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DESIGN AND OPERATION OF AIRCRAFT DEICING FACILITIES

INTRODUCTION

The division of this manual is intended to consolidate related technical material into a structure that facilitates its use with respect to specific areas of interest or consideration. The sections have been assembled in an order that reflects one logical progression through the decision-making process, and ultimately through the deicing facility planning and design process. However, the manual's structure supports the review and use of discrete sections in those situations that do not require the comprehensive application of all the planning and design considerations contained in the manual.

FOREWORD

This document presents guidance material for the planning, design, construction, and operation of terminal area or remote deicing/anti-icing facilities. It is intended to provide the airport operator and deicing facility planner/designer an understanding of the issues and relevant information necessary to define the need for a deicing facility and identify factors influencing its size, location and operation, including airport and aircraft operational characteristics, physical site constraints, and environmental considerations and/or constraints. While this document does not recommend any specific type or configuration of deicing facility, it does present the general issues and concerns which should be addressed in assessing the need for and the planning/design of such facilities based on the combined knowledge of the authors. It should be recognized that due to the unique physical and operational characteristics of each airport, there may be unique considerations at a specific site that are not raised in this manual. This manual has been developed by the SAE Subcommittee for Aircraft Deicing Facilities.

Recent events in the aviation industry have highlighted the need for more definitive procedures for the detection and treatment of ice contamination on aircraft control surfaces. Currently, regulations state that no person may dispatch or release an aircraft when, in the opinion of the pilot in command or dispatcher, icing conditions are expected or met that might adversely affect the safety of flight. However, recent incidents indicate that under the previous procedures the pilot in command may not always be able to effectively determine the presence of contaminants. In order to rectify this condition and to provide an added level of safety to aircraft operations in ground icing conditions, the Federal Aviation Administration (FAA) on July 22, 1992 issued a Notice of Proposed Rulemaking (NPRM)

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proposing an amendment to 14 Code of Federal Regulation (CFR) Part 121 requiring Part 121 certificate holders during icing conditions to comply with an FAA-approved aircraft ground deicing/anti-icing program or perform exterior aircraft checks five minutes prior to takeoff. The interim final rule was issued by the FAA on September 29, 1992, and included a compliance date of November 1, 1992. On December 30, 1993, the FAA issued an interim final rule covering 14 CFR Parts 125 and 135 certificate holders.

A key requirement for air carriers complying with an FAA-approved program is the use of estimated holdover times by aircraft within its fleet. At airports where winter weather-related delays are prevalent, use of off-gate or near departure runway end deicing facilities may become an integral part of an air carrier's ground deicing/anti-icing program necessary to meet estimated holdover times.

Environmental runoff mitigation should be an integral part of deicing facilities. Storm water discharge regulations enacted by the United States Environmental Protection Agency (USEPA), State and local authorities, or other environmental regulatory agencies, can significantly change or limit the disposal options available for spent deicing fluids at most airports. In terms of environmental mitigation, off-gate deicing facilities may in some cases be the best option for collecting spent deicing fluids for proper treatment and disposal.

It is important to recognize that the determination of the need for deicing facilities rests with airports which serve aircraft that can develop frost or ice on critical surfaces even though the airport itself may not experience ground icing conditions. If the development of a deicing facility is determined necessary, appropriate and feasible based on analysis, close coordination of planning and design efforts with airport management, users, FAA, Federal, State, and local environmental agencies, pilot groups, and the deicing facility operator(s) is strongly encouraged. To ensure development of a deicing facility capable of serving the needs of the airport and its users safely and efficiently, the formation of a deicing committee consisting of the listed representatives is recommended.

Proper planning, design, construction, and operation of deicing facilities requires the careful integration of numerous general issues and concerns. To facilitate the discussion of these parameters, this manual has been divided into the following sections:

1. Scope
2. References
3. Siting Considerations
4. Deicing Facility Design and Construction
5. Environmental Considerations
6. Operational Considerations

Each of these sections is further subdivided into subsections, as appropriate, to address specific issues.

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1. SCOPE:

This document provides information and guidance material to assist in assessing the need for and feasibility of developing deicing facilities, the planning (sizing and siting) and design of deicing facilities, and assessing environmental considerations and operational considerations associated with deicing facilities.

The document presents relevant information necessary to define the need for a deicing facility and factors influencing its size, location, and operation. The determination of the need for deicing facilities rests with airports.

2. REFERENCES:

2.1 Applicable Documents:

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. Nothing in this document supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001

AMS 1424 Deicing/Anti-icing Fluid, Aircraft, SAE Type I
AMS 1428 Fluid, Aircraft Deicing/Anti-icing, Non-Newtonian, Pseudo-plastic, SAE Type II, III and IV
AMS 1435 Fluid, Generic, Deicing/Anti-icing, Runways and Taxiways

ARP1971 Large Deicing Equipment
ARP4047 Small Deicing Equipment
ARP4737 Aircraft Deicing/Anti-icing Methods with Fluids, for Large Transport Aircraft

2.1.2 ISO Publications: Available from ISO, Case Postal 56, Rue de Varembe, CH-1211 Geneva 20, Switzerland.

ISO 11075 Aerospace - Aircraft deicing/anti-icing newtonian fluids ISO type I
ISO 11076 Aerospace - Aircraft deicing/anti-icing methods with fluids
ISO 11077 Aerospace - Deicing/anti-icing self propelled vehicles-Functional requirements
ISO 11078 Aerospace - Aircraft deicing/anti-icing non-newtonian fluids ISO type II

2.1.3 U.S. Federal Aviation Administration Publications: Available from U.S. Department of Transportation, General Services Section, M-443.2, Washington, DC 20590

AC 120-57	Surface Movement Guidance and Control System.
AC 150/5300-13	Airport Design.
AC 150/5300-14	Design of Aircraft Deicing Facilities.
FAR Part 77	Objects Affecting Navigable Airspace
FAR Part 139	Certification and Operations: Land Airports Serving Certain Air Carriers
Order 6750.16B	Siting Criteria for Instrument Landing Systems.
Order 8260.3B	United States Standards for Terminal Instrument Procedures (TERPS).

2.1.4 ICAO Publications: Available from International Civil Aviation Organization, Document Sales Unit, 999 University Street, Montreal, Quebec, Canada H3C 5H7.

Annex 6, Operation of Aircraft
Annex 14, Volume I, Aerodrome Design and Operations
DOC 9640-AN/940, Manual of Aircraft Ground De/Anti-Icing Operations

2.2 Definitions:

As used in this document, the following terms are defined as follows:

2.2.1 AIRCRAFT DEICING FACILITY: An aircraft deicing facility is a facility where: frost, ice, slush, or snow is removed (deicing) from the aircraft in order to provide clean surfaces, and/or clean surfaces of the aircraft receive protection (anti-icing) against the formation of frost or ice and accumulation of snow or slush for a limited period of time.

2.2.1.1 TERMINAL DEICING FACILITY: A deicing facility for one or several aircraft located at or near the terminal or other location where aircraft loading activity normally takes place.

2.2.1.2 REMOTE DEICING FACILITY: A deicing facility for single or multiple aircraft located away from the terminal or other area where aircraft loading activities normally take place.

2.2.2 AIRCRAFT DEICING PAD: An aircraft deicing pad consists of two areas: an inner area for the parking of aircraft to receive deicing/anti-icing treatment and an outer area for maneuvering two or more mobile deicing vehicles. This outer area provides the "vehicle lane width" necessary for two or more mobile deicing vehicles to satisfactorily perform simultaneous and complete left and right side uniform fluid distribution techniques for removing deposits of frost, ice, slush, and snow from aircraft surfaces and for anti-icing operations. ARP4737 notes: "Dual vehicle fluid applications help in eliminating potential aerodynamic problems resulting from fluid applications by a single mobile deicing vehicle." See Figure 1.

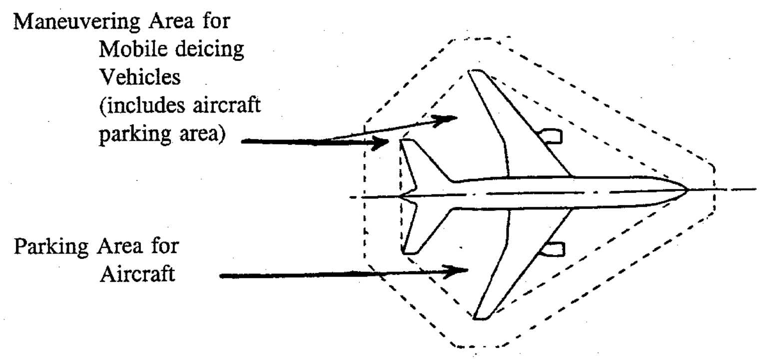

FIGURE 1 - Aircraft Deicing Pad

2.2.3 HOLDOVER TIME: Holdover time is the ESTIMATED time the application of anti-icing fluid will prevent the formation of frost or ice, and the accumulation of snow or slush on the protected surfaces of an aircraft. Holdover time begins when the final application of anti-icing fluid commences, and it expires when the anti-icing fluid applied to the aircraft loses its effectiveness. For departure planning purposes, the Society of Automotive Engineers (SAE) and the International Organization for Standardization (ISO) publish type I, II, III and IV fluid holdover time guidance in ARP4737 and ISO 11076.

2.2.4 AIRCRAFT DEICING/ANTI-ICING FLUIDS: Fluids used in the removal and prevention of frozen deposits of frost, ice, slush, and snow on exterior surfaces of parked aircraft. Present fluids are glycol-based fluids with additives, such as wetting agents, inhibitors, etc., meeting specific fluid specifications established by such organization as SAE and ISO. Since different deicing/anti-icing fluids are in use today, the appropriate fluid specification identifier should precede the word "type", e.g., SAE Type IV, ISO Type II.

