1,614,875	$21,333	$2,848
1117	Cherry Capital	3.5400	$0	$0	$1,680	$0
1118	Bethel	1.0000	$643,331	$1,936,511	$1,680	$56,625
1119	Rickenbacker International	4.3659	$710,969	$1,433,955	$1,680	$0
1120	Rapid City Regional	3.1082	$838,073	$4,548,952	$1,680	$0
1121	Theodore Francis Green State	1.0000	$0	$0	$9,279	$0
1122	Southwest Florida International	1.0000	$0	$0	$1,680	$0

Table 10-16 (Continued)

Airport ID	Airport	Airport Weighting Factor	Annualized Cost for 20% Control and Treatment Scenario (2006 $)	Annualized Cost for 40% Control and Treatment Scenario (2006 $)	Total Annualized ADF-Compliance-Related Costs ($/yr 2006)	Urea Substitution Total Annualized Cost ($/yr 2006)
1123	James M Cox Dayton International	1.0000	$0	$0	$9,279	$0
1124	Des Moines International	1.6211	$0	$0	$9,279	$0
1126	Minneapolis/St Paul International/Wold-Chamberlain	1.0000	$0	$0	$9,279	$0
1128	Charlotte/Douglas International	1.0000	$1,574,890	$2,111,996	$19,653	$91,667
1129	Bradley International	1.0000	$0	$0	$9,279	$6,590
1130	San Antonio International	1.0000	$780,240	$5,064,195	$1,680	$0
1131	Wilkes-Barre/Scranton International	2.6815	$971,556	$1,476,180	$1,680	$0
1133[1]	Phoenix Sky Harbor International	1.0000	NC	NC	$1,680	$0
1135[1]	Lafayette Regional	6.6425	$1,536	$1,536	$1,680	$0
1136	General Mitchell International	1.0000	$0	$0	$9,279	$0
1137	Dallas Love Field	1.0000	$0	$0	$1,680	$0
1138	Detroit Metropolitan Wayne County	1.0000	$0	$0	$9,279	$0
1139	Philadelphia International	1.0000	$0	$0	$9,279	$0
1140	Memphis International	1.0000	$1,740,377	$3,651,474	$19,653	$0
1141	Ronald Reagan Washington National	1.0000	$0	$0	$9,279	$24,660
1142	Washington Dulles International	1.0000	$0	$0	$19,653	$0
1143	San Francisco International	1.0000	$0	$0	$1,680	$0
1144	Central Wisconsin	3.0156	$952,550	$1,451,583	$1,680	$33,209
1145	Newark Liberty Intl	1.0000	$5,366,144	$9,674,611	$19,653	$0
1146	Northwest Arkansas Regional	1.8782	$873,730	$1,644,615	$1,680	$41,278
1147	Raleigh-Durham Intl	1.0000	$1,294,323	$4,254,332	$19,653	$65,807
1148	Kansas City Intl	1.0000	$0	$0	$9,279	$0

NC – Not Calculated.
[1] Airport is in a warm climate and uses either no ADF or small amounts of ADF, and EPA assumes the airport will contract out all ADF removal and disposal operations.
[2] Airport was sent an airport questionnaire but did not respond.

10.6 References

ACRP Fact Sheets, ACRP Report 14, Deicing Practices, Transportation Research Board, Sponsored to Federal Aviation Administration.

Airport Council International – North America Comments on EPA's Proposed Effluent Limitations Guidelines and New Source Performance Standards for the Airline Industry.

ERG. 2006. Memorandum from Lou Nadeau and Cal Franz (ERG) to Marla Smith (U.S. EPA). *Results of Airport Survey Sample Draw*. (March 17). DCN AD01234.

ERG. 2007a. Personnel communication (email) between Mary Willett (ERG) and Roy Fuhrmann, Minneapolis/St. Paul International Airport. (May 3). DCN AD00872.

ERG. 2007b. Personnel communication (email) between Mary Willett (ERG) and Mark Sober, Albany International Airport. (May 3). DCN AD00865.

ERG. 2007c. Personnel communication (email) between Mary Willett (ERG) and Mark Sober, Albany International Airport. (June 27). DCN AD00866.

ERG. 2007d. Personnel communication (email) between Mary Willett (ERG) and Akron-Canton International Airport. (May 3). DCNs AD00863 and AD00864.

ERG. 2008. Memorandum from Cortney Itle and Robyn Reid (ERG) to Airport Deicing Administrative Record. *Estimated Annual Costs for airports with Limited ADF Use*. (February). DCN AD01261.

ERG. 2010. Memorandum from Steve Strackbein and Mary Willett (ERG) to Airport Deicing Administrative Record. *Estimated Capital and Operation and Maintenance Costs for Glycol Collection Vehichle Operation*. (October 8). DCN AD01249.

ERG. 2010a. Memorandum from Steve Strackbein and Mary Willett (ERG) to Brian D'Amico and Eric Strassler (U.S. EPA). *Estimated Costs for Transition to Liquid Airfield Deicing Application from Solid Airfield Deicing*. (October 8). DCN AD01252.

ERG. 2010b. Memorandum from Mary Willett (ERG) to the Airport Deicing Administrative Record. *Estimated Compliance-Related Costs for the Final Airport Deicing Rulemaking*. (November 17). DCN AD001255.

ERG. 2010c. Memorandum from Mark Briggs (ERG) to the Airport Deicing Administrative Record. *Estimated Capital and O&M Costs for Additional Stormwater Piping*. (July 26). DCN AD01253.

ERG. 2010d. Memorandum from Mark Briggs and Mary Willett (ERG) to Airport Deicing Administrative Record. *Estimated Land Requirements and Opportunity Costs for the Anaerobic Fluid Bed Treatment System and ADF Stormwater Storage Tanks*. (October). DCN AD01251.

ERG. 2011. Memorandum from Cortney Itle and Mary Willett (ERG) to Brian D'Amico (U.S. EPA). *ADF Collection and Control Efficiency Review*. (June 15). DCN AD01270.

Google Earth Geographical Mapping System, 2007.

McQueen, R., and Arendt, T. Development of a Deicer Management System for Akron-Canton Airport.

RS Means Construction Cost Data, 68th Annual Edition, 2010.

Switzenbaum, et al. 1999. Workshop: Best Practices for Airport Deicing Stormwater. DCN AD00893.

Transport Canada, Transportation Development Center. "Laboratory Testing of Tire Friction Under Winter Conditions (TP 13392E)." May 1998.

USEPA. 2006a. *Final Engineering Site Visit Report for General Mitchell International Airport, Milwaukee, WI.* U.S. Environmental Protection Agency. Washington, D.C. (June 7) DCN AD00772.

USEPA. 2006b. *Airport Deicing Questionnaire.* U.S. Environmental Protection Agency. Washington, D.C. DCN AD00354.

USEPA. 2006c. *Final Sampling Episode Report for Albany International Airport.* U.S. Environmental Protection Agency. Washington, D.C. (July 19). DCN AD00842.

USEPA. 2010. *Airport Deicing Costing Database*. U.S. Environmental Protection Agency. Washington, D.C. DCN AD01256.

USEPA. 2012. *Economic Analysis for Final Effluent Limitation Guidelines and Standards for the Airport Deicing Category.* EPA-821-R-12-004. (March). DCN AD01280.

U.S. Department of Commerce. National Oceanic and Atmospheric Administration (NOAA) National Climate Data Center.

U.S. Federal Aviation Administration (FAA) National Flight Data Center.

11. REGULATORY OPTIONS CONSIDERED AND SELECTED FOR BASIS OF FINAL REGULATION

This section presents the technology options evaluated by EPA for the Airport Deicing Category as the basis for the final effluent limitation guidelines and standards. It also describes the methodology for EPA's selection of the final technology options. Specifically, this section describes the basis for BAT and NSPS; as detailed in this section, EPA is not establishing BPT, BCT, PSES or PSNS at this time.

The regulatory option selected provides the technology basis of the final effluent limitation guidelines and standards (ELGs). Entities subject to these regulations would not be required to use the specific technologies selected by EPA to establish the ELGs. Rather, an entity could choose to use any combination of operational changes, pollution prevention, and treatment technologies to comply with the limitations and standards, provided the limitations and standards are achieved.

11.1 BPT and BCT

EPA considered whether in this rule it was necessary to establish BPT limits, given that pavement deicers will be controlled at the BAT level. The Agency concluded that it is not necessary to promulgate BPT effluent limitation guidelines for the Airport Deicing Category, given that the BAT collection and treatment requirements would be at least as stringent as BPT requirements. Similarly, EPA is not establishing BCT limitations for this industry because the same wastestream that would be controlled by BCT is being controlled by BAT.

11.2 BAT

For airfield deicing (runways), EPA concludes that the "best available technology" for reducing ammonia in wastewater discharges from airfields consists of using deicing products not containing urea, instead of those that contain urea. The administrative record for this rulemaking shows that products without urea are widely available in the industry, and in fact are already in use at a majority of airports across the country. In addition, using only deicers without urea is economically achievable by the industry, as explained in the discussion of EPA's economics analysis below.

To comply with this limitation, a discharger subject to the rule must either certify annually that it does not use airfield deicing products that contain urea or airfield pavement discharges must achieve a numeric limitation for ammonia as nitrogen of 14.7 mg/L. Table 11-1 presents the in-scope airports impacted by EPA's BAT standards and EPA's estimates of costs and loading removals associated with the final rule.

Table 11-1. Final Rule BAT Annualized Costs and Load Removals for In-Scope Airports

Airport ID	Airport	Airport Weighting Factor	Urea Substitution Total Annualized Cost ($/yr 2006)	Potential Load Reduction (lbs of COD)	Potential Load Reduction (lbs of Ammonia)
1007	Yeager	2.1508	$41,141	42,471	15,572
1010	Fairbanks Intl	1.0000	$150,844	512,432	187,883
1012	Ted Stevens Anchorage Intl	1.0000	$657,442	3,881,674	1,423,212
1017	Austin Straubel Intl	2.3269	$16,346	69,240	25,387
1018	Piedmont Triad Intl	1.0000	$38,826	143,028	52,441
1022	Fort Wayne Intl	1.9682	$105,445	440,728	161,593
1041	Glacier Park Intl	3.1409	$27,256	514	189
1043	Ralph Wien Memorial	1.0000	$3,935	15,435	5,659
1053	General Edward Lawrence Logan Intl	1.0000	$52,122	15,769	5,782
1066	Salt Lake City Intl	1.0000	$577,406	1,730,588	634,519
1074	South Bend Regional	2.1417	$43,419	50,070	18,358
1079	Manchester	1.0000	$8,854	56,851	20,844
1090	Boise Air Terminal/Gowen Field	1.5043	$159,636	416,584	152,740
1103	Juneau Intl	1.0000	$231,436	737,779	270,506
1105	Spokane Intl	1.5192	$282,855	768,648	281,824
1114	Stewart Intl	2.8661	$59,734	234,299	85,905
1116	Reno/Tahoe Intl	1.0000	$2,848	17,265	6,330
1118	Bethel	1.0000	$56,625	103,927	38,105
1128	Charlotte/Douglas Intl	1.0000	$91,667	231,340	84,821
1129	Bradley Intl	1.0000	$6,590	25,849	9,478
1141	Ronald Reagan Washington National	1.0000	$24,660	120,391	44,141
1144	Central Wisconsin	3.0156	$33,209	190,526	69,856
1146	Northwest Arkansas Regional	1.8782	$41,278	27,782	10,186
1147	Raleigh - Durham Intl	1.0000	$65,807	97,753	35,841

Source: Airport Deicing Loadings Database (EPA, 2010).

11.2.1 Airfield Deicing: Product Substitution of Pavement Deicers Containing Urea

In general, airports discharge airfield pavement deicing chemicals without treatment, due to the difficulty and expense of collecting and treating the large volumes of contaminated stormwater generated on paved airfield surfaces. EPA is not aware of an available means to control these pollutants by collecting and using a conventional, end-of-pipe treatment system. It is possible, however, to reduce or eliminate certain pollutants by modifying deicing practices, such as using alternative chemical deicing products. In particular, EPA has identified ammonia and COD from airfield deicing as pollutants of concern, and both of these pollutants are a by-product of pavement deicers containing urea. Accordingly, to address discharges of ammonia from airfield pavement, EPA identified one candidate for best available technology: product substitution, or discontinuing the use of pavement deicers containing urea and using alternative pavement deicers instead. EPA found that using deicers without urea is the best available technology for reducing discharges of ammonia from pavement deicing because it is safe, technologically feasible, and available across the industry. Currently only about 10 percent of chemical pavement deicers applied nationwide contain urea. The most widely used pavement deicer is potassium acetate, which represents 63 percent of all chemical pavement deicers applied nationwide.

