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Source Water Protection Practices Bulletin

Managing Aircraft and Airfield Deicing Operations to Prevent Contamination of Drinking Water

The Federal Aviation Administration (FAA) requires that aircraft surfaces be deiced and anti-iced to ensure the safety of passengers. However, when performed without prevention measures in place, airport deicing operations can contribute to contamination of ground water and surface water supplies. This bulletin addresses two basic types of deicing/anti-icing operations that take place at airports: the deicing/anti-icing of aircraft, and the deicing/anti-icing of paved areas including runways, taxiways and gate areas. It also discusses some source water contamination prevention measures available for use at smaller airports. Additional information on deicing of roadways is presented in the bulletin on highway deicing.

AIRCRAFT DEICING/ANTI-ICING CHEMICAL USE

The most common technique for deicing/anti-icing of aircraft is the application of chemical deicing/anti-icing fluids (ADF), which are composed primarily of ethylene or propylene glycol. Frequently this is achieved using fixed booms or trucks with an operator bucket mounted on a boom. Temperature and weather conditions dictate the required concentration of glycol in ADF, but most operators use fluid with fifty percent glycol concentration by volume. Deicing/anti-icing fluids also contain additives, including corrosion inhibitors, flame retardants, wetting agents, and thickeners that protect aircraft surfaces and allow ADF to cling to the aircraft, resulting in longer holdover times (the time between application and takeoff during which ice or snow is prevented from adhering to aircraft surfaces). Limited information is available on the actual chemical compositions of ADF because their formulations are considered trade secrets.

Four types of deicing/anti-icing fluid are used on aircraft, and vary by composition and holdover time. Type I fluids, which contain glycol and less than one percent additives, are most commonly used for deicing and have relatively short holdover times. Types II, III, and IV fluids are used for anti-icing protection because they contain higher concentrations of additives (two percent or less) in addition to glycol. Larger airlines use both Type I and Type IV fluids for deicing and anti-icing. Because longer holdover times are not as important a consideration at smaller airports, smaller airlines typically use Type I and II fluids, which contain smaller amounts of additives, or no anti-icing fluids at all.

AIRFIELD PAVEMENT DEICING/ANTI-ICING CHEMICAL USE

Ice and snow is cleared from runways, taxiways, roadways, and gate areas using a combination of mechanical methods (e.g., plows and brushes) and chemical deicing agents. Pavement is typically cleared with mechanical equipment, then chemically treated to prevent further snow and ice accumulation. Chemicals commonly used for deicing/anti-icing include ethylene or propylene glycol, urea, potassium acetate, sodium acetate, sodium formate, calcium magnesium acetate (CMA), or an ethylene glycol-based fluid known as UCAR (containing ethylene glycol, urea, and water). Sand and salt (sodium or potassium chloride) may also be used, but they can cause damage to aircraft surfaces and mechanical parts.

WHY IS IT IMPORTANT TO MANAGE RUNOFF OF DEICING FLUID NEAR THE SOURCES OF YOUR DRINKING WATER?

EPA estimates that 21 million gallons of ADF (50 percent glycol concentration) are discharged to surface waters annually from airport deicing operations across the country, and an additional 2 million gallons are discharged to publicly owned treatment works (POTWs). Unless captured for recycling, recovery, or treatment, deicing agents will run off onto bare or vegetated ground where they may travel through the soil and enter ground water, or run off into streams. Unprotected storm water drains that discharge to surface water or directly to the subsurface (i.e., through a dry well) are also of concern.

Ethylene and propylene glycol can have harmful effects on aquatic life due to their high biological oxygen demand (BOD). Depletion of oxygen, fish kills, and undesirable bacterial growth in receiving waters may result. Although pure ethylene and propylene glycols have low aquatic toxicity, ethylene glycol exhibits toxicity in mammals, including humans (with the potential to cause health problems such as neurological, cardiovascular, and gastrointestinal problems, serious birth defects, and even death when ingested in large doses). Additionally, ethylene glycol is considered a hazardous air pollutant (HAP), and is subject to reporting requirements under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).