3. SITING CONSIDERATIONS:

3.1 Introduction:

Thoughtful siting of deicing facilities is critical in order to maximize the benefits of the deicing/anti-icing process while minimizing the potential adverse impacts on airfield efficiency and operations. This section identifies considerations in siting deicing facilities to facilitate compliance with the "clean aircraft" concept. Foremost among such considerations is the need to site deicing facilities so that the maximum time interval between the start of the last step of the deicing/anti-icing process, subsequent taxiing and the start of takeoff does not exceed the estimated holdover times of the applied fluids. Other major considerations include the need to site deicing facilities so that aircraft, deicing facility structures, and mobile deicing vehicles or fixed deicing equipment do not penetrate the object clearing criteria (airspace and ground areas, section 3.2.1.1.1) and airway facility critical areas, such as NAVAIDs (section 3.2.1.4).

3.1.1 This section also addresses the need to site deicing facilities in consideration of typical winter meteorological conditions (section 3.3.3), so that they are accessible to users, promote efficient ground movement of aircraft, facilitate maintenance and integrity of both aircraft arrival and departure schedules, and provide for the safety of passengers, ground crews, and aircraft.

3.1.2 Finally, this section identifies considerations involved in siting deicing facilities with respect to integrating them into the existing and future airport infrastructure (section 3.5).

3.2 Inventory:

An inventory of existing and future airport facilities and conditions at an airport should be the first step in siting deicing facilities, as well as of physical and operational constraints. Existing and future airport conditions should include operational scenarios and characteristics.

3.2.1 Physical Constraints: There are a number of areas on or near an airfield restricted to certain types of activity, or to no movement or object penetrations at all, which are defined by regulatory agencies (FAA, ICAO, Transport Canada, etc.) to enhance the safety of aircraft movements and operations. Although common regulatory agency design standards and recommendations are addressed here, it is emphasized that considering the unique nature of every airport, there may be other requirements not listed that bear on the siting process. Below are relevant FAA clearance and separation standards. Comparable ICAO standards, that may use similar terminology, are contained in Annex 14, Volume I, Aerodrome and Operations, and other ICAO related service manuals.

3.2.1.1 FAA Clearance and Separation Standards: To help ensure safe airfield operations, the following clearance and separation design standards and recommendations found in FAA Advisory Circular (AC) 150/5300-13 will impact the siting of deicing facilities. These areas cannot be compromised without an attendant impact on airport operations and potential reduction of the level of safety of aircraft operations.

3.2.1.1.1 Object Clearing Criteria: The object clearing criteria subdivides the 14 CFR Part 77, Subpart C, airspace and object free area (OFA) ground area by type of objects tolerated within each subdivision. Designers should be aware that aircraft are controlled by the aircraft operating rules and not by this criteria. Specific areas and their standard dimensions, as referenced in AC 150/5300-13, are as follows:

a. Object Free Area (OFA) - Tables 3-1, 3-2, 3-3, and 4-1.

b. Runway Safety Area (RSA) - Tables 3-1, 3-2, and 3-3.

c. Taxiway Safety Area (TSA) - Table 4-1.

d. Runway Obstacle Free Zone (OFZ) - Paragraph 306.

e. Threshold Siting Requirements - Appendix 2.

f. Airway Facilities - Chapter 6 provides site requirements for NAVAID "critical areas" and FAA Order 6750.16B defines the critical areas.

g. Runway Protection Zone (RPZ) - Table 2-5. The dimensions of the RPZ are a function of the design aircraft, type of operation, and runway visibility minimums.

3.2.1.1.2 Separation Standards: The physical separation standards between runways, taxiways, taxilanes and from objects, restrict the siting of deicing facilities. Tables 2-1, 2-2, and 2-3 of AC 150/5300-13 specifies the standard dimensions. The separation standards may need to be increased with airport elevation to meet RSA and OFZ standards. Noncompliance with these separation standards in siting a deicing facility can result in the need to utilize specific taxi routings which reduces aircraft operational efficiency and flexibility, or can impose other operating restrictions.

3.2.1.2 14 CFR Part 77, Subpart C: 14 CFR Part 77, Subpart C defines obstructions to air navigation (standards). Part 77 surfaces preclude deicing facility structures and users obstructions to air navigation, except those which an aeronautical study determines are not a hazard.

3.2.1.3 Terminal Instrument Procedures (TERPS): Certain portions of airspace, determined by the application of operating rules and TERPS, require clearing for aircraft operations. These are prescribed in the TERPS Manual, Order 8260.3B.

3.2.1.4 Airway Facility Critical Areas: Deicing facilities should be sited so that airway facilities such as NAVAIDS, monitoring equipment, and communication shelters are at a sufficient distance from aircraft in the facility so as to minimize the impact of jet blast/exhaust and the potential accumulation of exhaust deposits on antennas. Deicing facilities and mobile vehicle staging or operating areas, as well as power lines, fences, metal buildings, etc., must be located to preclude any reflection, derogation or blockage of signals from existing NAVAIDS or areas planned to support future NAVAID installations. It should also be noted that the signals of certain vintage NAVAIDS may be more susceptible to interference or derogation than newer generation equipment. This should be considered where applicable. Typical siting considerations include but are not limited to:

a. Localizer antenna
b. Glide slope antenna
c. Azimuth antenna
d. Elevation antenna
e. Distance measuring equipment (DME)
f. Marker beacons
g. Nondirectional beacon
h. Very high frequency omnirange (VOR)
i. Airport surveillance radar (ASR)
j. Airport Surface Detection Equipment (ASDE) antenna
k. Microwave communication paths for fixed systems

Some airports may have further requirements for the installation of additional communications equipment because of the assignment of operating frequencies to meet the operating needs of the deicing facility. Additional communications equipment installations may result from increased ground control frequencies necessary for air traffic control to provide safe flow of airport ground traffic and for ground deicing personnel to conduct safe deicing operations.

3.2.1.5 Air Traffic Control Tower (ATCT) Line-of-Sight Limitations: One siting objective relative to ATC is a clear line-of-sight to and through the deicing facility. Even though deicing facilities may be in nonmovement areas, line-of-sight from the ATCT should always be maintained. The deicing facility should also be sited to allow ATC a clear view of movements and activity in the area of the deicing facility. This capability enables ATC to hand-off aircraft to the deicing facility and pick up departing aircraft from the facility. An exception can be considered for a potential site where the deicing facility located in a nonmovement area interferes with line-of-sight but there is adequate line-of-sight for the hand-off and pickup points. Potential line-of-sight obstructions to existing or future airfield components resulting from aircraft utilizing the facility should also be evaluated. Additionally, to maintain visual contact from the ATCT, aircraft being deiced/anti-iced should not shadow active runway ends or their entrance taxiways. To minimize shadows, aircraft in use (or planned) with the largest surfaces (i.e., wingspan, tail height, etc.) to be treated should be evaluated.

Consideration should also be given to the evaluation of line-of-sight considerations associated with movement areas from future ATCT cab positions to the extent these areas are planned or relevant.

3.2.1.6 Other Physical Constraints: In addition to the requirements set by a regulatory agency and airport operators, a prudent facility siting approach dictates appropriate consideration of other factors as necessary. These can include but are not limited to:

a. Environmental runoff mitigation alternatives

b. Engine exhaust wake (jet blast) impacts on adjacent aircraft, personnel and facilities

c. Existing airfield complexity, topography and drainage

d. Adjacent land use considerations

e. Results of detailed FAA airspace analysis

f. Local building requirements

3.2.2 Operational Constraints: This section underscores how the intended use of a facility, the dispensed fluid types, and aircraft types to be treated can influence the size and configuration of a deicing facility, as well as support equipment and facilities. It may be necessary to reconfigure or reduce the size of a proposed facility in order to be accommodated in an operationally desirable area of the airfield.

3.2.2.1 Determination of Throughput Capacity Requirements: The facility's throughput capacity can have a bearing on siting a facility since the facility's configuration can limit the processing capacity. Throughput capacity requirements should include consideration of the following:

3.2.2.1.1 Aircraft Types and Associated Levels of Demand: Aircraft Types and Associated Levels of Demand provide information on the existing aircraft fleet mix at an airport. Future fleet mix information can be derived from airport planning documents and/or airlines.

3.2.2.1.2 Procedures and Methods: The extent (processing time) of the deicing/anti-icing treatment can influence the facility's location. Users may have varying ground deicing/anti-icing programs in which some require extra treatment time, fewer deicing vehicles, or post-treatment checks.

3.2.2.2 Type of Fluids:

3.2.2.2.1 Holdover Time: The varying estimated holdover times for different fluid types directly impact the siting of facilities. SAE and ISO publish fluid holdover time guidance in ARP4737 and ISO 11076.

3.2.2.3 Bypass Capability: A deicing facility's processing capacity can be enhanced if bypass taxiing capability can be provided to mitigate congestion/conflict with inbound and outbound taxiing aircraft and with aircraft entering or departing the facility. This capability, which may require additional physical space, can also facilitate the removal of a disabled aircraft at or near the deicing facility, or aircraft requiring bypass capability for other reasons. It may be possible to configure bypass capability to offer a return/recirculation route for aircraft that have exceeded the holdover time of the fluid applied and require a reapplication of fluid (deicing and anti-icing) or a physical check.

Additionally, new bypass taxiing routes should have a minimum of turns, taxiway intersections, and runway crossings, and should avoid areas that require repeated air traffic control clearances. The bypass taxi routes should not create potential bottlenecks or operational problems for landing aircraft.

3.2.2.4 Future Growth and Ultimate Demand: Growth in aircraft activity and future changes to both the airport's physical configuration and aircraft dimensions should be reviewed for pertinent information to the siting process. Trends in aircraft deicing practices and procedures to the extent that these can be identified or defined, can also be relevant to the siting process.

3.2.3 Completion of the Inventory Phase: At the conclusion of the inventory phase, a planner/designer should have a thorough understanding of the overall layout and ultimate development plan of the airport, as well as the airfield operational characteristics. The process of identifying potential sites begins at this point since primary physical and dimensional constraints are highlighted as the inventory of defining criteria progresses.

