Transport Canada Transports Canada

Aviation Safety Letter

Learn from the mistakes of others and avoid making them yourself . . . *Issue 1/2002*

Spiral During Flight Training

On April 6, 1999, an instructor and student departed in a Cessna 152 on a one-hour training flight to practise climbing, descending, and turning exercises. Near the end of the flight, a witness to the accident heard an aircraft flying overhead, then the engine noise stopped. This caused the witness to look in the direction of the aircraft; it was in a nose-down attitude, and it rotated twice to the right before disappearing behind a treeline located within 1000 ft of the witness. The aircraft struck trees at high speed and crashed in a swamp. The witness estimated that the aircraft was well below 2000 ft above ground level (AGL) when first observed. The instructor and student received serious injuries and succumbed later to their injuries. This synopsis is based on the Transportation Safety Board of Canada (TSB) Final Report A99O0079.

Visual meteorological conditions prevailed at the time of the occurrence. The aircraft was certified, equipped, and maintained in accordance with the existing regulations. The engine was disassembled and no discrepancies were noted that would have precluded normal engine operation prior to the accident. The wreckage was first examined at the crash site, then removed to a salvage facility and re-examined. None of the damage was identified as pre-impact. Examination revealed that the aircraft's rate of descent was shallow and that the wings were level at impact. The flaps were in the up position. There was no indication of pre-impact structural failure and, because of the severe impact damage and fragmentation of the airframe, it could not be determined if a flight control malfunction had occurred. The airspeed indicator (ASI) was forwarded to the TSB Engineering Branch for examination. Examination of the ASI did not provide any information with respect to airspeed indication at the time of impact. There was no pre- or post-crash fire.

The instructor pilot was certified and qualified in accordance with existing regulations to conduct the training flight. The student pilot had had a familiarization flight in May 1998 and had accumulated less than ten hours by the end of the year. The accident flight was the student's first flight in 1999. As of the accident date, the student had not obtained a pilot medical; therefore, there was no pilot file for review at Transport Canada.

The flight training curriculum requires that, during the turning exercise, the instructor demonstrate a steep turn (45° of bank or greater) and the student practise these turns. It is important to effectively monitor the aircraft attitude during a steep turn to avoid inadvertent entry into a spiral manoeuvre. Should a spiral manoeuvre be recognized, the correct recovery procedure is to close the throttle, level the wings using co-ordinated control inputs, and ease out of the dive. Radar data was retrieved in an attempt to identify the aircraft's movements; however, the TSB determined that the aircraft's altitude at the time of the spiral manoeuvre was below radar coverage and, therefore, not indicated.

Analysis—The weather was not a factor in the accident. Flight instructors are aware of the dangers of allowing a spiral to develop at low altitude and,

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especially, continue below 2000 ft AGL. The TSB could not determine why a spiral was continued to an altitude from which a safe recovery could not be performed. The wing impact damage indicated that the aircraft was probably entering a recovery attitude prior to striking the trees. The sudden absence of engine noise that captured the witness's attention likely resulted from the pilot initiating the spiral recovery procedure. It was evident that the engine was capable of producing power. The TSB could not determine why the aircraft entered a spiral manoeuvre.

An excellent article on the subject, called "The Deadly Spiral," can be found on the Avweb Web site at *http://www.avweb.com/articles/spiral/*. The author, legendary Northwest Airlines Captain Paul Soderlind, says "The phenomenon is known by many names—death spiral, graveyard spiral, suicide spiral, vicious spiral . . . and over the years has claimed many pilots and airplanes, heavy iron and flibs alike". Among other topics, Captain Soderlind discusses how and why these spirals develop, how to avoid them, and what to do if you find yourself in one. △

CASS 2002—March 18 to 20—Calgary, Alberta

Transport Canada, Prairie and Northern Region (PNR), is proud to be hosting Transport Canada's 14th annual Canadian Aviation Safety Seminar (CASS) 2002, March 18, 19 and 20 at the Westin Calgary hotel ((403) 266-1611) in beautiful downtown Calgary, Alberta. The theme for CASS 2002 is *Implementing Safety Management Systems (SMS) and Making the Most of Lessons Learned*. As outlined in the strategic framework Flight 2005, promoting safety management systems (SMS) represents an important evolving direction for Transport Canada. It is, in fact, the cornerstone to meeting our ambitious safety goals for 2005. Our approach recognizes the need for the collaboration and experience of our safety partners—the aviation community possesses an in-depth knowledge of the risks inherent to their operations, and they are well placed to manage these risks and achieve positive shifts in their safety culture.

To help achieve this goal, the CASS 2002 Committee has lined up several high-quality speakers, including our keynote speaker, Dr. John Lauber, Vice-president of Safety and Technical Affairs at Airbus Industries; Michael Smith, General Manager of Aviation Safety Promotion for Australia's Civil Aviation Safety Authority; and Captain Haile Belai, Chief of Safety Oversight, Audit Section, at the International Civil Aviation Organization (ICAO). The Plenary session is organized over two days (March 19 and 20) that will address the theme through various topics, such as "Changing Company Culture to SMS," "Meeting Tomorrow's Challenge in Airport Security," and "Runway Incursion Issues and Initiatives in Canada." In addition, the investigation process for Swissair Flight 111 as well as the process used for managing risk in the Antarctic rescue mission will be addressed.

In addition to two days of informative discussions from guest speakers, one full day (Mon., March 18) of aviation-related workshops is scheduled; these workshops cover a wide range of topical issues in aviation, including human factors in maintenance, air rage, SMS on the Internet, and crew resource management from the line pilot's perspective. Space will be limited for workshop sessions—so please register early!

Calgary offers its well-known and well-deserved western hospitality. The CASS 2002 full three-day registration fee is C$400 + 7% GST = $428 total. For further information or to register, visit the CASS 2002 Web site at *http://www.tc.gc.ca/aviation/cass2002/* or contact Transport Canada, System Safety, PNR, at (780) 495-3861 or send a fax to (780) 495-7355. △

Transport Canada's Safety Management Systems Briefing Campaign

In Flight 2005, Transport Canada Civil Aviation identified six principal adjustments it is to make to its Program. Implementing safety management systems (SMS) in aviation organizations figures prominently among these.

Educating industry on SMS concepts and requirements is critical to their successful implementation.

To this end, and in partnership with industry, Transport Canada will be embarking on an education campaign where, among other topics, the general concepts, principles and benefits of SMS will be explored through a series of briefing sessions.

