Transport Canada Transports Canada

Aviation Safety Letter

Learn from the mistakes of others and avoid making them yourself . . . Issue 4/2001

Déjà Vu—Frost Causes Loss of Control

On December 28, 1999, an amphibious Cessna 208 Caravan took off from Runway 19 at Abbotsford Airport, British Columbia, on a private flight to the Bahamas. One pilot and five passengers were on board. About one minute later, as the aircraft was climbing through an altitude of about 400 ft AGL and, as the pilot retracted flaps from ten to zero degrees, the aircraft became uncontrollable. The aircraft banked left, descended rapidly, and crashed in a field about one-half mile south of the runway threshold in a left bank with a near level pitch attitude. The aircraft was destroyed, and the pilot received serious injuries. Two passengers were also seriously injured, and three passengers received minor injuries. Day visual meteorological conditions (VMC) prevailed at the time of the accident. There was no fire. This synopsis is based on the Transportation Safety Board of Canada (TSB) Final Report A99P0181.

The pilot received a detailed weather briefing at the Abbotsford Flight Service Station. A quasi-stationary upper ridge of high pressure created extensive areas of low ceilings and low visibilities in stratus cloud and fog. Vancouver International Airport, about 34 mi. west of Abbotsford, was experiencing fog and freezing fog throughout the morning. Several aircraft destined for Vancouver had diverted to Abbotsford, where weather conditions were more favourable. The 0900 aviation routine weather report for Abbotsford included fog in the vicinity, temperature minus three degrees Celsius, dew point minus four degrees Celsius, and FROIN (abbreviation for *frost on the indicator*, meaning that frost had been forming over the last hour) was recorded in the remarks section.

The pilot assessed the takeoff and initial climb as normal. He retracted the landing gear after establishing a positive rate of climb and made a slight power reduction, while continuing to climb. The pilot used 20° of flap for takeoff. The pilot retracted the flaps in two increments: first from 20° to 10°, then from 10° to zero. The aircraft departed from controlled flight after the pilot initiated the retraction from 10°.

The aircraft rolled to the left and descended rapidly. The pilot's initial attempt to overcome the uncommanded roll by using aileron control was unsuccessful. He then lowered the aircraft's nose and advanced the throttle. The pilot was initially able to return the wings toward level and reduce the rate of descent; however, there was insufficient height for the aircraft to recover. The flight, from lift-off to collision with the ground, lasted about one minute.

When the aircraft contacted the ground, it was in a left bank, with a near level pitch attitude. The floats absorbed much of the impact force and separated from the aircraft during the impact sequence. Damage to the propeller assembly was consistent with the engine producing power at impact.

No records exist of the pre-flight calculations for the weight and balance at takeoff, and the pilot estimated that the weight of the aircraft at takeoff was about 100 lb under the maximum take-off weight (MTOW) of 8360 lb. Weight calculations performed by the TSB revealed that the take-off weight was about 8870 lb, about 510 lb over the MTOW. A portion of the difference between the weight estimates by the pilot and the TSB can be attributed to changes to the interior seating configuration, which resulted in an increase of about 150 lb to the aircraft empty weight. No entries reflecting these changes were made in the logbooks.

The aircraft had been parked overnight on the ramp at Abbotsford and had accumulated a layer of frost, which the pilot noted. He used cold tap water to remove frost from the windshield in order to see out

TP 185E
ISSN 0709-8103

Canada

of the aircraft. The pilot also checked the top of the wings during his pre-flight check and noted a layer of frost, which he indicated to be about 3/16 in. thick, but he assessed that it was insignificant. He believed that the sun would melt all the frost and that de-icing the wings would not be necessary. The sun rose at 0810 and was about eight degrees above the horizon by the time the aircraft took off. Ambient temperatures at 0900 and 0920 were recorded as -2.8°C and -0.5°C, respectively. The extent to which the early morning sun would have melted frost from the wing surfaces is negligible. The wings were not examined to confirm that the frost had melted before takeoff.

Witnesses who were experienced in aircraft icing/de-icing operations reported that the Caravan was covered in a pronounced layer of frost, about 1/4 in. thick. Adjacent aircraft were significantly covered in frost and ice, resulting in scheduled flights being postponed; those aircraft remained frost-covered until late that morning.

The detrimental effects of contaminated wings are well documented. Frost accumulation on the upper surface of an aircraft wing decreases a wing's efficiency and restricts its ability to produce lift. Frost increases stalling speed, decreases the stall angle of attack, and rapidly increases the drag near the stall speed. Stability and control of the aircraft are also adversely affected. These adverse effects on the aerodynamic properties of the aerofoil may result in sudden departure from the commanded flight path and may not be preceded by any indications or aerodynamic warnings to the pilot. Canadian regulations prohibit takeoff with ice or frost adhering to the wings.