3.3. Additional Siting Considerations:

Additional siting considerations should focus on minimizing resultant increases in ATC workload and ground movement complexities, impacts of additional taxi distances, delays, inefficiencies in supporting the operation of deicing/anti-icing operations, and environmental runoff impacts. The following items address these areas with respect to new or existing paved areas, and mobile deicing vehicles or fixed deicing equipment operations.

3.3.1 Siting Based on Runway and Taxiway Utilization: Runway and taxiway utilization can have a significant impact on the siting of a deicing facility. At airports with an ATCT, there is an established preferential runway and taxi routes for both arriving and departing aircraft to and from the gate area for particular operating configurations. The planner/designer should become thoroughly familiar with the established winter runway operating configurations and taxi routes through consultation with the local ATC representatives to develop an understanding of the level of operations on relevant taxiway segments and common or potential points of congestion in the taxiway system. Consideration should also be given to expected taxi speeds and reduced visibility under adverse weather conditions. Information can be obtained through consultation with the local ATC representatives.

3.3.1.1 Deicing facilities near winter departure runway end(s) tend to minimize the time between fluid application and aircraft takeoff and better accommodates the deicing facility's departure demand for the runway end(s) that it serves if it has adequate throughput capacity.

3.3.2 Aircraft Ground Movement Complexity: A potentially significant consideration in siting deicing facilities is the introduction of increased ground movement complexity that can cause substantial added ATC workload and the potential for runway/taxiway incursions. Aspects to avoid to the extent possible in siting a deicing facility include circuitous taxi routes, significant cross-field taxiing, introduction of inbound/outbound aircraft conflict points and congestion.

3.3.2.1 Runway Crossings: A site should minimize active runway crossings by ground vehicles and aircraft. By minimizing these crossings additional ATC workload, impacts to runway capacity, and exposure to runway incursions can be minimized.

3.3.2.2 Aircraft Queuing: Deicing facilities should optimally be enroute from the gate area to departure runways without introducing circuitous taxiing, nor points of congestion/conflict with other taxiing aircraft.

3.3.2.2.1 Runway Vicinity: Each departure runway requires adequate queuing space to maximize its departure capacity unless a deicing facility has bypass capability. A deicing facility should not be sited so that it limits departure capacity of a runway, access to the runway, or creates a situation in which deiced aircraft would be blocked by a runway departure queue.

3.3.2.2.2 Terminal Vicinity: The location of a deicing facility should not cause an aircraft queue on the ramp, any taxiway that blocks aircraft rescue and firefighting (ARFF) station exits, taxiway intersections, or direct access to a departure runway. These results will cause additional ground movement complexity and departure delays.

3.3.2.2.3 Departure Sequencing Program: Implementing a departure sequencing program that controls aircraft release from the gates during a deicing event can mitigate ground movement complexity and congestion in the area of the facility and for those aircraft not requiring access to the deicing facility. This program would need to be implemented in such a manner as to retain parity among airport tenants. This subject is discussed further in Section 4 of this document.

3.3.2.2.4 Modifying Departure/Arrival Priorities: Because minimizing pretakeoff delays for treated aircraft is safety related, consideration for modifying arrival/departure priorities during deicing events can be reviewed with the ATC and the local airline community. The profile of arrival/departure demand over time, particularly for hubbing airports, can be obtained from ATC.

3.3.3 Meteorological Conditions:

3.3.3.1 Typically, an airport experiences prevailing winds that dictate certain runway operating configurations a majority of the time. At many airports the prevailing winds may be seasonal. A deicing facility should adequately serve the departure end(s) dictated by prevailing winds during inclement weather/deicing season.

3.3.3.2 Airports with multiple runways often have certain runway operating configurations that give priority to keeping those runways operational during icing conditions. Information pertinent to an airport's winter runway operating configuration can be gained through consultation with ATC representatives and review of the airport manager's snow removal priorities described in the airport's Snow and Ice Control Plan (14 CFR Part 139).

3.3.4 Ground Vehicle Activity:

3.3.4.1 Deicing facilities, whether in movement or nonmovement areas, will have ground vehicle activity including but not limited to mobile deicing vehicles, fluid resupply tankers, airline operations vehicles, and airport operations vehicles. Even those deicing facilities with fixed fluid applicators and supporting facilities will experience a certain level of ground vehicle activity. These, plus other ground vehicles operating in movement areas, add to ground movement complexity and should be discussed during the deicing facility siting analysis by the deicing committee.

3.3.4.2 Siting a deicing facility will not be a function of ground vehicle activity, but must accommodate such activities. Conversely, the location of a deicing facility will influence the locations of related supporting facilities, such as, fluid storage for resupplying and vehicle staging areas. As recommended in more detail in Section 4, ground vehicle activity in movement areas will be either radio-equipped or escorted, preferably radio-equipped. Movement areas by definition include runways, taxiways and often portions of the terminal ramp that are controlled by ATC, whereas nonmovement areas are uncontrolled areas by ATC.

3.3.5 Ground Vehicle Access Routes:

3.3.5.1 The deicing facility site should address the demand for access routes by ground vehicles. Access routes are required for supply/resupply, equipment servicing, personnel changes, and airport operations personnel among other activities.

3.3.5.2 A deicing facility should have provisions for access routes such that ground vehicle movements minimize traversing active taxiways and runways, as this presents conflict with taxiing aircraft and aircraft queues, particularly considering that mobile deicing vehicles are usually among the slowest vehicles on an airfield. A site should reflect consideration of potential access road alignments and configurations. Additionally, access roads, if construction is required, should be aligned and located without adversely impacting other airport facilities and operations, including NAVAID signals.

3.3.6 Resupply and Fluid Storage Area:

3.3.6.1 Mobile Deicing Vehicle Requirements: A site supporting the utilization of mobile deicing vehicles should include consideration of the number of application vehicles required, the frequency of fluid resupply, the distance from the deicing area to the fluid resupply/storage area and the vehicle access route. Evaluation may indicate the need to relocate the existing fluid resupply/storage point to a more convenient location or the need for additional service roads. A ground vehicle staging facility in proximity to the deicing facility can reduce the number of ground vehicle movements by allowing resupply of the application vehicles on site. This staging area should be located so as not to present an obstruction to aircraft movements.

3.3.6.2 Fixed Deicing Applicators Requirements: A deicing facility with fixed deicing applicators may require a building for mixing and heating deicing fluids for underground delivery to the spray apparatus. A site for such deicing facilities with fixed applicators will typically need additional physical space to accommodate the building without becoming an obstruction to aircraft movements. This type of operation may minimize ground vehicle activity and provide opportunity for enhanced communications and a break room for personnel.

3.3.6.3 Tank Transfer Systems Designs: The viscoelastic property of type II fluids and other fluid types having extended holdover capabilities can be adversely affected by overheating, mechanical shearing, and contamination by corroded tanks in such a manner that the holdover times cannot be achieved. To protect the performance characteristics of such fluids from such degradation, storage tanks and transfer systems installed at deicing facilities should be designed in accordance with the fluid manufacturer's recommendations. Fluid manufacturers should provide the airport manager recommendations regarding compatible pumps, control valves, piping, and compatible storage tanks. Industry recommended practices covering tank and transfer systems for different fluid types are found in ARP4737 and ISO 11076.

3.3.6.4 Separate Tank Capacity: Deicing facilities that store different fluid types, such as both type I and type II fluids, will require greater physical space to store different fluids. Furthermore, facilities that store different fluid types, such as type IIs, should provide separate storage tanks to avoid mixing type IIs from different fluid vendors. To avoid cross contamination of deicing fluids, all tanks, fill ports, and discharge points should be conspicuously labeled for the type and vendor of fluid handled, e.g., SAE TYPE IV, ISO TYPE II.

3.3.7 ARFF Emergency Service Road Access: A site should include consideration of emergency access by ARFF equipment to the deicing facility and to any part of the airfield, particularly to runways when the deicing facility is in operation. Acceptable ARFF response times are critical to preserving the safety of airfield operations (see 14 CFR Part 139.319 for response times). Airport managers should review their Airport Emergency Plan (14 CFR Part 139.325) for possible changes introduced by the operation of a deicing facility.

3.3.8 Snow Removal Operations: A review of the airport's Snow and Ice Control Plan (14 CFR Part 139.313) is recommended to determine necessary changes with respect to snow removal and sanding priorities and/or chemical application for priority airfield facilities and notification of runway closures/openings. The deicing facility and supporting service roads may have to be integrated into the plan; however, following the initial clearing of snow/ice, the continual application of deicing fluids to aircraft on the facility will typically tend to keep the area clear of accumulating precipitation. Service roads supporting the facility have to be prioritized and maintained clear during operation of the deicing facility.

3.3.9 Environmental Considerations: As environmental regulations come into place to control storm water runoff containing spent deicing fluids, deicing facility site investigation should give careful consideration to the opportunities for collection and disposal of fluids. Environmental storm water runoff regulations can be a significant siting factor. Environmental considerations are presented in more detail in Section 5.

3.4 Multiple Site Considerations:

Whereas optimally one deicing facility site is capable of serving more than one departure runway end, multiple sites may be necessary in the case of expansive airfields, insufficient land area to meet the demand at an individual site, or when fewer sites do not meet the above criteria for aircraft/airfield and ground vehicle considerations.

Airports serving a wide variety of scheduled service by regional or commuter air carriers and nonscheduled service by air taxi, general aviation and/or airline charters may best meet their deicing/anti-icing needs by constructing a separate facility for the group. Additionally, if a single facility is identified for all airport users, additional physical space may be necessary to meet any specific needs (e.g., adequate space for storing appropriate deicing/anti-icing fluids for smaller aircraft).

Evaluation of combinations of multiple sites often leads to the use of a decision matrix.

3.5 Airport Infrastructure:

3.5.1 Utility Master Plan: Many airport operators maintain a utility master plan and drawings for the overall airport. This information can be valuable in considering potential sites for deicing facilities since utility service may be necessary. A utility master plan can also provide background on relevant future airport facilities such as on-airport storm water pretreatment facilities. A broad brush assessment of the utility network in the area of the airport under consideration is recommended. Although generally the availability of existing utility services will not dictate the site of a deicing facility, it can have a bearing if there is more than a single viable site identified. It can also be germane if the runoff mitigation alternative for deicing fluid runoff is to be treated or recycled on-site.