Goals

The goals of this session are to:

- provide participants with an overview of SMS concepts and principles;
- brief participants on current or proposed SMS requirements; and
- solicit industry feedback and input on SMS-related issues.

This briefing session will provide participants with an opportunity to gain insights into Transport Canada's direction regarding SMS, to discuss related issues and to share experiences.

Participants new to the concept of SMS will gain an understanding of what it is and what benefits can accrue through its implementation. △

Please contact your Regional System Safety Officer (RASO) for more details.

Transport Canada / Transports Canada

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Address correspondence to:
Editor, Paul Marquis
Aviation Safety Letter
Transport Canada (AARQ)
Ottawa ON K1A 0N8
Tel.: (613) 990-1289
Fax: (613) 991-4280
E-mail: marqupj@tc.gc.ca
Internet: *http://www.tc.gc.ca/CivilAviation/SystemSafety/Newsletters/Tp185/menu.htm*

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Paul Marquis

Regional System Safety Offices

Atlantic
Box 42
Moncton NB E1C 8K6
(506) 851-7110

Quebec
700 Leigh Capreol
Dorval QC H4Y 1G7
(514) 633-3249

Ontario
4900 Yonge St., Suite 300
Toronto ON M2N 6A5
(416) 952-0175

Prairie & Northern
- Box 8550
  344 Edmonton St.
  Winnipeg MB R3C 0P6
  (204) 983-5870
- 61 Airport Road
  General Aviation Centre
  City Centre Airport
  Edmonton AB T5G 0W6
  (780) 495-3861

Pacific
4160 Cowley Cres., Room 318
Richmond BC V7B 1B8
(604) 666-9517

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Message from the Minister of Transport

Dear aviation professionals:

As Canada's Minister of Transport, I would like to take this opportunity to express my appreciation for your continued co-operation since the tragic events of September 11.

The aviation industry has been a focal point of attention since the terrorist attacks took place. Transport Canada requested and received your understanding and patience as we closed down our airspace to all but military, police and humanitarian flights and prepared to accept flights diverted from the U.S. Undoubtedly, these measures affected you directly.

September 11 has prompted us to review our entire aviation system and to bring in new measures to improve aviation safety and security. In the December 2001 budget, as well as through the introduction of new legislation, the government has taken concrete steps to enhance aviation safety and security in Canada. These initiatives are in addition to the steps immediately taken in the days and weeks following September 11.

I look forward to your continued help as we implement these enhanced security measures. Working together, we will build on a solid foundation so Canadians can continue to enjoy safe and secure skies.

Again, I want to thank you for your support over the past few months. Our enviable aviation safety record is a reflection of your commitment, dedication and professionalism.

Yours sincerely,

The Hon. David M. Collenette, P.C., M.P.
Minister of Transport

In This Issue

Hand-propping Your Aircraft

The story goes that this pilot had problems starting his aircraft because of a dead battery. So with the ignition on, a little choke and the brakes off, he attempted to start the aircraft manually, *i.e., swinging the propeller*. The engine started OK, and at high taxi speed cleaned up about six light aircraft belonging to a local flying club.

The picture shows the last aircraft that the runaway attacked. Come to think of it, we haven't seen better slices in a loaf of bread. The damage was estimated at just under $2 million. △

Turbulence and Weak Bungee Cords Suspected in Loss of Control.

In March 2000, a ski-equipped Cessna 180J departed from the frozen surface of Delaronde Lake, Saskatchewan, on a visual flight rules (VFR) flight to Swan Lake. Midway through the flight, while the pilot was considering his options because of lowering ceilings and falling snow, the aircraft yawed to the right as it was rolling out of a left turn at about 500 ft above ground. Airframe buffeting was noted, and the pilot had difficulty maintaining pitch control. Despite the application of elevator pitch input and full engine power, the aircraft descended and crashed in a wooded area. The two occupants were seriously injured. This synopsis is based on the Transportation Safety Board of Canada (TSB) Final Report A00C0060.

The area forecast for the route predicted ceilings of 3000 to 4000 ft with visibilities three to six miles in light snow and frequent embedded altocumulus castellanus cloud (ACC), giving visibilities of one to three miles in light snow with frequent snow ceilings of 1000 to 2000 ft. Moderate turbulence was forecast in the vicinity of the ACC, and the aircraft encountered moderate low-level turbulence before and during the final descent. Examination of the aircraft revealed no pre-impact defects or anomalies, and no indication of in-flight airframe icing was found.

The skis were equipped with hydraulically operated attachment links that allow the skis to be retracted for wheel operations or extended for ski operations. Most of the takeoffs and landings conducted since the skis were installed were conducted from frozen lake surfaces near the pilot's home and at several other camp locations. The landing strip near the pilot's home had been mechanically smoothed, but the other locations were unprepared; the skis occasionally encountered small snowdrifts and irregular snow surfaces at those locations. The pilot usually retracted the skis in flight for aerodynamic efficiency; however, the skis were left in the extended position during the accident flight.

The skis were examined by the TSB, and both the left and right mechanical links by which the skis are attached to the main landing gear were found to be broken; the TSB considered most likely that the links separated on impact with the trees. The attitude of the skis in flight is maintained by rigging, with cable/bungee rigging lines. Wire rope limit cables are installed to prevent overextension or failure of the rigging lines. Correct rigging of the lines and limit cables is required to maintain the skis in the proper attitude in flight. If a ski is allowed to tilt up or down beyond specified limits in flight, air flow can be disrupted. In extreme situations, the resulting drag may overwhelm the aircraft's ability to maintain level flight.

Rigging specifications are prescribed by the ski manufacturer and are established individually on each aircraft installation. The forward bungee cords, which comprise part of the rigging lines, were tested. It was found that the bungee cords were at least five years old, although their exact age was not determined. Elongation testing was done to determine whether they met the requirements of military specification (MIL) C-5651. This standard specifies the resistance to stretching that the bungee cords should display at various elongation values. The tests indicated that the bungee cords in use on both of the aircraft's skis provided approximately half the resistance to stretching specified in MIL-C-5651.

The TSB concluded that the aircraft may have encountered air turbulence of sufficient strength to result in the aircraft's descent and that the forward rigging bungee cords, which had less than the required stretching resistance, may have allowed oscillation or vibration of either or both skis. An article entitled "In-flight Breakup Owing to Ski Attachment," discussing ski installation and maintenance issues, was published in issue 3/98 of Transport Canada's *Aviation Safety Maintainer* newsletter. Find it at: *http://www.tc.gc.ca/aviation/syssafe/newsletters/maintainer/main-398/english/419e.htm*. △

New Aviation Safety Video—Night VFR

Safety Services is pleased to announce the release of a new aviation safety video on night visual flight rules (NVFR) operations. The 10-min video is called *Black Holes and Little Grey Cells—Spatial Disorientation During NVFR*. It addresses NVFR, black hole illusion, somatogravic illusion and other traps and challenges facing pilots flying VFR at night. The video also contains some recommended procedures and practices that will assist pilots in making their NVFR flights as safe as possible.