11.2.2 Aircraft Deicing: ADF Collection Requirements and Effluent Limitations

11.2.2.1 Available ADF Collection Technologies and Scope

EPA is not aware of an available and economically achievable technology that is capable of capturing 100 percent of the sprayed ADF. As described above, the available technologies for collecting ADF are glycol collection vehicles, plug and pump equipment, and CDPs. EPA estimates these technologies collect 20 percent, 40 percent, and 60 percent of available ADF, respectively.

After considering the comments provided on the proposed regulation and reviewing the information in its record, EPA is not establishing a 60 percent ADF collection requirement based on CDPs for BAT. First, in response to FAA's concerns about the exclusive use of deicing pads for aircraft deicing, EPA contacted a number of Large Hub airports that currently use CDPs. EPA found the current percentage of flights for which these airports use the CDPs ranges from 50 to 95 percent. The airports explained that various operational or weather-related issues may make deicing pad use for all flights cumbersome if not impossible (i.e., severe system-wide delays), and require them to deice at the gate in some circumstances. EPA shares the commenters' and FAA's concerns that moving to exclusive use of CDPs for all deicing might lead to operational issues and delays. EPA, in discussions with FAA, attempted to craft regulatory provisions to allow an airport limited ability to bypass the use of a centralized pad to avoid these circumstances. However, limited data on the site-specific nature of this industry left EPA unable to develop regulatory provisions that would give airports the flexibility they need to avoid significant operational issues and delays. Second, based on public comments and information from FAA, EPA is concerned that some large airports critical to efficient air traffic operations in this country are space (land) constrained and that building well-located CDPs for all deicing operations at these airports is likely not feasible for that reason. At the time of the proposal, EPA estimated that 14 airports would be subject to the 60 percent collection requirement. Because the data in EPA's record indicate that many of these airports currently meet this requirement, EPA estimated approximately seven airports would likely need to install pads as a result of the proposed requirement. Of these seven airports, four are Large Hubs that, over years of expansions and other improvements, have already built out the majority of the land available to them. EPA has concluded that the lack of remaining available land, coupled with their existing layouts, has left these airports in a position where they cannot construct a CDP that conforms to FAA's Advisory Circulars on deicing pad design (e.g., in a location that aircraft can travel to safely and efficiently to conduct deicing operations).

Therefore, for the final rule, EPA has not established a 60 percent ADF collection requirement, which would have been based on identifying centralized deicing facilities as BAT for 100 percent of aircraft departures. Because of land constraints and the other reasons discussed above, EPA finds that centralized deicing facilities should not be identified as BAT for this nationwide rulemaking.

EPA then considered the other two technologies described in the proposed rule as a possible basis of BAT for aircraft deicing discharges for the final rule: 40 percent ADF collection requirement based on plug and pump with GCVs and 20 percent ADF collection requirement based on GCVs. With either of these collection technologies, as was the case in the proposed rule, EPA also included numeric COD limitations for direct discharges of collected ADF based on anaerobic treatment.

11.2.3 Options Considered for Today's Final Regulation for Identification of BAT for ADF Collection and Discharge Requirements

Using the technology bases identified above for airfield and aircraft deicing discharges, EPA developed three primary options for the final rule. All three of these options have the same airfield pavement deicing discharge requirements based on product substitution of deicers that do not contain urea, but would vary the approach to control aircraft deicing discharges:

- **Option 1:** 40 percent ADF collection requirement for large and medium ADF users (based on plug and pump with GCVs); numeric COD limitations for direct discharges of collected ADF (based on anaerobic treatment);

- **Option 2:** 40 percent ADF collection requirement for large ADF users (based on plug and pump with GCVs) and 20 percent ADF collection requirement for medium ADF users (based on GCVs); numeric COD limitations for direct discharges of collected ADF (based on anaerobic treatment); and

- **Option 3:** Site-specific aircraft deicing discharge controls: Do not establish effluent limitation guidelines in the final rule for aircraft deicing discharges, but instead, leave the determination of BAT requirements for each airport to the discretion of the permit writer on a case-by-case, "best professional judgment" basis based on site-specific conditions.

Under the first option, in addition to the airfield pavement requirements, all airports that use greater than or equal to 60,000 gallons of normalized ADF annually would be required to collect 40 percent of available ADF based on plug and pump with GCV technologies. In the proposed rule, EPA considered but did not identify this as its lead option because it found its costs to be comparable to those of CDPs, while CDPs collect more ADF. In the proposed rule, EPA therefore identified CDPs as BAT. Because EPA no longer considers CDPs to be the best available technology for existing airports, the plug and pump with GCV option represents the technology, among those that remain under consideration for the final rule, that would collect the most ADF.

Under the second option, in addition to the airfield pavement requirements, all airports that use greater than or equal to 60,000 gallons of normalized ADF annually but less than 460,000 gallons of normalized ADF ("medium ADF users," estimated to be 42 airports) would be required to collect 20 percent of available ADF based on GCVs, and airports that use more than 460,000 gallons of normalized ADF ("large ADF users," estimated to be 14 airports) would be required to collect 40 percent of available ADF based on the use of plug and pump with GCV technology.

Under both Options 1 and 2, facilities would need to meet numeric effluent limits for COD for the collected ADF prior to commingling it with other wastestreams prior to discharge.

Under the third option, EPA would establish national deicing discharge controls for airfield pavement deicing only. BAT limitations for aircraft deicing discharge would continue to be established by the permitting authority on a case-by-case basis.

11.2.4 BAT Options Selection

EPA is selecting Option 3 as best available technology for controlling airport deicing discharges. EPA has determined the best available technology for controlling airfield pavement discharges is product substitution. The administrative record for this rulemaking shows that products without urea are widely available in the industry, and in fact are already in use at a majority of airports across the country.

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 as well as myriad pollution prevention technologies and practices, ranging from alternative means of applying ADF (e.g., forced air nozzles) to alternate deicing technologies (e.g., infrared deicing). Thus, this industry has numerous technology options available for mitigating the pollutants associated with aircraft deicing activities.

However, EPA concludes that none of the ADF collection technologies considered for the final rule represents the "best available technology" for the entire category. Rather, EPA concludes that best available technology determinations should continue to be made on a site-specific basis because such determinations appropriately consider local operational constraints (e.g., traffic patterns), land availability, safety considerations, and potential impacts to flight schedules. Based on the information in its administrative record, EPA cannot identify with precision the extent to which such limitations may preclude any particular airports from implementing the technologies that it considered for BAT control of aircraft deicing discharges. However, the record demonstrates that such limitations exist and are not isolated or insignificant. More specifically, comments provided by airport and airline industry on the proposed regulation raised concerns about the impacts that ADF collection technologies may have on safety and operations at airports across the country. They also commented on the lack of available space at many land-constrained airports for ADF collection and treatment technologies. EPA reviewed the information submitted in comments, subsequent information provided by industry, and information obtained from site visits to thoroughly evaluate these concerns. After reviewing this information, EPA agrees with commenters that, while many airports likely are able to implement some form of collection or pollution prevention technologies to mitigate pollutant discharges associated with aircraft deicing, other airports may not be able to implement specific technologies due to space, safety, and operational considerations. This became particularly apparent after reviewing questionnaire responses from some of the airports at which EPA also conducted site visits. EPA found that its "model facility" approach was not a suitable substitute for a detailed analysis of the site constraints at each airport. For example, a permit authority may need to evaluate existing traffic patterns at an airport, not only of the aircraft, but also of the service vehicles, to determine if additional collection vehicles would lead to unacceptable safety concerns. With respect to land constraints, without detailed airport schematics or conducting a detailed site visit at each airport, EPA cannot determine if adequate space exists to incorporate the specific treatment and collection technologies evaluated as the basis for the final rule.

Additionally, industry, and FAA in particular, have expressed concerns about possible delays and economic impact that could result from using plug and pump and GCVs, both at specific airports and nationwide. EPA agrees that 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.

Airplane deicing activities, by their nature, occur during freezing precipitation events. For some airports, even small amounts of precipitation can lead to delayed aircraft departures – even without deicing activity and/or ADF collection and treatment. As such, it is difficult to determine if delays at an airport during inclement weather are associated with the weather, the ADF collection and treatment technologies, or both. Further, even small delays at certain hub airports have a ripple effect that can affect the entire national air traffic schedule.

Some airports have identified procedures to mitigate or prevent delays associated with aircraft deicing discharge controls, but these approaches may not be applicable nationwide. Further, the extent of delays deemed acceptable is likely to vary by airport. As with land constraints, the confounding factors that need to be considered to evaluate possible delays that may be associated with the technology bases do not lend themselves to a national determination using a model facility approach. Further, EPA does not have detailed site-specific information to evaluate delays on an airport-by-airport basis.

While the facts stated above do not preclude the ability of an airport to collect and treat spent ADF, they do illustrate why EPA did not select any of the technologies considered as BAT for the final rule, and why a site-specific BAT determination for ADF collection and treatment requirements is the proper approach.

Therefore, for the reasons identified above, EPA determined Option 3 is the only technologically feasible and available option considered for today's final BAT requirements. Option 3 would remove 4.4 million pounds of ammonia and 12 million pounds of COD, with a projected annual cost of $3.5 million. The costs of Option 3 are reasonable in terms of the pollutant reductions achieved ($0.21/lb). Further, as discussed in more detail in the preamble to the final rule, EPA finds Option 3 is economically achievable. In addition, EPA examined the non-water-quality impacts anticipated from compliance with Option 3 requirements and found none or only very minor impacts in comparison to typical industry energy use, emissions generation, and sludge generation. Therefore, based on all the factors above, EPA is identifying Option 3 as BAT and has based today's final rule on the Option 3 BAT requirements.

11.3 NSPS

For today's final rule, EPA evaluated "best available demonstrated control technologies" for purposes of setting new source performance standards under CWA section 306. Section 306 directs EPA to promulgate NSPS "for the control of the discharge of pollutants which reflects the greatest degree of effluent reduction which the Administrator determines to be achievable through application of the best available demonstrated control technology, processes, operating methods, or other alternatives, including, where practicable, a standard permitting no discharge of pollutants." Congress envisioned that new treatment systems could meet tighter controls than existing sources because of the opportunity to incorporate the most efficient processes and treatment systems into the facility design. As a result, NSPS should represent the most stringent controls attainable through the application of the best available demonstrated control technology for all pollutants (that is, conventional, nonconventional, and priority pollutants).

After careful consideration of the information in its record, EPA is today promulgating the same NSPS requirements for both airfield pavement deicing discharges and airplane deicing discharges as it proposed. However, the applicability of the NSPS requirements has changed and EPA has revised the new source definition in the rule to mean new airports only and exclude new runways at existing airports. EPA determined that, just as with existing sources, all new sources would be able to substitute airfield deicing products without urea for those with urea. Furthermore, product substitution represents the greatest ammonia level reduction among the available technologies considered. Accordingly, EPA identifies product substitution of non-urea-containing airfield deicers as the best demonstrated available control technology for all new sources. As with BAT, there would be two alternatives for meeting this effluent limitation: either a certification requirement or a numeric limit on ammonia for all direct discharges of the stormwater from the airfields.

The final rule NSPS also includes a 60 percent collection (based on CDP technology) and control requirement for ADF-contaminated stormwater at new airports anticipated to conduct significant aircraft deicing activities. EPA, in consultation with FAA, finds that safety, space, and operational constraints that may be present at existing airports for the collection and treatment technologies discussed in the final rule (CDPs, plug and pump with GCVs, and GCVs alone), would not apply to new airports. New airports can be designed to minimize space and logistical constraints identified for retrofits at existing airports. Further, among the collection technologies for ADF that EPA considered, CDPs collect the greatest level of available ADF. Meeting the new source requirements would not be an economic barrier to entry for new airports, as the cost of new airport construction, even small airports, is significantly greater than the costs associated with collection and/or treatment of spent deicing fluids (see DCN AD01260 for further detail). Moreover, according to FAA, when designed properly, CDPs often improve traffic flow and reduce delays associated with aircraft deicing. When designing a new airport, the local operating agency plans the site for all needed facilities, such as runways, taxiways, terminal(s) and other components needed to comply with safety and environmental requirements, and this includes deicing facilities. See FAA Advisory Circular 150/5070-6B, "Airport Master Plans," and FAA Advisory Circular 150/5300-14B, "Design of Aircraft Deicing Facilities," DCN AD00852. Finally, EPA notes that it did not receive any negative comments on its proposal to base the NSPS ADF collection requirements on CDPs. See DCNs AD01260, AD01284, and AD01335for EPA's rationale for setting NSPS applicability.

