PUSHBACK HAZARDS

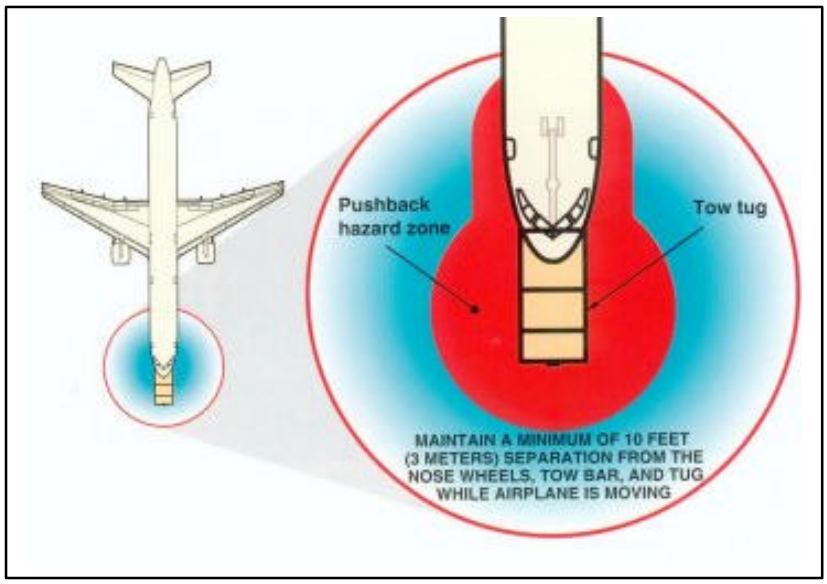
Original idea from Transports Canada & Airliner

Only two words : WATCH OUT !

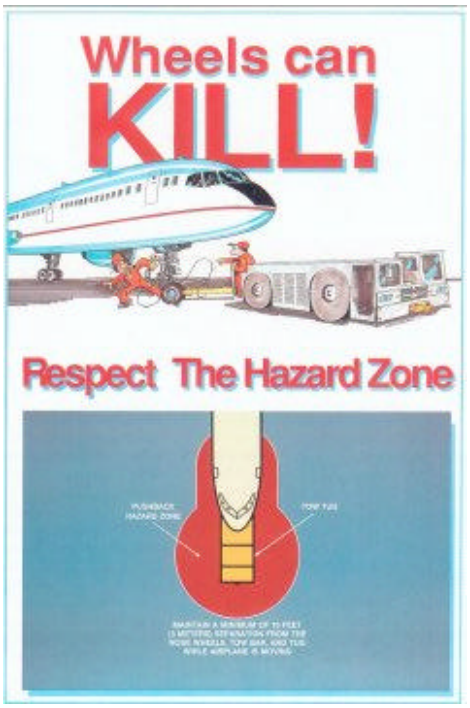
Pushbacks present a potentially serious hazard to ground personnel. From 1964 through December 1991, a search of the Boeing Product Safety Jet Transport Safety Events data base revealed 31 reported accidents worldwide where personnel were run over by the airplane wheels during the pushback process. Pushback or towing involves three phases: positioning and connecting the tug and tow bar, the actual moving of the airplane, and disconnecting the tow bar. Eighteen of the accidents have been fatal. The majority of the accidents (81%) occurred during the airplane movement phase and the remainder occurred during the connect or disconnect phases. If not fatal, the crushing injuries incurred are always serious, sometimes requiring leg amputation.

The nose gear was involved in 65% of the accidents and the main gear was involved in 7%. The gear involved in the remaining accidents is unknown.