Cessna's Icing Training Program and the Pilot's Checklist produced for the Caravan state that "It is essential in cold weather to remove even small accumulations of frost, ice, or snow from wing, tail, and control surfaces . . . ." They warn that "If these requirements are not performed, aircraft performance will be degraded to a point where a safe takeoff and climb-out may not be possible." Additionally, Cessna warns that "0.1 in. of evenly distributed frost on the aircraft's wing could increase the stalling speed by 35%. This roughly doubles the required take-off run."

The U.S. National Transportation Safety Board (NTSB) investigated several Cessna 208B Caravan accidents that have been directly attributed to the pilots not removing the contamination on the wings. Research indicates that for a contaminated wing, the onset of stall occurs at a lower-than-normal angle of attack. The angle of attack must therefore be increased to produce the required lift at normally scheduled speeds. As well, the increasingly unsteady airflow over the wing results in correspondingly degraded lateral stability, requiring larger and larger control wheel inputs to keep the airplane from rolling off. The airplane becomes increasingly unstable, eventually stalling without stick shaker activation at speeds normally scheduled for takeoff.

Wind tunnel and flight tests indicate that frost, ice, or snow formations having a thickness and surface roughness similar to medium or coarse sandpaper on the leading edge and upper surface of a wing can reduce wing lift by as much as 30% and increase drag by as much as 40%. The primary influence of wing contamination is surface roughness on critical portions of the aerodynamic surface. These adverse effects may result in sudden departure from the commanded flight path and may not be preceded by any indications or aerodynamic warning to the pilot. Therefore, it is imperative that takeoff not be attempted unless the pilot has ascertained, as required by regulation, that all critical surfaces are free of adhering frost, ice, or snow formations.

In a Cessna 208B Caravan take-off accident in Dec. 1999 from Bethel, Alaska, the NTSB determined that the pilot had parked the aircraft outside all night and that a noticeable layer of frost had accumulated on the wings, horizontal stabilizer, elevators, and windshield. He used a broom to remove an accumulation of frost and snow. The pilot recalled that shortly after lift-off, about 100 ft above the runway, he retracted 10° of flap. As the aircraft climbed through 200 ft AGL, the pilot retracted the remaining flap, and the aircraft descended while rolling left. The pilot had to apply full aileron to keep the airplane upright. Despite full engine power, the airplane continued to descend to the ground.

Flaps on the Cessna 208 have a large span and are of the single, slotted type. Extension of the flap surface is a combination of aft and downward travel. When the flaps are moved from 0° to 10°, the flap surface moves about eight inches rearward and about one inch down. This increases the total wing surface area by about 30 sq. ft. Accordingly, when flaps are retracted from 10° to zero, total wing area is reduced, resulting in a reduction to the total amount of lift being produced by the wing.

Analysis—The TSB concluded that the aircraft was contaminated with frost during the takeoff, which would have increased drag and reduced the ability of the wings to produce lift. The aircraft was also overloaded, which adversely affected aircraft performance. The decreased performance of the aircraft during the takeoff and climb is attributable to the combined effects of aircraft overloading and wing and flight control surface contamination. As well, increased weight and surface contamination both increase the stall speed of an aircraft. When the flaps were retracted, further reducing lift, the aircraft experienced an aerodynamic stall and loss of control from which the pilot was unable to recover. Finally, because the wings were contaminated, the classic stall indicators of aircraft buffet and audible stall warning were likely absent, at least initially. △

Transport Canada / Transports Canada

The **Aviation Safety Letter** is published quarterly by Civil Aviation, Transport Canada, and is distributed to all Canadian licensed pilots. The contents do not necessarily reflect official policy and, unless stated, should not be construed as regulations or directives. Letters with comments and suggestions are invited. Correspondents should provide name, address and telephone number. The ASL reserves the right to edit all published articles. Name and address will be withheld from publication at the writer's request.

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/aviation/syssafe/newsletters/letter/index_e.htm

Reprints are encouraged but credit must be given to the ASL. Please forward one copy of the reprinted article to the Editor.

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) 983-2926
- 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

Sécurité aérienne — Nouvelles est la version française de cette publication.