3.5.2 Nighttime Lighting Systems: All deicing facilities should have either permanent or portable nighttime lighting.

3.5.2.1 Deicing Crews: Nighttime lighting should be provided to provide sufficient light for deicing crews to enhance evaluation of nighttime deicing treatment. Permanent nighttime lighting structures may not be possible at a deicing facility because of height and clearance restrictions. Portable nighttime lighting can be provided by deicing operators, typically mounted on the deicing vehicle (See 4.4.2). If acceptable sites for ambient lighting installations are found, it is possible that the magnitude of the illumination necessary to provide sufficient brightness to visually inspect the aircraft surfaces after the application of deicing fluids will result in a substantial amount of glare to both aircraft, either on approach or moving on the airfield, and controllers in the ATCT. (See section 4.4.2 for related information).

3.5.2.2 Staging Areas: Lighting of the ground vehicle staging areas is recommended when sufficiently distant from the deicing facility so as not to pose an obstruction to aircraft movements and the light standards can be directionally oriented to mitigate impacts to aircraft and ATC operations.

3.5.2.3 In-pavement Lighting: If considered, in-pavement lighting could delineate the limits of the aircraft parking positions on deicing pads although the need for lighting will be a function of the type of airport operations and configuration of the deicing pad. In-pavement lighting will not typically influence the site of a deicing facility.

3.5.3 Paved Areas:

3.5.3.1 Consideration of existing utilities that support paved areas on the airport can highlight potential sites for constructing a deicing facility. The existing drainage system for the paved areas under consideration can influence the location and/or configuration of a deicing facility. This may eliminate a potential site from consideration based on an inability to incorporate the new deicing facility's drainage into the existing drainage and/or the environmental runoff mitigation alternative. To reduce construction costs, deicing facilities should be sited when practicable on relatively flat land where the natural terrain features conform to the final grades of the ultimate facility design.

3.5.3.2 Consideration should also be given to the extent of infrastructure or utility retrofitting that may be necessary to integrate the proposed facility into the existing utility systems. The extent of infrastructure modifications and retrofitting necessary can outweigh the desirability of a potential site if there are other viable alternatives available. Pavement profiles and grades can also have a bearing on the selection of a location in those instances where a substantial amount of pavement reconstruction would be necessary to support the integration of a facility.

3.6 Interrelationships:

Although the proposal of a dedicated deicing facility can be conceptually attractive, it is not necessarily appropriate or feasible at every airport. Absent the eventual development of regulatory requirements to conduct all aircraft deicing at a dedicated facility, the integration of such a facility into an airport and its operating environment is a decision that should be arrived at with full consideration of the alternatives and attendant benefits/disadvantages. An assessment of siting considerations as a starting point in the determination of the applicability of deicing facilities is strongly recommended. Essentially, if a deicing facility cannot be adequately sited at an airport without adverse impact to airport safety and efficiency, gate deicing or a different approach to aircraft deicing/anti-icing would be necessary.

4. DEICING FACILITY DESIGN AND CONSTRUCTION:

4.1 General:

A deicing facility has to be properly planned, designed and constructed to perform as intended. Elements of planning, design and construction include such items as facility siting (Section 3), number and size of deicing facilities phased implementation, construction materials, drainage facilities, and other related components. Most of the design criteria for these components are addressed in FAA advisory circulars and other accepted industry design guidelines and standards. A deicing facility is intended to provide an area for parking of aircraft to receive deicing/anti-icing treatment. To perform this function, the deicing pad requires a pavement system that supports the anticipated loads and a drainage system to collect runoff containing spent deicing fluids. Considerations for siting deicing facilities are found in Section 3 and runoff mitigation alternatives are discussed in Section 5.

4.1.1 The size and number of deicing facilities are essential to maintaining airport departure activity at a level that reflects ATC's departure rate. A deicing facility can artificially constrain an airport's capacity if it is not planned and designed to handle anticipated levels of demand. Delays at a busy airport during adverse weather conditions can significantly increase as they propagate throughout the national airport system. For this reason the designer should give careful consideration to factors affecting the number of facilities, their sizes and their ability to accommodate the deicing demand.

4.1.2 For purposes of this document, storm water that contains deicing chemicals is referred to as contaminated storm water, and normal runoff without chemicals will be designated as clean storm water.

4.2 Sizing and Siting of Deicing Facility:

Deicing facilities optimally should be sited and sized so that the established levels of airport demand departure are maintained during icing conditions. Sizing of deicing facilities is closely interrelated with siting and can entail an iterative approach in the preliminary planning stages.

4.2.1 Size: The size of the facility is directly governed by the needs of present and projected users. The site of a deicing facility(s) can impact or limit the proposed size due to the airfield configuration, airport property limits, land acquisition opportunities, and/or other physical site constraints. Design parameters required to determine the unconstrained size of a deicing facility includes:

a. Typical deicing processing time and fluid requirements
b. Airport peak hour departure demand under icing conditions
c. Aircraft fleet mix forecast to utilize the deicing facility over its design life
d. Local weather records, including typical and severe wind information
e. Potential number of mobile deicing vehicles; sizes and type of stationary deicing equipment
f. Deicing procedures and methods

4.2.2 Processing Time: The extent (process time) of the deicing operations, pre-checks and post-check methods called for by the individual users should be assessed. The facility may be used for the first deicing operation or for subsequent deicing of aircraft requiring further treatment immediately prior to departure. Secondary deicing for some users may be the reapplication of fluid to an aircraft that has previously been deiced. However, for some air carriers' deicing programs, there is no difference between primary and secondary deicing activities, fluid usage, or processing time. The level of deicing and an understanding of the processing requirements will begin to define the length of time an aircraft can be expected to occupy a pad on the facility.

4.2.3 Peak Hour Departure Demand: The airport peak hour departure demand under adverse weather conditions is one of the primary factors affecting the size of deicing facilities, particularly at busy or hub airports. Adjustments to the airport peak hour departure demand can be expected to reduce the peak demand in adverse weather conditions. The reduction in peak hour demand results from the effects of weather conditions on airline operations, airport operations, and the air traffic control system. Therefore, it is recommended that designers/planners use the airport peak hour demand as a starting point and adjust it for anticipated operational conditions. The resultant facility departure demand is used in sizing the deicing facility, with consideration of other factors noted above.

4.2.4 Fleet Mix: Because airport users typically operate a wide variety of aircraft, a “fleet mix” served by the deicing facility needs to be evaluated. This determination can follow the identification of the number of deicing pads required in a facility. Analyzing a representative fleet mix avoids planning a facility to serve only the existing aircraft fleet mix, which may ultimately be undersized in the future as the fleet mix evolves. Fleet mix information should be factored into the determination of the overall area associated with the required number of deicing pads. Forecasts of aircraft fleet mix are typically contained in an airport master plan and/or other planning documents. A planning period of 20 years is recommended for selecting a range of fleet mix. Factors that can influence the projected fleet mix include, but are not limited to; the dominant air carrier(s) at the airport, peak departure periods, anticipated airline operation expansion, changes in the airline route structure, trends in aircraft orders, phase out of older aircraft, and forecast airfield expansion. The fleet mix also will impact the length of time an aircraft will occupy a position on the deicing pad. Generally, smaller aircraft will be processed through the deicing facility more quickly than larger aircraft. A facility serving primarily narrow-bodied aircraft would be sized smaller than if it were forecast to serve wide-bodied aircraft.

4.2.5 Number of Aircraft Deicing Pads: Sufficient aircraft deicing pads should be provided at the deicing facility to maintain the departure demand without creating unacceptable delays for subsequent aircraft awaiting deicing/anti-icing or direct departures. Therefore, facility size is dictated by the number of deicing pads rather than a minimum square footage of area. The number of deicing pads should be based on two-step deicing/anti-icing procedures instead of one-step approach. This would provide users greater flexibility in the treatment of aircraft. Variations in meteorological conditions, e.g., type of precipitation, increase the extent (and frequency) of the deicing/anti-icing treatment. Airports that commonly experience heavy wet snows or freezing rain should consider an increase in the number of deicing pads to maintain departure flow rates at levels that avoid unacceptable delays for subsequent aircraft awaiting treatment.

4.2.5.1 Single Deicing Pad Facility: If it is determined that a single deicing pad is sufficient to satisfy the forecast departure demand, it is recommended that the largest aircraft from the projected fleet mix be designated as the design aircraft. The design aircraft in this case would be that which requires the greatest maneuvering and apron area for deicing/anti-icing. For a "single-aircraft" facility, minimum recommended deicing pad dimensions are the length of the design aircraft plus 25 feet, and the width of the upper wingspan of the airplane design group defined in AC 150/5300-13 for the design aircraft plus 25 feet. The 25-foot buffer allows maneuvering room for the mobile deicing vehicles to operate. It also ensures that no aircraft surfaces extend outside the paved areas, which facilitates the collection of deicing fluid runoff. Dimensions for fixed deicing facilities, such as, gantry systems or telescopic booms, may be less depending on manufacturer information. However, a 12.5-foot mobile deicing vehicle lane between the gantries, booms, etc., and the airplane design group is recommended as a backup to accommodate mobile deicing vehicles in the event that a fixed system becomes inoperable.

