TORONTO **STAFF REPORT**

March 21, 2002

To: Board of Health

From: Dr. Sheela V. Basrur, Medical Officer of Health

Subject: Management of De-icing Activities at Toronto Lester B. Pearson International Airport

Purpose:

To report on the collection, treatment, monitoring and reporting procedures that are in place at the Toronto Lester B. Pearson International Airport on discharge management of de-icing fluids to mitigate health and environmental effects.

Financial Implications:

There are no financial implications stemming from this report.

Recommendations:

It is recommended that the Board of Health:

(1) request the Greater Toronto Airports Authority (GTAA) to:

   (a) continue to monitor discharges from the airport for ethylene glycol, including at locations along the property boundary; and

   (b) continue to enhance and fine-tune their de-icing fluid and stormwater management program at Toronto Lester B. Pearson International Airport;

(2) request the Federal Ministers of the Environment and Transport to:

   (a) work with the GTAA and other Canadian Airport Authorities to encourage manufacturers to replace tolyltriazole in the aircraft de-icing and anti-icing formulations with less toxic additives; and

(b) work with the GTAA and other Canadian Airport Authorities to investigate the level and total loading of tolytriazole in the effluents of Canadian airports. Should there be concerns identified, the Federal Minister of the Environment must develop a suitable effluent guideline for tolyltriazole discharge to the natural waterways, and assess the treatability of tolytriazole and its potential impact on the treatment of spent de-icing and anti-icing fluids;

(3) request that the GTAA consult with Works and Emergency Services on the safe discharge of tolyltriazole into the municipal sanitary sewer system if concerns are identified. In this case, the GTAA should include tolyltriazole in its monitoring program prior to discharge of spent de-icing waste to the sanitary sewer system and the environment;

(4) request the Ontario Minister of the Environment and the Commissioner of Works and Emergency Services to continue to make random site visits to ensure all the environmental management procedures for de-icing are followed;

(5) forward this report to the GTAA, Works Committee, the Federal Ministers of the Environment and Transport, the Ontario Minister of the Environment, and the Medical Officer of Health of the Regional Municipality of Peel for their information and appropriate action; and

(6) the appropriate City officials be authorized and directed to take the necessary action to give effect thereto.

Background:

On October 27, 1999, Toronto City Council adopted Clause No. 22 of Report No. 4 of the Works Committee, authorizing the City of Toronto to enter into the following agreements with the Greater Toronto Airports Authority (GTAA):

(1) an Encroachment Agreement for the connection of a forcemain to Toronto's sanitary sewer system to convey spent de-icing fluids to Toronto's Humber Treatment Plant;

(2) a Sanitary Discharge Agreement for the payment of a surcharge on the water not supplied by our municipal system for water pollution control treatment purposes; and

(3) an Industrial Waste Surcharge Agreement for the payment of a surcharge for the treatment of biochemical oxygen demand (BOD) in excess of our Sewer Use By-law No. 153-89 limit.

During the same meeting, Toronto City Council requested the Medical Officer of Health to ensure that the appropriate monitoring equipment and monitoring reporting procedures are in place to ensure that any danger to public health from glycol is eliminated.

Toronto Public Health has consulted with Works and Emergency Services during the preparation of this report.

Comments:

(1) De-icing and Anti-icing Fluids and the Air Transport Industry

De-icing of aircraft is a mandatory requirement under Canadian federal regulations. Under the regulations, aircraft are not allowed to take off with ice on their wings. To ensure flight safety, aircraft surfaces are sprayed with de-icing or anti-icing fluids prior to departure when weather conditions are conducive to ice formation on the surface of aircraft.

The active component of aircraft de-icing or anti-icing fluids is ethylene glycol or propylene glycol. Ethylene glycol is the active component in aircraft de-icing or anti-icing fluids used at Toronto Pearson International Airport. Although its toxicity is relatively low and it breaks down readily in the environment, rapid loading of large volumes of de-icing fluids into the surface water bodies can lead to oxygen depletion, threatening the survival of aquatic life. Ethylene glycol-based de-icing products are about 3-10 times more toxic to aquatic organisms than pure ethylene glycol due to the presence of small amounts (about 1%) of additives in the formulations. One of these is tolyltriazole, which functions as a corrosion inhibitor and a flame retardant.