As a point of clarification, EPA is promulgating the same numeric COD limitations for collected ADF that is discharged directly from new sources as were proposed. The technology basis of the COD limitations, AFB, is available to new airportsand achieves the greatest level of pollutant removals of those technologies considered during the development of this regulation.

Further, installing and using this technology is not economically a barrier to entry for new airports.

11.4 PSES and PSNS

EPA is not promulgating PSES and PSNS for the Airport Deicing Category. Although some airports in the United States discharge ADF-contaminated stormwater to POTWs, EPA received no comments or other information indicating that POTWs currently have problems of pollutant pass-through, interference, or sludge contamination stemming from these discharges that would necessitate the promulgation of national categorical pretreatment standards.

Like the biological treatment system that forms the basis for today's COD limitations, POTWs typically use biological treatment systems and are similarly designed to remove organic pollutants that contribute to COD and/or BOD_5. In general, POTWs can achieve comparable removals to the BAT technology basis. However, some airports and POTWs may need to make operational adjustments to process the wastewater effectively while avoiding POTW upset. EPA received a comment about the Downriver Treatment Facility in Detroit, Michigan, which accepts ADF wastewater from the Detroit Metropolitan Wayne County Airport. The treatment plant experienced viscous bulking due to a nutrient imbalance that occurred during the months that ADF was accepted. The issue was resolved by removing phosphorus at a later stage in the treatment plant system, rather than from the raw wastewater. The airport also made significant changes to segregate their deicing stormwater, capture and recycle the most concentrated ADF-contaminated stormwater, and control the amount and concentration of stormwater discharged to the POTW.

EPA is aware that high concentration or "slug" discharges of deicing stormwater can create POTW upset. The national pretreatment program regulations specifically prohibit industrial users from discharging high concentrations of oxygen-demanding pollutants to POTWs if they cause interference to the POTW (see 40 CFR 403.5(b)(4)). Under 40 CFR 403.5(c), control authorities may set and enforce "local limits" for airport discharges to POTWs to implement the prohibitions listed in § 403.5(b)(4). This provision ensures that any potential limits would protect against POTW interference by the oxygen-demanding pollutants in airport deicing discharges. See "Local Limits Development Guidance," document no. EPA 833-R-04-002A, July 2004, available on EPA's website at: http://cfpub.epa.gov/npdes/pretreatment/pstandards.cfm.

As a result, many airports that discharge to POTWs have airport-specific requirements on allowable BOD_5 or COD discharge loadings per day to the receiving POTWs. Airports usually meet this requirement by storing deicing stormwater in ponds or tanks and metering the discharge to meet the POTW permit loading requirements.

11.5 References

ERG. 2008. Memorandum from Cortney Itle (ERG) to Brian D'Amico (U.S. EPA). *Airport Deicing Loading Calculations.* (April 17). DCN AD01140.

ERG. 2012. Memorandum from Mary Willett and Cal Franz (ERG) to Brian D'Amico (U.S. EPA). *NSPS Feasibility – ADF Collection and Treatment Requirements*. (January 23). DCN AD01284.

USEPA. 2009. *Economic Analysis for Proposed Effluent Limitation Guidelines and Standards for the Airport Deicing Category.* U.S. Environmental Protection Agency. Washington, D.C. EPA 821-R-09-005. DCN AD01196.

USEPA. 2010. *Airport Deicing Loadings Database.* U.S. Environmental Protection Agency. Washington, D.C. DCN AD01257.

USEPA. 2012. Memorandum from Brian D'Amico (U.S. EPA) to Record. *Final Rule Barrier to Entry Analysis for New Source Performance Standards for Airport Deicing.* (February 8). DCN AD01260.

12. NON-WATER QUALITY IMPACTS

Sections 304(b) and 306 of the CWA require EPA to consider non-water-quality environmental impacts (including energy requirements) associated with effluent limitation guidelines and standards. As explained in the preamble to the final rule, EPA evaluated three regulatory options for today's rule. The first two options are based on technologies to control aircraft and airfield deicing discharges, while the the third option is based on technology solely to control airfield deicing discharges.

In considering non-water quality environmental impacts, EPA first analyzed the potential impact of the Option 1 technologies on energy consumption, air emissions, and solid waste generation. Because Option 2 is similar to Option 1, but would result in fewer operational changes at a subset of airports and therefore lead to fewer non-water quality impacts than Option 1, EPA did not analyze non-water quality impacts associated with Option 2. Rather, EPA concluded that the results for Option 2 will be similar to or less than Option 1. Additionally, Option 3 has no associated non-water quality impacts as substituting one airfield deicing product with another causes no increase in energy usage, air emissions, or solid waste generation.

12.1 Energy Requirements

EPA estimated that the total incremental electrical usage for Option 1 to pump ADF-contaminated stormwater into storage tanks would be approximately 1.2 million kilowatt hours per year (kWh/yr). EPA also developed a relationship between electrical use and COD removal by the AFB bioreactors based on information provided by Albany International (ALB) airport. Using ALB's information, EPA estimated the electrical requirement for COD removal for Option 1 as approximately 1.3 kWh/lb COD removed. Using this unit rate, EPA estimated total electrical requirements to remove COD for Option 1 to be a maximum additional 22 million kWh/yr.

EPA also analyzed fuel use by GCVs collecting ADF-contaminated stormwater. EPA used airport questionnaire data for diesel fuel costs for GCVs and then estimated an average diesel fuel use based on the unit cost for diesel fuel of $2.07/gal.[6] EPA then estimated annual fuel usage per gallon of applied ADF to be 0.08 gal/gal ADF applied. Using this relationship, EPA estimated that the total incremental consumption of No. 2 diesel fuel, at all airports subject to BAT and installing additional collection equipment, is 354,500 gallons per year.

Additionally, as EPA assumes that aircraft operations will not be delayed as a result of Option 1 and that deicing will occur at the gates, there is no increase in jet fuel consumption associated with Option 1.

Below are the calculations to determine the net energy requirements associated with Option 1 of the final rule for the collection and treatment of ADF-contaminated stormwater. Detailed calculations regarding net energy consumption for the various collection and treatment technologies considered for the rule are provided in a separate memorandum entitled *Energy Requirements for ADF Contaminated Stormwater Collection and Treatment Alternatives* (ERG, 2008a).

[6] This diesel fuel price was the average reported by the Energy Information Administration (EIA) for the 2004-05 winter season, the same period that EPA is analyzing for airport deicing activity.

To estimate incremental electrical requirements associated with pumping collected ADF to storage tanks, EPA assumed airports would continuously operate three well-pit pumps with 40-horsepower (hp) electric motors during each deicing day. EPA also conservatively assumed that all airports would use pumps rather than allow ADF-impacted stormwater to flow by gravity to holding tanks. To estimate electrical use by airport based on the number of deicing days per year, EPA developed the following equation:

$$\text{Pumping Electrical} = 3\text{ pumps} \times 40\,\frac{\text{HP}}{\text{pump}} \times 0.7456\,\frac{\text{kW}}{\text{hp}} \times 24\,\frac{\text{hr}}{\text{day}} \times \text{SOFP}\,\frac{\text{days}}{\text{yr}} \quad (12\text{-}1)$$

Using the equation above, the total SOFP days for those airports that EPA assumed would install additional collection equipment, and a wire-to-water efficiency of approximately 40 percent (Bower, H., 1978), the total incremental electrical usage to pump ADF-contaminated stormwater into storage tanks would be approximately 1.2 million kilowatt hours per year (kWh/yr).

EPA developed another relationship between electrical use and COD removal by the AFB bioreactors based on information provided by Albany International (ALB) airport. Using ALB's information, EPA estimated the electrical requirement for COD removal as approximately 1.3 kWh/lb COD removed. Using this unit rate, EPA estimated the total electrical requirements associated with COD treatment. EPA estimates an additional 22 million kWh/yr will be required to remove 16,602,900 total pounds per year of COD as a result of the final rule.

The national estimated increase in electrical power consumption related to increased pumping and AFB treatment is 23.2 million kilowatt hours per year. This represents a very small fraction (0.0006 percent), of the electrical energy used annually in the United States, which is 3,950 billion kWh based on EIA statistics.

EPA notes that AFB treatment systems also generate biogas that can be used as a source of heat when burned in facility boilers or when converted to electricity using technologies such as microturbines or fuel cells. EPA did not include microturbine costs in its option-costing methodology. However, to estimate the potential electricity that could be generated if all AFB treatment systems installed microturbines to generate electricity, EPA developed a relationship between biogas generation and COD removal based on data provided by ALB airport. EPA estimated the AFB reactors will generate approximately 8 cubic feet of biogas per pound of COD removed, and the biogas is approximately 60 percent methane. Because one cubic foot of methane provides 100 therms and 1 therm is equivalent to 29.3 kWh when converted to electrical energy (U.S. Code, Title 15), EPA was able to predict the potential electrical energy available from biogas generated by the AFBs treating ADF-contaminated stormwater (see Table 12-1).

Table 12-1. Potential Electricity Generation from AFB Biogas Generation

Regulatory Scenario	Total COD Removal (pounds/yr)	Potential Biogas Generation (million ft^3/yr) [1]	Potential Methane Generation (million ft^3/yr) [2]	Potential Electrical Generation (million kWh/yr) [3]
40% ADF Capture	16,602,900	129	77.5	23

[1]Calculation based on 8 cubic feet of biogas per lb COD removed.
[2]Assumes biogas is approximately 60% methane per Metcalf and Eddy Wastewater Engineering and Design (Metcalf and Eddy, 1979).
[3]Calculation based on 100 therms per cubic foot of methane and 29.3 kWh per therm.

Comparing the potential electrical generation from converting biogas to electricity to the electrical requirements discussed above indicates that AFB treatment of ADF-contaminated stormwater could generate most of the electricity needed to operate the treatment systems.

Fuel use by GCVs collecting ADF-contaminated stormwater is another incremental energy requirement for compliance with Option1. To estimate incremental diesel fuel use by GCVs, EPA obtained annual diesel fuel costs for GCVs from the airport questionnaire (U.S. EPA, 2006) and then estimated diesel fuel use based on the unit cost for diesel fuel (e.g., $/gal). According to questionnaire data, one airport spent $17,600 on diesel fuel to operate GCVs to recover ADF-contaminated stormwater during the 2004-2005 deicing season, collecting approximately 20 percent of their applied ADF in stormwater. Based on an average diesel fuel cost of $2.07 per gallon during the 2004/2005 deicing season (U.S. DOE, 2006), EPA estimates this airport burned approximately 8,500 gallons of diesel fuel in GCVs. Based on annual ADF use and size, EPA estimated diesel fuel use in GCVs to be 0.08 gal/gal ADF applied. Using this relationship, EPA estimated total incremental No. 2 diesel fuel consumption at in-scope airports installing additional collection equipment to be 354,500 gallons per year. This volume is a conservative estimate because it is based on an airport that currently uses only GCVs to collect ADF-contaminated stormwater (e.g., 20 percent ADF collection). If airports install a plug and pump system to collect ADF-contaminated stormwater, GCV usage and therefore diesel fuel use are expected to be less.

EPA compared incremental diesel fuel use by GCVs at all airports to diesel fuel use on a national basis. According to the EIA, approximately 25.4 million gallons per day of No. 2 diesel fuel was consumed in the United States in 2005 (U.S. DOE, 2006). Total annual diesel fuel use by GCVs to collect ADF-contaminated stormwater at airports would account for a small fraction, 0.004 percent, of the annual diesel fuel use on a national level.

12.2 Air Emissions

Additional air emissions as a result of the final rule can be attributed to added diesel fuel combustion by GCVs collecting ADF-contaminated stormwater and from anaerobic treatment of ADF. Emissions from these sources are discussed below.

12.2.1 Emissions from GCV Collection

As discussed in Section 12.1, EPA conservatively estimated that GCVs collecting ADF-contaminated stormwater at airports will consume an additional 354,500 gallons per year of No. 2 diesel fuel. To estimate air emissions related to combustion of No. 2 diesel fuel in GCVs' internal combustion engines, EPA used published emission factors for internal combustion engines (U.S. EPA, 1996 AP-42). The Agency selected emission factors for gasoline and diesel industrial engines rather than on-road mobile sources because the emission factors for the industrial engines include equipment such as forklifts and industrial sweepers and scrubbers (U.S. EPA, 1006 AP-42). To estimate emissions from the GCVs, EPA first converted the additional 354,500 gallons of diesel fuel to million British Thermal Units (MMBtu) and then applied the appropriate emission factors (U.S. EPA, 1996 AP-42). Table 12-2 shows the estimated increase in criteria pollutant emissions associated with the use of GCVs. Additional details regarding emissions from GCVs are contained in a memorandum titled *Air Emissions from Airport Deicing Collection and Treatment Technologies* (ERG, 2008b).