4.2.5.2 Multiple Pad Deicing Facility: If the need exists for more than one aircraft to be deiced/anti-iced at a time, several deicing pads should be considered. Once the number of deicing pads is determined, the required area for each should be defined. The projected fleet mix may be critical to this area determination. The most conservative approach is to size each deicing pad for the largest aircraft in the fleet mix served by the facility. While providing maximum operational flexibility, this can prove uneconomical, particularly at those airports that have a very small amount of wide-body aircraft activity. Therefore, as discussed above, it is recommended that an analysis of the fleet mix, both current and projected, be conducted to determine the optimal configuration and dimensions of the deicing pads. One approach is to designate certain deicing pads on the facility for wide-body aircraft, sizing them accordingly, with the remainder of the deicing pads sized for the remaining aircraft. This would allow an airport that does not currently have wide-body aircraft operations to plan for a facility that can be expanded to accommodate them when departure demand warrants. Another approach is to determine a "composite" deicing pad layout, developed by correlating the fleet mix with the projected percentage of occurrence. This may promote efficient deicing pad sizing and layout without the construction of unnecessary pavement. See 4.3.1 for wingtip separations and 4.3.3 for effects of jet blasts on adjacent aircraft.

4.2.6 Type of Deicing Equipment: Preference for the type of deicing equipment needs to be addressed. This will require input from the direct user(s) of the facility, which are typically airlines but can be a third party operator. The types of equipment currently used for aircraft deicing/anti-icing are as follows:

4.2.6.1 Mobile Deicing Vehicles:

Open basket
Enclosed basket

4.2.6.2 Fixed Deicing Equipment:

Fixed boom
Gantry (drive-through)
Others: scissors

4.2.6.3 Industry Standards: Specifications for mobile deicing vehicles are contained in SAE and ISO vehicle specifications, namely, ARP1971, ARP4047, and ISO 11077.

4.2.6.4 Operational Differences Between Deicing Equipment: Mobile deicing vehicles will likely continue to be the most widely used due to the flexibility of their operations and the existing inventory base of such equipment. In addition, mobile deicing vehicles can augment the deicing operations of fixed deicing equipment. Furthermore, certain advantages are inherent to mobile deicing vehicles with an enclosed cab as opposed to open basket types. These can include protection of operator from fluid, harsh winter environments, aircraft exhaust emissions, and noise. If storage facilities for deicing/anti-icing fluids are to be located adjacent to the deicing facility, additional physical space needs to be dedicated.

4.2.6.5 Physical Constraints: It is important to note that certain types of fixed deicing equipment, fluid storage, and mixing facilities should be carefully located to avoid being an obstruction to aircraft operations and should be considered in the overall physical space requirements.

4.2.6.6 Number of Mobile Deicing Vehicles: The recommended number of mobile deicing vehicles forecast to be in operation should be based on the rate at which aircraft can be processed through the deicing facility. This information can be obtained from the airlines operating at the airport or any third party that may have contractual responsibility for aircraft deicing. In order to avoid constraining the facility's capacity, sufficient deicing vehicles or fixed deicing equipment should be available to meet the deicing demand. Additionally, adequate areas to support vehicle movements, staging, and resupply activities are suggested, including access capability for continuous deicing/anti-icing operations while a portion of the mobile deicing vehicles is being resupplied with fluid.

4.2.6.7 Effects on Facility Sizing: Knowledge of the number of mobile deicing vehicles required for different aircraft in the fleet is helpful. This will affect the rate aircraft can be processed and the necessary vehicle staging area that should be accommodated. Coupled with the knowledge of the fleet mix, this will be useful in sizing the facility. It is important that a facility not be limited by the quantity of mobile deicing vehicles or fixed deicing equipment in use.

4.3 Pad Configuration and Layout:

Configuration of deicing facilities should take into account factors related to the deicing/anti-icing process, environmental issues, maneuverability of aircraft and deicing vehicles to, on, and from the deicing facility, accessibility, visual guidance considerations, and clearances for supporting facilities. Configuring deicing facilities with two or more aircraft deicing pads requires wingtip clearances between aircraft. Wingtip and wingtip to object clearances should be in accordance with established regulatory agency standards.

4.3.1 Wingtip Separations: Wingtip separations for aircraft operating in deicing facilities should be based on the number of deicing pads at the facility and ATC control, i.e., movement or nonmovement areas. AC 150/5300-14 provides separation criteria for single/adjacent deicing pads. As with single-aircraft facilities, clearances for facilities with a fixed deicing system, such as, gantry systems or telescopic booms, should have adequate access to accommodate mobile deicing vehicles in the event of a system failure. These facilities should have a backup plan in the event of system failure.

4.3.2 Deicing Pads Adjacent to Fixed or Movable Objects: The separation between the centerline of a deicing pad and a fixed or movable object should be in accordance with established regulatory agency standards.

4.3.3 Jet Blast: Special layout consideration should be given to the effect of jet blast at breakaway power especially upon adjacent aircraft receiving deicing/anti-icing fluids and upon personnel and equipment as aircraft maneuver in and out of deicing facilities. Jet blast may cause a degradation of the anti-icing protection of a fluid to the extent that holdover times may be shortened considerably. Reduced holdover times may also result when departing taxiing aircraft recirculate snow onto following aircraft when trailing separations are short.

4.3.4 Accessibility: As discussed with respect to siting considerations, access to the deicing facility should be reasonably direct, both for aircraft and mobile deicing vehicles. Occasionally an aircraft in a deicing queue or at a deicing facility will need to return to the gate. The conceptual layout should examine provisions for this event and resultant aircraft movement. Widened fillets for taxiing turns accommodating cockpit over centerline tracking rather than judgmental oversteering can reduce excursions from taxiways (see AC 150/5300-13). The frequency of overall airport departures can be enhanced when bypass taxiing capability exists to reduce congestion near the facility and conflicts with in-bound taxiing aircraft. This capability may require additional physical space to accommodate this capability.

4.3.5 Continuous High Winds: Airport sites that experience continuous high winds should consider, to the extent practicable, orienting the centerlines of deicing pads with the prevailing wind. This allows heated fluids to be applied closer to the surface of the aircraft skin thereby minimizing heat loss, fluid usage, and taking full advantage of the hydraulic force of the fluid spray.

4.4 Visual Guidance Considerations:

4.4.1 Pavement Guidance:

4.4.1.1 Pavement Markings: Gate deicing pads should have lead-in, parking position, and lead-out guidelines that are consistent with the rest of the airport. Off-gate deicing pads should have marked pavement edge and taxiway centerlines for safer aircraft taxiing. Off-gate deicing facilities should mark the entrance(s) and exit(s) with a taxiway/taxiway holding position marking to indicate the boundary of the facility. The marking serves to reduce incursions onto the connecting taxiway during nighttime or low visibility conditions. The taxiway/taxiway holding position marking should be located outside all taxiway/taxilane object free areas (OFA), runway safety areas, runway obstacle free zones (OFZ), and airway facility critical areas, e.g., NAVAIDs. A single deicing pad located on a taxiway may not need a boundary marking. Pavement edge, taxiway centerlines, and taxiway/taxiway holding position markings should be marked in accordance with established regulatory agency standards.

4.4.1.2 Pavement Lighting:

4.4.1.2.1 SMGCS Plans: Airports operating during low-visibility conditions (under 1200 RVR) that implement a Surface Movement Guidance and Control System (SMGCS) Plan may need to elevate taxiway/pad/apron edge lights, as well as provide in-pavement taxiway edge and centerline lighting (see AC 120-57). This may include the use of retroreflective markers. In addition to taxiways, service roads that intersect an aircraft movement area operating under such a plan may require items necessary to support the operation, such as, vehicle stop signs, stop bars, etc.

4.4.1.2.2 Off-gate Facility Boundary. If in-pavement lights are installed to further enhance nighttime recognition of the facility's boundary (FAA taxiway/taxiway holding position marking), unidirectional yellow lights are recommended in accordance with AC 150/5300-14. Lights should be located 2 feet (0.6 m) inward of the taxiway/taxiway holding position marking and spaced every 20 feet (6.0 m) with the illuminated portion facing the deicing pads.

4.4.2 Nighttime Lighting Systems: As discussed in section 3.5.2, optimally nighttime lighting should be provided for nighttime deicing/anti-icing treatments. However, due to the constraints on the height of light structures by controlling surface standards, their use may be limited. If such structures are restricted, it is suggested that portable nighttime lighting systems be used to permit visual/physical checks of the aircraft, thereby verifying that no snow/ice/frost contamination is present prior to takeoff. For example, one alternative is mobile deicing vehicles with modified lights that provide sufficient illumination for deicing/anti-icing treatments and pretakeoff checks during nighttime or low visibility conditions. Where nighttime lighting structures are installed, designers should ensure that floodlights created for the airport environment are utilized with illumination comparable to gates and proper glare cutoff to reduce the “potential for blinding” effects on pilots and air traffic controllers.

4.5 Pavement System:

The pavement system for deicing facilities should be designed in accordance with established regulatory agency standards. Rigid pavement (concrete) or flexible pavement (asphalt) can be used, although typically, rigid pavements are preferred for aircraft parking areas. Pavement underdrains and special drainage guidance should be in accordance with established regulatory standards. Porous pavements that allow deicing fluid-laden storm water to be collected in an underlying drainage network have been constructed. However, due to limited in-service experience, the performance of porous pavement over the life of the deicing facility has yet to be determined.

4.5.1 Benefits of Grooved Pavements: It is important to recognize that the accumulation of deicing fluid on the pavement, with or without snow or slush, can create slippery conditions. To some extent, grooved pavement may help channel deicing fluid to the runoff mitigation system. Additionally, grooved pavements may help reduce the amount of fluid blown off the facility by jet blast and prop wash. In turn, higher concentrations of captured glycol may make the recycling of glycol more cost effective if recycling is a component of the runoff mitigation system.

4.5.2 Extent of Apron Perimeter: The perimeter of the facility pavement should extend such that no aircraft surfaces being deiced/anti-iced extend beyond it. The apron perimeter should have a means for redirecting spent fluid runoff.

4.6 Drainage and Collection:

Special attention should be given to pavement grades on a deicing facility, particularly on large facilities designed to accommodate several aircraft deicing pads. Adequate grades to promote positive drainage and prevent ponding may have operational implications for aircraft and ground vehicles especially during periods of deicing activities when the deicing fluids can contribute to increase pavement slipperiness. A balance should be achieved between accomplishing the drainage objectives, consistent with regulatory agency standards, without creating potentially adverse operating conditions. Considerations can include the impacts of pavement grades on the level of breakaway thrust by aircraft, particularly for wide-bodies maneuvering on or departing the deicing facility, the overall pavement profile that results from the placement of a series of individual area inlets (an undulating profile may not be operationally acceptable if aircraft operate longitudinally over it), and the locations of inlets relative to aircraft deicing pads, as well as other issues.