(2) Federal Target for Glycol Management

Since ethylene glycol is used in large quantities in the aircraft de-icing and anti-icing activities under cold weather conditions in Canada, Transport Canada, in concert with local airport authorities, Air Transport Association of Canada and air carriers, embarked on various environmentally protective glycol management initiatives. A voluntary guideline for ethylene glycol in airport effluent has been established. The Canadian Environmental Protection Act (CEPA) Part IV effluent guideline of 100 mg/L (i.e. 0.01%) is the current target at airports (Government of Canada, 1999) and is expected to be protective of direct toxicity to aquatic organisms and indirect toxicity due to oxygen depletion.

(3) Environmental Management Plan for De-icing at Toronto Pearson International Airport

Only ethylene glycol-based de-icing or anti-icing fluids are used at the Toronto Pearson International Airport. To address growing concerns for operational safety and environmental compliance, the GTAA decided to construct a Central De-icing Facility (CDF) to better manage de-icing activities at the airport. One of the goals is to minimize the release of contaminants to the surrounding waterways by minimizing consumption and spillage of de-icing fluids, as well as by collection, treatment and safer disposal of spent fluids. The CDF opened in 1998 and expanded in 1999/2000, with plans in place for further expansion and service enhancement as need arises.

The GTAA has also devised an elaborate collection system for the spent fluids, has an arrangement for recycling and treatment of the spent fluids and built a series of stormwater control facilities. Monitoring equipment and monitoring reporting procedures as well as safeguards have been put in place for the smooth operation of the system (see Attachment 1). These procedures ensure that the discharge of the spent fluids to the sanitary sewer system is conducted in accordance with the GTAA's compliance agreement with the Regional Municipality of Peel/City of Toronto under the Sewer Use By-law. Only stormwater that meets the Federal effluent guideline is released to the environment.

(4) Toronto Public Health Evaluation of De-icing Fluid Management at Toronto Airport

The GTAA has greatly improved the environmental management of ethylene glycol. Stormwater effluent from the airport shows a decline in ethylene glycol measurement over the years (maximum of 200 mg/L in 1998-1999 season as compared to 3,100 mg/L before the implementation of the management plan) (Sills and Blakeslee, 1992; GTAA, 1999). For the 2000-2001 season, despite the heavy winter weather conditions and the increase in overall volume of glycol applied (total volume was 6,958,417 L) at the airport, the Toronto Pearson International Airport experienced a record low number of glycol exceedances (16, as compared to 319 in 1992-1993 season) in stormwater discharge to the surrounding natural waterways (GTAA, 2001). The total amount of wastewater that exceeded the Federal guideline was generally small (GTAA, 2002).

Annual reviews of de-icing operations are conducted. Based on the lessons learned, the GTAA launches a series of initiatives to improve de-icing operations and stormwater management plans. The goal is to reduce the number of water quality exceedances in any given de-icing season to zero.

Toronto Public Health has examined the CDF facility, the stormwater control facilities, the monitoring equipment and reporting procedures for glycol management and found the GTAA de-icing management system sophisticated and generally well designed. There is a quality assurance/quality control process in place for glycol testing at the CDF, and at the stormwater facilities. Procedures also exist to monitor and address discrepancies between on-site chemical testing results and those of external accredited laboratory analyses. Fluids with concentrations below the Federal guidelines from the de-icing facility are not released to the natural environment. They are sent to the GTAA stormwater control facilities (with built-in safeguard), where they are subject to treatment, monitoring and testing prior to final discharge. Most exceedances are due to leakage in the seals and the GTAA staff are constantly checking and maintaining valves.

Potential for groundwater contamination at Toronto Pearson International Airport is low because of the dense clay soil and the extensive underground drainage network, which forms part of the GTAA stormwater management system.

Toronto Public Health is satisfied with GTAA's commitment to exercise due diligence with regard to environmentally responsible management of its de-icing operations. GTAA must continue to monitor discharges, at monitoring stations located in the direct vicinity of de-icing

operations, at stormwater control facilities and at the 40 sample locations on the airport property, particularly those at property boundaries. This type of monitoring will allow the GTAA to evaluate the airport's overall performance and to plan necessary modifications.