Table 12-2. Estimated Incremental Pollutant Emissions from GCVs

Criteria Pollutant	Diesel Fuel Consumption in GCV Internal Combustion Engine (gal/yr)	Diesel Fuel Consumption in GCV Internal Combustion Engine (MMBtu/yr) [1]	Emission Factor for Diesel Fuel Combustion in Internal Combustion Engine (lbs/MMBtu)[2]	Estimated Annual Emissions from GCVs Burning Diesel Fuel (tons/yr)
Carbon Monoxide	354,500	49,630	0.95	24
Carbon Dioxide	354,500	49,630	164	4,070
Nitrogen Oxides	354,500	49,630	4.41	109
Sulfur Dioxide	354,500	49,630	0.29	7
PM_{10}	354,500	49,630	0.31	8

[1]Heat content of diesel fuel is approximately 140,000 Btu/gal per Perry's Chemical Engineers Handbook, 6th Edition, Figure 9-4.
[2]Emission factors from EPA Compilation of Emission Factors AP-42.
PM_{10} – Particulate matter less than 10 um.

The annual emissions provided in Table 12-2 indicate that an additional 4,070 tons per year of carbon dioxide would be emitted from GCVs combusting additional diesel fuel to comply with the regulatory options evaluated in the final rule. Carbon dioxide is the primary greenhouse gas attributed to climate change; although 4,070 additional tons per year appears to be considerable, the amount is very small relative to other sources. For example, in 2006, industrial facilities combusting fossil fuels emitted 948 million tons of CO_2 equivalents. An additional 4,070 tons per year from GCVs is an increase of 0.0004 percent in the overall CO_2 emissions from all industrial sources (U.S. EPA, 2008).

Comments provided by industry on the proposed rule correctly indicated that additional nitrogen oxides would be emitted by equipment constructing the ADF-contaminated stormwater collection systems, the AFB treatment system, and any ancillary systems such as roadways and storage tanks. According to comments, the Environmental Assessment for the Portland ADF collection and treatment system estimated annual nitrogen oxide emissions at 4.48 tons/yr during construction. Construction of the ADF collection and treatment system in Portland was estimated to occur over approximately 2.5 years, resulting in total nitrogen oxide emissions of 11.2 tons. Based on the number of in-scope airports that would potentially require construction under EPA's Option 1, total construction-related nitrogen oxide emissions will be approximately 168 tons. In comparison, EPA estimated total nitrogen oxide emissions in the United States at 18.3 million tons (U.S. EPA, 2005).

12.2.2 Emissions from AFB Treatment Systems

Anaerobic digestion of glycols found in ADF-contaminated stormwater generates biogas containing approximately 60 percent methane and 40 percent carbon dioxide. Airports installing AFBs to treat ADF-contaminated stormwater are expected to burn a portion of the gas in on-site boilers to maintain reactor temperature. The remainder of gas can be either combusted in a microturbine for electricity generation or flared. Regardless of the combustion technology, nearly all biogas generated by AFBs is converted to carbon dioxide, the primary green house gas.Table 12-3 shows biogas generation and potential carbon dioxide emissions from AFB treatment systems for the costed collection scenario.

Table 12-3. Potential Air Emissions from AFB Treatment Systems

Regulatory Scenario	Total COD Removal (pounds/yr)	Potential Biogas Generation (million ft^3/yr) [1]	Potential Carbon Dioxide Generation (tons/yr) [2]
40% ADF Capture	16,602,900	129	3,730

[1] Calculation based on 8 cubic feet of biogas per lb COD removed. Biogas is 60% methane and 40% CO_2.
[2] Assumes 99.9 percent of biogas is converted to CO_2 during combustion.

Carbon dioxide is the primary greenhouse gas attributed to climate change; although 3,730 additional tons per year for 40 percent ADF capture appears to be considerable, the amount is very small relative to other sources as discussed in 12.2.1.

12.3 Solid Waste Generation

AFB bioreactors will generate sludge that will require disposal, likely in an off-site landfill. To estimate the potential for annual sludge generation by AFB bioreactors treating ADF-contaminated stormwater under Option 1, EPA first estimated the potential COD removal for the collection and treatment scenario and then applied published anaerobic biomass yield information (Metcalf & Eddy, 1979) to estimate potential total sludge generation on a national basis. The biomass yield calculation, which simply multiplies the COD removal by the yield, is a rough method of estimating sludge generation and does not account for other factors such as degradation or inorganic material (e.g., AFB media) that may be entrained into the sludge. However, this method does provide an order of magnitude estimate of sludge generation that can be compared to other types of common biological treatment systems to determine if AFB sludge generation would be unusually high at airports treating ADF-contaminated stormwater.

Table 12-4 shows the total COD removal for the collection and treatment scenario and the estimated sludge that would likely require disposal. This sludge is expected to be nonhazardous and can be disposed of in a municipal landfill. Detailed calculations showing how EPA estimated biomass amounts are provided in a memorandum entitled *Estimated Sludge Generation from AFBs Treating ADF-Contaminated Stormwater* (ERG, 2008c).

Table 12-4. Estimated Sludge Generation from AFB Bioreactors Treating ADF-Contaminated Stormwater

Regulatory Scenario	Total COD Removal (pounds/yr) [1]	Anaerobic Biomass Yield (lbs biomass/lb COD removed) [2]	Total Sludge Generation (dry tons/yr)
40% ADF Capture	16,602,900	0.03	271

[1] Total COD removal from all AFB bioreactors that may be installed at airports.
[2] Biomass yield from Metcalf and Eddy.

To provide some perspective on the potential total amount of biomass produced annually by the AFB biological reactors treating ADF-contaminated stormwater, EPA compared the total biomass generation data in Table 12-4 to the national biosolids estimates for all domestic wastewater treatment plants throughout the United States. According to EPA's Municipal and Solid Waste Division, approximately 8.2 million dry tons of biosolids will be produced in 2010 (U.S. EPA, 1999). Using the biosolids generation amount shown in Table 12-4 (271 tons/yr), EPA estimates that AFB bioreactors treating ADF-contaminated stormwater would increase biosolids generation in the United States by approximately 0.003 percent.

12.4 Summary

EPA reviewed the potential non-water quality impacts of collection and treatment of spent ADF using plug and pump with GCVs combined with an AFB treatment system and determined that there was an insignificant increase in energy usage and generation of air emissions and solid waste.

EPA then determined that the other regulatory options under consideration would have similarly insignificant impacts because the other regulatory options involve fewer or no GCVs and smaller or no treatment system. Based on this evaluation of non-water quality impacts, EPA concludes there are no non-water quality impacts associated with today's final rule.

12.5 References

Bouwer, H. 1978. *Groundwater Hydrology*. McGraw Hill Press.

ERG. 2008a. Memorandum from Mark Briggs (ERG) to Airport Deicing Administrative Record. *Energy Requirements for ADF-Contaminated Stormwater Collection and Treatment Alternatives*. (December) DCN AD01166

ERG. 2008b. Memorandum from Mark Briggs (ERG) to Airport Deicing Administrative Record. *Air Emissions from Airport Deicing Collectoin and Treatment Technologies*. (December) DCN AD01165

ERG. 2008c. Memorandum from Mark Briggs (ERG) to Airport Deicing Administrative Record. *Estimated Sludge Generation from AFBs Treating ADF-Contaminated Stormwater*. (December) DCN AD01164

Metcalf and Eddy. 1979. *Wastewater Engineering, Treatment/Disposal/Reuse*, Second Edition. McGraw Hill Press.

U.S. Code Title 15, Commerce and Trade, Chapter 6. 2007. Weights and Measures and Standard Time. (January).

U.S. DOE. 2006. Department of Energy, Energy Information Administration (EIA), No. 2 Fuel Oil All Sales/Deliveries by Prime Supplier. DCN AD00919.

USEPA. 1996. *Compilation of Air Pollutant Emission Factors (AP-42),* Fifth Edition, Section 3.3. U.S. Environmental Protection Agency. Washington, D. C.

USEPA. 1999. *Biosolids Generation, Use and Disposal in the United States.* U.S. Environmental Protection Agency. Washington, D. C. EPA 530D-R-99-009.

USEPA. 2005. *Summary of Nitrogen Oxides Emissions*. U.S. Environmental Protection Agency. Available online at http://www.epa.gov/air/emissions/nox.htm#noxnat.

USEPA. 2006. *Airport Deicing Questionnaire*. U.S. Environmental Protection Agency. Washington, D.C. DCN AD00354.

USEPA. 2008. *Inventory of U.S. Greenhouse gas Emissions and Sinks: 1990 – 2006.* U.S. Environmental Protection Agency. Washington, D. C. (April). EPA 430-R-08-05.

13. LIMITATIONS AND STANDARDS: DATA SELECTION AND CALCULATION

This section describes the data selection and statistical methodology that EPA used to calculate the final rule limitations for the Airport Deicing Category. As described in this section, the effluent limitations and standards account for variation in treatment performance of the model technology. For simplicity, the following discussion refers only to effluent limitation guidelines; however, the discussion also applies to new source standards.

EPA is finalizing limitations for COD and ammonia as nitrogen (the latter as a compliance alternative), and Section 13.1 briefly describes the pollutant parameters. Section 13.2 provides an overview of EPA's data review and selection process. Section 13.3 describes EPA's data conventions. Sections 13.4 and 13.5 describe the COD and ammonia as nitrogen data selected as the basis of the final limitations. Section 13.6 describes the percentile basis and calculations used for the limitations. Section 13.7 describes achievability and compliance related to the limitations.

13.1 Selected Pollutant Parameters

As described in Section 6, there are a number of pollutants associated with discharges from airport deicing operations. EPA is setting effluent limitations for two pollutant parameters, COD and ammonia. This section briefly describes the pollutant parameters and the chemical analytical methods used to measure their concentrations.

13.1.1 COD

COD is a measure of the total organic matter content of both wastewaters and natural waters. Measurement of COD can be used to rapidly recognize deterioration in wastewater treatment plant performance and the need for corrective action. EPA evaluated data collected by the Albany International Airport in New York and by EPA. The Agency evaluated data for COD that was measured using EPA Method 410.4 and Hach 8000, both of which are approved for compliance monitoring in 40 CFR Part 136. EPA measured COD using Method 410.4, and Albany Airport used Hach 8000. Data from the two methods are directly comparable.

Method 410.4 is a colorimetric procedure with a measurement range of 3 to 900 mg/L for automated procedures and a measurement range of 20 to 900 mg/L for manual procedures. The Hach 8000 method is a colorimetric procedure that utilizes a preliminary digestion procedure and can be used for various concentration ranges. A user has the option of purchasing three different sets of reagents and standards. The first has a measurement range of 0 to 40 mg/L; the second, 0 to 150 mg/L; and the third, 0 to 1500 mg/L. The industry data had a lower measurement limit of 2.0 mg/L.

13.1.2 Ammonia as Nitrogen (Ammonia)

Ammonia as nitrogen (ammonia) is generated as a by-product of using urea-containing products for deicing operations. Ammonia can be directly toxic to fish and other aquatic organisms and can reduce ambient dissolved oxygen concentrations in receiving surface waters. In the data EPA evaluated, ammonia was measured using Methods 350.1 and 350.2, both of which are approved for compliance monitoring in 40 CFR Part 136. Albany Airport supplied data that was generated using Method 350.1 (ERG, 2008), and EPA used Method 350.2. Both methods produce comparable results.

Method 350.1 is an automated colorimetric method that uses a continuous flow analytical system and has a detection range of 0.01 to 2.0 mg/L. Method 350.2 utilizes either colorimetric, titrimetric, or electrode procedures to measure ammonia. Method 350.2 has a lower measurement range limit of 0.20 milligrams per liter (mg/L) for the colorimetric and electrode procedures and a lower measurement range limit of 1.0 mg/L for the titrimetric procedure.