Carelessness and inattention have contributed to most of the accidents. In thirteen accidents the rolling wheels directly pinned personnel suggesting a lack of attention to the changing airplane position. Four accidents were caused by persons slipping or falling into the path of the nose gear or main gear. Three accidents were caused by persons slipping or falling off the tug which was not intended to carry people. Two accidents were caused by the airplane rolling forward after pushback during tow bar disconnect. Two accidents were caused by a tug driver who drove under the airplane and was crushed. One accident involved the headset operator being pulled off…



The key to understanding the hazards present during all of the pushback phases. Prevention of injury during connection and disconnection of the tug and tow bar requires anticipation of tug or airplane movement when not expected and have a plan for escape should it occur. During airplane movement, personnel must be aware of the possibility of being run over by the nose wheel and of the continually changing positions of the airplane and tug. The training should be recurrent so as to continually renew the consciousness of the hazards, and provide a review of the techniques for reducing the risks.



Training, however, can not completely eliminate the risk of pushback accidents but there are possible accident prevention methods : creation of a hazard zone, cordless headsets, removal of the ground headset operator, procedures for working around the aircraft, tug driver procedures, identification of hazard zones for turns, verification of wheel chock position, cross-check on brakes set and wearing of proper clothing. Airlines can potentially obtain the most leverage by establishing a hazard zone around the nose wheel. Twenty-four accidents might have been avoided if the hazard zone had been understood by ramp personnel.

Cordless headsets can be used as an alternative interphone system. Cord length can cause either cord entanglement followed by being pulled into the nose gear or by ramp personnel being too close and getting pinned by the nose gear. While the current continued research could make the technology has some limitations, use of cordless headsets feasible.

Ground personnel should be removed from the hazard area. The headset operator, walking in the vicinity of the nose wheel, is the person killed or injured in the majority of accidents which occur during actual airplane movement. One method for accomplishing this is to have the tug driver conduct communications with the airplane flight crew. If two or more people are required for the pushback operation, procedures for working around the aircraft during pushback must be developed.

There needs to be an increase in awareness about carelessness and inattention.

Pushback is a fairly routine operation, performed thousands of times a year. Don't give into complacency! Remember, most accidents occur when you are too close to the nose gear. Pay attention to your position relative to the nose gear as the airplane moves.

ANALYSIS OF A MAJOR PUSHBACK ACCIDENT

One de-icing vehicle was parked on each side of the Boeing 747's fuselage and forward of its horizontal stabilizers. The vehicles' operator buckets were extended on telescoping booms 15 meters above the ground when the aircraft taxied forward into the booms and overturned the vehicles. Three members of the de-icing crew were killed when they were thrown from the buckets.

The Royal Air Maroc Boeing 747-400 was preparing for scheduled flight from Mirabel International Airport, Montreal, Canada to Casablanca, Morocco, via New York, New York, U.S. The B-747 crew heard the words "degivrage termine" (de-icing completed) on the radio frequency assigned to the de-icing crew. The captain assumed that the operation had been completed and that the de-icing crew had left the area.

After making an external visual check from the cockpit, the captain released the brakes. Unknown to the B-747 flight crew, two de-icing vehicles were still positioned on opposite sides of the fuselage forward of the horizontal stabilizers, with five deicing personnel who were continuing the de-icing operation. As the aircraft moved forward, its horizontal stabilizers struck the telescoping booms of the de-icing vehicles, overturning the vehicles. The three occupants of the two buckets (cherry pickers) were killed when they struck the ground, and the two vehicle drivers received minor injuries.

The cause of the accident, as cited in the official Transportation Safety Board of Canada (TSB) accident investigation report, was that "flight crew started to taxi the aircraft before its perimeter was clear, following confusion in the radio communications.

Contributing to the accident, the report said, were a lack of de-icing procedures within Royal Air Maroc; noncompliance with procedures on the part of the CAIL (Canadian Airlines International Ltd.) de-icing crew; inadequate or inappropriate communications equipment; incomplete training of Snowman 1 (the chief de-icing truck driver, who was in charge of communications with the flight crew); a regulatory framework less demanding of foreign air carriers than of Canadian carriers, a lack of operational supervision; and a lack of adherence to radio protocol".

The accident occurred in daylight at 1652 hours local time on Jan 21 1995. The outside air temperature was -1 degree C (31 degrees F), and there were moderate snow showers.