This video is available for loan from your regional System Safety office or for purchase through the TC Civil Aviation Communications Centre, which you can reach at 1-800-305-2059. △

Is Your Heater a Carbon Monoxide Threat?

by Richard Berg, System Safety, Transport Canada

Anyone who operates an aircraft that is equipped with an exhaust manifold heat exchanger or gas-fired cabin heater is exposed to a carbon monoxide (CO) risk. The following event highlights the importance of being aware of the CO risk, whether from a heater or from the exhaust system.

On March 17, 2000, the crew of a Douglas DC-3 lost control of the aircraft and crashed on an ice strip on Ennadai Lake, Nunavut (Transportation Safety Board of Canada (TSB) Final Report A00C0059). The crew had been attempting to overshoot from a balked landing. Both the pilot and co-pilot sustained fatal injuries. Investigation by the TSB revealed that CO gas had entered the cockpit area from leaks in the heater shroud assembly. Toxicology tests showed that the CO might have adversely affected the crew.

CO poisoning is the most common cause of anemic hypoxia in aviation. Anemic hypoxia occurs when there is sufficient oxygen in the lungs, but the blood cannot carry it in sufficient quantities. When CO is present in the air, usually from engine emissions or tobacco smoke, it is absorbed into the bloodstream instead of oxygen. In small amounts, inhaling CO causes impairment of brain functions and sight; in large amounts, it causes death.[1]

The DC-3 operator had recognized the risk of CO poisoning, and as a safety precaution, installed a card style of CO detector with an indicator spot that changes colour in the presence of CO gas. Although the card was not found at the accident site, the TSB noted that the detector user directions for these types of cards are found on the back of the card and are not visible after installation. The following are some of the directions found on the back of the card:

- the reaction rate of the detector varies with levels of CO and humidity;
- the card detector will be ruined by halogen, ammoniac and nitrous gases, and must be kept away from certain agents such as chlorine, cleansers, solvents, etc.;
- Note the date opened on the front of the card and replace every 30–60 days;

There are no regulatory requirements or standards for the installation and maintenance of CO detectors. As a result, the TSB sent an aviation safety advisory to Transport Canada (TC), which suggested that TC may wish to establish standards with regards to the installation and maintenance of CO detectors.

While the TSB states in their advisory that the installation of CO detectors is desirable, TC believes that implementing standards for this equipment is unnecessary and that, indeed, the emphasis must be on proper maintenance of aircraft systems that present a CO risk. In researching this article, it was determined that:

- CO poisoning is a contributing factor for a very small number of accidents.
- The Federal Aviation Administration (FAA) does not carry any regulatory requirements for CO detectors.
- If operators follow the recommended manufacturers' inspection criteria, the risk of an undetected leak of CO is greatly reduced.
- There are no supplemental type certificates (STC) or Technical Standard Orders (TSO) for the electronic type of CO detectors that we have researched. Electronic detectors have been approved by Underwriter's Laboratory (UL) standards for commercial and home use but not for aircraft.
- There may be physical and regulatory problems associated with mounting non-STC/TSO parts in an aircraft.

If you do carry a CO detector, remember to check it regularly, and always have a plan to put into action if you suspect CO poisoning in flight. However, the emphasis must remain on proper and vigilant maintenance of CO-generating systems, such as exhaust manifold heat exchangers, gas-fired cabin heaters, or exhausts, to prevent the risk in the first place. △

[1] TP 12863, *Human Factors for Aviation—Basic Handbook*

❄ ❄ ❄ *Think Winter Flying* ❄ ❄ ❄

Safety Target: Runway Incursions

by Don Côté, Procedures Specialist, Air Traffic Services, NAV CANADA

Editor's Note: This article follows up on another major article on runway incursions, which we published in the last issue of the Aviation Safety Letter. *This is part of our ongoing Incursion Prevention Action Team (IPAT) awareness campaign and provides readers with a NAV CANADA perspective on the issue.*

Safety officials in both the United States and Canada have identified the risk associated with runway incursions as one of the most urgent issues facing the aviation community today. Studies have shown that in spite of years of professional training, pilots, airport vehicle operators, air traffic controllers and flight service specialists continue to unwittingly find themselves involved in runway incursion incidents.

Most people in the aviation industry feel they know what a runway incursion is, claiming "I know one when I see one." Until recently, though, no official definition could be found within Transport Canada or NAV CANADA. By implementing the recommendations from two separate studies on runway incursions, both Transport Canada and NAV CANADA adopted the following definition: *Any occurrence at an airport involving the unauthorized or unplanned presence of an aircraft, vehicle, or person on the protected area of a surface designated for aircraft landings and departures.*

How does a runway incursion happen? In 1987, the Canadian Aviation Safety Board (now the Transportation Safety Board of Canada (TSB)) issued a report entitled *Report on a Special Investigation into the Risk of Collisions Involving Aircraft on or Near the Ground at Canadian Civil Airports.* It stated "Both the Canadian and U.S. experience would suggest an extremely wide range of cause-related factors for the occurrences already examined which involve actual or potential ground conflicts. *Unexpected human behavior is by far the most commonly recurring theme in these occurrences.*"

On March 12, 1997, an airport controller cleared a Swearingen Metro to land with a Canadair Regional Jet holding in position on the runway. Reported visibility was 3/4 mi. in snow showers, with vertical visibility of 1200 ft. Descending through 200 ft AGL, the Metro crew observed the aircraft on the runway and executed a missed approach. The TSB determined that a risk of collision occurred as the result of an ineffective controller handover procedure.

Two months earlier, another controller issued a take-off clearance to an ATR-42. Visibility was 1/2 mi. in snow and blowing snow, with vertical visibility of 600 ft. Five minutes earlier, six snow removal vehicles entered the runway without clearance. At rotation speed, the crew of the ATR-42 observed the vehicles on the runway, pitched the aircraft nose up to a steeper-than-normal attitude and flew over the vehicles at an altitude between 200 and 300 ft. In its report on the ATR incident, the TSB wrote "The following factors contributed to this dangerous situation: visibility was considerably restricted; and *the local snow removal orders caused confusion*" (emphasis added). The source of this confusion was a requirement in the local snow removal orders for the control tower to advise maintenance personnel when the runway was *available* for snow removal. The leader of the snow removal team incorrectly interpreted the term *available* as permission to enter the runway, without asking for authorization from the ground controller. These procedures have since been changed to prevent a repeat of the occurrence.

