



Miscommunication Leads to Three Fatalities During Ground Deicing of Aircraft

One deicing 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 (49 feet) above the ground when the aircraft taxied forward into the booms and overturned the vehicles. Three members of the deicing crew were killed when they were thrown from the buckets.

FSF Editorial Staff

The Royal Air Maroc Boeing 747-400 was preparing for a 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 “*dégrivage terminé*” (deicing completed) on the radio frequency assigned to the deicing crew. The captain assumed that the operation had been completed and that the deicing 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 deicing vehicles were still positioned on opposite sides of the fuselage forward of the horizontal stabilizers, with five deicing personnel who were continuing the deicing operation. As the aircraft moved forward, its horizontal stabilizers struck the telescoping booms of the deicing 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 “the 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 deicing procedures within Royal Air Maroc; noncompliance with procedures on the part of the CAIL [Canadian Airlines International Ltd.] deicing crew; inadequate or inappropriate communications equipment; incomplete training of Snowman 1 [the chief deicing 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 airplane, the copilot called the apron (ground) control tower and requested authorization to start the engines and taxi to the deicing center, which is a separate facility located at the west end of the airport, between the terminal building and Runway Kilo.

Seven companies offered aircraft deicing 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 deicing program. CAIL held the contract for deicing aircraft operated by Royal Air Maroc.

When the accident airplane arrived at the deicing center, two CAIL deicing trucks and crews were waiting. One truck moved to the front of the airplane and signaled to the flight crew to tune the airplane's very-high-frequency (VHF) radio to 130.775 megahertz (MHz), which was CAIL's working frequency. When VHF communication had been established, the chief deicing attendant, who was called Snowman 1, and the B-747 captain agreed that only the wings and empennage would be deiced, and that the deicing would be done with the airplane's engines running — standard practice for the aircraft types among several of the Mirabel deicing contractors. Deicing was begun.

The report said, "At ... Mirabel, the deicing coordinator, who was called [the] Iceman, was responsible for the direction of deicing crews and for ensuring that deicing 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 deicing. 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 [122.4 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 deicing was completed."

The pilots of the B-747 heard a fragment of the Iceman's message. "The crew of the [B-474] heard [the words] '*dégrivage terminé*' (deicing completed) on 130.775 MHz," the report said. "Neither the [apron] controller nor the Iceman received any acknowledgment from Snowman 1.

"The copilot then advised the apron controller that the aircraft was ready to taxi. Then the captain repeated 'deicing completed' twice on the CAIL frequency.

"The [apron] controller issued instructions for Royal Air Maroc to taxi to Runway Kilo. As the pilot had not received a negative response or contraindication from Snowman 1, he assumed that deicing of the aircraft was completed and that the deicing 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 deicing operation."

The captain of the B-747, after making an external visual check from the cockpit, advanced the throttles and the airplane began to move forward. At that moment, the two deicing trucks were

still positioned on either side of the fuselage, forward of the empennage, and three deicing personnel (two regular employees and one trainee) were in the cherry-picker buckets on the end of extended booms, spraying deicing fluid onto the horizontal stabilizers.

The report said, "After he had taxied [29 meters (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 deicing vehicles, causing the occupants of the cherry-pickers to fall and knocking the deicing 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 falling 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 deicing crew and Iceman, between the flight crew and the deicing crew, and between the apron controller and the flight crew.

Transport Canada (TC) encouraged air carriers to develop their own deicing 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 deicing. Some had a deicing 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 deicing 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 a 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 were 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 deicing center."



Hearing a fraction of a radio communication in which one deicing crew member asked another to notify the apron controller when deicing was completed, the flight crew of the Boeing 747 believed that deicing had been completed. The miscommunication became part of the chain of errors that led to the B-747 being taxied with two deicing trucks still in place, resulting in three operator fatalities. (Photo: Transportation Safety Board of Canada)

According to the investigators' reconstruction, the pilot and Snowman 1 agreed on the type of deicing fluid to be used and the surfaces to be deiced. But they did not discuss the manner in which the deicing trucks would maneuver near the aircraft, nor did they discuss the appropriate communication cues to expect when deicing 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 deicing 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 'dégrivage terminé' [that was mistakenly assumed by the flight crew to be directed to them] ... was not preceded by the aircraft call sign or the deicing crew call sign."

That 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 deicing. In

addition, the pilots assumed that 130.775 MHz was a communication system analogous to the interphone, although the frequencies used for air-ground communications are in the VHF band, 118 [MHz]–136 MHz. Consequently, the pilots presumed that the Iceman's message about the completion of deicing came from Snowman 1, that the message was intended for them and that it indicated that deicing was completed. ...