13.2 Overview of Data Review and Selection

As described in Sections 13.4 and 13.5, EPA qualitatively reviewed all the available influent and effluent data for COD and ammonia. For purposes of limitation development, data are defined to be numerical values resulting from laboratory determination of pollutants in physical samples collected from influent and effluent wastestreams. A laboratory expresses the results of its analysis either numerically or as "not quantitated" for a pollutant in a sample. When the result is expressed numerically, the pollutant was quantitated, or more commonly referred to as "detected," in the sample. The definition includes measured values (e.g., 10 mg/L) and values reported as being below some level of quantification (e.g., <10mg/L). The latter are often referred to as "nondetected" and are usually reported with a "detection limit." (EPA also uses terms such as "quantitation limit" in other documentation.) The definition of "data" excludes estimated values and statistical summaries, such as averaged values.

This section describes EPA's review of the available data. Section 13.2.1 describes the criteria that EPA applied in selecting data for the development of the final limitations. Section 13.2.2 describes other considerations that were evaluated as part of the data review.

13.2.1 Data Selection Criteria

This section describes the criteria that EPA applied in selecting data to use as the basis for the final effluent limitations. EPA has used these or similar criteria in developing limitations and standards for other industries. EPA uses these criteria to select data that reflect consistently good performance of the model technology in treating the industrial wastes under normal operating conditions. Model technology is technology that is carefully designed and diligently operated. The following paragraphs describe the criteria and modifications specific to the Airport Deicing Category.

One criterion generally requires that the influent and effluent from the treatment components represent typical wastewater from the industry, with no incompatible wastewater from other sources (e.g., sanitary wastes). By applying this criterion, EPA selects only those facilities where the commingled wastewaters did not result in substantial dilution, unequalized slug loads that result in frequent upsets and/or overloads, more concentrated wastewaters, or wastewaters with different types of pollutants than those generated by the categorical (i.e., airport deicing) wastewater.

A second criterion typically ensures that the pollutants were present in the influent at sufficient concentrations to evaluate treatment effectiveness. To evaluate whether the data meet this criterion for the final rule, EPA often uses a "long-term average test" for sites where it has paired influent and effluent data. EPA has used such comparisons in developing regulations for other industries (e.g., the Iron and Steel Category (USEPA, 2002)). The test looks at the influent concentrations to ensure a pollutant is present at sufficient concentration to evaluate treatment effectiveness. If a pollutant fails the test (i.e., is not present at a treatable concentration), EPA excludes the data for that pollutant at that facility from its long-term average and variability calculations. In this manner, EPA would ensure that the limitations resulted from treatment and not simply the absence or substantial dilution of that pollutant in the wastestream. If industry supplies EPA with effluent data, but not the corresponding influent data, EPA may choose to use the effluent data without performing a long-term average test provided it determines that the pollutant would have been present at consistently treatable concentrations at the facility. This approach would satisfy EPA's objective to include as much data from as many facilities as possible in the calculation of limits.

A third criterion requires that the facility must have the model treatment technology and demonstrate consistently diligent operation. The Agency may include facilities with treatment or performance that is equivalent to the model technology, but this is rare. EPA generally determines whether a facility meets this criterion based upon site visits, ability to comply with its existing discharge requirements, discussions with facility management, and/or comparison to treatment system performance at other facilities. EPA often contacts facilities to determine whether data submitted were representative of normal operating conditions for the facility and equipment. Based on this review, EPA typically eliminates facilities that experience repeated operating problems with their treatment systems. In addition, EPA typically excludes data when the facility has not optimized its treatment. For example, facilities may use the model technology as a pretreatment step before sending the wastewater to a POTW and consequently might not fully optimize its system.

A fourth criterion typically requires that the data cannot represent periods of frequent unequalized slug loading treatment upsets or shut-down periods[7] because these excursion data do not reflect performance that would be expected from well-designed and operated treatment systems. Furthermore, it would not be appropriate for the limitations to be based, in part, upon data reflecting extreme events that are beyond the control of the facility, because regulatory provisions at 40 CFR 122.41(n) would apply to such circumstances. More specifically, after the final limitations are incorporated into permits, EPA expects that, when such events occur, the facility would abide by the procedural requirements in §122.41(n) to obtain an affirmative defense to any potential enforcement action.

In applying the fourth criterion, EPA evaluates the pollutant concentrations, flow values, mass loadings, plant logs, and other available information. As part of this evaluation, EPA typically asks the facility about process or treatment conditions that may have caused extreme values (high and low). EPA may consequently identify certain time periods and other outliers in the data that reflect poor performance by an otherwise well-operated site.

[7] EPA applies this criterion to data from two types of shut-downs. First, treatment systems are sometimes halted to control upset conditions. As part of the recovery activities, the facility may pump out wastewater from the equipment (e.g., tanks) which contains highly concentrated wastes associated with the upset. Second, the facility may shut down its operations for maintenance and other atypical operations. During these periods, the facility may still operate its treatment system, but typically discharges effluent associated with atypical influent. For example, the influent might include cleaning solvents instead of process wastewater.

EPA also applies the fourth criterion in its review of data corresponding to "start-up" periods, an adjustment period that most industries incur only when installing, acclimating, and optimizing new treatment systems. During this adjustment period, the concentration values tend to be highly variable with occasional extreme values (high and low). After this period, the systems should operate at steady state for years with relatively low variability around a long-term average. Because start-up conditions typically reflect one-time operating conditions, EPA generally excludes such data in developing the limitations. In contrast, EPA expects airports to encounter start-up operations at the start of every deicing season because they probably will cease treatment operations during warmer months. Because this adjustment period will occur every year for the Airport Deicing Category, EPA is including start-up data in the data set used as the basis of the limitations. However, through its application of the other three criteria, EPA would exclude extreme conditions that do not demonstrate the level of control possible with proper operation and control even during start-up periods.

In part, by retaining start-up data for limitations development, the limitations will be achievable because EPA based these limits on typical treatment during the entire season. Once the treatment system reaches steady state, EPA expects a typically well-designed and operated system to run continuously until the end of the deicing season.

13.2.2 Other Considerations in Data Selection

In comments on proposed regulations across a range of industry categories and subcategories, industries often suggest that EPA consider additional criteria in selecting data as the basis of the limitations. EPA routinely evaluates whether the suggested criteria are relevant and should be considered as it develops new regulations. As explained below, EPA also considered additionalcriteria for the airport deicing rulemaking, but determined that they were not relevant in selecting data as the basis of the final limitations. EPA's rationale is consistent with its findings for other industries.

Commenters often suggest a criterion related to the size of facilities because of concerns about a perceived impact of volume, or flow, of wastewater on treatment performance. In considering this issue for the airport deicing industry, EPA concluded that the size of the airport, collection technology, and other features by themselves would not affect the performance of the treatment system. Instead, the airport size and water flow would determine the size of the treatment system, rather than its performance. EPA expects that each airport would build and operate a system that is sized appropriately for its volume of wastewater. Because the method of treatment is the same regardless of the flow, properly sized systems should all perform in the same manner, and achieve the same effluent concentrations. Before reaching this conclusion for airport deicing and other industries, EPA reviewed treatment technologies such as biological treatment, oil-water separators, dissolved air floatation, and settling tanks. EPA's record supports the finding that, for a variety of industrial sectors, well-operated and designed treatment systems treat different wastewaters with varying flows to a narrow range of effluent concentrations (USEPA, 2010).

In addition, commenters typically suggest a criterion that would require a minimum number of facilities be used as the basis of the limitations. Such suggestions are based upon two main concerns. First, commenters are concerned that the limitations do not reflect treatment from a range of typical influents, because the concentration levels vary from facility to facility.

Second, commenters are concerned that not all facilities could achieve the same high level of performance using the model technology. For the first concern, as part of its evaluation of the effect of flow described above, EPA also considered the impact of influent pollutant concentrations. EPA found that well-operated and designed treatment systems are capable of treating the wastewaters to a narrow range of effluent pollutant concentrations. For the second concern, EPA only needs to demonstrate that the model technology can be operated at the level of performance on which the limitations are based. EPA's selection of the model technology used at the Albany International airport as the basis of the limitations is appropriate because that facility demonstrates that the technology can achieve the levels reflected in the final limitations.

The CWA authorizes EPA to base BAT/NSPS limitations and standards on the performance of a single facility and it is not unusual for EPA to base effluent limitations on data from a single facility. For example, in the Organic Chemicals, Plastics and Synthetic Fibers (OCPSF) effluent guideline promulgated in 1987, EPA based 38 percent of the limitations on the performance of a single facility (USEPA, 1987). Courts have recognized that EPA must act on the information it has and need not wait for perfect information(e.g., see *BASF Wyandotte Corp. v. Costle,* 598 F.2d 637, 652-653 (1st Circuit, 1979)).

13.3 Conventions for Modeling Multiple Data Sets from the Same Facility

This section describes EPA's conventions for modeling multiple data sets from the same facility. Data from a particular facility are sometimes collected at different times, from different treatment units, or by different organizations. In such cases where multiple data sets exist for the same facility, EPA often statistically models the data as if each data set represents a different facility. This section describes conventions applied to the data from the airport deicing industry.

EPA generally considers data from different time periods to characterize different operating conditions due to changes such as management, personnel, and procedures. Because EPA expects airports to operate treatment systems only for a limited time each year, it considered whether the conditions and performance for each deicing season tend to vary in a manner that more appropriately reflects different treatment systems. Because it may better capture the variability of airport deicing operations under a range of conditions, EPA has calculated the final limitations using all of the data, without regard to season. For informational purposes, the data and summaries are presented by season.

EPA generally uses data from separate treatment units (depending on the rulemaking, also called "trains" or "systems") as if they characterized separate facilities. EPA has determined this is appropriate because the units were operated separately. Even if the wastes were generated by the same processes or drawn from the same storage pond, EPA considers that the performance of each system can vary due to slightly different influents, equipment, and other factors.

EPA generally considers data from different organizations to characterize different collection methods and analytical methods. The different organizations typically are EPA sampling teams and the facility's monitoring crew at the treatment system. EPA often separates such data into multiple data sets, to better model the variability consistent with the use of a single analytical method and the same collection procedures. Consistent use of a single method and procedure is often required by permits and is typical of compliance monitoring. Therefore, the

Agency generally uses this convention to model typical variability that each facility would experience in compliance monitoring activities. EPA then determines which, or all, multiple data sources are appropriate choices as the basis of the limitations.

13.4 COD: Data Selected as Basis of Final Limitations

In establishing the final limitations, EPA reviewed COD data from a treatment plant at the Albany International airport, which used the model BAT. (Selection of the model technology is described in Section 8 and in the preamble to today's rule.) EPA collected COD data during a sampling episode at Albany International airport and obtained several years of monitoring data and other information from the airport. After evaluating these data, EPA determined that the Albany data were the only available performance data from the model technology.[8] Thus, all other data sets were excluded by applying the third criterion in Section 13.2.1, because they did not demonstrate the performance of the model technology. The following sections describe the Albany airport and apply the criteria in identifying the specific data points used as the basis of the final limitations.

13.4.1 Albany Treatment System

EPA based the final limitations for COD upon data from Albany Airport's treatment system. This system consists of two identical units that are consistent with EPA's model technology described in Section 8. The airport diverts stormwater from deicing operations into a lagoon. Facility personnel then pump water from the lagoon to one anaerobic unit or the other for treatment. The airport generally operates the two treatment systems in parallel, but sometimes runs them in series. At the end of each unit, regardless of whether the system is in parallel or series, the airport monitors COD concentrations each morning by collecting grab samples to evaluate the treatment performance. These locations are labeled as ArprtR-101 and ArprtR-102 in Figure 13-1. During its five-day sampling episode conducted from February 5-9, 2006, EPA measured COD and ammonia concentrations in composite samples collected at a point (labeled EPA_SP-2) where the two units combine into a single flow before entering an aerobic polishing pond for more treatment. After this step, the airport typically directly discharges waste into Shaker Creek, a tributary of the Mohawk River, which has been classified as a New York State Class A drinking water stream. As a consequence, the airport is required to meet stringent limitations when it discharges directly to the creek. In warmer weather (i.e., when the soil is 50 degrees or warmer), the airport sometimes uses the treated wastewater for irrigation. In addition, the airport is able to discharge to a POTW, although it seldom does.

[8] Akron Canton Airport in Ohio started operating the model technology in mid-November in 2007. When EPA was completing its technical analysis of the industry in late spring 2008, the airport's treatment unit was not operating at full capacity.