Since 1990, four runway incursions in the U.S. have killed 45 passengers and crew. The worst aircraft accident in history killed 583 passengers and crew when two B747s collided in fog on a runway in Tenerife, Canary Islands, in 1977. In 1978, 38 passengers and crew were killed in Cranbrook, B.C., when a B737 crashed and burst into flames trying to avoid a snowplow on the runway. At a 1998 workshop on runway incursions in Washington, the Executive Director of the Aircraft Owners and Pilots Association (AOPA) Safety Foundation commented on the general aviation (GA) involvement by noting that while the *incursions* tended to involve GA aircraft in conditions of good visibility, the *accidents* involve commercial aircraft at night or in conditions of poor visibility. The four fatal crashes in the U.S. in the 1990s and the Cranbrook and Tenerife crashes all fit this profile.

The 1987 Canadian Aviation safety Board Special Investigation contained 28 recommendations for areas such as scanning techniques for controllers, airport signage and markings, mandatory readbacks of ATC instructions, pilot training and safety promotion. Many of the recommendations have been implemented.

- Airport signs are better now than they were 12 years ago.
- The Mandatory Frequency Order was put in place to establish mandatory communication procedures at uncontrolled aerodromes.
- Flight service specialists were given authority to provide vehicle control service.
- Direction was issued to pilots through the A.I.P. to read back hold-short instructions.

And yet, runway incursions happen in Canada at a rate of four to five each week. Canadian and Federal Aviation Administration (FAA) officials have raised the alarm with respect to runway incursions and the apparent inability to stem the steady increase in the number of incursions each year. In Canada, incursions have risen steadily from 60 in 1997 to 279 reported cases in 2000.

Good analysis requires good data.

Current NAV CANADA data on runway incursions comes from a variety of sources and, until recently, it has been difficult to make year-to-year comparisons with the available data. In 1999, however, detailed statistics on runway incursions gathered by NAV CANADA enabled authorities to determine exact incursion figures and design incursion prevention strategies.

With the introduction of a common definition, Transport Canada and NAV CANADA have also adopted identical terms to classify runway incursions. The following terms are used for the classification of incursions by type:

- **OI:** Incursions that occur as the result of actions taken by a controller or flight service specialist. Safety may have been jeopardized or less than the appropriate separation minima may have existed in these cases.
- **PD:** Pilot deviation.
- **VPD:** Vehicle/pedestrian deviation.

The following table lists the number and types of incursions recorded by NAV CANADA over the last four years. It is possible that the noticeable increase in incursion numbers is the result of an increased awareness of the incursion problem by air traffic service (ATS) personnel and pilots.

NAV CANADA	OI	PD	VPD	Total
1997	28	26	6	60
1998	31	49	40	120
1999	37	104	72	213
2000	32	155	92	279

What is being done to reduce the number of runway incursions?

1. Transport Canada created the Sub-committee on Runway Incursions to study the Canadian incursion phenomenon; its final report was produced in Sept. 2000.
2. NAV CANADA created its own incursion-prevention committee to provide senior management with recommendations for the prevention of runway incursions.
3. Daily monitoring of incursions and statistical information gathering was initiated by NAV CANADA.
4. Discussions were held across the country with local stakeholders during site visits organized by NAV CANADA.
5. A safety bulletin was issued by NAV CANADA providing controllers and flight service specialists with an incursion alert.
6. Controllers and flight service specialists received recurrent training aimed at incursion prevention.
7. Transport Canada and NAV CANADA developed separate runway incursion action plans and are working on the joint implementation of common recommendations.

The current rate and number of runway incursions is unacceptable and remains a very serious concern for all and a risk that must be addressed. Although less than 15% of runway incursions are directly attributable to controllers or specialists, we know that emphasis on better scanning, position relief briefings and precise communication will help to reduce runway incursions—including those caused by pilot errors. It is also known that a significant number of pilot and vehicle deviations can be attributed to misunderstandings of control clearances, instructions and restrictions. Controllers and flight service specialists have been asked to help in several key areas:

- **The readback**—Many runway incursions involved the incorrect or missing readbacks of hold-short instructions. It is mandatory for the controller or flight service specialist to obtain a readback of any hold or hold-short instruction.
- **Ground taxi**—During taxi and before takeoff, pilots must go through checklists, copy clearances, enter flight management system (FMS) data, and communicate with cabin crew and dispatchers. After landing, most of the same activity goes on again. Controllers and flight service specialists should limit their attempts at communication with the aircraft during these periods unless absolutely necessary.
- **Use of memory aids**—Controllers have looked past cocked strips, alert strips and red lights intended to serve as defense mechanisms. Future recurrent training is expected to address this issue.
- **Use of position relief checklists**—The TSB described the risk of collision at another airport as ". . . the result of an ineffective controller handover procedure." Position relief briefings were also identified causes in two other fact-finding boards and will be addressed in the next recurrent training year.
- **Scanning techniques**—Controllers and flight service specialists have explicit instructions to scan the runways and other controlled surfaces at all times. In addition, recurrent training will also cover this subject.
- **Use of cleared-on-the-field clearances for airport service vehicles**—These authorizations should be avoided. In more than one instance, the controller completely forgot about the vehicle on the runway when issuing a landing or take-off clearance to an aircraft.

A recent NAV CANADA study into runway incursions suggested that the management of the risk associated with runway incursions rests with the entire aviation community and not only the service providers such as NAV CANADA. The one recurring theme heard throughout this study was a call for a partnership between federal agencies, the aviation community and NAV CANADA. △

Still Don't Believe Icing Can Get You?

Icing articles are a mainstay in the *Aviation Safety Letter*. We obviously do not take this subject lightly. On April 12, 2000, a Cessna 310I departed Manning to return to Calgary, Alberta, on an instrument flight rules (IFR) flight plan with Lethbridge as the alternate airport. The aircraft started to pick up light rime icing during the initial descent to Calgary. While on radar vectors for an instrument landing system (ILS) approach to Runway 34, the aircraft entered an area of moderate icing. The approach was unsuccessful, and the pilot was vectored for another approach. On the second approach, the aircraft descended into a rail yard 4.5 SM short of the runway. The aircraft collided with a structure on the roof of a building and came to rest in an inverted position. The pilot sustained serious injuries and the passengers, minor injuries. This synopsis is based on the Transportation Safety Board of Canada (TSB) Final Report A00W0079.