After the passengers had boarded the aircraft, the co-pilot called the apron (ground) control tower and requested authorization to start the engines and taxi to the de-icing centre, which is a separate facility located at the west end of the airport, between the terminal building and Runway Kilo. Seven companies offered aircraft de-icing service at Mirabel. Two of the companies were air carriers; the other five were private contractors. One of the air carriers was CAIL, whose maintenance department was responsible for implementing and monitoring the CAIL aircraft de-icing program. CAIL held the contract for de-icing aircraft operated by Royal Air Maroc.

When the accident aircraft arrived at the de-icing centre, two CAIL trucks and crews were waiting. One truck moved to the front of the aircraft and signalled to the flight crew to tune the aircraft's very high frequency (VHF) radio to 130.755 megahertz (MHz), which was CAIL's working frequency.

When VHF communication had been established, the chief de-icing attendant, who was called Snowman 1, and the B-747 captain agreed that only the wings and empennage would be de-iced, and that the de-icing would be done with the aircraft's engines running - standard practice for the aircraft types among several of the Mirabel de-icing contractor. De-icing was begun.

The report said, *"At ... Mirabel, the de-icing coordinator, who was called (the) Iceman, was responsible for the direction of de-icing crews and for ensuring that de-icing crews complied with CAIL standards and procedures. The Iceman was in the CAIL offices.... and he was aware that Snowman 1 had not taken the course for engines-on de-icing. However, he did not intervene when he heard Snowman 1 suggest to the captain of the B-747 that he leave the engines running...*

"About seven minutes after the aircraft came to a stop, the apron controller tried unsuccessfully to contact Snowman 1 on the apron frequency (1 22.4 MHz). A few seconds later, Iceman tried to raise Snowman 1 on the (CAIL) frequency (130.775 MHz). The Iceman asked Snowman 1 to notify the apron controller when the de-icing was completed".

The pilots of the B747 heard a fragment of the Iceman's message. "The crew of the B747 heard (the words) *"degivrage termine"* (de-icing completed) on 130.775 MHz", the report said. Neither the (apron) controller nor the Iceman received any acknowledgement from Snowman 1.

"The co-pilot then advised the apron controller that the aircraft was ready to taxi. Then the captain repeated "de-icing completed" twice on the CAIL frequency.

"The (apron) controller issued instruction for Royal Air Maroc to taxi to Runway Kilo. As the pilot had not received a negative response or contradiction from Snowman 1, he assumed that de-icing of the aircraft was completed and that the de-icing crew had left the area. At the time of these transmissions, the elapsed time since the beginning of the operation matched the time usually required for this kind of de-icing operation".

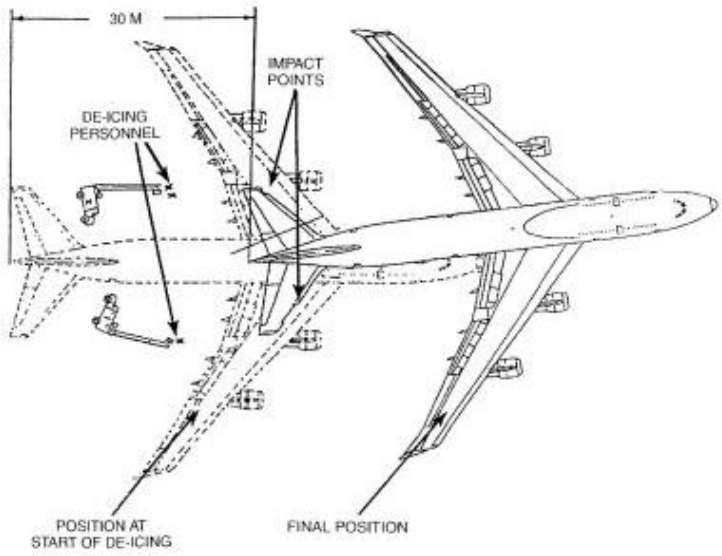
The captain of the B-747, after making an external visual check from the cockpit, advanced the throttles and the aircraft began to move forward. At that moment, the two de-icing trucks were still positioned on either side of the fuselage, forward of the empennage, and three de-icing personnel (two regular employees and one trainee) were in the cherry-picker buckets on the end of extended booms, spraying de-icing fluid onto the horizontal stabilizers. The report said, "After he had taxied (29 meter (95 feet), the captain stopped the aircraft suddenly when he heard a radio message directing him to shut down the engines. The horizontal stabilizers of the aircraft had struck the telescopic booms of the de-icing vehicles, causing the occupants of the cherry-pickers to fall and knocking the de-icing vehicles over on their sides.

