VII. SAFETY ON ICE: HUMAN FACTORS TRAINING FOR GROUND DEICE / ANTI-ICE PROGRAMS

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This paper has been prepared for distribution in conjunction with the Royal Aeronautical Society's CRM and Ground Operations Conference held at London Gatwick Airport on 5 February 1999. It is based on a presentation made by the author at the 1997 Society of Automotive Engineers (SAE) Ground Deice/Anti-Ice Conference at Pittsburgh, Pennsylvania on 13 June 1997.

A. Overview

In addition to a high level of technical knowledge and proficiency, ground deice/anti-ice operations require effective teamwork to ensure safety and efficiency. All team members must exercise good judgement and decision making, and have a high level of awareness of conditions in a difficult and dynamic ramp environment. Good training conducted as part of an approved ground deice/anti-ice program currently focuses on the technical aspects of deice/anti-ice operations. These programs, however, do not typically address the human factors knowledge and skills required to further reduce the risk of accidents and incidents.

This paper explores the causal factors of ground deice/anti-ice accidents and incidents, and suggests training strategies for mitigating the human factors related hazards not addressed in traditional technical training programs.

Using a case study of a fatal deice/anti-ice accident, this paper identifies the human factors knowledge and skills required by deice/anti-ice crews. This is followed by an overview of current human factors training initiatives in aviation maintenance and ground operations which survey how the industry is addressing the need to develop crew proficiency in these areas.

B. A Case Study

On 21 January 1995, a collision occurred between a Royal Air Maroc Boeing 747-400 and 2 deice vehicles at Mirabel Airport in Montreal, Canada. The three occupants of the deice cherry-pickers received fatal injuries when the B-747 began taxiing and overturned them with its horizontal stabilizer. The vehicle drivers sustained minor injuries and substantial damage was done to the aircraft and vehicles.

The accident occurred during daylight (1652 EST) in moderate snow showers. The temperature was –1 degree C with a dewpoint of –1 degree C and the wind was from the northeast at 18 knots. There was drifting snow being reported at the time.

1. Arrival at the Deice Center

The Boeing 747-400, registration CN-RGA, was operated by Royal Air Maroc. It was preparing for a scheduled flight AT 205 from Mirabel, Quebec to Casablanca, Morocco with a stop at New York, New York. The aircraft was parked at gate 124 near fuelling station 2 on the main apron. The passengers boarded at the scheduled time, and the co-pilot asked the apron controller for authorization to start the engines and taxi to the deicing center.

The aircraft taxied and stopped at the deicing center, where two Canadian Airlines International Ltd. (CAIL) deicing vehicles were waiting for it. One deicing vehicle moved to the front of the aircraft and raised its cherry picker to flight deck level; the cherry picker operator signaled to the pilot to tune his radio to 130.775 megahertz (MHz), the working frequency of CAIL. The crew had used this same frequency during engine start, but was unaware that it was the working frequency of CAIL.

2. A Critical Decision

The captain and the chief deicing attendant (Snowman 1) agreed that only the wings and horizontal stabilizers were to be deiced with Type I deicing fluid. Snowman 1 initially asked the captain to shut down the engines. After the captain indicated that there would be a delay to start the APU, Snowman 1 suggested that the aircraft be deiced with the engines running, and the captain agreed. At this point, deice operations began with the two deice vehicles starting at the wings and then moving to the horizontal stabilizers.

3. Seven Minutes after Arrival

About seven minutes after the aircraft came to a stop, the apron controller tried unsuccessfully to contact Snowman 1 on the apron frequency. A few seconds later, the CAIL deicing coordinator (Iceman), who was in the company offices, tried to raise Snowman 1 on the company frequency. The Iceman asked Snowman 1 to notify the apron controller when the deicing was completed. The crew of the Boeing heard "dégivrage terminé" (deicing completed) on 130.775 MHz. Neither the controller nor the Iceman received any acknowledgement from Snowman 1.