While on radar vectors for the approach to Runway 34, the pilot advised the arrival controller that he was experiencing moderate icing and requested a lower altitude. The accumulations were described as one to two inches thick, covering the leading edges of both wings and tip tanks. Ice was observed shedding from the propellers and the wings as the aircraft flew in and out of cloud. The pilot was vectored to final and transferred to tower control. He was unable to use the automatic direction finder (ADF) for the approach; however, he was able to identify the ILS frequency. Apparently, the glide path indicator did not move from the upper portion of the instrument, but the course indicator for the localizer did work. The aircraft did not descend on the glide path. At one mile on final, the aircraft was $^{3}/_{4}$ mi. west of the localizer, at 5000 ft ASL (the minimum descent altitude for a localizer-only approach on Runway 34 is 3880 ft ASL), and the tower controller instructed the pilot to conduct a go-around. The pilot was now operating the aircraft at full power to maintain flight.

During vectors for the second approach, the pilot commented to air traffic control (ATC) that he was having trouble maintaining altitude. The pilot was able to identify and use the Yankee non-directional beacon (NDB) for this approach. During this second approach, the aircraft intercepted the localizer. Two minutes later, the pilot contacted the tower controller. The arrival controller told the tower controller (via land line) that the Cessna was having a hard time maintaining the localizer and altitude. At no time did the pilot declare an emergency.

Shortly after the descent was initiated for the glide path, the right engine surged, with a resultant loss of power. The pilot had difficulty controlling the aircraft laterally at this time. Eyewitnesses described the aircraft rocking from side to side as it came out of cloud just before striking the building. The radar tapes indicate an average descent rate of 2400 fpm during the last 35 seconds of the flight.

There was no indication of any airframe failure or system malfunction before or during the flight. All damage to the aircraft was attributable to the severe impact forces. The aircraft was not certified for flight into known icing conditions.

The aircraft had an estimated 485 lb of fuel when it left Manning, whereas a minimum of 564 lb were required to comply with the fuel requirements for IFR flight to Calgary with Lethbridge as an alternate. The gas combustion heater in the Cessna 310I uses fuel from the right main tank at approximately three pounds per hour. The heater had been in use for most of the $4^{1}/_{2}$-hr return trip. It was reported that the aircraft auxiliary fuel gauges read empty en route to Calgary and that the main tank (tip tank) fuel gauges were reading close to empty towards the end of the flight.

TSB Analysis—The weather briefing given to the pilot before departure indicated that icing conditions would be present during the flight, and the pilot departed although the aircraft was not certified for flight into known icing conditions. When the pilot first encountered in-flight icing 60 NM northwest of Calgary, he based his decision to continue on the low catch rate of the ice and the absence of icing reports being broadcast on radio by other pilots and ATC. When the accumulations reached moderate proportions, the pilot requested a lower altitude to leave the icing area and to enter warmer air to reduce the accumulations on the airframe. The airframe ice was seen departing from the aircraft at times, but it was accumulating faster than it was shedding.

The first approach was unsuccessful because of a lack of situational awareness. Without an operating ADF, the pilot was unaware of the aircraft's exact position relative to the airport. During the second approach, the ADF functioned properly, probably because some ice had shed from the antennas.

The prolonged exposure to the icing conditions increased the amount of ice on the aircraft, decreasing its lifting capability. The situation was aggravated by the fuel exhaustion that started to occur on the right engine. With the loss of power on the right engine and the ice accumulation on the airframe, the pilot could not control the aircraft's rate of descent.

The low amount of fuel, in combination with the lateral movement of the aircraft, most likely caused the right main fuel tank port to become exposed to air, causing the power loss on the right engine. The higher-than-normal power setting used while in the icing conditions, the extra flying time required for the second approach, and the use of the cabin heater for the duration of the round-trip flight contributed to the lower quantity of fuel in the main tanks, particularly in the right main tank.

The TSB's conclusions are stark: the aircraft did not have enough fuel on departure from Manning to meet the requirements for IFR flight; the aircraft was not certified for flight into known icing conditions; the pilot continued flight into forecast icing conditions; the weather in Calgary had deteriorated faster than forecast; the aircraft was unable to maintain altitude because of ice on the wings; and the right engine lost power because of fuel exhaustion. I encourage you to read the full report on the TSB Web site (*http://www.tsb.gc.ca*), which includes the entire weather background and other investigation findings that could not be included here for space considerations. △

Your Bird Strike Reports Do Matter!

by Bruce MacKinnon, Aerodrome Safety Inspector, Transport Canada

Did you know that between 15% and 30% of the total foreign object damage (FOD) incurred by the world's airline fleet is caused by collisions between aircraft and wildlife? Did you also know that the annual cost associated with this worldwide problem is $1.2 billion? It's true. Unfortunately, studies have shown that on average, only 14% to 30% of bird strikes at airports are reported, and airport operators have difficulty implementing an efficient wildlife management program with such deficient data. Habitat manipulation, wildlife control officer shift schedules, staffing levels and equipment choices are only a few of the many decisions influenced by the number of wildlife incident reports.

A major American airport with a high bird strike rate worked together with the Federal Aviation Administration (FAA) and the United States Department of Agriculture to improve the record, by implementing a data-driven, science-based, wildlife management program. The number of bird strikes involving gulls dropped by more than 85% in the span of 12 years as a result of this formal process. This achievement was made possible primarily because improvements were made in the collection and analysis of data.

At one of Canada's major airports, all wildlife interventions, actions and incidents are reported on a database. The information contained in this database is addressed at monthly meetings attended by representatives from all of the airport's divisions, and the tactics that are implemented each day to control wildlife are dependent on the information derived from the database. Nevertheless, in a random three-month period, there was a significant discrepancy between the numbers recorded by the airport and those submitted by the operators.

At another of Canada's major airports, the bird strike database failed to provide justification for wildlife control activities outside of normal daylight hours. Anecdotal evidence indicated that numerous strikes occurred at night, but the formal data did not support the expense associated with around the clock coverage. However, approximately half an hour after the wildlife control team had completed its shift one evening, a large turbojet aircraft collided with waterfowl on the climb-out, resulting in the failure of one engine. Shortly after this incident, the airport instituted 24/7 wildlife control coverage, and a post-incident risk assessment revealed considerable waterfowl activity during the hours of darkness.