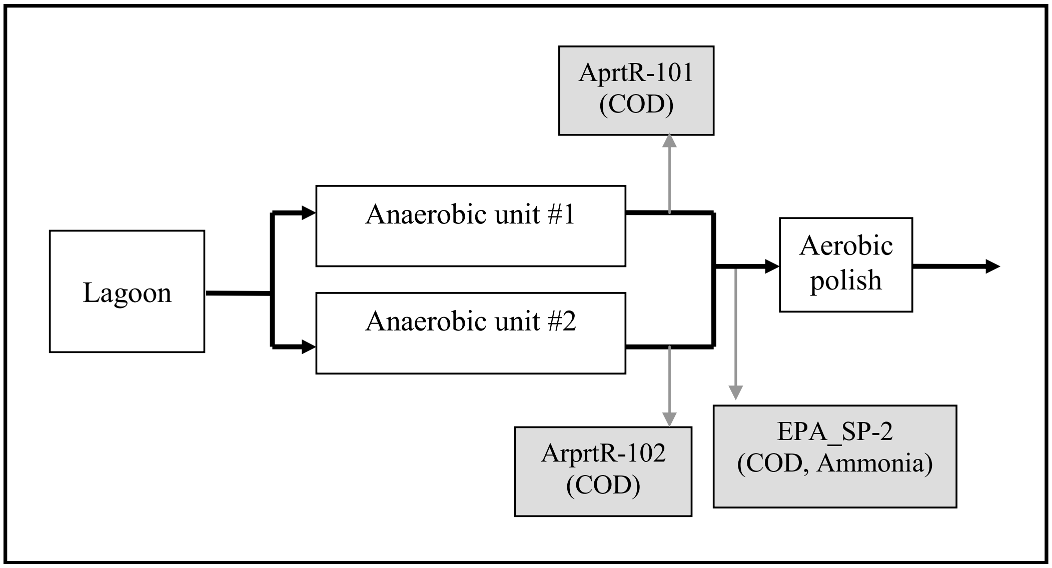


Figure 13-1. Simplified Drawing of Albany Airport Treatment System and Sample Points

As the basis for the final limitations for COD, EPA selected the data at sample points ArprtR-101 and ArprtR-102 because each unit is the same as the model treatment system that EPA identified in Section 11. The airport has monitored its performance for a relatively long time and provided EPA with data from December 1, 1999, through April 10, 2009 (10 deicing seasons). Because the influent was highly concentrated, it was not necessary to perform the long-term average test described in Section 13.2.[9]

DCN AD01181 provides the influent and effluent COD data as originally submitted by the airport and the data are graphically displayed in the statistical support memorandum (USEPA, 2006). The following sections describe the exclusion of data collected from the EPA sampling episode and the airport's self-monitoring data.

13.4.2 COD Data from EPA Sampling Episode at Albany

During EPA's sampling episode, EPA and the airport collected separate sets of samples (see Table 13-1 analytical results). At sample point EPA_SP-2, EPA collected samples of the combined flow from the two units. In contrast, the airport monitored the effluent directly from each unit at sample points ArptR-101 and ArptR-102 and filtered the samples prior to analyzing for COD. Both sets of samples demonstrate the performance of the model technology because no additional treatment steps exist between the airport sample points and EPA's sample point. Rather than include data from two different sources (i.e., EPA and the airport) for the same dates, EPA preferentially selected the airport data because they were part of longer-term monitoring. Although the EPA data were therefore excluded as the basis of the limitations, EPA notes that all of the values are less than the value of 271 mg/L for the final daily maximum limitation.

[9] EPA typically compares average influent levels to a multiplier of 5 to 10 times the quantitation limit (or reporting limit). As explained in Section 13.1.1, the airport data had a lower measurement limit of 2.0 mg/L. Thus, in the long-term average test, EPA would probably have compared the influent data to a reference level of 10 to 20 mg/L. However, because the minimum influent value of 100 mg/L exceeded this range of potential reference values, the average values also will meet the requirements of the long term average test.

Table 13-1. COD: EPA and Albany Airport Self-Monitoring Effluent Data Collected During EPA's Sampling Episode

Sample Date	COD Concentrations (mg/L)			
	EPA Sampling Episode Data		Airport Self-Monitoring Data	
	Original Sample	Field Duplicate (where collected)	AprtR-101	AprtR-102
2/5/06	72		29	74
2/6/06	228	208	53	108
2/7/06	92	177	56	94
2/8/06	81		31	90
2/9/06	193		48	96

13.4.3 COD Self-Monitoring Data from Albany Airport

The airport typically runs the two units in parallel. EPA considers each unit's performance, when operated in this manner, to be consistent with the model technology. In its evaluation of the data from each unit, EPA applied the criteria and other considerations described in Section 13.2. As a result of this evaluation, EPA excluded data associated with atypical operations, influent concentrations reported as zero, estimated values, and poor performance. The exclusions are described below.

By applying the third criterion in Section 13.2.1, EPA excluded all periods when the units were operated in series because the data did not reflect treatment by the model technology. Table 13-2 identifies these time periods by deicing season (e.g., Season99 started in 1999 and continued into 2000). During these periods, one unit provided initial treatment and the second provided additional treatment. Although the facility reported effluent values from each unit during this period of operating in series, it only discharged the effluent from the second unit in the series. EPA considers the effluent data from the first unit to reflect less than optimal performance, because the operators presumably would have not optimized treatment as they intended to treat the wastes a second time (criterion 3). EPA considers the effluent data from the second unit to characterize treatment of atypical influent (i.e., effluent that had been treated by the first unit).

Table 13-2. COD: Dates Excluded Because Units Operated in Series

Season	Number Days Excluded	Beginning Date	End Date
Season99	32	2/9/2000	3/11/2000
Season00	31	12/12/2000	1/11/2001
Season01	3	2/7/2002	2/9/2002
Season02	8	11/17/2002	11/24/2002
	3	4/5/2003	4/7/2003
Season05	25	1/10/2006	2/3/2006
Season06	79	1/15/2007	4/3/2007
Season07	31	2/2/2008	3/3/2008
Season08	25	11/17/2008	12/11/2008

EPA excluded effluent values for both units when the influent concentration was reported as “zero” for two reasons. First, if COD could not be detected in the influent (criterion 2), then the effluent concentrations would not reflect any additional treatment. Second, it appears that the plant used this convention to indicate shut-downs of the system (criterion 4). Table 13-3 identifies the dates when the influent concentration was reported to be zero.

Table 13-3. COD: Dates Excluded Because Influent Concentration Reported as Zero

Season	Date
Season01	6/14/2002
Season02	11/16/2002
Season06	4/10/2007

EPA also excluded any values that were estimates because they did not meet EPA’s definition for “data” described in Section 13.2. There were two types of estimated values. One type was in italics in the facility’s spreadsheets, indicating that the operator’s log noted issues with the sample or its analysis, and thus, the reported value was an estimate. The second type was a series of identical values reported over consecutive monitoring days. Although it is possible to find exactly the same pollutant concentrations on consecutive days, variations from day to day are more typical. In response to EPA’s questions about the strings of identical values, the facility stated that it sometimes repeated the last known number when they did not monitor (ERG. 2008a). To model the variability likely to be present in the effluent, EPA assumed that the first non-zero value was the only day when COD was monitored when three or more days had identical values for the same unit. Therefore, EPA retained the value for the first day and deleted the (identical) values on subsequent days for that unit. If the values were zero, EPA assumed that the unit was not operating and excluded the entire time period, including the first reported zero value. The statistical support memorandum (USEPA, 2010) identifies these exclusions.

In addition, by applying the fourth criterion in Section 13.2, EPA excluded periods that did not reflect the typical performance of the technology. As shown in Table 13-4, these exclusions included treatment system upsets and method error. For example, EPA excluded the maximum value of 1,283 mg/L recorded at ArprtR-101 on 3/21/2001 because it was inconsistent with the other data values during that time period. The plant management agrees that the value does not reflect normal operations and suspects that it was likely a sample with high solids content (ERG. 2008b).

Table 13-4. COD: Dates Excluded Because of Performance Excursions

Season	Number Days Excluded	Beginning Date	End Date	Reason
Season99	11	12/1/2000	12/11/2000	System Upset
Season00	42	1/12/2001	2/22/2001	System Upset
	1	3/20/2001	3/20/2001	Method Error
	1	3/21/2001	3/21/2001	System Upset

After the exclusions were incorporated, more than 2,500 measurements of COD remained and were used as the basis of the final limitations. Table 13-5 summarizes the data. The statistical support memorandum (USEPA, 2010) provides a list and plots of the data.

Table 13-5. COD: Summary of Albany Airport Self-Monitoring Effluent Data After Exclusions

Unit	Season	# of Days	Standard Deviation	COD Concentrations (mg/L) [1] Minimum	Maximum	Median	Mean [2]
ArprtR_101	Season99	147	50.31	1	326	14.0	28.60
	Season00	112	71.93	2	575	64.0	75.46
	Season01	168	20.97	9	157	37.0	44.02
	Season02	180	64.41	20	655	73.0	86.80
	Season03	146	103.19	2	699	50.0	76.32
	Season04	140	30.76	2	275	25.0	31.51
	Season05	90	18.08	8	162	29.5	31.56
	Season06	62	24.08	1	136	17.0	23.10
	Season07	124	98.07	9	1042	41.5	54.48
	Season08	120	59.85	15	674	35.0	42.74
	ALL	1289	66.67	1	1042	37.0	52.28
ArprtR_102	Season99	141	17.41	1	93	11.0	16.85
	Season00	117	51.50	11	393	55.0	63.09
	Season01	165	20.23	10	168	35.0	40.01
	Season02	183	51.73	25	685	51.0	57.61
	Season03	147	30.03	1	210	60.0	63.12
	Season04	145	73.96	2	725	76.0	87.42
	Season05	95	33.21	22	275	72.0	77.19
	Season06	62	41.68	2	148	46.5	61.34
	Season07	98	10.01	12	58	34.0	33.70
	Season08	120	24.92	12	282	37.0	39.07
	ALL	1273	45.65	1	725	45.0	53.40

[1] In this summary, nondetected values are set equal to the detection limit.
[2] The mean is calculated as the arithmetic average.

13.5 Ammonia: Data Selected as Basis of Final Limitation

For ammonia, EPA is promulgating a compliance alternative with a daily maximum limitation for airports that use deicers containing urea on the runways. This section describes the data selected as the basis of the final limitation for ammonia.

After evaluating the available data, EPA transferred the 1-day-lag serial correlation value from the AFB technology, which is the model technology for COD. This transfer was necessary because an AFB system by design creates ammonia as a by-product of wastewater treatment. Consequently, AFB discharges could have higher ammonia concentrations than typically found in airfield stormwater when airfield deicers containing urea are not used. If the treated aircraft deicing stormwater discharges then were discharged to the same pipe as the runway wastewater, the airport might have difficulties complying with the ammonia limitation. EPA also confirmed that ADF treatment provided less concentrated discharges than observed from the application of urea products (ERG. 2009). For these reasons, EPA determined that it was appropriate to use the

ADF data as a basis of limitations that would apply to discharges associated with runway deicing.

As it had for COD, EPA initially evaluated the Albany data for setting final limitations for ammonia, because EPA had data on the performance of its model technology. In contrast to its practice of monitoring COD at the end of each treatment unit, the airport monitored ammonia at its permit compliance point after additional treatment provided by an aerobic polishing step. The anaerobic polishing step would result in decreased ammonia concentrations and would not represent ammonia discharges from using urea on airfields. Thus, to promulgate an effluent limit consistent with the model technology, EPA used the EPA data and excluded the Albany ammonia data (criterion 3).

Instead, because they reflect the capability of the model treatment system, EPA used its sampling data from EPA_SP-2, shown in Table 13-6, as the basis of the final ammonia limitations. (Section 13.6 describes field duplicates and the importance of daily values for the limitation calculations.) In analyzing samples from this episode, the laboratory achieved a detection limit of 0.05 mg/L. During the laboratory's quality assurance step of the chemical analysis, it detected ammonia in the laboratory preparation blank at a concentration of 0.069 mg/L. Other quality assurance parameters, initial calibration blanks and continuing calibration blanks, were between 0.052 mg/L and 0.054 mg/L. The ammonia results for all samples are greater than 10 times the blank result, with the exception of four influent and one source water samples that were not used as the basis of the final limitation. Consequently, EPA determined that the data were of acceptable quality to use as the basis of the final limitation.