4. A Critical Assumption

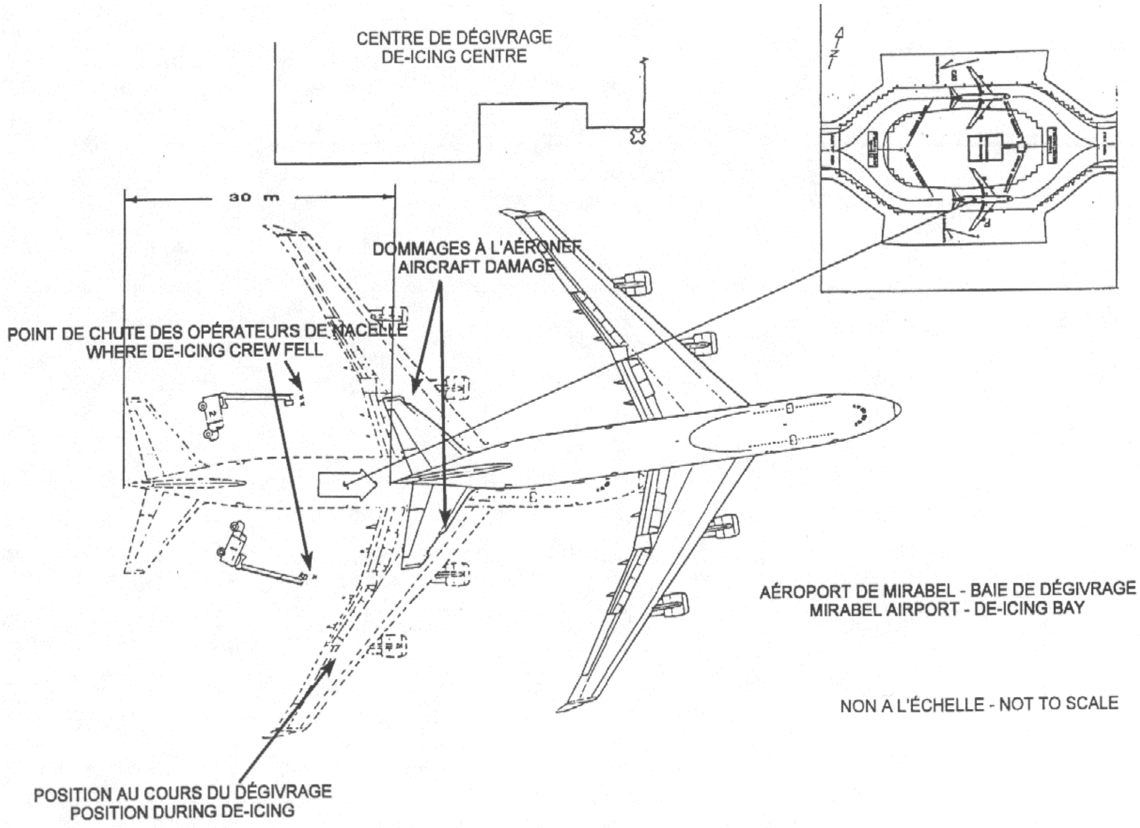
The copilot then advised the apron controller that the aircraft was ready to taxi. Then the captain repeated "Deicing completed" twice on the CAIL frequency. The controller issued instructions for Royal Air Maroc to taxi to taxiway Kilo. As the pilot had not received a negative response or contra-indication 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.

5. 26 Seconds Later

About 26 seconds later, after making an external visual check from the cockpit, the captain released the brakes. At that time, the two deicing vehicles were positioned on either side of, and perpendicular to, the fuselage, forward of the horizontal stabilizers, and five deicing personnel were still deicing the horizontal stabilizers. After he had taxied 95 feet, the captain stopped the aircraft suddenly when he heard a radio message directing him to shut down the engines.

6. The Result

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 sustained fatal injuries when they struck the ground.



C. TSB Determination of Cause

The Canadian Transportation Safety Board (TSB) determined that the flight crew started to taxi the aircraft before its perimeter was clear, following confusion in the radio communications. They identified the following factors that contributed to the accident:

- a lack of deicing procedures within Royal Air Maroc;
- non-compliance with procedures on the part of the CAIL deicing crew;
- inadequate or inappropriate communications equipment;
- incomplete training of Snowman 1;
- 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.

D. Human Factors Analysis

The training programs offered to deice crews typically focus on the technical aspects of the equipment and application of fluids used to deice/anti-ice aircraft. This accident, however, was not a failure of technical skill or knowledge of the ground or flight crews. Rather, it resulted from failures in human factors such as decision making, communications, situational awareness, and teamwork.

Additionally, the errors committed by both crews were induced by larger system factors. Such errors are best thought of as outcomes, and not accident causes in and of themselves. This implies that the solutions to these problems are not restricted to interventions at the “sharp end” of the process, such as training for ground operations personnel.

1. Decision Making

In the Montreal accident, there were two critical decisions which contributed to the outcome. The first was Snowman 1’s decision to deice with engines running. The second was the flight deck crew’s decision to begin taxi.

The decision to deice with engines running was both contrary to existing policy, and an operation for which all members of the deice crew had not been trained. There were several factors which may have influenced this decision. First, the “norms” in the deicing organization’s culture created a strong desire to provide customers with good, rapid service. This was magnified by the fact that there were several providers of deicing services leading to a highly competitive commercial environment This environment encouraged the ground crew to deviate from the established procedures.