Suggested Internet Reading—Boeing 747 CFIT

On August 6, 1997, a Boeing 747-300 crashed at Nimitz Hill, Guam. The flight departed from Gimpo International Airport, Seoul, Korea, with 17 crew and 237 passengers on board. The airplane had been cleared to land on Runway 06L at Won Pat Guam International Airport, Agana, Guam, and crashed into high terrain about three miles southwest of the airport. Of the 254 persons on board, 228 were killed. The National Transportation Safety Board (NTSB) determined that the probable cause of the accident was the captain's failure to adequately brief and execute the non-precision approach and the first officer and flight engineer's failure to effectively monitor and cross-check the captain's execution of the approach.

The Guam accident report is so voluminous (and important) that it would be a disservice to edit it down to fit in this newsletter. The safety issues in the report focus on flight crew performance, approach procedures, pilot training, air traffic control, regulatory oversight and flight data recorder documentation. We strongly encourage all readers to read the full report, available on the NTSB Web site at *<http://www.ntsb.gov/events/KAL801/default.htm>*, which also includes video animation. The report can also be read on the Flight Safety Foundation Web site at *<http://www.flightsafety.org/special.html>*.

Filing Those Position Reports—It's Not for Big Brother

by Mike Casey, Provincial Safety Officer, CASARA Ontario

Position reports are considered by some pilots to be a nuisance and another instance of procedures infringing on their right to fly off into the wild blue yonder without a care or a worry. The thing is, if something disastrous should happen during the flight, search and rescue resources are deployed based on the last known position (LKP) and the destination.

In Canada, the primary search area is determined by drawing a line from the LKP to the destination, according to the intended route. A ten-nautical mile box is drawn around the track line. This is known as CSAD1 (Canadian Search Area Definition). CSAD2 expands the search area by another five nautical miles and normally occurs several days after the search has been initiated.

On a flight from Maniwaki to North Monetville Skypark, the CSAD1 would be 3980 sq. NM.

Allowing for refuelling, it is reasonable to expect 60 sq. NM to be searched per hour, based on the search aircraft being at 500 ft AGL and with a search width of 0.5 NM either side of the search platform. Allowing for six hours of good light per day and no weather conflicts, four search aircraft would require three days to cover the area.

In the meantime, family and friends are wearing out carpets back home as they pace back and forth with worry.

One position report, or relaying any changes in course, will reduce the task considerably and concentrate resources more effectively.

And one last thing: After making a precautionary landing in the middle of nowhere, dial up the guard frequency (121.50 MHz) and call out your situation. High fliers will gladly pass news and reports of your continued good health, position and intentions to FSS.

Fly Safe.

CASS 2001: Something for Everyone

Special report by Steve Kurzbock, Transport Canada, Civil Aviation, Safety Services

The thirteenth annual Canadian Aviation Safety Seminar (CASS 2001) was held in Ottawa from May 14–16. This year's theme was "Making Safety Management Systems Work in the 21st Century—Something for Everyone." Nearly 400 delegates from Canada, the United States and abroad gathered to discuss safety management systems (SMS) and other pressing issues in aviation safety.

The seminar commenced with a full-day plenary session where speakers discussed such topics as "Error Management and Safety Culture," "Return on Investment for Safety Management" and "Implementing Safety Management." The next two days of the seminar featured twenty workshops—the largest number in CASS history—to give participants an opportunity to develop skills and share their experiences.

Dr. Patrick Hudson, a professor with the Centre for Safety Research at the University of Leiden in the Netherlands kicked off the plenary session with a discussion on safety management and safety culture. He pointed out that safety is never easy, especially with complex aviation organizations. In emphasizing the importance of establishing a safety culture within a company, Dr. Hudson opined that nothing short of a revolution in thinking on the part of management will ensure safe aviation organizations. While smaller companies may be reluctant to develop safety management systems because of the perceived burden of required investment, Hudson argued "the single greatest barrier to success for smaller organizations is the belief that it is too difficult. The opposite view is that, in the long run, it is more dangerous not to!"

Jeff Hawk, Director of Regulatory Compliance with Boeing, spoke about managing safety in operations. He noted that in terms of hull-loss rates, the worldwide aviation sector is quite safe—for now! However, with the dramatic rises in demand for air travel, predicted volume of flights will be increasing at unprecedented rates. At the current worldwide accident rate, the sheer number of accidents will rise as well. Mr. Hawk stressed that change is needed *now*—if we do nothing, in the not so distant future the world will see one major airline disaster *every week*.

Captain Walter Wolfe, Director of Safety Services at Canada 3000 Airlines, spoke on the implementation of an SMS at Canada 3000. Having defined a *safety culture* in the context of his company, he underscored its importance in everyday operations. He pointed out that each operator must take the initiative to manage safety and that "safety is a shared responsibility, we have to live up to that commitment." Captain Wolfe ended with the notion that changes in data-gathering are needed. In the aviation industry, data-gathering focuses on what *went wrong*. Captain Wolfe believes in the need to concentrate on what *went right* and sees this as a necessary step in the safety management process.