The de-icing fluids are found to be 3-10 times more toxic to aquatic life than pure ethylene glycol (see Attachment 2), mainly due to the presence of a small amount of tolyltriazole. Although tolyltriazole may comprise only up to 0.5% of aircraft de-icing fluids, it is about 600 to 900 times more toxic to aquatic life than pure ethylene glycol (USEPA, 2000). While GTAA is to be commended for its efforts to monitor and manage the spent glycol, more needs to be done to examine if tolyltriazole poses an environmental problem to the natural waterways around the Toronto airport. Toronto Public Health therefore recommends that the Federal Ministers of the Environment and Transport work with GTAA and Canadian Airport Authorities to encourage the manufacturers to replace tolyltriazole in the aircraft de-icing and anti-icing formulations with less toxic additives. The Federal Ministers of the Environment and Transport must also investigate the level and total loading of tolytriazole in the effluents of Canadian airports.

In the event that concerns are identified, the Federal Minister of Environment must develop a suitable effluent guideline for tolyltriazole for discharge of airport effluents to the natural waterways and assess the treatability of tolytriazole and its potential impact on the treatment of spent de-icing and anti-icing fluids. As well, the GTAA must consult with Works and Emergency Services on the safe discharge of tolyltriazole into the municipal sanitary sewer system and should include tolyltriazole in its monitoring program prior to discharge of spent de-icing waste to the sanitary sewer system and the environment.

To ensure that the operations are well run on a daily basis, staff must continue to follow the procedures that have been put in place. Toronto Public Health recommends that the Ontario Ministry of the Environment and the Works and Emergency Services make random site visits and examine GTAA logs and reports to determine how well the procedures are followed on an ongoing basis.

Conclusions:

Ethylene glycol is the active component in aircraft de-icing and anti-icing fluids used at Toronto Pearson International Airport. Although its toxicity is relatively low and it breaks down readily in the environment, rapid loading of large volumes of de-icing fluids into the surface water bodies can lead to oxygen depletion, threatening the survival of aquatic life.

Since high levels of ethylene glycol have been measured in the runoff water in the early 1990s, the Greater Toronto Airports Authority has greatly improved the environmental management of de-icing fluids at the airport. It has centralized de-icing activities in the newly constructed Central De-icing Facility and has built a sophisticated infrastructure to capture, store and send spent de-icing fluids for recycling, biological treatment or to sanitary sewer systems in accordance with agreements signed with respective municipal authorities. Monitoring procedures for ethylene glycol are in place to facilitate diversion of spent glycol to the appropriate waste streams, and compliance with effluent guidelines and municipal agreements.

Compared to the early 1990s, the number of glycol exceedances in the airport discharge to the natural watercourse has been greatly reduced. The Airports Authority needs to continue monitoring discharges, enhancing and fine-tuning its de-icing operations and stormwater management to achieve its set goal of "reducing water quality exceedances to zero". A concern that has not yet been sufficiently addressed is the impact of toxic additives, in particular tolytriazole, present in the de-icing fluids. Regulatory agencies and the Airport Authority are encouraged to consider ways to reduce the impact of these additives on the environment.

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List of Attachments:

(1) Environmental Management Plan for De-icing at Toronto Pearson International Airport
(2) Ethylene Glycol: Environmental Fate and Health Impact
(3) References

Attachment 1

Environmental Management Plan for De-icing at Toronto Pearson International Airport

To address growing concerns for operational safety and environmental compliance, the GTAA decided to construct a Central De-icing Facility (CDF) to better manage de-icing activities at the airport. One of the goals is to minimize the release of contaminants to the surrounding waterways by minimizing consumption, spillage of de-icing fluids, and by collection, treatment and safer disposal of spent fluids.

The CDF facility is located as close as possible to departure runways, reducing time between de-icing and take-off while decreasing the overall de-icing time. The plan to build and move all de-icing activities to the CDF was phased in over 5 years. The facility opened in 1998 and expanded in 1999/2000, with plans in place for further expansion and service enhancement as needs arise in the future. At present, the CDF conducts 96% of all de-icing activity at the airport. Only some on-gate frost de-icing (about 4% of total de-icing activity at the airport) involving slight spraying takes place at Terminals 2 and 3.

