Winter Airport Maintenance : Developing a Unique Expertise

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SUMMARY

Aéroport de Québec inc. is the second airport receiving the most snow in Canada. As such, we have developed our own winter planning expertise as well as procedures for procurement, communications and the publication of critical information regarding aircraft maneuvering areas. Using a standardized method including the analysis of various criteria, we send the control tower and airlines detailed runway surface condition reports up to six times an hour. The Canadian Runway Friction Index (CRFI) - obtained with an electronic decelerometer - is the ideal tool to keep pilots informed of runway conditions. High tech equipment is also essential for optimal airport maintenance. As road salt is prohibited on runways, operators use urea, potassium acetate and sodium formate. These chemicals are 10-30 times more expensive, but specific application techniques help to keep operating costs down while maintaining safe service levels.

KEY WORDS

CRFI / RUNWAY SWEEPER / RUNWAY BLOWER / AIRPORT SNOW REMOVAL / UREA

1. INTRODUCTION

With extreme winter conditions being one of the main reasons for airport closures during winter in North America, snow removal is a major challenge. Because time is always of essence, winter planning, equipment performance and dedicated work techniques are essential to maintain a smooth air traffic flow and to maximize runway opening times while ensuring passenger safety.

2. WINTER MAINTENANCE PLANNING

Aéroport de Québec inc. is the second airport receiving the most snow in Canada, getting on average 316 cm (124.41 inches) of snow per year with precipitations peaking around 550 cm (220.47 inches) (Figure 1). Winter planning is a major component of the airport's operations requiring the development of a winter maintenance plan including airport closure guidelines, snow removal priority areas and aircraft movement runway surface condition reporting parameters.

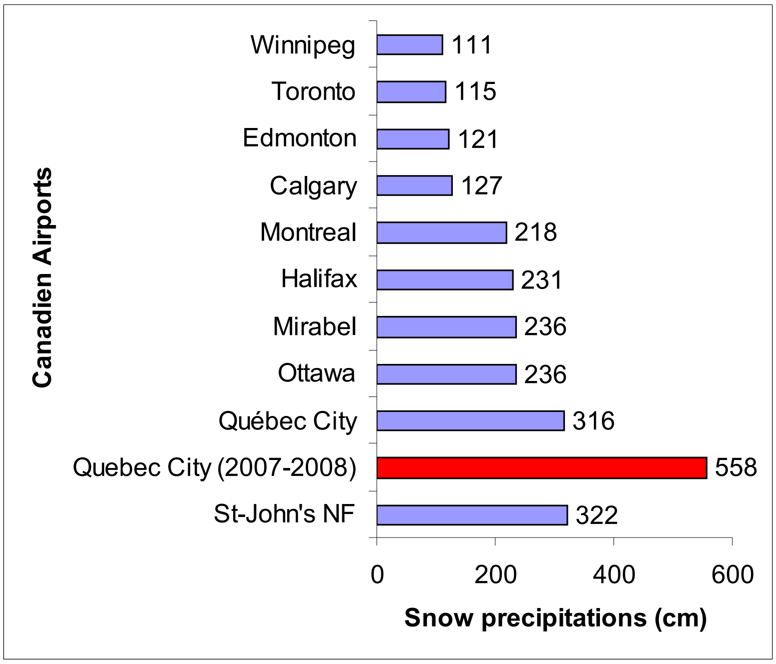

Figure 1 – Annual snow fall average at Canadian airports (over a 30-year period)

2.1 Airport Closure Guidelines

Aéroport de Québec inc. follows strict runway closure guidelines to ensure that the utmost passenger and aircraft safety standards are met at Jean-Lesage International Airport. These guidelines include weather conditions preventing vehicle circulation to execute Runway surface condition reporting, snow banks higher than 46 cm (18 inches) alongside areas where snow has been removed, snow banks higher than 76 cm (30 inches) for dry snow or 61 cm (24 inches) for wet snow between the area where the snow was removed and runway lighting, a Canadian Runway Friction Index (CRFI) under 0.15, difficulty seeing runway lights from the center of the runway, as well as freezing rain or heavy snow, de-icing product application procedures and periods when runway conditions cannot guarantee safe aircraft landing. Snow removal planning is critical in keeping runway closure time to a minimum.

2.2 Snow Removal Priority Areas

There are three priority areas for snow removal. These areas are determined according to the level of runway and apron utilization to ensure that the running surface meets aircraft requirements (Figure 2). Snow is first removed in the aircraft maneuvering areas, i.e. the main runway for take-off/landing and feeder taxiways, dedicated aprons for passenger enplaning and deplaning and cargo loading and unloading. Second, snow is removed from the secondary runway and feeder taxiways. Lastly, snow is removed from movement area shoulders, runway lighting and localizer, glide path and runway pre-thresholds.