"The two vehicle drivers sustained minor injuries. The three occupants of the cherry pickers (who were not wearing their protective equipment) sustained fatal injuries when they struck the ground" after failing 15 meters (49 feet). The deicing trucks were heavily damaged, and the aircraft sustained substantial damage.

Many of the findings in the TSB accident report involved communications: between the de-icing crew and Iceman, between the flight crew and the de-icing crew, and between the apron controller and the flight crew. Transport Canada (TC) encourage air carriers to develop their own de-icing procedures for the aircraft they operate; consequently, there were differences in methods of communication. Some air carriers used a ground marshal, visible to the pilot, who directed the movements of the aircraft before and after de-icing.
Some had a de-icing crew chief who talked to the pilot via the aircraft interphone. CAIL procedures recommended that the VHF radio be used to communicate with the pilot, and that Snowman 1 act as the ground controller (marshal).

The report said, "Royal Air Maroc had not developed specific de-icing procedures for its operation; its pilots were required to comply with the instructions of local authorities, service companies and the aircraft manufacturer.....

"The accident aircraft had three VHF radios, two of which were used for routine communications; one remained tuned to the CAIL operating frequency, the other to the apron frequency. The CAIL offices had one VHF radio, a VHF scanner and UHF (ultra high frequency) transceiver. Each truck was equipped with one VHF radio, one portable UHF (walkie-talkie) and an interphone linking the truck driver with the person in the cherry picker.



Because the communications on 130.775 MHz not recorded, the precise content of the conversations between the captain and Snowman 1 could not be determined. However, information compiled through interviews was used to make an approximate reconstruction of the communications on the CAIL VHF frequency while the aircraft was in the de-icing centre.
According to the investigators' reconstruction, the pilot and Snowman 1 agreed on the type of de-icing fluid to be used and the surfaces to be de-iced. But they did not discuss the manner in which the de-icing trucks would manoeuvre near the aircraft, nor did they discuss the appropriate communication cues to expect when de-icing was completed.

The report said, "*The communications systems on the trucks were set up to allow the drivers to hear the captain and the cherry-picker operators at the same time. After the pilot and Snowman 1 agreed on the de-icing method, the truck drivers selected the interphone buttons on their microphones to talk only with their cherry-picker operators. From that moment on, the drivers did not transmit on 130.775 MHz."*

"The message 'degivrage termine' (that was mistakenly assumed by the flight crew to be directed to them) ... was not preceded by the aircraft call sign or the de-icing crew call sign". The mistaken assumption led to the decision to taxi. "The flight crew did not realize that 130.775 MHz was the CAIL working frequency", the report said, "They mistakenly concluded that this frequency was reserved for de-icing. In addition, the pilots assumed that 130.775 MHz was a communication system analogous to the interphone, although the frequencies used for airground communications are in the VHF band, 11 8 (MHz)- 136 MHz. Consequently, the pilots presumed that the Iceman's message about the completion of de-icing came from Snowman 1, that the message was intended for them and this it indicated that de-icing was completed....

"The co-pilot then advised the apron controller [on 122.4 MHz] that the aircraft was ready to taxi, and, in doing so, the co-pilot conveyed to the apron controller that de-icing was completed and the aircraft was clear. Relying on that information, the controller indicated to the co-pilot his assigned route for taxiing from his current parking spot to [the] Kilo turn-off. The pilot mistakenly interpreted the issuance of taxi instructions as confirmation that the aircraft was clear."