4.6.1 Surface Gradients: Surface gradients for deicing facility aprons should be in accordance with established regulatory agency standards to ensure positive drainage of fluids for collection and minimize the potential for ponding. Facility aprons constructed adjacent to existing pavements should have a smooth transition. Shoulder and safety area grading should be in accordance with established regulatory agency standards.

4.6.2 Slope of Facility: The slope of the facility should be coordinated with the layout of the system used to collect storm water runoff. Given that it generally may be advisable and even necessary to separate contaminated storm water from “clean” storm water, and that it is preferable to convey collected storm water by gravity rather than pumped flow, there are a limited number of options for the storm water mitigation systems. Section 4 provides additional discussions on this subject.

4.6.3 Snow Removal at Facilities: When designing the pavement drainage and/or runoff collection system, methods and priorities for snow removal at the deicing facility need consideration and potential problems associated with blockage of drains by compacted snow and ice or freezing of diluted deicers in drain systems should be addressed. Any blockage of the drainage system can impact the utility of the deicing facility if there is a resultant ponding of storm water and deicing runoff.

4.6.4 Impacts of Facility Runoff: Impacts to existing drainage facilities need to be considered. The added pavement area at the deicing facility may increase runoff sufficiently to require an increase in capacity of downstream drainage systems. Local storm water drainage criteria/regulation may require the runoff to be detained before release to the downstream system.

4.6.5 Segregating Storm Water: The modifications required to segregate portions of storm drain systems at existing airports can be extensive or relatively simple depending on the airport configuration. Some airports have been successful in diverting apron drainage to detention and/or treatment facilities with only minor changes to the storm drain system. Pump stations and force mains will be required if contaminated fluids cannot be discharged by gravity to the desired location.

4.6.5.1 Design Options: Mechanical diversion devices consist of valves, sluice gates, and similar equipment. These devices would typically be placed in or just downstream of a junction box and used to route contaminated fluids to a specific location. Valves, for example, can be set in opened or closed positions depending on upstream activities and the desired destination of fluids. A system of this nature would require monitoring by airport personnel so that glycol-contaminated runoff is not inadvertently directed to the wrong destination. Valves or gates can be operated hydraulically or pneumatically from a remote location. A surcharge overflow should be provided for each mechanical diversion structure to provide positive relief of the system in case of gate control failure or in the event of a major storm. The placement of diversion structures should be in locations which will minimize upstream drainage areas yet fully contain all areas of deicing activity.

4.6.5.2 Detention Ponds: The elevation of the deicing facility area with respect to surrounding terrain can complicate the storage of contaminated runoff. While a total gravity flow system is generally desirable, pumps may be required to lift the runoff to the pond area and/or move the runoff from the pond to the treatment facility. Standards for this type of facility should follow the state and/or local standards for lagoon-type design. Any liner requirements and/or monitoring well requirements should follow state/local standards also. An impermeable liner may be required to protect the groundwater. While pond facilities can entail more extensive design efforts, the construction cost can be significantly less than underground storage facilities.

4.6.5.2.1 Design Considerations: Currently, no federal regulations exist governing the design or use of retention/detention ponds in aviation or other types of applications. In general, no state environmental regulations exist for these ponds, which are for the handling and control of stormwater runoff. Construction permits are typically required by local agencies, which have regulator authority over this type of construction activity. For the above reasons, there are no standardized regulations governing the environmental design criteria for these stormwater detention ponds. It is not uncommon, however, for the regulatory agencies to require the following hydrologic design criteria:

a. The pond to be sized using a design storm of 100-year frequency

b. The allowable rate of release to be equal to or less than a 10-year frequency storm peak runoff occurring under predevelopment conditions.

Other design criteria, such as required minimum depth, allowable maximum depth, emergency spillway sizing requirements, and minimum freeboard requirement, are strictly dependent on the local agency.

4.7 Alternative Use Consideration:

Though deicing facilities may be designed primarily to accommodate aircraft deicing/anti-icing, in many cases a facility(s) can be used for other purposes. The number of deicing events and hence the amount of time the facility is utilized for deicing/anti-icing, will vary widely at airports. However, in the majority of instances, a deicing facility would be available for other uses a large portion of the year. The location, size, and configuration will have a bearing on potential alternative uses. If the deicing facility is near the end of a departure runway, alternative uses can include an inbound and outbound aircraft holding apron. The deicing facility may also be available for aircraft maintenance, overnight aircraft parking, or aircraft washing. Utilization of a deicing facility as a storage area for snow removal equipment outside of the snow season may be possible, particularly if the facility is remote from the terminal area and it is not in a location conducive to use as an aircraft hold pad. It is recommended that consideration be given to alternative uses to avoid planning/designing a deicing facility that cannot be efficiently utilized for other purposes. In regards to other uses such as aircraft maintenance, controlling runoff of regulated hazardous materials may present distinct design considerations.

4.8 Future Development:

Optimally, a deicing facility should be designed for phased expansion in keeping with the forecast increase in aircraft activity over the planning horizon. It is advisable that the site be developed for planned future facility expansion, and that pavement edge, drainage, electrical, and related systems be designed to allow for adjacent future tie-ins.

4.9 Construction Considerations for Design:

A primary objective in the implementation of airfield facilities is minimizing the impact to airport/airline operations during the construction phase. This is particularly applicable to the development of deicing facilities remote from the terminal area since these tend to be located in proximity to departure runways. The facility planner/designer should consider construction and phasing aspects of the project as appropriate during the planning and design phase. Other aspects of construction to quality control can be noted in the American Society of Civil Engineers (ASCE) Handbook on Quality in the Constructed Project. Listed below are additional factors to bear in mind:

a. The design team should be sure the Deicing Committee considers the ramifications of the construction phase and impacts to operators early in the design process.

b. Major seasonal and operational constraints need identification early and should be reviewed throughout the design and planning effort.

c. Once the schematic documents exist, a summary master schedule should be developed so that the program can be contemplated in light of the major constraints.

d. The ultimate cost of the project is directly related to the perceived challenge of undertaking construction activities while maintaining airport operation throughout the construction program. Generally, the more flexibility in minimizing operational impacts, the better the final pricing for the project, as well as the speed by which the project will progress.

e. A representative of the airfield operation staff for each of the various agencies and airlines should provide input to the construction process during the design period as part of the Deicing Committee.

f. A complete construction operations plan covering all aspects of construction, including but not limited to scheduling, phasing, work hours, safety, security, access, material delivery, NAVAIDs, and airfield operational impacts, should be developed. Such a plan should reflect involvement of the airport, airlines, aviation regulatory agency (including local ATC), impacted airport users/tenants, environmental officials as appropriate, representative utilities as appropriate, and emergency response agencies. This construction operations plan is intended to ensure the safety of aircraft operations during construction, ensure the safety of workers and equipment on the ground during construction, and present the contractor and resident engineer with the constraints under which the construction activity is to be accomplished. Height restrictions in the area of construction can be particularly significant.

g. Consideration should be given to preventing an interruption in service to any utilities impacted by construction, including planning/coordinating any tie-ins to existing utilities, as necessary.

5. ENVIRONMENTAL CONSIDERATIONS:

5.1 Types of Environmental Problems:

5.1.1 Migration and Release Pathways: Most of the glycol sprayed on aircraft in deicing fluids flows off the aircraft onto the apron and a large portion eventually may be carried to waterways or soil through runoff.

5.1.1.1 Other Pathways: Not all glycol applied to aircraft can be recovered. Glycol may be carried away by aircraft (quiet areas) or support vehicles; it may undergo biodegradation or be broken down by photolysis; or it may be carried away by air currents or snow.

5.1.1.2 Off Pavements: Aircraft deicing fluids can flow from a paved area to an earthen area. Ethylene glycol and propylene glycol have been found to be very conducive to biological degradation by naturally occurring organisms found in native soils. Ethylene glycol breaks down very rapidly when exposed to naturally occurring organisms in the soil. Literature indicates that the half-life of 100 milligrams of ethylene glycol mixed with one kilogram of topsoil was found to be approximately 30 hours at 20 C. At 5000 mg/kg of soil, the half-life increased to only 35 hours.

5.1.2 Oxygen Depletion Potential: Biochemical oxygen demand (BOD) and aquatic toxicity are the primary effects of deicing/anti-icing contaminated runoff requiring control. Generally, glycol-based deicing fluids are inhibitory to bacterial and algae only at concentrations greater than 20,000 mg/L. As deicer-contaminated runoff is further diluted by stream flow, rainfall or snow, inhibition is eventually overcome and biodegradation can readily proceed.

5.1.2.1 Breakdown: Glycol-based deicers/anti-icers at the proper concentration biodegrade rapidly, consuming dissolved oxygen (DO) from the stream and generating carbon dioxide ($C0_2$) and water (H_2O). These fluids have a huge oxygen depleting potential during biodegradation. As a result, the discharge to a sanitary sewer system of high levels of glycol may adversely impact wastewater treatment plants such as Publicly Owned Treatment Works (POTWs) due to slug loadings on the plant. Equalizing runoff flows, limiting total glycol loads to sanitary systems, and/or metering discharge to sanitary systems over time can reduce adverse impacts/slug loadings on POTWs. It is important to recognize that few POTW have adequate capacity to absorb higher loadings.

5.1.2.2 Anaerobic Conditions: Normally, natural reaeration occurs on a continual basis but aerobic conditions may not be maintained under heavy glycol loads, particularly the initial flush of glycol contaminated fluid. Concentrated deicing fluid runoff can cause receiving streams' bacteria to proliferate, using glycols as a food source and the stream's dissolved oxygen for respiration. The depletion of the stream's oxygen levels can eventually lead to anaerobic (lack of oxygen) conditions, which in turn kill aquatic organisms that also depend on a constant supply of stream dissolved oxygen for their respiration. Many environmental agencies define minimum dissolved oxygen levels that must be maintained at all times.