Good data is critical to the decision-making process. Information on time of day, wildlife species, effect on flight, altitude, weather conditions, aircraft and engine type and a contact phone number are all pieces of information that benefit those airports motivated to proactively improve their programs.

Transport Canada provides a number of options for reporting wildlife incidents, including report forms with self-addressed and postage paid envelopes, a toll-free telephone reporting line (1-888-282-BIRD) and an on-line reporting system. However, the most useful action that a pilot can take is to issue a radio report to air traffic service (ATS) providers immediately following an incident so that the airport operator can quickly mitigate the threat. Indeed, your wildlife incident reports play a crucial role in airport risk management programs. △

Helicopter Pilots! We Have a New Vortex Editor!

System Safety is pleased to announce the arrival of a new editor for the *Aviation Safety Vortex* newsletter, Mr. Brad Vardy. Brad began flying in 1981 at Ocean Air Services in St. John's, Nfld., where he trained as a commercial helicopter pilot. His commercial career started with Viking Helicopters in Pasadena, Nfld., flying mainly in support of mining and mineral exploration. The purchase of Viking by Canadian Helicopter Corp. (CHC) in 1989 sent him to Goose Bay, where he stayed until 1996. During that time, he flew extensively in Labrador and the Arctic, toured internationally in support of CHC's United Nations contracts in Cambodia and Somalia, and was Project Manager of the giant Voisey Bay nickel discovery in northern Labrador. Immediately before joining Transport Canada, Brad flew as a test pilot in the Engineering Division of Bell Helicopter Textron in Mirabel, Quebec, for five years. He holds an instrument flight rules (IFR) rating and an airline transport pilot licence (ATPL) in Canada, a U.S. Commercial licence, and has flown over 7000 hr. in light, medium and heavy helicopters. You can expect your next Vortex issue in March 2002. △

Upcoming Regional Events

The following schedule for upcoming workshops is tentative. All requests for non-scheduled workshops will be considered.

Company Aviation Safety Officer (CASO). This workshop introduces aviation safety management principles to participants. It provides both theoretical and practical applications of topics such as flight safety philosophy, human factors, risk management and the decision-making process. The workshop also addresses the role of the flight safety officer as advisor to senior management; as well as the principles and practices of accident prevention; accident/incident management and incident investigation. System Safety offers ***one free seat*** to each CEO, Operations Manager, Chief Pilot, Chief of Maintenance or Chief Flight Attendant for every company employee that attends.

Pilot Decision Making (PDM). This workshop, intended for (but not restricted to) pilots in VFR operations in uncontrolled airspace, introduces participants to the decision-making process. The workshop examines human performance factors, including both the influence and limitations of physical, psychological and physiological phenomena and their consequences. The workshop also provides participants with practical exercises to demonstrate good airmanship and illustrate countermeasures to contain or mitigate human error.

Human Performance in Aircraft Maintenance (HPIAM). This workshop promotes awareness of human performance issues for aviation maintenance personnel. Through case studies, participants investigate how errors happened, determine contributing factors that interfered with performance at the critical moment, and develop "safety net strategies" to prevent future errors from occurring.

Atlantic Region

HPIAM February 13–14, 2002 Halifax, N.S.

For information or to register, please contact System Safety at (506) 851-7110 or e-mail ***vautoua@tc.gc.ca***.

Quebec Region *(Events are in French unless specified).*

Skills Review Seminars—Night Flying *(exact dates unavailable at press time, please contact the System Safety office for details).*

February 2002	Quebec City	February 2002	Chicoutimi	March 2002	St-Hubert
March 2002	Les Cèdres (*English*)	April 2002	Rouyn	April 2002	Gatineau
May 2002	Mascouche				

For information or to register, please contact System Safety at (514) 633-3249 or e-mail ***qcsecursys@tc.gc.ca***.

Ontario Region

HPIAM February 5–6, 2002 Sioux Lookout; March 5–6 Hamilton (Canadian Warplane Heritage)

For information or to register, please call (416) 952-0175, fax (416) 952-0179 or e-mail ***neln@tc.gc.ca***.

Prairie & Northern Region (PNR)

CASO January 24–25, 2002 Edmonton, Alta.; February 13–14 Calgary, Alta.

For information or to register, please contact Carol Beauchamp at (780) 495-2258, fax (780) 495-7355 or e-mail ***beaucca@tc.gc.ca***.

Pacific Region

Ben Hoben Aviation Safety Seminar January 26, 2002, Pacific Flying Club, Boundary Bay Airport
(Pre-registration required by e-mailing ***pkennedy@pacificflying.com*** *or calling (604) 278-9871).*

CASO	February 27–28, 2002	Richmond		
PDM	January 24, 2002	Abbotsford	February 21	Richmond
	March 5	Fort St. John	March 21	Richmond
	April 18	Abbotsford	April 18	Richmond
HPIAM	January 28–29, 2002	Richmond	February 25–26	Victoria
	March 6–7	Fort St. John	March 26–27	Richmond

For information or to register, please contact Lisa Pike at (604) 666-9517, toll-free 1-877-640-2233, e-mail ***pikel@tc.gc.ca****, fax (604) 666-9507.*

to the letter

On Runway Incursions

Dear Editor,

When I read "Anatomy of a Runway Incursion" in issue 2/2001 of the *Aviation Safety Letter*, it reminded me of something that happened to me. I was ready to take off from Runway 27, and I received my take off clearance from the tower controller. I learned later that another controller (not the one who had cleared me for takeoff) cleared a larger aircraft to land on intersecting Runway 18. I did not know about this when I started rolling, a time at which the engine noise is at its loudest. I heard "abort" in this noisy time period, but I could not pick up the rest, including the call sign. It took two or three seconds for a non-experienced pilot such as myself to understand what was going on and how I should react. This was a first-time experience for me.

In the next two or three seconds, the controllers yelled "abort" three times (although I only heard it twice, but I guess I missed it once because of the noise). Although I could still not confirm the call sign, I aborted my take-off roll and stopped before the intersection of Runway 18 and Runway 27. While still on Runway 27, the controller asked me if I could take off on Runway 18, but I said "negative" because I was not comfortable with taking off from the intersection. I was and felt that the controller was also upset. I requested to go back to Runway 27, did another run-up and called "Ready for takeoff at 27," but received no reply. Unfortunately there were no aircraft behind me, and I called "Ready for takeoff at 27" again after a few minutes, and with no aircraft in view for landing. The controller told me "You want to leave quickly, huh?" I had to wait for about ten minutes to get a clearance for takeoff.