(a) Management of De-icing Activities at Pearson Airport's Central De-icing Facility

The new de-icing facility offers a totally self-contained de-icing operation. It has six de-icing pads each consisting of a de-icing bay and a staging bay, with a total capacity of up to 12 aircraft being de-iced simultaneously and 12 aircraft in waiting. Aircraft movement, de-icing and snow removal (during snow events) operations are being co-ordinated and directed from the Icehouse facility which includes a glassed-in control tower for visual management of the facility and houses all CDF equipment. The CDF has sufficient on-site area to store "pink" snow (with more than 100 mg/L ethylene glycol) and a centralized glycol storage facility that has capacity to accommodate on-site storage of both fresh and spent glycol.

De-icing Operations at Central De-icing Facility:

De-icing is supported by one-person vehicles with an enclosed operator's cab and an extended telescopic spray arm that can change spray patterns and get close to all critical surfaces being de-iced to save time and fluid. The enclosed cab ensures operator safety and no human exposure to ethylene glycol. These vehicles are designed for minimum glycol consumption, thus generating minimum spent glycol.

Following each de-icing operation, glycol recovery vehicles, which have a large on-board storage capacity, vacuum the pad surfaces at high speed to maximize the collection of highly concentrated glycol. The recovered spent fluid is then discharged into designated storage tanks.

The refilling of de-icing vehicles and discharge of spent fluid by glycol recovery vehicles are done on site. The de-icing fluid is tested daily. All snow is melted and discharged into designated storage tanks.

The GTAA conducts testing of surface runoff at the CDF year round. During the de-icing season (between October and May), all surface runoff is handled through the collection system at the CDF. Once runoff is found to comply with the Federal effluent guideline on repeated testing usually around the end of May, runoff is allowed to bypass the CDF collection system and directly enter the GTAA stormwater management facilities, where it is further monitored for compliance with Federal guidelines prior to discharge.

Underneath the CDF pads, a HDPE Geomembrane (plastic liner) was installed throughout the facility to ensure that any spent de-icing fluid seeping through the ground surface will not reach groundwater but will be contained and redirected to a storage tank. Liquid seeping through the ground surface is collected year round.

Storage and Disposal of Spent De-icing Fluids:

There are three types of storage tanks for spent de-icing fluids (see Table 1 for details) with a total fluid capacity of 12,720,000 L. Collected spent fluids are temporarily stored in these tanks until disposal.

The fluids captured by the vacuum sweepers are directly unloaded into the high concentrate tank. This high concentration fluid (>30,000 mg/L) is transported off site to the Lakeview Water Pollution Control Plant for biological treatment. GTAA is starting a pilot glycol recycling program in early 2002 to recycle this high concentrate fluid stream.

Table 1 CDF storage tanks for spent de-icing fluids

Fluid Concentration	Amount of Ethylene Glycol	Disposal
High concentrate	> 30,000 mg/L (> 3%)	Transfer for recycling or off-site biological treatment
Low concentrate	100 - 30,000 mg/L (0.01- 3%)	Discharge into municipal sanitary sewer system
Below Federal guideline	< 100 mg/L (< 0.01%)	Direct discharge to GTAA stormwater control facilities

Fluid collected by the surface and subsurface collection system is directed to a holding tank. After testing for ethylene glycol concentration, the fluid is diverted into suitable concentrate tanks. The fluid containing 100 - 30,000 mg/L ethylene glycol will be discharged directly through a forcemain into the sanitary sewer system according to a compliance agreement with the Regional Municipality of Peel/City of Toronto under the Sewer Use By-law. Fluids meeting the Federal guideline of 100 mg/L will be pumped directly to the GTAA stormwater control facilities. The concentration of ethylene glycol is confirmed before the fluids are discharged.

Waste Stream Fluid Management:

The ability to achieve the overall objective of minimizing ethylene glycol discharge to the environment rests on the successful diversion of various waste streams and tight control of the discharges. This requires support from a competent laboratory with good testing capability.