5.1.2.3 Regulatory Monitoring: For regulatory purposes, under the US Environmental Protection Agency (USEPA) National Pollutant Discharge Elimination System (NPDES) (see section 5.2.1), BOD concentration is expected to be used for compliance monitoring and enforcement. Depending on the type of discharge permit, specific monitoring items are generally based on BOD, COD, Total Organic Carbon (TOC), Total Suspended Solids (TSS), oil/grease, pH and flow rate limits.

5.1.2.4 Increased Suspended Solids: Algae blooms can occur in storm water holding ponds under the right conditions of temperature, organic loadings, and nutrients (phosphorus and nitrogen). It is probable that nutrients necessary to produce an algae bloom will be present in the airfield runoff, but wintertime temperatures will usually slow algae growth. Algae present in discharge samples will be detected both as an apparent “BOD” loading and as suspended solids (SS), which can exceed NPDES discharge limits.

5.1.2.5 Differences Between Glycols: Much information is available about the environmental merits of one type of glycol deicing fluid over another. For practical purposes, all glycol-based deicers will impact receiving streams if not controlled.

5.1.3 Waste Stream Characteristics: The number of variables involved makes it difficult to predict the waste stream characteristics for a specific deicing operation. Routine monitoring provides an empirical method of determining the in-stream waste concentration. Monitoring and/or toxicity testing (biomonitoring) should be performed at the outfalls or conveyances and instream, as appropriate. Simple laboratory tests can easily determine pollutant and BOD concentrations.

5.2 Applicable Regulations:

5.2.1 USEPA NPDES Storm Water Permits: On November 16, 1990, the USEPA enacted the NPDES Storm Water Permit Program. The new regulations require that many airports across the nation apply for and obtain a storm water discharge permit for industrial activities that occur at their facility. In addition to refueling activities and maintenance operations, aircraft deicing operations are specifically classified as industrial activities, requiring storm water permits.

5.2.1.1 Obtaining a Permit: To obtain a permit, each airport was required to submit to USEPA (or to a state with permitting authority) either an individual or group permit application by the specified date indicated for the type of permit applied for or File a Notice of Intent. The application to cover the individual airports or a general permit will be developed to cover monitoring requirements and Best Management Practices (BMP) that may be required.

5.2.1.2 Best Management Practices (BMP): A BMP is defined as a practice or combination of practices that prevent or reduce the amount of pollution generated by nonpoint sources. BMPs will most likely be necessary to bring airports into compliance with the regulations and any other criteria established by the USEPA or the NPDES permits. The NPDES permits may limit glycol-contaminated deicing fluid flows of any kind during the year, especially during the deicing season.

5.2.2 Above-Ground Storage Tanks: In many cases, spent deicing fluids cannot be contained in above-ground storage tanks in proximity to the deicing facility due to obstruction clearance and separation requirements, critical areas, and height restrictions. An above-ground storage tank remote from the deicing facility would require the conveyance of the spent fluid to the tank, either mechanically or via force main.

5.2.2.1 Tank Construction: There are no existing federal regulations covering above-ground storage tanks which are specific to deicing fluids. Deicing fluids are neither a USEPA Resource Conservation and Recovery Act (RCRA) hazardous waste nor are they considered ignitable, unless contaminated with petroleum products from other airport operations.

5.2.2.2 Design Consideration: When practical, a berm (secondary containment) with the capacity to contain the total tank capacity within the bermed area is recommended. To protect groundwater from a potential leak, rupture, or spill, it is recommended that an impervious surface or liner be installed as a floor within the bermed area. The berm should be constructed of an impervious material, such as, concrete, soil, cement, or clay. A depressed area or slump may be provided within the bermed area to provide a low point for pumping or evacuating any spilled contents contained within the berm.

5.2.3 Publicly Owned Treatment Works (POTWs) Standards: The US Federal Water Pollution Control Act Amendments of 1972 recognized that many industrial wastewaters are incompatible with POTWs. In 1973, the USEPA developed general pretreatment standards, including rules and regulations, to protect POTWs from the detrimental effects of industrial wastewaters. In 1977, the USEPA developed a national pretreatment strategy under the Clean Water Act. The regulations were published as 40 CFR Part 403 in 1978. These regulations include prohibited discharge standards which are intended to prevent inhibition of or interference with the POTW by prohibiting the discharge of pollutants of such nature or quantity that the mechanical or hydraulic integrity of the plant is endangered.

5.2.3.1 Particular Concerns: Wastewater resulting from deicing activities can discharge pollutants including BOD in such volume or strength as to cause unit process upset and violation of the POTW's NPDES permit. Deicer-contaminated discharges to a municipal sewer system will therefore need to be controlled to minimize impacts to the primary and secondary wastewater treatment facilities. Direct discharge to a municipal sanitary sewer system most often requires that the airport obtain a wastewater contribution permit from the municipality where the connection is made and/or from the POTW where the industrial discharges (deicing fluid contaminated runoff) will be biologically treated. Typical contribution permit parameters contain limits for BOD, suspended solids, oil and grease, pH, and hydraulic load (flow).

5.2.3.2 Pretreatment Requirements: Pretreatment requirements may include sand, oil and grease removal with the use of sand, oil and grease (SOG) traps, oil-water separators and clarifiers. Loading of glycols may require the installation of a tank or pond to provide detention and metering of flow at a controlled rate so as to not upset the biological treatment capacity of the municipal treatment plant. The primary control element for discharge to the POTW in all cases is BOD.

5.2.4 Groundwater Protection: Deicing facilities should incorporate in the design a concrete pad or other impermeable surface on which to deice, and should have a means of collecting or redirecting fluid runoff. Swales and detention ponds, if utilized to collect and store glycol-contaminated runoff, are typically designed with impermeable liners. The possibility of contamination of the groundwater should be recognized in the design of a detention pond. Conveyance features such as pipes and structures may require watertight seals as are required for sanitary sewers when conveying runoff laden with glycol.

5.2.5 Drinking Water Standards:

5.2.5.1 Providing safe drinking water is directly related to meeting water quality standards. Both surface water and groundwater serve as sources of drinking water. A number of federal programs address the goal of making the nation's water "swimmable, fishable, and drinkable." The first major environmental legislation, the Clean Water Act (CWA) of 1972, regulates the discharge of contaminants into surface or groundwater. The NPDES permit program was introduced through the CWA, requiring permits for discrete discharges. Water quality is protected under Sections 210 and 208 of the CWA through regional planning programs for point and nonpoint sources of contamination.

5.2.5.2 The Safe Drinking Act (SDWA) of 1974, as amended, deals with contaminants which affect the public health and those which affect the aesthetic qualities of drinking water. The legislation provides for the protection of aquifers which are the sole source of drinking water and for the control of underground injection of contaminants. The regulations also address conditions where the groundwater quality is under the direct influence of surface water, as well as contaminant levels and required treatment technologies for those contaminants.

5.2.5.3 State and local laws and ordinances have been enacted throughout the country to address drinking water source protection. Statewide water quality standards have been established in some states, setting water quality standards for both surface water and groundwater, recognizing that both serve as drinking water sources.

5.2.5.4 It is possible that, under certain conditions, contaminated airport runoff could adversely affect a drinking-water source. Contaminated runoff entering a surface river/stream or impoundment used as a drinking-water source can exceed allowable pollution standards. Also, surface discharges of contaminated runoff can percolate through granular subsurface soils and enter the groundwater, thus affecting the source of public or private drinking water.

5.2.5.5 While these conditions many not be widespread, they should be addressed at each airport facility. Standard engineering practice requires a minimum separation of sewers from water mains. It may be desirable, or required in some instances, to provide linings to storm water storage ponds to prevent the seepage of deicing contaminants to the groundwater. Containments of more concentrated deicing fluids should have spill containment provided to prevent accidental spillage to surface or groundwater sources of drinking water.

5.2.6 FAA: Though the FAA has no specific regulations related to storm water discharges, it will enforce storm water mitigation measures included in FAA Findings of No Significant Impacts (FONSI) or Records of Decision (ROD). Airports must comply with the measures in its FONSI, ROD, and applicable Federal ad state regulations or face the loss of FAA funding for improvements.

5.3 Structural Best Management Practices:

5.3.1 Collection Alternatives: The implementation of off-gate deicing facilities can make the issue of collecting contaminated runoff less difficult to deal with. Collection of fluids can be facilitated by the incorporation of impervious deicing pads which drain the application area to a single location. Collected fluids can be pumped or gravity fed to a designated area for eventual treatment or recycling. Alternatives for the conveyance of contaminated runoff collected from deicing facilities include:

5.3.1.1 Open Channels: Open channels convey storm water directly to surface waters or detention facilities. Filter strips and grassed swales, when designed for low velocity flow, can be effective for removing pollutants. These practices utilize filtering action of the grass, deposition of solids in low-velocity areas, and infiltration into the subsoil. The use of riprap checkdams is effective in lowering channel velocities to aid in these functions. However, in some instances this infiltration may be discouraged because of the potential for groundwater contamination.

5.3.1.2 Conventional Storm Drain Systems: Storm drain systems typically discharge directly to surface waters (i.e., lakes, rivers, and streams) or detention facilities. These discharges are now coming under government monitoring and control. Configurations consist of apron or other collection lines tied into main or "trunk" lines. Collection lines for hangar roof drainage and vehicular roadway drainage may also be tied into these systems.

5.3.1.2.1 Utilization of storm drain systems to convey runoff to surface water discharge points is generally the most economically attractive alternative for the conveyance of glycol-contaminated fluids particularly if much of the system is existing. This alternative, however, is viable only if surface water disposal is proven to be an acceptable form of discharge unless the runoff is routed to a detention facility for eventual treatment or disposal.