While I admit I did not stop immediately because of the noise, I aborted three or four seconds later, reacting to the orders from the Tower. Even though the incident originated with his mistake, the controller made me wait an extra ten minutes for not responding quickly to the abort calls and likely for refusing the intersection departure. I felt this was unprofessional and mean. After this problem, I lost my confidence in my radio communication as my native language is not English, and I gave up my instrument flight rules (IFR) training.

Name withheld upon request

This letter was sent to me a few months ago and has been de-identified so none of the people or the location can be recognized. It had few details and I could not verify it, but it seemed genuine to me. Real or not, the event is complex in that it involved an alleged air traffic control (ATC) error, critical radio calls being missed or misunderstood, an inexperienced pilot whose mother tongue was not English, and two individuals high on adrenaline after the abort was finally executed. The tension between the pilot and the controller is palpable, and I am quite sure many of us can relate to the story. The key is better communication, patience and understanding. —Ed.

More on Circuit Breakers Please

Dear Editor,

I have been flying since I was in grade 11 and am now employed as a first officer on jumbo jets. Let me say that issue 1/2001 of the *Aviation Safety Letter* got my full attention. The reason I am finally writing after all these years is the article on **circuit breakers**! I have seen these items abused and misused **many, many, many** times to my great disappointment. One of the occasions included the ground engineer resetting a breaker in the cockpit six times before he finally decided to visit the electronics compartment downstairs to see why it was popping! I told him we were *allowed* (not to be confused with *expected*) to attempt only one reset in the air! The next thing I know, I get a call from the boss saying the airplane is in the mechanics hands when it is on the ground, and they are not limited to the same reset limits we are! I was thinking, "what if he were able to weld the bloody thing shut only for me to find out later in the air!" I wish I had a dollar for every time I saw this take place! I can only hope that the editor of Maintainer will write the same article because, from this pilot's point of view (which includes six years as 727 command), the aircraft maintenance engineers (AME) are not all on the same page.

Name withheld upon request

Search and Detect cont. from p. 12

Improved aircraft conspicuousness reduces the risk of collision in high traffic-density areas. Strobe lighting, pulsing landing lights, and electronic surveillance technology help pilots search for and detect conflicting traffic in a timely manner. Relatively inexpensive strobe lights are available on the market and light aircraft owners may want to consider them.

This short accident synopsis does not give justice to the full TSB Final Report, which expands considerably on important issues such as physiological limitations of the human eye, vision limitations of aircraft design, design eye-reference point, the see-and-avoid principle, recognition and reaction times, mid-air collision defences and more. Readers are encouraged to log on to the TSB Web site at *http://www.tsb.gc.ca* and read the full report. △

Search and Detect

On November 20, 1999, an ERCO Aircoupe 415C and a Cessna 152 collided on nearly opposing headings while flying in visual meteorological conditions in designated flying training area CYA 125(T), near Vancouver, B.C. Both aircraft broke up in flight and plunged to the ground, killing the four occupants. This synopsis is based on the Transportation Safety Board of Canada (TSB) Final Report A99P0168.

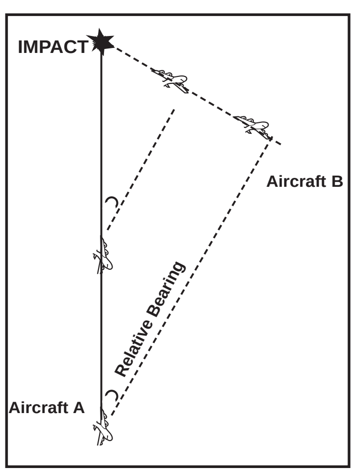
The Aircoupe had done touch-and-go circuits at Pitt Meadows Regional Airport and then flew into training area CYA 125(T) from the Northeast. The instructor and the student in the Cessna 152 left Boundary Bay Airport to the South, to review basic flying exercises in the same area. Radar data showed that the Cessna maintained a track of about 025º magnetic (M) and was not seen to deviate from its flight path or take evasive action before the collision.

One minute before the collision, the Aircoupe orbited an ultralight, and then flew on a southwesterly track for about 40 seconds. It then turned right to the northwest, rapidly closing on the Cessna's flight path. The Aircoupe appears to have then turned to the left, nearly into a head-on situation with the Cessna, and about 10 seconds later the two aircraft collided. During the last five or so seconds before impact, the Aircoupe was reportedly in a nearly straight and level flight attitude.

Collision damage patterns suggest that the Aircoupe's pilot may have attempted an evasive action to the right immediately before impact. The two pilots in the ultralight indicated that the Cessna had its landing lights on, but they could not see those of the Aircoupe, even though the Aircoupe flew around them before the collision. The Aircoupe pilot was very familiar with the local area, and the Cessna 152 instructor was properly qualified for the flight. The student pilot was considered a capable and eager young man, and his flight training progress had been normal.

In Canada, the see-and-avoid principle is used as the primary means of maintaining spacing between aircraft in visual meteorological conditions. Research shows that this principle is the least effective of the available mechanisms to keep aircraft apart because of the physiological limitations of the human eye and the motor-response systems. Because those limitations challenge pilots to employ assiduous scanning techniques, "search-and-detect" has to take place before the see-and-avoid concept becomes effective.

Constant relative bearing—When two aircraft are on a collision course with constant headings and constant speed, they have a constant relative bearing to each other. Each aircraft, if detected, would appear to be motionless to the other pilot. This illusion increases the difficulty for each pilot to visually acquire the other aircraft. Even if one aircraft is travelling faster than the other, as long as their relative bearings remain constant, the aircraft will collide. From a pilot's perspective, if the approaching aircraft has no apparent relative motion and stays at the same point on the windshield, a collision will likely occur unless evasive action is taken.



Constant relative bearing.

The flight profiles of both aircraft indicate that neither pilot saw the other aircraft in sufficient time to initiate effective and timely evasive action. The Aircoupe pilot's attention was probably focused on manoeuvring around the ultralight, whereas the attention of the Cessna pilots was likely focused on the training environment. Although this cannot be proven, it is a scenario to which most pilots can relate and emphasizes why constant vigilance is so important, especially in uncontrolled airspace.

The Aircoupe is a low-wing aircraft with the pilot's seat over the wing. During the right bank in the turn, the left wing would have restricted the pilot's field of view to his left, the direction from which the Cessna approached. It may therefore have been physically impossible for the occupants of the Aircoupe to see the Cessna until just before the aircraft collided. From the perspective of the Cessna pilots, the Aircoupe would have been approaching from the front right quadrant. The target image would have been a small profile view. The yellow Aircoupe may have blended with the variegated background, and no indication was found that the Aircoupe's landing light was on.