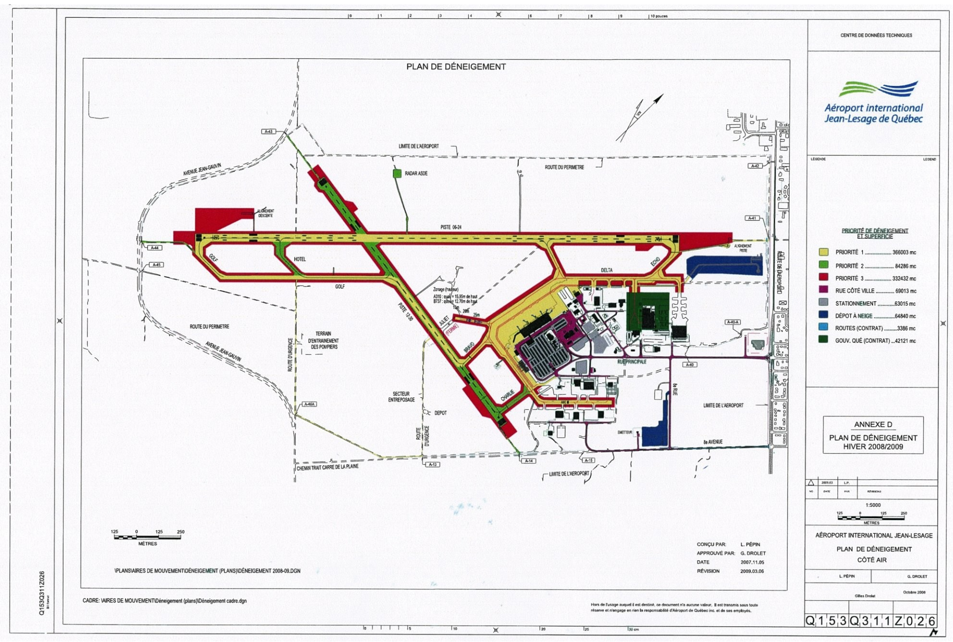

Figure 2 – Snow Removal Priority Areas

2.3 Aircraft Movement Runway Surface Condition Reporting Parameters

During winter, airports must provide users with an accurate assessment of the maneuvering areas' surface pavement conditions. A standardized Runway surface condition report is used nationally to provide this assessment (Figure 3).

Aéroport international Jean-Lesage de Québec

AIRCRAFT MOVEMENT SURFACE CONDITION REPORT
CANADIAN RUNWAY FRICTION INDEX (CRFI)

COMPTE-RENDU DE L'ÉTAT DES AIRES DE MOUVEMENT POUR AÉRONEFS
COEFFICIENT CANADIEN DE FROTTEMENT SUR PISTE (CRFI)

Aéroport international Jean-Lesage

Piste: 06/24					NEIGE									GLACE				
		LARGEUR Pieds	NUE SEC %	nue et mouillée %	poudreuse		Durcie	Mouillée		Fondante		Congère		Glace	Fond de plaque de glace	GIVRE %	Sablée	Urée
Date	5-janv				%	pouce	%	%	pouce	%	pouce	%	pouce	%				
Locale	19:49																	
Zulu	0:49																	
CRFI	.51	100	85%		5%	trace	5%							5%				
Temp.	-7,0 °C	50			50%	1/4								50%	X			
	REMARQUES:																	
Sign.	[signature]																	

Runway: 12/30					SNOW									Ice				
		WIDE FEET	BARE DRY %	Bare & wet %	Loose		Compacted	Wet		Slush		Snow drift		Ice	Base of ice patches	Frost %	Sanded	Urea
Date	Janv. 5				%	Inch	%	%	Inch	%	Inch	%	Inch	%				
Local	19:49																	
Zulu	0:49																	
CRFI		100	75%		15%	trace	5%							5%				
Temp.	-7,0 °C	50			20%	trace								80%				
	REMARKS:																	
Sign.	[signature]																	

Taxiways and Aprons	
	Compacted snow patch — Ice patch — Slippery
	Snow and slippery
	Taxi hotel closed

Figure 3 – Aircraft Movement Surface Condition Reporting Standardized Form

This report is the primary decision-making tool for air carriers and pilots, providing them with accurate data on runway surface conditions. The report must include the following: the percentage of bare and dry pavement, free of snow, ice, slush, frost, or water; the percentage of bare and wet/damp pavement; the percentage and height of loose snow; the percentage of compacted snow; the percentage and height of snow banks; the percentage and height of wet snow; the percentage of frost; the percentage of ice patches; the use of abrasives or chemicals; the outside temperature, including the runway's surface temperature; snow removal procedures if underway and friction measure test results.