Additives in deicing/anti-icing fluids can be significantly more toxic to the aquatic environment than glycols alone. Corrosion inhibitors are highly reactive with each other and with glycols; reactions can produce highly toxic byproducts. Other additives such as wetting agents, flame retardants, pH buffers, and dispersing agents also exhibit high aquatic and mammalian toxicities. Manufacturers and formulators have attempted to reduce the toxicity of additives present in their ADF formulations and, when possible, use environmentally benign chemicals. The Society for Automotive Engineers (SAE) is currently working to set an ADF toxicity standard in the near future.

Sodium chloride, or salt, is applied to paved surfaces to prevent icing. (See the bulletin on highway deicing for more information on deicing paved surfaces.) Sodium can contribute to cardiovascular, kidney, and liver diseases, and has a direct link to high blood pressure. There is no MCL or health advisory level for sodium; however, there is a Drinking Water Equivalent Level of 20 mg/L, a non-enforceable guidance level considered protective against non-carcinogenic adverse health effects. Sodium is one of the contaminants EPA is considering for a regulatory determination. Chloride, which has a national secondary drinking water standard of 250 mg/L, adds a salty taste to water and corrodes pipes.

AVAILABLE PREVENTION MEASURES TO ADDRESS AIRCRAFT AND AIRFIELD DEICING

An overview of several management measures are described in this section, though they are not exhaustive. The reference materials below can provide additional resources and information. Please keep in mind that individual prevention measures may or may not be adequate to prevent contamination of source waters. Most likely, individual measures should be combined in an overall prevention approach that considers the nature of the potential source of contamination, the purpose, cost, operational, and maintenance requirements of the measures, the vulnerability of the source water, the public's acceptance of the measures, and the community's desired degree of risk reduction.

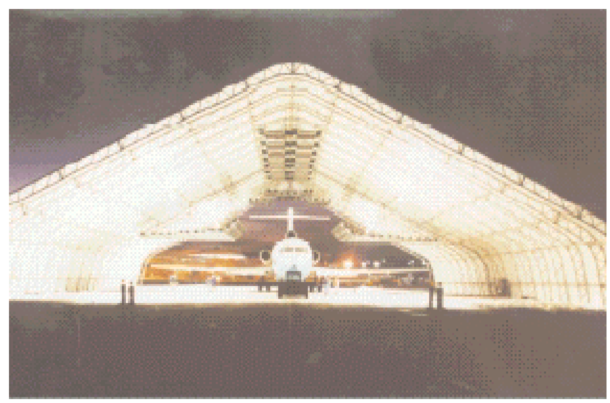
Alternative Deicing/Anti-Icing Materials

Use alternative airfield deicing products such as potassium acetate, sodium acetate, sodium formate, potassium formate, or CMA instead of urea or glycol deicers. These products have lower toxicities, are readily biodegradable, and have a lower BOD in the environment. Many of these products can be applied using the same mechanical spreaders used for urea or spray booms used for glycol-based fluids. (See the bulletin on highway deicing for more information on some of these alternative deicers.)

Reducing Deicing/Anti-Icing Fluid Usage

On Aircraft:

Mechanical deicing technologies eliminate the need for deicing fluids and reduce the need for anti-icing fluid. Below are some examples of newer technology.



Infra-red radiant heating unit.

- ***Boot deicing*** works by inflating a rubber boot located on the leading edge of an aircraft wing. When inflated, the boot causes ice to crack and become dislodged from the surface. Passing air blows the ice away. This method is used primarily on propeller-driven aircraft.
- For small aircraft, ***infra-red deicing systems*** use natural-gas-fired radiant heaters inside a drive-through hanger. Follow-up chemical deicing or anti-icing is usually required to prevent re-freezing.
- ***Electrical resistive heating*** can remove ice from the surface of small to medium sized aircraft. By applying resistive heating to heating mats located near the skin of an aircraft, ice is melted and is easily dislodged from aircraft surfaces.
- ***Hot air blast*** deicing systems use heated compressed air to blow snow and ice off of aircraft wings. This may be followed by conventional deicing/anti-icing.