Dr. Gary Eiff, Purdue University, emphasized that safety should be viewed as an *investment*, not a cost. Seeking out strategies that will produce measurable results in both safety and productivity will make it easier to sell managers on safety initiatives. Dr. Eiff concluded with a powerful question: "What is the price of doing nothing?" Continuing the discussion on safety investment, Dr. John Lewko, Director, Centre for Research in Human Development, Laurentian University, demonstrated that the full costs of safety initiatives *can* be measured. Through the logic of total process costing, a comprehensive picture of all activities and costs associated with a safety feature can be generated and evaluated by managers.

Other speakers at CASS 2001 included Günter Matschnigg, Vice President, Operations and Infrastructure, International Air Transport Association (IATA), who spoke about managing safety in operations; Captain Ron Clark, Vice-President, Corporate Safety and Environment, Air Canada, who spoke about safety performance measurements; and Dr. Jan Davies, Professor of Anesthetics, University of Calgary Medical School, who pointed out that lessons can be learned from the human/machine interaction in both an operating room and a flight deck. These speakers presented unique perspectives on safety management, each of them touching upon the theme of a *safety culture* and its necessary existence in aviation organizations.

Implementing SMS is a key aspect of Transport Canada's Flight 2005 framework. The goal of CASS 2001 was to provide participants with not only a better understanding of what an SMS is and how an SMS fits into Flight 2005, but also to provide them with specific and usable strategies to incorporate SMS into their companies. Participant feedback of CASS 2001 indicated that Transport Canada is looking forward and taking steps to ensure Canada's civil aviation program maintains its stature as one of the safest in the world.

CASS 2002 will be held March 18–20, 2002, in beautiful Calgary, Alberta, at the Westin Calgary hotel—watch for further information in an upcoming newsletter. △

Safe Flight Begins on the Ground

Article originally published in "Aviation Safety Letter" Issue 4/92

The most vital and indispensable step toward a safe flight is your pre-flight inspection. The only investment a pilot makes in an efficient and thorough pre-flight is time but considering the alternatives it pays dividends like no other investment. Why is it so vital? After all, the aircraft was working tine when you last flew it. It's vital because every year pilots come to grief by cutting short their pre-flight and not taking the extra care that the inspection deserves. The temptation to take shortcuts may be even stronger when the aircraft is coming out of maintenance because, after all, it has just been checked, repaired, or over-hauled. However, the list of accidents (involving doors opening in flight, water contaminated fuel, loose fuel/oil lines, the unbriefed passengers, no fuel, magneto switches left on, gust locks not removed) goes on and on and on.

The specifics of a pre-flight inspection may vary from aircraft to aircraft, but the basics are the same, starting with the cockpit and followed by a careful walkaround using the appropriate checklist. The aircraft's checklist, found in the Aircraft Flight Manual or the Pilot's Operating Handbook, contains the specifics for your aircraft. The Checklist shows you what to look at but, more importantly, it should tell you what to look for. We are not going to provide a detailed pre-flight guide in the following paragraphs to replace your checklist but a reminder that some critical items might have slipped out of your routine.

The pre-flight check should begin with the aircraft documentation, in particular the Journey Log. The walkaround must start with a pre-external cockpit check to ensure it's safe to complete the external. Your pre-flight cannot be considered complete when you get in and close the door. The taxi check, engine run-up and pre-takeoff checks are really part of the pre-flight inspection and should be done with the same thoroughness.

Last but not least, as part of your pre-flight checks, brief the passengers. The outcome of many an accident has been decided by the post-accident action taken or not taken by the passengers (include the need for cockpit discipline if one of your passengers is sharing the pointy end with you).

Most of the time, the pre-flight inspection is dull, and monotonous. After all, the aircraft usually works as advertised. But, for those few times when it doesn't, it's a lot easier to troubleshoot and fix it on the ground. Consider it a free safety check conducted by someone you can truly trust, YOU.

And if you are one of the vast majority of pilots who are normally careful and thorough in completing your pre-flight, remember Murphy's Law and read the following story.

Inadequate Pre-Flight Inspections—The age-old problem discussed on this article is highlighted by these selected accident investigations completed by the TSB. In September 1988, a Britten-Norman BN-2A Islander climbed steeply after takeoff, stalled and crashed by the side of the runway. One passenger died, and the pilot and other passenger were seriously injured by the impact and post-crash fire that destroyed the aircraft. Investigation revealed that the external elevator control lock was still in place, and the pilot had never made a check for the movement of the controls, either externally or internally.