The report said, "In normal aviation practice, the expression *"ready to taxi"* means that the pilot-in-command of an aircraft has ensured that all maintenance operations and other operations around the aircraft have been completed and that the aircraft perimeter is clear."

The flight crew did not consult the cabin crew before releasing the brakes. "Given that the pilots could not see the aft section of the aircraft from the flight deck and they did not see the de-icing vehicles depart the area, consulting the flight attendants was a conceivable and reasonable option in this particular situation", the report said.

"According to the International Civil Aviation Organization (ICAO), the following information must be given to the pilot-in-command on completion of de-icing: the type of fluid used, the time of last application and confirmation that the aircraft complies with the clean aircraft concept", the report said. "The captain released the brakes before receiving this information."

Noise is always a potential problem when de-icing is done with the engines running. "The drivers - heard the noise of the engines continuously over the interphone", the report said. "Except for [that], communications between the drivers and the cherry-picker operators were clear."

That was not so for communications among Iceman, the pilot and Snowman 1. The report said, "During the de-icing, the Iceman and the pilot tried without success to communicate with the de-icing crew on the CAIL frequency. By all indications, the noise of the engines prevented Snowman 1 from hearing the pilot and the Iceman when they tried to communicate with him [Snowman 1]. The fact that the truck drivers did not hear these messages attests to the ineffectiveness of the vehicles' communication systems in blocking out the noise of the [aircraft's] engines."

There were questions about de-icing the B747 with its engines in operation. The report said, "Article 11 of the Convention [on International Civil Aviation] requires that foreign air carriers abide by the laws and regulations in effect in the host country.

"[TC] Air Regulations, paragraph 540.2(4)(b) states that ... the operator establish a ground icing Operations programme (GIOP) ... which contains a of approved procedures, guidelines and methods, as prescribed in [TC] official manuals, and is intended to ensure that no aircraft takes off with frost, ice or snow adhering to any of its critical surfaces."

In August 1994, TC issued Air Carrier Advisory Circular Nr. 0072, which encouraged air carriers to allow, when technically feasible, their aircraft to be de-iced with the main engines running. The purposes of the directive were to speed up the deicing process, to reduce departure delays in bad weather and to maximize holdover times for deicing fluids. De-icing crews were not authorized to de-ice an aircraft with its engines running unless they had received training in engines-on de-icing for that aircraft type. The CAIL de-icing crew had had some training in engines-on de-icing, but information about their specific qualifications was conflicting. The report said, "Some employees [of CAIL] mistakenly thought they were authorized to de-ice [B747] aircraft with the engines running."

Three of the five personnel involved in the accident had attended a CAIL-sponsored training course in engines-on de-icing of Boeing 727 and Lockheed 1 01 1 aircraft. The attendees said that, during the course, the trainer had approved de-icing the B747 with the engines running.

"However, analysis of the electronic mail prior to the accident [among] the manager [of] system aircraft de-icing, the manager of client services at Mirabel and the instructor/developer revealed that the [course] participants were not authorized to deice the B747 with the engines running", the report said. There was no prohibition against engines-on deicing in the operations manual for the B747.

Geography was a factor in the accident. The control tower for the apron is 1.2 kilometers (0.7 mile) north of the de-icing centre. The south station of the de-icing centre, where the accident aircraft was being de-iced, was not visible to the apron controller because the central building obstructed the view. The de-icing trucks, the aircraft's fuselage and activities on the ground around the aircraft could not be seen from the apron control tower.

The report said, *"Only the vertical stabilizer and upper deck of the B747 ... could be seen from the [apron control] tower."* Thus, the apron controller did not know that the aircraft was being de-iced with engines running.
The report said, *"The controller is not required to check with the de-icing crew or the pilot to confirm that de-icing is completed and that the aircraft perimeter is clear. Before issuing instructions to the pilot to taxi to [runway] Kilo, the apron controller observed that the rotating beacon on top of the aircraft was on, and he concluded that the pilot had started the engines without authorization. As he [the controller] was not familiar with CAIL procedures, he assumed that an attendant was in contact with the pilot via interphone and that the aircraft perimeter was clear."*