The installation of a ***computerized spraying system*** to apply deicing chemicals may reduce the use of deicing/anti-icing fluids. These systems can reduce both the volume of deicing fluid used and the time needed for deicing, and increase the collection efficiency of runoff. These "car-wash" style systems can be operated by personnel with a minimum of training. This option may be cost-prohibitive for smaller airports, and in some cases, planes may need additional deicing using traditional means (trucks or fixed booms) to deice engine inlets, undercarriages, or the underside of aircraft wings. Deicing fluid sprayed from truck-mounted booms allows more effective and efficient deicing. The deicer can be sprayed closer to the aircraft surface, reducing over-spray and wastage.

Using ***ice detection systems or sensors***, especially on larger aircraft, can reduce and, in some cases, eliminate application of deicing fluid. Because operators and flight crews often have difficulty detecting ice on aircraft wings, aircraft are deiced whenever ice is suspected to be present. Magnetostrictive, electromagnetic, and ultrasonic devices can detect ice on aircraft surfaces, including areas that are difficult to inspect visually and in cases where ice build-up is not apparent. This allows operators to more accurately determine when deicing is unnecessary and can decrease the amount of ADF used at an airport.

Increase storage for multi-strength glycol solutions. Using a technique called "blending to temperature," operators can vary the concentration of glycol in deicing fluid. Operators, particularly at small airports, commonly use a fluid with 50 percent glycol, a concentration that is formulated for worst-case cold weather conditions. However, concentrations of 30 to 70 percent glycol may be used in different conditions. Reducing the glycol concentration in deicing fluid decreases the amount of glycol in surface runoff and storm water collection systems.

On Pavement Surfaces:

Prevent strong bonding of ice to pavement surfaces by pre-treating and/or promptly treating pavement using either mechanical methods or chemicals. Pre-treating pavement with chemicals such as aqueous potassium acetate prior to the onset of freezing conditions or a storm event can allow easy removal of snow and ice using sweepers and plows. The FAA estimates that the correct application of pavement anti-icing chemicals can reduce the overall quantity of pavement deicing/anti-icing agents used by 30 to 75 percent.

Use mechanical methods for dry snow removal rather than applying chemicals.

Use the proper amount of pavement deicing/anti-icing chemicals by following recommendations from the manufacturer, and properly maintaining spreading equipment. This will reduce unnecessary or over-application of chemicals. Avoid applying glycol-based deicers near storm drains, particularly those that are not routed to a publicly-owned sewage treatment plant.

Collection and Disposal of Spent Fluid to Reduce Runoff

Centralized deicing pads restrict aircraft deicing to a small area, minimizing the volume and allowing for the capture of deicing waste. A deicing pad is specially graded to capture and route contaminated runoff to tanks. If the pads are located near gate areas or at the head of runways, deicing may be completed just prior to takeoff; as a result, less Type IV anti-icing fluid may be necessary for shorter holdover times, reducing the amount of glycols released onto the runway or into the air. In addition, fluids recovered from deicing pads may be suitable for reuse.

Vacuum sweeper trucks collect spent aircraft and airfield deicing fluids as well as any slush or snow from gate areas, ramps, aircraft parking areas, taxiways, and aircraft holding pads. Vacuum vehicles are a cost-effective alternative to installing traditional drainage collection systems or deicing pads, typically ranging in cost from $200,000 to $400,000 each. In addition, the recovered fluid may be suitable for recycling.

Detention basins or constructed wetlands are open-water ponds that collect ADF runoff from runways and airport grounds. Basins allow solids to settle, and reduce oxygen demand before the runoff is discharged to receiving waters. A pump station can discharge metered runoff by way of an airport storm sewer. Airports operating these may be required to install liners to protect ground water and monitoring wells to detect leakage from breached liners. An aeration system may be required to treat glycol contaminated runoff. See the storm water bulletin for more information on runoff controls.

Anaerobic bioremediation systems, in conjunction with sewage treatment plants or detention basins, can be an effective means to dispose of glycol-contaminated runoff. Bioremediation systems generally consist of a runoff collection and storage system, an anaerobic bioreactor treatment system (one that requires little or no oxygen), and a gas/heat recovery system. These systems can reduce oxygen demand levels sufficiently to permit unrestricted disposal to a sewage treatment plant. Additionally, these systems can remove additives from runoff. An economic benefit to the anaerobic process is that it converts glycol in runoff to methane gas that can be used for heating.