Table 13-6. Ammonia: Data from Albany Airport Used to Develop Limitations

Sample Day	Ammonia Concentrations (mg/L)			
		Effluent		
	Influent	Original Sample	Field Duplicate (where collected)	Daily Value Used in Limitations Calculations
1	ND (0.1)	2.58		2.58
2	ND (0.1)	4.14	3.95	4.05
3	ND (0.1)	4.45	5.54	5.00
4	ND (0.1)	6.12		6.12
5	0.91	6.65		6.65

ND – Not Detected

13.6 Limitations: Basis and Calculations

The final limitations, as presented in the final rule, are provided as the daily maximum limitations for COD and ammonia. In addition, the notice includes a weekly average limitation for COD. This section defines the limitations (Section 13.6.1) and describes the statistical percentile basis of the limitations (Section 13.6.2) and the estimation of the percentiles for COD and ammonia (Sections 13.6.3). The statistical support memorandum (USEPA, 2010) describes the calculations used to model the ammonia data.

13.6.1 Definitions

Definitions provided in 40 CFR 122.2 describe the limitations in terms of "daily discharge," which it defines as "the 'discharge of a pollutant' measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling." Therefore, EPA generally arithmetically averages all measurements recorded for each uniquely reported time period (e.g., 12/21/2004) before calculating limitations. EPA refers to this averaged value as the "daily value."

First, in calculating the limitations, EPA ensures that it has only one value for each day. Field duplicates are one example of multiple measurements, and were included in the ammonia data used to develop the final limitations. Field duplicates are two samples collected at the same sample point at approximately the same time, flagged as duplicates for a single sample point, and measured separately. Because the analytical data from each duplicate pair characterize the same conditions at that time at a single sample point, EPA typically averages the data to obtain one data value for those conditions on that day. For example, Table 13-6 shows the field duplicates and daily, averaged values for ammonia.

Second, EPA uses the daily values in calculating the limitations. Definitions provided in 40 CFR 122.2 further describe the "maximum daily discharge limitation" as the "highest allowable 'daily discharge.'" The "average weekly discharge limitation" is the "highest allowable average of 'daily discharges' over a calendar week, calculated as the sum of all 'daily discharges' measured during a calendar week divided by the number of 'daily discharges' measured during that week."

13.6.2 Percentile Basis of the Limitations

EPA uses a statistical framework to establish limitations that facilities are capable of complying with at all times. Statistical methods are appropriate for dealing with effluent data because the quality of effluent, even in well-operated systems, is subject to a certain amount of fluctuation or uncertainty. Statistics is the science of dealing with uncertainty in a logical and consistent manner. Statistical methods together with engineering analysis of operating conditions, therefore, provide a logical and consistent framework for analyzing a set of effluent data and determining values from the data that form a reasonable basis for effluent limitations. Using statistical methods, EPA has derived numerical values for its final daily maximum limitations and weekly average limitations.

The statistical percentiles upon which the limitations are based are intended to be high enough to accommodate reasonably anticipated variability within control of the facility. The limitations also reflect a level of performance consistent with the CWA requirement that these limitations be based on the best technologies that are properly operated and maintained.

In establishing daily maximum limitations, EPA's objective is to restrict the discharges on a daily basis at a level that is achievable for an airport that targets its treatment system design and operation at the long-term average while allowing for the variability around the long-term average that results from normal operations. This variability means that at certain times airports may discharge at levels that are greater or considerably lower than the long-term average. To allow for possibly higher daily discharges, EPA has established the daily maximum limitation at a relatively high level (i.e., the 99th percentile). Due to routine variability in treated effluent, an airport that discharges consistently at a level near the daily maximum limitation, instead of the long-term average, may experience frequent values exceeding the limitations. For this reason, EPA recommends that airports target the treatment system at the long-term average that it derived for the model technology.

In its derivation of the weekly average limitation for COD, EPA used an estimate of the 97th percentile of the weekly averages of the daily measurements. This percentile basis is the midpoint of the percentiles used for the daily maximum limitation (i.e., 99th percentile of the distribution of daily values) and the monthly average limitation (i.e., 95th percentile of the distribution of monthly average values). Courts have upheld EPA's use of these percentiles, and the selection of the 97th percentile is a logical extension of this practice. Compliance with the daily maximum limitation is determined by a single daily value; therefore, EPA feels the 99th percentile provides a reasonable basis for the daily maximum limitation by allowing for an occasional extreme discharge. Because compliance with the monthly average limitation is based upon more than one daily measurement and averages are less variable than daily discharges, EPA has determined that facilities should be able to control the average of daily discharges to avoid extreme monthly averages above the 95th percentile. Similar to the monthly average limitation, compliance with the weekly average limitation also would be based upon more than one daily measurement. However, the airport would monitor for a shorter time and thus would have fewer opportunities to counterbalance highly concentrated daily discharges with lower ones. For this reason, EPA is utilizing a larger percentile for the weekly average limitation than the one used for the monthly average limitation. Consequently, EPA is using the 97th percentile as an appropriate basis for limiting average discharges on a weekly basis. EPA also considers this level of control in avoiding extreme weekly average discharges to be possible for airports using the model technology.

13.6.3 Estimation Procedures for Percentiles

This section describes the estimation procedures that EPA used to calculate the limitations for the final rulemaking. Sections 13.6.3.1, and 13.6.3.2 describe the estimation procedures used to model the COD data and the June 8, 2009, memorandum on calculation of percentiles (Westat. 2009) describes the calculations used by the statistical software. Section 13.6.3.3 describes the procedures for ammonia.

Table 13-7 summarizes the limitations that EPA established for COD and ammonia. Because of the importance of targeting treatment to the long-term average, EPA recommends that facilities design, maintain, and operate the treatment system to achieve a long-term average of 52.8 mg/L, which is the median of the averages from the two units (52.28 mg/L for ArprtR_101 and 53.40 for ArprtR_102, as shown in Table 13-5). The allowance for variability, or the ratio of the limitation to the long-term average, is 5.13. (EPA usually refers to this allowance as the "variability factor.") In other words, the daily maximum limitation is 5.13 times greater than the long-term average achievable by the model technology. By targeting the system to the long-term average and controlling its variability within this range, the facility will be able to comply with the limitation.

Table 13-7. COD and Ammonia: Final Limitations with Long-Term Averages and Variability Factors

Parameter	Time Period	COD	Ammonia
Limitations (mg/L)	Daily Maximum	271	14.7
	Weekly Average	154	NA
Long-Term Average (mg/L)	All	52.8	5.24
Variability Factors	Daily	5.13	2.81
	Weekly	2.92	NA

NA – Not applicable

13.6.3.1 COD: Daily Maximum Limitation and the 99th Percentile

For COD, EPA based the final daily maximum limitation on an estimate of the 99th percentile of the distribution of the daily values. This section describes the percentile estimates and the long-term average.

First, EPA used nonparametric methods to estimate the 99th percentile of the daily values from each unit. A simple nonparametric estimate of the 99th percentile of an effluent concentration data set is the observed value that exceeds 99 percent of the observed data points. Because EPA had more than 1,200 data points for each unit, it determined that the empirical approach would provide reasonable estimates of the 99th percentiles.

Second, EPA set the final limitation equal to the median of the two 99th percentile estimates, or 271 mg/L. The median is, by definition, the midpoint of all available data values ordered (i.e., ranked) from smallest to largest. As result, half of the unit 99th percentiles are higher than the median and half are lower. (In this particular case, because there are two units, the median is equal to the arithmetic average (or mean).)

Table 13-8 summarizes the percentile estimates for the two units, the minimum and maximum values observed in the data, the 50th percentiles, and the 99th percentiles.

Table 13-8. COD: 99th Percentile Estimates from Each Treatment Unit

Treatment Unit	Number of Daily Values	Concentrations (mg/L)			
		Minimum	50th Percentile	Maximum	99th Percentile
ArprtR-101	1,289	1	37	1042	326
ArprtR-102	1,273	1	45	725	216
Median Values			41		271

13.6.3.2 COD: Weekly Average Limitation and the 97th Percentile

For the weekly average limitation of COD, EPA first calculated, for each unit, the arithmetic average of the measurements observed during each week, excluding weekends (to be consistent with the assumed monitoring costs, although permit authorities may specify different monitoring requirements). EPA then used the nonparametric method to derive a 97th percentile of the more than 200 weekly averages for each unit, and set the final limitation equal to the median of the two 97th percentile estimates, or 154 mg/L. The statistical support memorandum (USEPA, 2010) lists the weekly averages.

Because data were not always available for every weekday during a week, EPA examined whether the weekly averages were affected by the number of weekdays included in the average. As shown in Table 13-9, the value of the limitation varied only slightly if the weeks were required to have data for all five days. The June 23, 2009, memorandum on percentiles for weekly averages (Westat, 2009a) provides a more detailed evaluation.

Table 13-9. COD: Effect of Number of Daily Values in Weekly Averages

Number of Daily Values in Average	Unit ArprtR-101		Unit AirprtR-102		Median of 97th Percentiles
	Number of Weekly Averages	97th Percentile	Number of Weekly Averages	97th Percentile	
5	155	176.8	157	133.6	155.2
4 or 5	181	176.8	181	133.6	155.2
1 to 5 [1]	209	162.4	203	145.5	153.95

[1] Averages in this row were used as the basis of the final weekly average limitation.

13.6.3.3 Ammonia: Percentile Estimates Based Upon the Lognormal Distribution

Because the ammonia data set had fewer than 100 observations, EPA used a parametric approach to model the data. If a data set comprisese fewer than 100 observations, the best that can be done, using nonparametric methods, is to use the maximum value as an approximate nonparametric estimate of the 99th percentile, but this can underestimate the true value. Parametric methods require that a probability distribution be specified, which allows estimation of unknown parameters from the available data. The estimated parameters are a function of the defined distribution and the data, and thus the parametric method enables the percentiles of effluent concentrations to be computed analytically. EPA's selection of parametric methods in developing limitations for other industries is well documented (e.g., Iron and Steel, Pulp, Paper, and Paperboard, and Metal Products and Machinery categories). EPA considers the lognormal distribution to be appropriate for the ammonia data, and this section describes its application in estimating the final daily maximum limitation. The daily maximum limitation of 14.7 mg/L is based upon an estimate of the 99th percentile of the lognormal distribution of the daily values.

The calculations include an adjustment for possible bias due to statistical autocorrelation. The adjusted variance then better reflects the underlying variability that would be present if the data were collected over a longer period. When data are said to be positively autocorrelated, it means that measurements taken at specific time intervals (such as 1 day or 2 days apart) are similar. For example, positive autocorrelation would be present in the data if the final effluent concentration was relatively high one day and was likely to remain at similar high values the next and possibly succeeding days. EPA sampling data, used as the basis of the limitations, were collected on five consecutive days, and thus, the data may be autocorrelated, but the length of time was not sufficient for autocorrelation evaluations. Albany Airport's self-monitoring data also were not suitable for the evaluation because they were collected at three-week intervals rather than consecutive days. In contrast, the Iron and Steel rule had 244 data points for ammonia that generally were collected on consecutive days, so it was possible to evaluate autocorrelation in the data. Because the model technologies for both industries are biological systems, EPA concludes that the Iron and Steel autocorrelation adjustment is a reasonable transfer that can be used to calculate the airport deicing limitations.[10] Table 13-10 summarizes the final long-term average and daily maximum limitation, with and without the adjustment for autocorrelation. The final daily maximum limitation of 14.7 mg/L is 2.8 times greater than the long-term average, of 5.24 mg/L, achievable by the model technology. By targeting the system to the long-term average and controlling its variability within this range, the facility will be able to comply with the limitation. However, ammonia is generated as a by-product of the model technology, and EPA expects the concentrations of ammonia to have similar variability to what is being treated (i.e., COD). In contrast to the COD limitations, which are based on a mixture of start-up and steady-state periods, the ammonia limitation is based upon data collected only during steady-state operations.

Table 13-10. Ammonia: Consideration of Autocorrelation for Final Limitations, Long-Term Averages, and Variability Factors

Statistical Parameter	Adjusted for Autocorrelation?		Percent Difference
	No	Yes (Final)	
Long-Term Average (mg/L)	4.97	5.24	5%
Variability Factor	2.25	2.81	25%
Daily Maximum Limitation (mg/L)	11.2	14.7	31%

Unlike COD, EPA is not setting a weekly ammonia effluent limitation. The technology basis for the COD effluent limitations would operate throughout the deicing season with continuous discharges allowing for weekly monitoring. In contrast, urea is applied to airfield pavement as needed, and discharges would occur for a short time after the initial application, as the urea works its way through the stormwater collection and any associated treatment system that may be present. Most airports would have noncontinuous and somewhat infrequent urea discharges. Consequently, it would be difficult to assume a single value for the monitoring frequency that could reasonably be applied to all airports, regardless of climatic conditions.