Research indicates that a pilot is eight times more likely to acquire a target if alerted to its presence. Without a warning, the Cessna pilots may not have detected the Aircoupe. The Aircoupe would have appeared motionless to them for about ten seconds because of their constant relative bearing, which commenced when the aircraft speeds and headings combined to establish the collision course. We all need to maintain a more assiduous lookout in training areas because training aircraft generally follow erratic flight paths, perform unpredictable manoeuvres, and lookout is degraded by the focus on training.

cont. on p. 11

In *Managing the Risks of Organizational Accidents*, Dr. James Reason argues that three ingredients are vital for driving a company's safety engine, all of them the purview of top managers: *commitment, competence* and *cognizance*—the three Cs.

But managers come and go. This is a fact of life.

So how does a company maintain a commitment to safety in the face of personnel turnover, volatile market forces and economic reality?

James Reason suggests that this is where an organization's safety culture comes in to play!

Dr. Reason states that "A good safety culture is something that endures and so provides the necessary driving force."

To find out if your organization has or is well on its way to having a good safety culture, Dr. Reason prepared the following checklist.

Score Your Safety Culture

Checklist for assessing institutional resilience

Scoring: YES = This is definitely the case in my organization (scores 1);
? = "Don't know," "maybe" or "could be partially true" (scores 0.5);
NO = This is definitely not the case in my organization (scores zero).

	YES	?	NO
Mindful of danger: Top managers are ever mindful of the human organizational factors that can endanger their operations.	☐	☐	☐
Accept setbacks: Top management accepts occasional setbacks and nasty surprises as inevitable. They anticipate that staff will make errors and train them to detect and recover from them.	☐	☐	☐
Committed: Top managers are genuinely committed to aviation safety and provide adequate resources to serve this end.	☐	☐	☐
Regular meetings: Safety-related issues are considered at high-level meetings on a regular basis, not just after some bad event.	☐	☐	☐
Events reviewed: Past events are thoroughly reviewed at top-level meetings and the lessons learned are implemented as global reforms rather than local repairs.	☐	☐	☐
Improved defence: After some mishap, the primary aim of top management is to identify the failed system defences and improve them, rather than to seek to divert responsibility to particular individuals.	☐	☐	☐
Health checks: Top management adopts a proactive stance toward safety. That is, it does some or all of the following: takes steps to identify recurrent error traps and remove them; strives to eliminate the workplace and organizational factors likely to provoke error; brainstorms new scenarios of failure; and conducts regular "health checks" on the organizational process known to contribute to mishaps.	☐	☐	☐
Institutional factors recognized: Top management recognizes that error-provoking institutional factors (under-staffing, inadequate equipment, inexperience, patchy training, bad human-machine interfaces, etc.) are easier to manage and correct than fleeting psychological states, such as distraction, inattention and forgetfulness.	☐	☐	☐
Data: It is understood that the effective management of safety, just like any other management process, depends critically on the collection, analysis and dissemination of relevant information.	☐	☐	☐
Vital signs: Management recognizes the necessity of combining reactive outcome data (i.e., the near miss and incident reporting system) with active process information. The latter entails far more than occasional audits. It involves the regular sampling of a variety of institutional parameters (scheduling, budgeting, fostering, procedures, defences, training, etc.), identifying which of these vital signs are most in need of attention, and then carrying out remedial actions.	☐	☐	☐

	YES	?	NO
Staff attend safety meetings: Meetings relating to safety are attended by staff from a wide variety of departments and levels.	☐	☐	☐
Career boost: Assignment to a safety-related function (quality or risk management) is seen as a fast-track appointment, not a dead end. Such functions are accorded appropriate status and salary.	☐	☐	☐
Money vs. Safety: It is appreciated that commercial goals and safety issues can come into conflict. Measures are in place to recognize and resolve such conflicts in an effective and transparent manner.	☐	☐	☐
Reporting encouraged: Policies are in place to encourage everyone to raise safety-related issues (one of the defining characteristics of a pathological culture is that messengers are "shot" and whistleblowers dismissed or discredited).	☐	☐	☐
Qualified indemnity: Policies relating to near miss and incident reporting systems make clear the organization's stance regarding qualified indemnity against sanctions, confidentiality, and the organizational separation of the data-collecting department from those involved in disciplinary proceedings.	☐	☐	☐
Blame: Disciplinary policies are based on an agreed (i.e., negotiated) distinction between acceptable and unacceptable behaviour. It is recognized by all staff that a small proportion of unsafe acts are indeed reckless and warrant sanctions but that the large majority of such acts should and attract punishment. The key determinant of blameworthiness is not so much the act itself—error or violation—as the nature of the behaviour in which it was embedded. Did this behaviour involve deliberate unwarranted risk-taking or a course of action likely to productive avoidable errors? If so, then the act would be culpable regardless of whether it was an error or a violation.	☐	☐	☐
Non-technical skills: Line management encourages their staff to acquire the mental (or non-technical) as well as the technical skills necessary to achieve safe and effective performance. Mental skills include anticipating possible errors and rehearsing the appropriate recoverable recoveries. Such mental preparation at both individual and organizational levels is one of the hallmarks of high-reliability systems and goes beyond routine simulator checks.	☐	☐	☐
Feedback: The organization has in place rapid, useful and intelligible feedback channels to communicate the lessons learned from both the reactive and proactive safety information systems. Throughout, the emphasis is upon generalizing these lessons to the system at large.	☐	☐	☐
Acknowledge error: The organization has the will and the resources to acknowledge its errors, to apologize for them and to reassure the victims (or their relatives) that the lessons learned from such accidents will help to prevent their recurrence.	☐	☐	☐

HEALTH WARNING

High scores on this checklist provide no guarantee of immunity from accidents or incidents.

Even the "healthiest" institutions can still have bad events. But a moderate to good score (8–15) suggests that you are striving hard to achieve a high degree of robustness while still meeting your other organizational objectives. The price of safety is chronic unease: complacency is the worst enemy.

There are no final victories in the struggle for safety.

INTERPRETING YOUR SCORE

16–20	So healthy as to be barely credible.
11–15	You're in good shape, but don't forget to be uneasy.
6–10	Not at all bad, but there's still a long way to go.
1–5	You are very vulnerable.
1	Jurassic Park

This checklist was written by Professor James Reason and presented at the 2000 Manly Conference. Reprinted with permission.