At the CDF, the diversion of the collected waste streams is managed through the Fluid Room, where analytical field testing of glycol concentration is conducted. A sample is taken from the flow to the diversion vaults every 15 minutes and the waste stream diverted to storage tanks accordingly.

Fluid testing is conducted every time fluids are discharged from the storage tanks to the sanitary sewer system. The amount of fluid to be pumped is calculated based on the percentage of glycol in the tank and the sanitary discharge pumping guide and must not exceed the limits set forth by the municipality. The municipality is informed prior to and on completion of discharge to the sanitary sewer system. Fluid testing is also conducted for every discharge to the GTAA stormwater control facilities.

While GlobeGround North America operates the CDF, the Ontario Clean Water Agency (OCWA) manages the Fluid Room. The Compliance Manager for OCWA visits the Fluid Room three to four times a week and is on call 24 hours daily to trouble shoot in case of any problems with the operation. A procedure is in place in case of anomalies being observed in the testing results.

There are also quality assurance/quality control measures. A composite sample taken from each discharge to the sanitary sewer system is held in the refrigerator for the municipality. Random samples are taken to an external accredited laboratory for independent laboratory analysis. Random samples taken prior to discharge to the stormwater control facilities are also split for analysis with an external accredited laboratory. Any discrepancy in chemical testing results between on-site testing and external accredited laboratory analysis is investigated and remedial steps taken. The GTAA procedures have built in buffers to ensure that the daily limit for discharge into the sanitary systems is not exceeded.

Record Keeping and Backup Plan:

The efficient running of the CDF is co-ordinated with the help of a complex and comprehensive Co-ordination and Communication System. Each operation at the CDF has two backup plans in place.

The Fluid Room keeps extensive logs of each fluid control valve, each chemical analysis and each discharge. In addition, the Ontario Clean Water Agency has weekly and monthly reports available at all times.

On-gate Frost De-icing:

Only some minor frost de-icing activity takes place on-gate at Terminal 2 and 3. The drainage at these locations is sealed during the de-icing season. All spent glycol fluid on the ground is vacuumed and unloaded into suitable storage tanks. The drains remain closed until the surface runoff meets the Federal effluent guideline for ethylene glycol. The drains will then be opened and all liquid directed to the GTAA stormwater management system.

(a) Stormwater Management System

In addition to the CDF, the airport has built a series of stormwater control facilities and an extensive underground drainage network that feed into these facilities. At present, there are two underground stormwater facilities and a surface stormwater facility, each with its own online analyzer. The surface stormwater facility uses a vertical and horizontal reed-bed to treat contaminated stormwater. Stormwater throughout the airport, such as runoff from the runways, are collected in these facilities. Anti-icing fluid that "shears off" from the airplane as the plane takes off is captured through the stormwater management system.

The GTAA environment staff manages the GTAA stormwater management system. Strict control of discharge is achieved with the help of an automatic analyser and an automatic electronic system. Wastewater is discharged to the municipal storm sewer system only if it meets the Federal effluent guideline for ethylene glycol. Otherwise, it is pumped to municipal sanitary sewers.

To ensure the system works properly, daily backup composite samples (24-hour sample) are taken by staff at each stormwater control facility and sent to an external accredited laboratory for ethylene glycol analysis. The testing results are used to calibrate the automatic analyser in the stormwater facility. The electronic system diverts the wastewater to the municipal sanitary sewers or to the municipal storm sewer system according to the measurements recorded by the analyser. The GTAA environment staff monitors daily what is happening in the system both through the electronic system and manually. If something goes wrong in the electronic system, the discharge is automatically shut down.

If unusually high ethylene glycol levels are reported at the stormwater control facilities, GTAA environment staff proceeds to sample wastewater at different locations in the airport to identify the source of the observed anomaly. Remedial actions are then taken to correct the problem.

Attachment 2

Ethylene Glycol: Environmental Fate and Health Impact

(a) Release to the Environment

In Canada, the air transport and aircraft service industries release a large quantity of de-icing and anti-icing fluids to the environment. In 1995 and 1996, the release from these industries was 2,067 and 3,084 tonnes/year, respectively, accounting for 75% of the total ethylene glycol released to all environmental compartments (Government of Canada, 1999). While a portion of the fluid would evaporate when it is sprayed onto the aircraft, and some residue is retained on the aircraft, about 50% to 80% drains onto the airport surface. Under uncontrolled conditions, the entry of ethylene glycol into the environment can be substantial. Monitoring data from several airport authority reports in the early 1990s reveal that stormwater runoff from airports may contain up to 19,000 mg/L (milligrams per litre) ethylene glycol (Sills & Blakeslee, 1992).