An electronic decelerometer is used for friction measurement. This device measures runway friction under specific conditions. Measurements are based on the analysis of several reports combined with sound technical judgment. Once the device is set, vehicle operators must keep a speed of 50 km/hour (31 mph) over a distance of 10 meters (30 feet), going over each side of the runway center line and braking every 305 meters (1,000 feet), the equivalent of nine braking actions in each direction, for a total of 18 measurements (Figure 4). When runway inspection is completed the instrument provides an average called the Canadian Runway Friction Index (CRFI) which is included in the report.

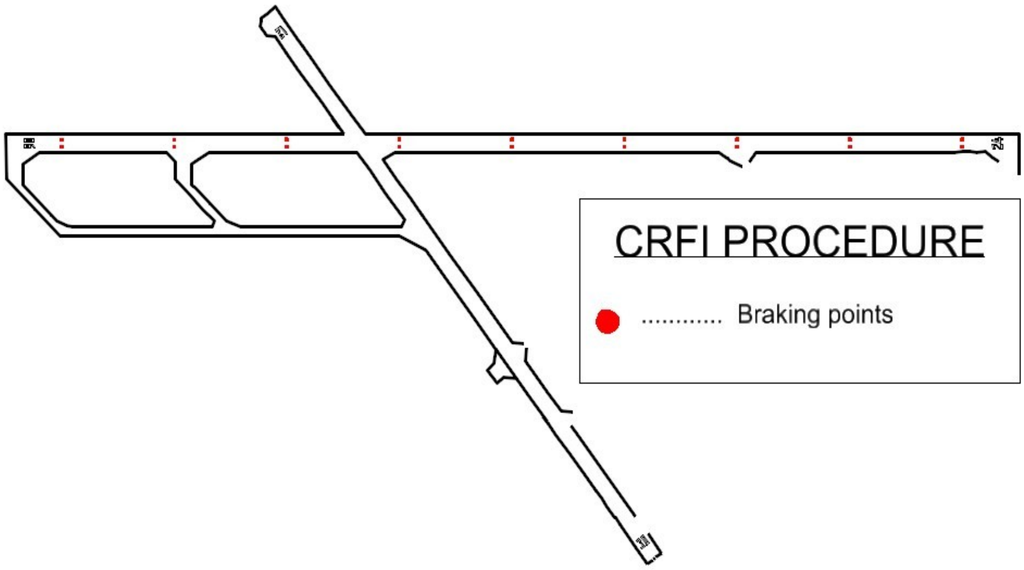

Figure 4 – Canadian Runway Friction Index (CRFI) measurement procedure

CRFI values depend on the type of surface where braking tests are performed, i.e. whether there is ice, compacted snow, loose snow over ice, loose snow over compacted snow or loose snow over pavement. For instance, a mean value of 0.15 usually indicates the presence of ice and a value over 0.40 indicates that the pavement is dry. Between these values, the CRFI varies depending on factors such as the presence of abrasives or snow thickness.

Aircraft maneuvering area conditions are evaluated at least twice during airport business hours, and each time a change occurs in runway surface conditions, i.e. when snow is removed from the runway or plowed after the application of an anti-icing treatment, after de-icing procedures or the application of abrasives, following any aircraft accident or incident on a runway or in response to a carrier or pilot’s reasonable request. In case of heavy precipitations of snow or freezing rain, the transmission frequency can reach up to six times per hour to help users make informed decisions and to determine whether the conditions are safe for landing.

The Aircraft Movement Surface Condition Report and the Winter Maintenance Plan are communications tools designed to ensure successful airline and airport operations. They help to maximize runway utilization time and reduce delays, which is paramount to ensuring passenger satisfaction. These reports are also the basis for winter maintenance operations and glazed frost management as they provide the information required for the implementation of snow removal techniques.

3. SNOW REMOVAL AND GLAZED FROST MANAGEMENT

Airport operators must carry out winter maintenance activities as to not perturb air traffic. Equipment performance and snow removal techniques are therefore essential to ensure excellent service levels. As de-icing salts such as calcium chloride and sodium chloride cannot be used in aircraft movement areas, ice removal must be done using alternative products. The following sections describe specific airport requirements in terms of snow removal and glazed frost management.

3.1 Equipment and Snow Removal Techniques

Over the last 30 years, Aéroport de Québec inc. has used increasingly efficient airport equipment to minimize the negative impact of delays due to aircraft movement area safety maintenance procedures and runway closing time each season (Table 1). Fleet optimization results in faster snow removal procedures on runways and increased clearance widths.