Transport of spent fluid to a sewage treatment plant by way of a sanitary sewer is almost always the most economical method of treating deicing fluid, provided that sufficient biological loading capacity is available at the treatment plant. However, many sewage treatment plants will only accept limited quantities of glycol-contaminated runoff; check with the appropriate local agency to verify applicable regulations. Airport maintenance crews should not assume that storm drains are routed to a sanitary sewer. They should be knowledgeable about which drains or collection systems discharge directly to surface waters or to the subsurface, e.g., through a dry well.

Recycling and Recovery of Spent Fluid

Recycling of glycol from spent deicing/anti-icing fluid decreases the amount that reaches and potentially impairs surface and ground waters. The recycling process consists of several steps including filtration, reverse osmosis, and distillation to recover glycol from spent deicing fluid. Technology is available to recycle fluids containing at least 5 percent glycol. Glycol recycling reduces the amount and strength of wastewater, reducing wastewater disposal costs. In addition, the recovered glycol may be sold; the value of recovered glycol depends on the type of glycol and its concentration and purity. Recent developments have made on-site recycling successful at smaller airports; however, the volume of fluid used at very small airports may still be insufficient to make recycling economically viable at these facilities.

Additional Prevention Measures

Under the National Pollutant Discharge Elimination System (NPDES) Permitting Program, airports are required to obtain permit coverage for storm water discharges from vehicle maintenance, equipment cleaning operations, and airport deicing operations. While specific permit conditions vary from state-to-state, in general, NPDES storm water permits require airports to develop and implement ***Storm Water Pollution Prevention Plans*** (SWPPPs) that include the following elements:

- Description of potential pollutant sources and a site map indicating the locations of aircraft and runway deicing/anti-icing operations and identification of any pollutant or pollutant parameter of concern.
- Description of storm water discharge management controls appropriate for each area of operation.
- Consideration of alternatives to glycol- and urea- based deicing/anti-icing chemicals to reduce the aggregate amount of deicing chemicals used and/or lessen the environmental impact.
- Evaluation of whether deicing/anti-icing over-application is occurring and adjustment as necessary.
- Employee training on topics such as spill response, good housekeeping, and material management practices for all personnel that work in the deicing/anti-icing area.

Many NPDES storm water permits issued to airports also require a variety of monitoring activities to evaluate the effectiveness of storm water controls in preventing deicing/anti-icing activities from impacting receiving water quality. For example, monitoring requirements for airport deicing/anti-icing activities in EPA's Multi-Sector General Permit include monthly inspections of existing storm water controls during the deicing season (weekly if large quantities of deicing chemicals are being spilled or discharged), quarterly visual monitoring of storm water discharges, and periodic effluent monitoring for BOD, chemical oxygen demand (COD), ammonia, and pH (for larger users of deicing/anti-icing chemicals) during storm events.

Storm water that discharges directly to the subsurface by way of dry wells, drain fields, or any other type of distribution system is subject to ***Underground Injection Control (UIC) Program*** requirements. These types of drainage systems are regulated as Class V injection wells and operators should contact their state or federal UIC Program authority for information on applicable regulations.

Employee training is an important tool in reducing contaminated runoff. Deicing personnel receive eight hours of FAA-mandated training, but industry sources state that three years of experience is required to become adept at aircraft deicing. Personnel should be trained on proper application techniques and best management practices, and be informed of the presence of any sensitive water areas nearby. Properly trained personnel will also use less deicing/anti-icing fluid, saving money and reducing contamination.

Monitor ground water quality and identify the direction of ground water movement on-site through the creation of a water table map. Once the direction of ground water flow is known, annual monitoring up gradient and down gradient of deicing areas should provide early detection of deicing fluid contamination and other harmful impacts.

FOR ADDITIONAL INFORMATION

These sources contain information on airport deicing practices and facilities and provide prevention measures to avoid source water contamination. All of the documents listed are available for free on the Internet.

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USEPA. (No Date) Shallow Injection Wells (Class V). Available at
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