The runoff fluid either enters surface water through the storm drainage system, or is absorbed into the subsurface soils and may leach into the groundwater. The vaporized fluid, if not broken down, will enter the soil eventually when washed down by rainfall or snow. Ethylene glycol is highly soluble in water, does not adhere to soil significantly, and therefore is expected to be highly mobile in soil. Although the potential for groundwater contamination exists, the available data indicate that the environmental impact is of less concern than surface water contamination.

(b) Environmental and Health Impact of Glycol

Although ethylene glycol is readily broken down in the environment through the action of naturally occurring microorganisms in the soil, surface water and groundwater, evidence of high levels reaching the environment has caused considerable concern.

In general, the toxicity of ethylene glycol to aquatic organisms is relatively low. The likelihood for terrestrial organisms to be exposed to ethylene glycol is generally lower than for aquatic organisms and their sensitivity to the substance is also lower (WHO, 2000). However, the sweet or semi-sweet taste of ethylene glycol does encourage animals to consume ethylene glycol containing fluids and ethylene glycol poisoning is common among domestic animals and wildlife. The most likely source of poisoning is from consuming automobile antifreeze (Government of Canada, 1999).

As a result of degradation by microorganisms that use free oxygen, rapid break down of large volumes of ethylene glycol in surface water can result in significant oxygen depletion, which can be detrimental to populations of aquatic organisms in the receiving water bodies. Low oxygen levels can cause a variety of lethal and non-lethal effects among aquatic organisms, with young fish being more sensitive than the older fish.

It was found that de-icing formulations containing ethylene glycol generally show greater toxicity (about 3-10 times more toxic) to aquatic organisms than pure ethylene glycol due to the

presence of the minor (about 1%) additives in the formulations (see Table 1). The toxicity of formulations varies considerably depending on the particular additives present (WHO, 2000).

Table 1 De-icer formulations vs pure ethylene glycol – toxicity[a]

Toxic Endpoint	Pure Ethylene Glycol (mg/L)	De-icing Formulations (mg/L)
Acute test		
48-h LC_{50}[b] for water flea	34,440	13,140
96-h LC_{50} for fathead minnow	72,860	8,050
Chronic NOEC[c]		
Survival for water flea	24,000	8,400
Reproduction for water flea	8,590	< 3,330
Survival for fathead minnow	32,000	6,090
Growth for fathead minnow	15,380	< 3,300

[a]Pillard, D.A. (1995).
[b]Concentration at which 50% of the exposed population die.
[c]No observable effect concentration

Attachment 3

References

1. Government of Canada, 1999. Canadian Environmental Protection Act. Priority Substances List Assessment Report. Ethylene Glycol. Draft. Environment Canada and Health Canada. Ottawa, Ontario.

2. Sills R.D. and P.A. Blakeslee, 1992. The environmental impact of deicers in airport storm water runoff. Michigan Department of Natural Resources. Surface Water Quality Division. Lansing, Michigan. In Chemical Deicers and the Environment. Lewis Publishers, Boca Raton, FL, pp. 323-340. Cited in World Health Organization, 2000. Ethylene Glycol: Environmental Aspects. International Programme on Chemical Safety, World Health Organization, Geneva.

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7. Pillard, D.A., 1995. Comparative toxicity of formulated glycol de-icers and pure ethylene and propylene glycol to Ceridaphnia dubia and Pimephales promelas. Environmental Toxicology and Chemistry, 14: 311-315. Cited in WHO, 2000. Ethylene Glycol: Environmental Aspects. International Programme on Chemical Safety, World Health Organization, Geneva.

8. Greater Toronto Airports Authority and Hudson General Aviation Services, 1998. Information Brief: Central De-icing Facility.

9. Greater Toronto Airports Authority (GTAA), 2002. Personal Communication. 2000 - 2002.