Table 1 – Snow Removal Equipment Performance Evolution

Year	Number of plows	Maximum Execution Speed (km/h)	Width Clearance (meters)	Average Execution Time (minutes)
1970	2	15	**15**	30
1980	3	20	**25**	25
1990	4	25	**30**	20
Future	3	40	**30**	12

Snow removal equipment includes snowplows equipped with a 4,3 meters (14-foot) plow running at 500 rpm and blowing air at 360 km/hour (223 mph) (Figure 5). Under optimal conditions these snowplows can reach speeds of 25 km/hour (16 mph). As Aéroport de Québec inc.'s priority is to clear at least 30 meters (100 feet) of width, four plows are used simultaneously (Figure 6) to clear the snow on a distance of approximately 5500 meters (18,045 feet). This procedure takes about 20 minutes on average (Table 1). In addition, a 5000 ton/hour snow blower reaching over 40 km/hour (25 mph) (Figures 6 and 7) removes windrows of snow left behind by snowplows on either side of the runway center line.

Figure 5 – Runway Plow

Figure 6 – Runway Snow Removal

Figure 7 – Snow Blower

During periods of precipitations, snow is removed down to the pavement. If there is little or no wind, snow removal is done in longitudinal strips, from the center to the edge of the runway. In the presence of strong cross-winds, snow removal begins on the windy side and proceeds towards the least windy side.

3.2 Runway De-icing Operations

Planning and carrying out de-icing operations depend on cross-wind velocity, in addition to other factors such as JBI, climate trends and direction, and specific aircraft operational requirements. Specifically, such operations include the application of de-icing chemicals and abrasives before and after freezing rain precipitations, and the mechanical removal of ice from the movement area thereafter to ensure sufficient friction surface on the movement area in accordance with aircraft operating requirements. The response must be planned as soon as freezing rain is forecasted and carried out as soon as the freezing rain starts falling or when ice is present.

Road salts are prohibited on runways because of their corroding effect on aircraft construction materials. As a result, operators must use alternative methods including the application of urea and sodium formate to control the ice. These chemicals are 10-30 times more expensive (Table 8) but specific application techniques help to keep costs down.

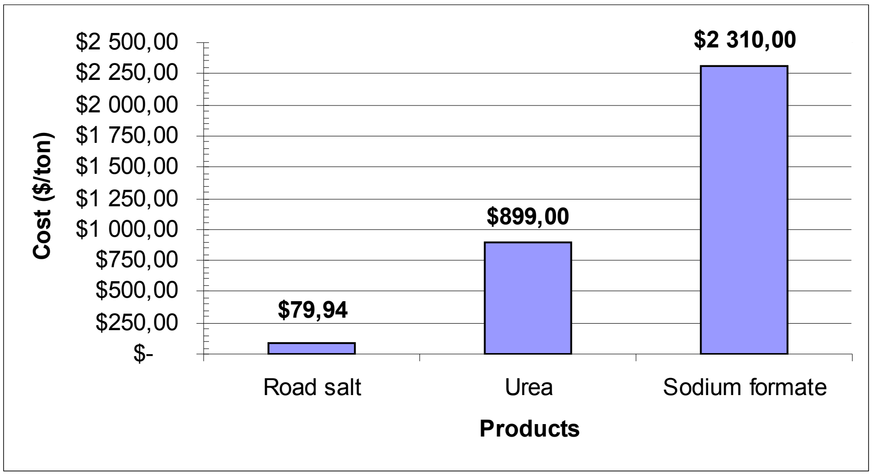

Figure 8 – Cost comparison between various de-icing products

Urea has a granular texture and is white in color. It is used at temperatures is higher than -8°C (17°F). Because of their shape, the granules are pushed away from the runway by the thrust of engines. Consequently urea application must be well planned, between arrivals and departures. Runway closures may also be required to allow for reasonable reaction time. Urea must be applied at least 25 meters (82 feet) wide from the runway center line or on the runway's entire width if the runway is completely covered or if there are strong cross-winds. Sodium formate is more effective than urea. It reacts at temperatures as low as -18°C (0.4°F) and its flaky shape adheres more easily to the runway surface. On the other hand, it is very expensive. If the temperature is quickly dropping and the application of a de-icing product is not possible, an abrasive product size 3/16 (limestone 2,5–5mm) is used to make the running surface rougher and to improve braking. The stone is often used with chemicals to maintain an acceptable CRFI.

Finally, with the use of salt on aircraft movement areas being prohibited and the time constraints inherent to airline traffic, airport operators have no choice but to develop unique techniques.

4. CONCLUSION

Since 1970, Aéroport de Québec inc. has continued to evolve with the aeronautics industry. Increasing aircraft performance constantly raises the requirements for surface conditions which in turn results in increasing runway widths to be kept clear of snow. In addition, due to the constant rise in air traffic, snow removal planning has become a major challenge with stricter time constraints in terms of runway availability. Given that a one-hour runway closure represents on average revenue losses of $35,000, winter maintenance operations must be effective and efficient to ensure the airport's sustainability. Over the next few years, Aéroport de Québec inc. will need bigger and better equipment using the latest technologies to ensure timely service and optimal safety levels.