"The copilot then advised the apron controller [on 122.4 MHz] that the aircraft was ready to taxi, and, in doing so, the copilot conveyed to the apron controller that deicing was completed and the aircraft was clear. Relying on that information, the controller indicated to the copilot 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 deicing 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 deicing: 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 deicing 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 deicing, the Iceman and the pilot tried without success to communicate with the deicing 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 deicing the B-747 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 program (GIOP) ... which contains a series 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 No. 0072, which encouraged air carriers to allow, when technically feasible, their aircraft to be deiced 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.

Deicing crews were not authorized to deice an aircraft with its engines running unless they had received training in

engines-on deicing for that aircraft type. The CAIL deicing crew had had some training in engines-on deicing, but information about their specific qualifications was conflicting. The report said, "Some employees [of CAIL] mistakenly thought they were authorized to deice [B-747] aircraft with the engines running."

Three of the five personnel involved in the accident had attended a CAIL-sponsored training course in engines-on deicing of Boeing 727 and Lockheed 1011 aircraft. The attendees said that, during the course, the trainer had approved deicing the B-747 with the engines running.

"However, analysis of the electronic mail prior to the accident [among] the manager [of] system aircraft deicing, the manager of client services at Mirabel and the instructor/developer revealed that the [course] participants were not authorized to deice the B-747 with the engines running," the report said.

There was no prohibition against engines-on deicing in the operations manual for the B-747.

Geography was a factor in the accident. The control tower for the apron is 1.2 kilometers (0.7 mile) north of the deicing center. The south station of the deicing center, where the accident aircraft was being deiced, was not visible to the apron controller because the central building obstructed the view. The deicing 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 B-747 ... could be seen from the [apron control] tower." Thus, the apron controller did not know that the aircraft was being deiced with engines running.

The report said, "The controller is not required to check with the deicing crew or the pilot to confirm that deicing 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 deicing station. The report said, "This was the first time that the captain had been to the Mirabel deicing center. In the past, his aircraft had been deiced at the gate with the engines shut down. The communications procedures had also been different; in the past, the station

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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 deicing crew. When the deicing was completed, the crew had started the engines, and a marshaller, visible to the pilot, had guided the aircraft using hand signals.”

The copilot had used the services of Mirabel deicing center 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 deicing and the aircraft had been deiced with the engines shut down.

The report said that there was strong competition among the deicing contractors at Mirabel. “As private deicing 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 deicing contractors in their desire for deicing 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 deicing 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 deicing operations, as it did not block out engine noise;
- “The pilot and deicing 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 deicing 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 B-747 with the engines running, and the deicing crew was not authorized by CAIL to deice B-747s with the engines running;
- “The apron controller did not have enough information or sufficient tools to accurately evaluate the situation in the deicing center, which he could not see from his work station; [and,]
- “It is possible that competition between deicing companies [at Mirabel] and a concern for efficiency influenced Snowman 1’s decision to deice 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 deicing/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* (Document no. 9640-AN/940) for use by member-state aircraft operators. The manual says that the deicing/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 deicing/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 airplane, which ensures that it complies with the clean aircraft concept, the following information shall be communicated to the flight crew.

- “a. Fluid type;
- “b. Fluid/water ratio;
- “c. Start time of the last step in the de/anti-icing procedure; [and],
- “d. Confirmation that the airplane 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 deicing/anti-icing of the airplane. 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 deicing 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 or attempt to conduct a takeoff in the aircraft unless:

- "a. The aircraft has been inspected immediately prior to takeoff 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 no. 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 deicing/anti-icing have also been changed. Under the new policy, engines-on deicing/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 deicing process can be started or terminated," the report said. "Cue cards to support correct verbal radio communication have been developed and deployed to all deicing vehicles and designated team members. The reporting structure, briefing, training, audit process and base deicing team leadership along with the use of designated VHF radios have been upgraded ... with particular emphasis on teamwork and related communication. Deicing-team check sheets and daily shift briefings have also been developed"

A copy of CAIL's deicing procedures has been given to all contract carriers for whom CAIL provides deicing services.

After the accident, a Labour Canada safety officer issued a directive under Part II of the Canada Labour Code requiring CAIL to provide its employees with the supervision necessary to ensure the employees' health and safety.♦

Editorial note: This article is based on Transportation Safety Board of Canada report no. A95Q0015. The 21-page report included appendices with an illustration.

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