The flight crew’s decision to begin taxi was based on incomplete information about the status of the deice operation and was aggravated by poor communications with the deice crew. The flight crew made an assumption about the position of the ground vehicles without outside confirmation.

2. Communications

A critical element of the human communications process is the use of feedback to confirm a shared understanding of the messages being transmitted. Several of the key transmissions by both crews received either no response or an incomplete response. This lead to misinterpretation of the messages and the inappropriate actions discussed above.

Most communications during the accident sequence were conducted via VHF radio. It is significant that those involved did not follow standard radio procedures that require the statement of the sending station and the receiving station as part of the message. This caused the flight crew to believe that the message “deicing complete” was directed to them.

Further, since there were two radio frequencies in use (deice and ramp control), the ability of the two crews to maintain a clear picture of the progress being made was impaired.

3. Situation Awareness

Because of the physical separation and poor communications, no single individual had a complete picture of the status of the deice operation. Restricted by flight deck visibility, the flight crew was unable to monitor deice progress. The ramp controller was unable to visually observe activity at the deice pad due to the distance from his station. The deice crew was unaware of the flight crew's intentions and actions. This lack of situational awareness contributed to the accident.

4. Teamwork

To be safe and efficient, those involved in the deicing operation must function as a single coordinated team. In this case, the flight crew and deice were functioning as two independent entities. Further, the deice crew did not question the team leader's "engines on" decision. The use of such advocacy would have provided the opportunity for revisiting the wisdom of this decision.

E. Recommendations

The means for addressing the human factors which contributed to the Mirabel accident exist in a number of programs that have been implemented in aviation over the past 20 years. These include training programs, and reporting and analysis systems to identify risk areas. As with all new programs, there are barriers to their implementation which must be overcome to ensure their success.

F. Training Human Factors

Training programs which address the skills detailed above were first introduced for flight crews two decades ago. Originally called Cockpit Resource Management (CRM), they have more recently been adopted in cabin crew, maintenance technician (as Maintenance Resource Management - or MRM), and dispatcher training programs.

The successful implementation of CRM and Human Factors (HF) training programs is usually approached with a phased implementation. Initial Indoctrination/Awareness builds a basic awareness of the concepts and vocabulary of the CMR/HF skills. Recurrent practice and feedback provides an annual opportunity to build proficiency, while continuing reinforcement from peers and supervision in the work environment ensures that the knowledge and skills become firmly imbedded in the organizational culture.

A variety of instructional techniques have been proven to be effective in the delivery of CRM/HF training. Computer Based Training is effective in the teaching of initial concepts and terminology. Once those are mastered, group workshops using case studies, role playing, and other techniques allow the participant to begin building the team skills required for successful job performance. In the workplace, structured On-the-Job (OJT) training provides the trainee with practice and feedback.

G. Further define the problem

Since there are few examples of CRM/HF programs in the ramp operations environment, it is important that the industry continue to gather data about human performance in this environment. There are several examples of programs which can provide the necessary data. These include the Managing Engineering Safety Health (MESH) program initiated by British Airways, the Maintenance Error Decision Aid (MEDA) developed by Boeing and used by several airlines worldwide, and the Aviation Safety Reporting System (ASRS) program operated by NASA. ASRS has recently expanded its capability to capture data specific to maintenance and ramp operations.

Measuring the results of training programs is also a critical element in the development of successful human factors programs. Delta Air Lines' Team Resource Management (TRM) Program for ramp operations teams has been a pioneering effort in this area.

H. Barriers to Implementation

In spite of the proven performance of CRM/HF training in other domains, there remain barriers to its implementation in the ramp operations area. These include:

- A need for organizational support of both the training and the team process which the training supports.
- The use of contractors at different stations, which reduces the ability of the airline to control the quality and training of ramp personnel.
- Employee turnover and transfer occurs at a higher rate on the ramp than in other job areas.
- CRM/HF training is not currently a regulatory requirement for ramp operations personnel.

I. Summary

The deice accident described in this paper was not a failure of technical skills or knowledge on the part of the deice or flight crews. It was a failure of team performance. Proven human factors training programs are available which address these failures. Implementation of human factors training interventions requires training, supervisory, and process changes to ensure their effectiveness. This results in improved safety and competitive advantage for both the airline and the ground operator.

J. Reference

Transportation Safety Board of Canada. Aviation Occurrence Report, Collision with Vehicle, Royal Air Maroc, Boeing 747-400 CN-RGA, Montreal (Mirabel) International Airport, Quebec, 21 January 1995. Report Number A95Q0015. 1995. Report also available on the Internet at http://bst-tsb.gc.ca/.

K. About the Author

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