13.6.3.4 Significant Digits for Final Limitations

In presenting the values of the final limitations, EPA rounded the values to three significant digits. EPA used a rounding procedure where values of five and above are rounded up and values of four and below are rounded down. For example, a value of 5.235 would be rounded to 5.24, while a value of 5.234 would be rounded to 5.23.

13.7 Achievability of Limitations

EPA promulgates limitations that sites are capable of complying with at all times by properly operating and maintaining their processes and treatment technologies. As a consequence of using the percentile basis for each final limitation, treatment systems that are designed and operated to achieve long-term average levels should be able to comply with the limitations, which incorporate variability, at all times. As verification that the limitations are achievable,

[10] EPA has not incorporated a similar adjustment for autocorrelation into the data for the COD limitations because the limitation is based upon more than 2500 measurements collected over 10 years, which presumably would show a full range of variability expected by the model technology. (DCNs AD01210 and AD01214)

EPA performs additional statistical and engineering reviews, as described in Section 13.7.1. As a result of these reviews, EPA has concluded that these limitations are achievable, and thus EPA expects facilities to comply with the limitations as explained in Section 13.7.2.

13.7.1 Statistical and Engineering Review of Limitations

In conjunction with the statistical methods, EPA performs an engineering review to verify that the limitations are reasonable based upon the design and expected operation of the control technologies and the airport conditions. The following sections describe two types of comparisons. First, EPA compares the final limitations to the data used to develop the limitations. Second, EPA compares the limitations to the influent data.

13.7.1.1 Comparison to Data Used As Basis for the Limitations

As part of its data evaluations, EPA compared the value of the final limitations to the values used to calculate the limitations. None of the data selected for ammonia were greater than its final daily maximum limitation that supports the engineering and statistical conclusions that the limitation values are appropriate. Because of the statistical methodology used for the COD limitations, some values were greater than the final limitations.

For COD, appropriately one percent of the values were greater than the final daily maximum limitation, which is consistent with the statistical basis (i.e., use of the 99^{th} percentile) of the limitation. Table 13-11 lists the data from both units and the influent, when one or both effluent values were greater than the limitation. Of the 27 values greater than the final limitation, 20 were from the ArprtR-101 unit, and 7 from ArprtR-102 unit. Both units had values greater than the final limitation on three dates: 3/31/2001, 1/4/2005, and 12/25/2008.

Of the 412 weekly averages of the COD concentrations, 12 averages had values that were greater than the final weekly average limitation of 154 mg/L. Of those 12 averages, 10 were during weeks when the unit also had one or more daily values that were greater than the daily maximum limitation. The statistical support memorandum (USEPA, 2010) identifies the weeks and the corresponding daily values.

13.7.1.1 Comparison to Influent

In addition to evaluating the data used as the basis of the limitations, EPA often compares the value of the final limitations to influent concentration levels. In these comparisons, EPA determines if the limitations perform as expected.

As part of its evaluation to determine if the COD limitation was sufficiently stringent to require that the influent be treated, EPA evaluated the COD influent discharges from Albany Airport. As shown in the summary statistics in Table 13-12, all influent values were greater than the final limitation during nine deicing seasons. For the season 06, only two values (1/1/2007 and 1/2/2007) were less than the final limitation.[11] This finding confirmed that the final limitation can only be met through treatment.

[11] For both dates, the facility reported the same values for influent (100 mg/L), the same values for ArprtR-101 (30 mg/L), and the same estimated values for ArprtR-102.

Table 13-11. COD: Dates and Values Greater than Final Limitation of 271 mg/L

Season	Date	COD Concentrations (mg/L) [1]	
		ArprtR_101	ArprtR_102
Season99	16MAR2000	**326**	33
	23MAR2000	**315**	93
Season00	01MAR2001	**276**	232
	11MAR2001	**288**	64
	12MAR2001	**575**	92
	22MAR2001	129	**393**
	31MAR2001	**357**	**288**
Season02	18MAY2003	(Estimated to be 800) [2]	**685**
	19MAY2003	**460**	95
	20MAY2003	**655**	86
	22MAY2003	**290**	101
Season03	20DEC2003	**278**	2
	03JAN2004	**690**	36
	08JAN2004	**387**	37
	08FEB2004	**435**	74
	09FEB2004	**453**	49
	16MAR2004	**316**	124
	17MAR2004	**699**	118
Season04	04JAN2005	**275**	**725**
	04FEB2005	38	**360**
Season05	09DEC2005	162	**275**
Season07	09JAN2008	**1,042**	Out of service
	10JAN2008	**433**	Out of service
Season08	25DEC2008	**674**	**282**

[1] Bold text indicates effluent values greater than the limitations.
[2]This value was not used in calculating the limits because it was an estimated value (see DCN AD01246)

Table 13-12. COD: Summary Statistics of Influent Concentrations

Season	#of Days	COD: Influent Concentration (mg/L)				
		Standard Deviation	Minimum	Maximum	Median	Arithmetic Average
Season99	141	1,536	1,000	6,560	2,784	3,242
Season00	115	1,257	1,797	7,950	5,505	5,208
Season01	167	1,505	342	7,105	3,975	3,949
Season02	187	1,825	2,915	10,470	7,270	7,144
Season03	145	2,412	655	10,060	6,520	5,996
Season04	141	1,790	1,848	8,870	5,580	5,272
Season05	85	1,685	528	7,410	4,900	4,373
Season06	62	1,700	100	5,760	1,880	2,588
Season07	127	2,132	485	11,000	7,540	6,805
Season08	120	4,409	3,550	18,300	8,875	10,022
ALL	1,290	2,928	100	18,300	5,490	5,630

13.7.2 Compliance with Limitations

EPA promulgates limitations that sites are capable of complying with at all times by properly operating and maintaining their processes and treatment technologies. However, the issue of exceedances or excursions (values that exceed the limitations) is often raised. In other rules, including EPA's final OCPSF rule, commenters suggested that EPA include a provision that a facility is in compliance with permit limitations provided its discharge does not exceed the specified limitations, with the exception that the discharge may exceed the daily maximum limitation 1 day out of 100. EPA's general approach in that case for developing limitations based on percentiles was the same as this rule and was upheld in *Chemical Manufacturers Association v. U.S. Environmental Protection Agency,* 870 F.2d 177, 230 (5th Cir. 1989). The Court determined the following:

> EPA reasonably concluded that the data points exceeding the 99th and 95th percentiles represent either quality-control problems or upsets because there can be no other explanation for these isolated and extremely high discharges. If these data points result from quality-control problems, the exceedances they represent are within the control of the plant. If, however, the data points represent exceedances beyond the control of the industry, the upset defense is available. Id. at 230.

This issue also was raised in EPA's Phase I rule for the Pulp, Paper, and Paperboard Category (USEPA, 1998). In that rulemaking, EPA used the same general percentile approach for developing monthly average limitations that it used for daily maximum limitation for the airport deicing rule. The percentile approach for the monthly average limitation was upheld in

National Wildlife Federation et al. v. Environmental Protection Agency, 286 F.3d 554, 573 (D.C. Cir. 2002). The Court determined that:

> EPA's approach to developing monthly limitations was reasonable. It established limitations based on percentiles achieved by facilities using well-operated and controlled processes and treatment systems. It is therefore reasonable for EPA to conclude that measurements above the limitations are due to either upset conditions or deficiencies in process and treatment system maintenance and operation. EPA has included an affirmative defense that is available to mills that exceed limitations due to an unforeseen event. EPA reasonably concluded that other exceedances would be the result of design or operational deficiencies. EPA rejected Industry Petitioners' claim that facilities are expected to operate processes and treatment systems to violate the limitations at some pre-set rate. EPA explained that the statistical methodology was used as a framework to establish the limitations based on percentiles. These limitations were never intended to have the rigid probabilistic interpretation that Industry Petitioners have adopted. Therefore, we reject Industry Petitioners' challenge to the effluent limitations.

As that Court recognized, EPA's allowance for reasonably anticipated variability in its effluent limitations, coupled with the availability of the upset defense, reasonably accommodates acceptable excursions. Any further excursion allowances would go beyond the reasonable accommodation of variability and would jeopardize the effective control of pollutant discharges on a consistent basis and/or bog down administrative and enforcement proceedings in detailed fact-finding exercises, contrary to Congressional intent. See, for example, Rep. No. 92-414, 92d Congress, 2d Sess. 64, reprinted in *A Legislative History of the Water Pollution Control Act Amendments of 1972* (at 1482); *Legislative History of the Clean Water Act of 1977* (at 464-65).

More recently, for EPA's rule for the iron and steel industry, EPA's selection of percentiles was upheld in *American Coke and Coal Chemicals Institute v. Environmental Protection Agency,* 452 F.3d 930, 945 (D.C. Cir. 2006). The Court determined that:

> The court will not second-guess EPA's expertise with regard to what the maximum effluent limits represent. *See Nat'l Wildlife*, 286 F.3d at 571-73. As EPA explains in the Final Development Document, the daily and monthly average effluent limitations are not promulgated with the expectation that a plant will operate with an eye toward barely achieving the limitations. Final Development Document at § 14.6.2. Should a plant do so, it could be expected to exceed these limits frequently because of the foreseeable variation in treatment effectiveness. Rather, the effluent limitations are promulgated with the expectation that plants will be operated with an eye towards achieving the equivalent of the long term average for the BAT-1 model technology. *Id.* However, even operated with the goal of achieving the BAT-1 long term average, a plant's actual results will vary. EPA's maximum daily limitations are designed to be forgiving enough to cover the operations of a well-operated model facility 99% of the time, while its maximum monthly average limitations are designed to be forgiving enough to accommodate the operations of a well-operated model facility 95% of the time. *See id.* EPA's choice of percentile distribution represented by its maximum

effluent limitation under the CWA represents an expert policy judgment that is not arbitrary or capricious.

EPA expects that airports will comply with promulgated limitations at all times. If an exceedance is caused by an upset condition, the airport would be able to defend against an enforcement action if it meets the requirements of 40 CFR 122.41(n). If the exceedance is caused by a design or operational deficiency, EPA has determined that the airport's performance does not represent the appropriate level of control (best available technology for existing sources; best available demonstrated technology for new sources). For promulgated limitations and standards, EPA has determined that such exceedances can be controlled by diligent process and wastewater treatment system operational practices such as frequent inspection and repair of equipment, use of backup systems, and operator training and performance evaluations.

13.8 References

ERG. 2008. Personnel communication (email) between Mary Willett (ERG) and Mark Sober, Albany International Airport. (July 22). DCN AD00824.

ERG. 2008a. Email from Mark Sober (Albany International Airport) to Mary Willett (ERG). RE: One More Query. (July 22). DCN AD01206.

ERG. 2008b. Telecon between Cortney Itle (ERG) and Mark Sober (Albany International Airport). RE: ALB Follow-up Questions. (August 14). DCN AD00825.

ERG. 2009. Memorandum from Mary Willett (ERG) to Brian D'Amico (EPA). *Evaluation of Proposed Compliance Alternative Ammonia Limitations with respect to Airport Deicing Stormwater Typical Ammonia Discharges.* (June 30). DCN AD01194.

USEPA. 1987. *Organic Chemicals and Plastics and Synthetic Fibers Category Effluent Limitations Guidelines, Pretreatment Standards and New Source Performance Standards; Final Rule.* 40 CFR Part 414, 52 FR 42522, November 5, 1987.

USEPA. 1998. *National Emission Standards for Hazardous Air Pollutants for Source Category: Pulp and Paper Production; Effluent Limitations Guidelines, Pretreatment Standards, and New Source Performance Standards: Pulp, Paper, and Paperboard Category; Final Rule.* 40 CFR Part 430, 63 FR 18503, April 15, 1998.

USEPA. 2002. *Development Document for Effluent Limitations Guidelines and Standards for the Iron and Steel Manufacturing Point Source Category*. EPA-821-R-02-004. Section 14.1. Available online at www.epa.gov/guide/ironsteel/.

USEPA. 2006. *Notice of Availability of Final 2006 Effluent Guidelines Program Plan.* December 21, 2006; 71 FR 76655.

USEPA. 2010. Memorandum from Cuc Schroeder (EPA) to Brian D'Amico (EPA). *Statistical Support Memorandum*. (November). DCN AD01246.

Westat. 2009. Memorandum from John Rogers (Westat) to Marla Smith (EPA). *Calculation Percentiles*. (June 8). DCN AD01213.

Westat. 2009a. Memorandum from John Rogers (Westat) to Marla Smith (EPA). *Percentiles for Weekly Averages*. (June 23). DCN AD01214.