Another contributing factor may have been the pilot's unfamiliarity with the de-icing station. The report said, "*This was the first time that the captain had been to the Mirabel de-icing centre. In the past, his aircraft had been de-iced at the gate with the engines shut down. The communications procedures had also been different; in the past, the station attendant had communicated with the captain via an interphone in the nose-gear well and had acted as intermediary between the flight crew and the de-icing crew. When the de-icing was completed, the crew had started the engines, and a marshaller, visible to the pilot, had guided the aircraft using hand signals."*

The co-pilot had used the services of Mirabel deicing centre on one prior occasion, the previous year. But on that occasion, the aircraft had been different, a flight engineer had been in charge of the de-icing and the aircraft had been de-iced with the engines shut down.

The report said that there was strong competition among the de-icing contractors at Mirabel. *"As private de-icing contractors were not regulated, they were able to respond quickly to client demands"*, the report said. *"The regulatory requirements applicable to CAIL, with attendant requirements to develop procedures and provide training, meant that CAIL, working within the rules, could not provide as fast and ready a service as could the private contractors. This undoubtedly heightened competition between CAIL and private de-icing contractors in their desire for de-icing contracts, and this competition might have led some CAIL employees to take liberties with the established safety standards."*

The TSB's conclusions about the accident included the following findings:

- Engine noise probably prevented the de-icing crew from hearing the pilot and the Iceman when they tried to communicate with the deicing crew;
- CAIL communication equipment was neither adequate for nor designed to be used in engines-on de-icing operations, as it did not block out engine noise;
- The pilot and de-icing crew did not use standard aeronautical terminology and phraseology on some occasions;
- The pilots thought that the Iceman's message to Snowman 1 was addressed to them and that it meant that the de-icing was completed;
- Following the confusion in radio communications, the flight crew started to taxi the aircraft before its perimeter was clear;
- At the time of the accident, the cherry-picker operators were not wearing their protective equipment;
- Snowman 1 was not in a position to prevent the aircraft from advancing, given that he was behind the aircraft where he could not be seen by the flight crew and where the noise of the aircraft engines prevented his hearing the radio transmissions of the pilot and the Iceman;

- CAIL had not developed procedures for deicing a B747 with the engines running, and the de-icing crew was not authorized by CAIL to de-ice B747s with the engines running;
- The apron controller did not have enough information or sufficient tools to accurately evaluate the situation in the de-icing centre, which he could not see from his work station; [and]
- It is possible that competition between de-icing companies (at Mirabel) and a concern for efficiency influenced Snowman I's decision to de-ice the aircraft with engines running despite the fact that he had not had the formal training."

Several safety actions have been taken as a result of this accident. The report said, *"The TSB notes that, following this occurrence, several changes were made to procedures, regulations and manuals affecting the de-icing/anti-icing of aircraft operating in Canada. These measures, to a large extent, address the significant aviation safety deficiencies identified during the investigation, and therefore reduce the probability of a recurrence of this type of accident".*

At the end of 1995, ICAO published the *Manual of Aircraft Ground de/anti-icing Operations* for use by member-state aircraft operators. The manual says that the de-icing/anti-icing program shall clearly define areas of responsibility for the operator. The manual also says that all persons involved shall be trained and qualified in de-icing/anti-icing procedures and communications, and that they shall know the limitations of their areas of responsibility.

"The communication between ground and flight crews are an integral part of the de/anti-icing process and must be included in every de/anti-icing procedure", says the manual. *"Upon completion of the de/anti-icing procedure and the associated check of the aircraft, which ensures that it complies with the clean aircraft concept, the following information shall be communicated to the flight crew:*

a. Fluid typo;
b. Fluid/water ratio;
c. Start time of the last step in the de/anti-icing procedure;
d. Confirmation that the aircraft is in compliance with the clean aircraft concept."