5.3.1.2.2 Collection lines, particularly in the gate areas or at deicing facilities, can be used for the conveyance of both contaminated and noncontaminated runoff. Diversion structures can be used at strategic locations to segregate contaminated fluids.

5.3.1.2.3 In some cases where adjacent surface waters have exhibited no significant oxygen depletion, airports have been permitted to directly discharge glycol-contaminated runoff. However, since specific performance standards for storm water discharges will be uncertain for quite some time, the option of surface water disposal may not continue to be available without some form of treatment.

5.3.1.3 Storm Drain Systems with Diversion Capabilities: The FAA has recommended that in the planning of airport expansion or the designing of new airports, airside drainage systems have the capability, when required, of channeling certain portions of or all of airside runoff to specific locations for proper management.

5.3.1.4 Pavement Sweeping/Vacuum Systems: One new development in the area of glycol collection has been the advent of "modified pavement sweepers." These vehicles are equipped with mechanical brooms and a vacuum system to collect deicing fluids as well as any slush, snow, or rainwater in the apron area. The accumulated load is transferred to a tanker truck or holding tank. The recovered diluted glycol would then be transported to a facility which specializes in the recycling, disposal or treatment of glycol products. These vehicles have been successfully used under certain gate and apron operations and conditions. However, considerations that need to be addressed include:

a. Percentages of glycol materials recovered vs. allowable releases per NPDES criteria;

b. Cost/benefit analysis;

c. Logistics in the gate area(s);

d. Operational impact of increased vehicle activity and congestion in ramp area(s).

5.3.1.5 Force Mains: Where gravity flow to collection vessels is not attainable, a series of pump stations and force mains may be required for the conveyance of contaminated runoff. For example, this type of system can be appropriate for discharge to above-ground tanks located away from the airfield.

5.3.2 Storage Alternatives: Storing runoff from a deicing facility prior to treatment can present a challenge at airports. Available space and relief of the surrounding terrain often reflect conditions which make each situation unique in its design. The most commonly used methods of storage are by underground tanks, above-ground tanks and detention/retention ponds.

5.3.2.1 Underground Storage Tanks (USTs): UST facilities are one option at airports which do not have the required acreage for pond storage. While generally more expensive, this is a viable option in many cases. USTs allow for storage without the loss of surface area which may otherwise be used for airport operations. In many cases, they can be gravity-fed from areas of deicing operations; however, subsequent pumping of the runoff to the treatment area is usually required. USTs can offer the benefit of being constructed in immediate proximity to glycol runoff collection points. At some locations however, the presence of high groundwater can greatly impact the construction of large USTs. A consideration in the planning of USTs is the potential need for BOD reduction prior to discharge from the tank.

5.3.2.2 Above-Ground Storage Tanks: Aboveground tanks can offer the runoff storage and flow attenuation capabilities as detention ponds or lagoons. In addition, diffused aeration systems can be installed for suspension of solids, odor control, and partial BOD reduction prior to discharge.

5.3.2.2.1 Tank Location: Tanks for aboveground runoff storage on an airport must be located so as to be below all controlling surfaces, and in compliance with all clearances/separation standards and critical area requirements. Pumps may be required to lift the runoff to these tanks.

5.3.2.3 Detention Ponds: In many cases, the most economical storage approach, where feasible, is an open detention pond. Dedicating sufficient space for a pond facility can be limited by the availability of suitable undeveloped areas.

5.3.2.3.1 Volume Requirements: Pond storage volume requirements to contain the surface runoff for winter months are typically less than summer requirements. However, the need to detain glycol-contaminated runoff for a longer period (to allow metering, biodegradation, etc.) may dictate a larger pond than runoff quantities would suggest. Required oxygen can be provided by mechanical aeration or photosynthesis, although there would be a decrease in algae growth during cold weather. Pond capacity requirements can be reduced by continuous aeration that allows for more rapid biodegradation and, thus, earlier release of glycol-based fluid wastes. However, storage requirements for this type of process are significant. Without proper aeration, odor problems can become significant, suggesting that ponds be located away from populated areas.

5.3.2.3.2 Fluid Types: With respect to detention ponds, different glycols have distinct BOD loads which may affect the sizing of ponds.

5.3.2.3.3 Pretreating Glycol: Detention ponds can be used to stabilize and pretreat glycol-based fluid wastes prior to discharge to a local treatment plant, an approach that has been successfully implemented at several airports. However, in colder climates, the pretreatment effectiveness of "open" ponds is somewhat decreased as a result of decreasing biodegradation with lower temperatures.

5.3.2.3.4 Extended Holding Time: Extending the detention time in ponds is an effective means of removing particulate pollutants. By detaining stormwater for 24 hours or more, removal of as much as 90% of particulate pollutants is possible.

5.3.2.3.5 Maintenance: Detention ponds require periodic maintenance as sediment accumulates and may have to be checked after every major storm to ensure continued effectiveness. Sediment accumulation is not as significant in ponds that receive runoff from a closed conduit system as compared to runoff that is conveyed through an open channel.

5.3.2.3.6 Pond Location: Care should be taken in locating the ponds so that they do not attract wildlife or birds in the areas of aircraft operations. This can be accomplished by locating the ponds away from the ends of runways, configuring them so that birds are not attracted to the water and/or implementing other design features to minimize the potential for attraction. Typically, long ponds offer greater bird control measures than square ponds.

5.3.3 Treatment Processes: Several treatment alternatives currently exist for the concentration of or destruction of glycol-based deicing fluid runoff. The treatment units described in the following section may require pretreatment for grit removal and skimming of hydrocarbons.

5.3.3.1 Biological Destruction: The most efficient and cost-effective method of destroying organic compounds such as glycol is by biological means.

5.3.3.1.1 Off-airport biological treatment at a POTW following limited on-airport pretreatment provides proven results. On-airport biological treatment options can include the use of one or more biological reactor trains, trickling filters, or activated sludge lagoons. However, biological treatment systems require a fairly continuous flow to provide effective treatment. As a result, equalization basins which equalize and ensure continuous flow to the treatment system, are normally required as a component of biological treatment.

5.3.3.1.2 Biological treatment options typically require a high initial capital expenditure and should be operated and maintained by a qualified operator. Unless an airport has a desire and the expertise to enter into wastewater treatment facility operation, these processes are more appropriately operated by wastewater treatment professionals. Additionally, the seasonal and intermittent nature of aircraft deicing discourages the use of an on-airport wastewater treatment facility. This is due to the fact that biological activity in the system is difficult to maintain between deicing events. It can be very difficult to justify the expenditures required to construct, operate, and maintain an on-airport biological treatment facility to treat only deicing fluid discharges from airports.

5.3.3.2 Evaporation (Distillation): One method of minimizing the quality of product requiring treatment is to concentrate the runoff by removing the water through evaporation. What remains is concentrated glycol. Sufficient temperature to drive off this water is achieved through the application of a heat source. The concentrated glycol solution can either be taken off airport by a glycol distributor for recycling, or after addressing reapplication considerations, may be reused. Reapplication to aircraft as is presently done on a very limited basis in Europe, but not in the U.S. (see 5.3.4.1). Because of the difficulties in directly reformulating and re-using the glycol on aircraft, this is not presently done in North America. However, reuse as an airfield deicer may be a possibility.

5.3.3.3 Photochemical Oxidation: Oxidation was intended to be a viable treatment technology for the destruction of glycol. However, it has been shown that chemical oxidation methods, which utilize ultraviolet light, peroxide (H_2O_2), ozone (O_3), and permanganate ($KMnO_4$) in the destruction of glycol result in either (a) limited effectiveness of the oxidant in reducing glycol concentration, or (b) the amount of oxidant needed to show significant reduction leads to prohibitively high costs. Additionally, there are significant equipment requirements including in-line mixers, contact vessels with agitators, chemical storage vessels, and metering equipment. Treatment utilizing photochemical agents to adequately reduce glycol concentrations has yielded disappointing results.

5.3.4 Recycling Alternatives:

5.3.4.1 Airport Reuse: At commercial-use and larger general aviation airports, it may be possible to obtain glycol in the runoff in sufficient quantity and concentration to make recycling feasible. Reformulation and recertification to AMS 1424 and AMS 1428 or ISO 11075/11078 would also be required for use on aircraft. Nonaircraft reuse of glycols for pavements is possible when fluids are recertified to meet established runway specifications, such as, AMS 1435.

The spent glycol may be diluted considerably by precipatation and other factors following initial application. This needs to be considered in the design of any recovery facility. Deicing fluids are not presently recycled for aircraft use in the United States.

5.3.4.2 Industrial Reuses:

5.3.4.2.1 Glycol may be present in the runoff in sufficient quantity and concentration to make recycling feasible. Glycol recyclers may be available to enter into an agreement with the airport to pump out the storage facility and transport the deicing fluid off site.

5.3.4.2.2 Experience to date indicates that commercial recyclers typically require approximately an 8 to 10% glycol concentration at a minimum to provide this service to an airport. The desirable concentration is a function of the current prices of glycols and natural gas.

5.3.4.2.3 Recycling Type I fluid for industrial reuse is a fairly simple process and the technology is readily available. It is more difficult to extract glycol from glycol-based runoff when the mixture consists of Type I and Type II or other fluid types having extended holdover capabilities.

5.4 Nonstructural Best Management Practices:

5.4.1 Product Substitution:

5.4.1.1 Glycols have been used historically to deice aircraft because of their effective deicing characteristics and compatibility with aircraft metal surfaces. These fluids had been used for many years with minor environmental concerns or no particular need to search for substitute chemicals. However, increasing environmental sensitivity and awareness, as well as the recent NPDES stormwater permit program, have highlighted the environmental effects presented by the glycols.

5.4.1.2 Substitution of another aircraft deicing compound for glycols is not presently an option available to the aviation industry as suitable alternative aircraft deicing agents are limited. Efforts are being made to develop a suitable substitute compound with lesser environmental impacts. This being the case, efforts need to be directed towards the proper handling and disposal of the collected glycol deicing fluids.