In October 1995, Royal Air Maroc published interim procedures pending the amendment of the *"Deicing/Anti-icing Operations"* section of the Royal Air Maroc policy manual. The changes specify that the ground crew will report to the pilot-in-command the correct and complete accomplishment of de-icing/ anti-icing of the aircraft. The manual outlines the phraseology to be used by flight crews and ground crews, and describes in detail the verbal and visual cues to be employed during the de-icing operation and subsequently to inform the flight crew that ground material has been removed.

New Canadian Aviation Regulations (CARS) came into effect in October 1996. For non-Canadian air carriers, the report said, "Where conditions are such that frost, ice or snow may reasonably be expected to adhere to an aircraft, no person shall conduct a take-off in the aircraft unless:

a. The aircraft has been inspected immediately prior to take-off to determine whether any frost ice or snow is adhering to any of its critical surfaces; or

b. The foreign air operator or the holder of the flight authorization has:

   i. Established, in accordance with ICAO Document Nr. 9640 ... an aircraft ground icing operations program that has been approved by the state of the foreign air operator or of the holder of the flight authorization, or,

   ii. Submitted ... an aircraft ground icing operations program that meets the applicable standards."

CAIL's procedures for de-icing/anti-icing have also been changed. Under the new policy, engines-on de-icing/anti-icing will be used only on aircraft operated by CAIL and Canada Regional Airlines.

"Both visual and verbal communication must be received and acknowledged by aircraft flight crew before the de-icing process can be started or terminated", the report said. *"Cue cards to support correct verbal radio communication have been developed and deployed to all de-icing vehicles and designated team members. The reporting structure, briefing, training, audit process and base de-icing team leadership along with the use of designated VHF radios have been upgraded ... with particular emphasis on teamwork and related communication. De-icing team check sheets and daily shift briefings have also been developed ... ."*

A copy of CAIL's de-icing procedures has been given to all contract carriers for whom CAIL provides de-icing services. After the accident, a Labor Canada safety officer issued a directive under Part 11 of the Canada Labor Code requiring CAIL to provide its employees with the supervision necessary to ensure the employees' health and safety.

Date	Location	A/C Type	Result
1968	San Juan, P.R.	DC8	FATAL
1971	Milan, Italy	B747	Serious leg injury
1972	Philadelphia, USA	DC8	Lost leg at hip
1973	Tokyo,Japan	DC8	FATAL
1974	New York, USA	DC9	FATAL
1976	Vancouver, Canada	DC9	Nosewheel ran over & crushed left foot & leg
1977	Honolulu, USA	B747	FATAL
1978	Miami, USA	A300	FATAL
1979	Atlanta, USA	L1011	FATAL
1979	Miami, USA	DC8	FATAL
1979	Dusseldorf, Germany	A300	FATAL
1980	Newark, USA	DC10	Loss of leg
1981	Miami, USA	DC1 0	FATAL
1982	Casablanca, Morocco	A300	Loss of leg
1983	Kuala Lumpur, Malaysia	B747	Loss of foot
1985	Amsterdam, Holland	B747	Loss of leg
1986	Tel Aviv, Israel	Unknown	FATAL
1986	London, England	L1011	Nose gear ran over foot
1988	Tulsa, USA	B737	Nose gear ran over foot
1989	Phoenix, USA	B757	Loss of leg
1989	Chicago, USA	B767	Loss of leg
1989	San Juan, P.R.	A300	FATAL
1989	Orlando, USA	DC9	FATAL
1990	Memphis, USA	DC10	Loss of leg
1990	Indianapolis, USA	B727	FATAL - crushed by tug
1990	Melbourne, Australia	B767	Loss of leg
1990	Christchurch, NZ	BAel46	Broken arm/leg - run over by tug
1990	Glasgow, Scotland	B757	Loss of leg
1990	Unknown	Unknown	Brokenlegs
1991	Madinah, Saudia Arabia	A300	FATAL - run over by nosewheel
1991	Albuquerque, USA	B737	Loss of leg - run over by nosewheel
1991	Ontario, Canada	B727	Broken ankle - run over by tug
1991	Copenhagen, Denmark	MD-80	Broken leg - crushed

Courtesy U.S. National Safety Council Newsletter