In the same year, a Cessna 172N crashed after a loss of power due to fuel starvation, and the aircraft was badly damaged. The pilot had not checked the quantity of fuel during the pre-flight inspection.

In 1991, an Otter pilot, while on approach to Darontal Lake, Quebec, selected the tank with the most fuel. At 400 feet agl, the engine stopped and the aircraft was structurally damaged in the resulting hard landing on the lake. When the aircraft was inspected, at least one half gallon of water was drained from the tank that the pilot had selected.

In 1992, an A-2 Aircoupe pilot was hand-propping the engine, when the engine started and the aircraft accelerated across the tarmac. Fortunately, its progress was stopped by a snow bank without causing any injuries but the aircraft suffered substantial damage.

There is certainly nothing unique about these incidents. Simple counter measures, such as paying attention to the details, and treating every pre-flight as life-saving, will go a long way to preventing accidents. △

Know Your RASOs—Bernard Maugis and Guy Lapierre, Quebec

Bernard Maugis (left) and Guy Lapierre.

Before becoming involved in aviation, Bernard Maugis was trained as a professional photographer in Paris. He discovered helicopters during a film shooting in the Amazon. In 1975, Mr. Maugis registered at the flying school in Cartierville, and over the years he has flown approximately 10,000 flight hours in Africa, Canada and Europe. In Sept. 1999, the Transport Canada System Safety Branch in Montreal offered him a position, which he accepted, believing that his experience could contribute to aviation safety.

Guy Lapierre began his career as a pilot in May 1966 in the Quebec City region. He acquired experience on aircraft with floats and skis, and he acted as a flight instructor before taking on a career as an airline pilot in 1973. Among the long list of aircraft that Mr. Lapierre has flown are the DHC-6 Twin Otter, the Boeing 737 and the ATR-42. Mr. Lapierre joined Transport Canada in October 2000.

Mr. Maugis and Mr. Lapierre will work together with all stakeholders from the aviation industry, and they are looking forward to hearing your safety-related questions or comments. You can reach them at (514) 633-3249. △

Runway Incursions

by Bryce Fisher, Manager, Safety Education and Promotion, Safety Services

Some things happen in waves with peaks and troughs, resulting in a pattern that is repeated over and over again in time. Some safety issues, it seems, display similar characteristics. Take runway incursions. At one point, their number reached an alarming level—a peak. Studies were conducted and changes, such as the readback of hold-short instructions issued by air traffic controllers, were institutionalized. These changes resulted in a reduction of runway incursions to a better level—a trough. Now it seems another wave, perhaps larger than previous ones, is looming on the horizon.

In 1999, both Transport Canada and NAV CANADA noted a rise in the number of runway incursions at Canadian airports. Each commissioned studies to analyze the phenomenon, confirm the trend, identify contributing factors and make recommendations for their redress. (An article from NAV CANADA on runway incursions will appear in the next issue of ASL.)

The Transport Canada study team found that, from 1996 to 1999, the number of runway incursions reported at Canadian aerodromes increased by 145%. While not included in the report, the figures for 2000 kept rising: 368 incursions were recorded for the year, representing a 40% increase over 1999.

These figures clearly indicate that the number of runway incursions at Canadian aerodromes has increased sharply in recent years and is continuing to do so.

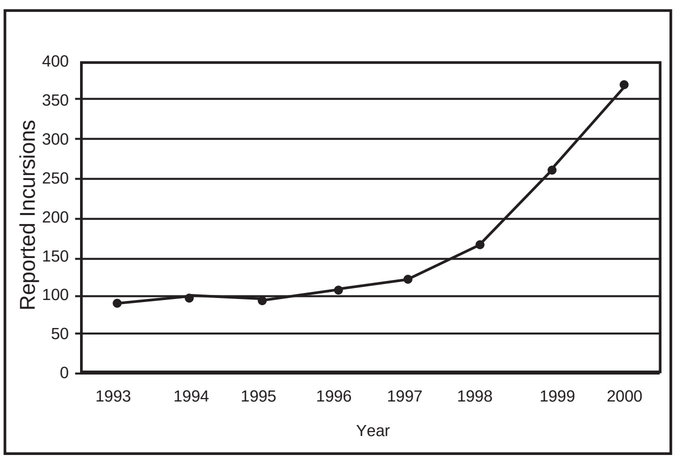

Figure 1

What has contributed to this increase?

According to the Transport Canada report, a number of factors that are potentially responsible for this upward trend include traffic volume, capacity-enhancing procedures, airport layouts, complexity and, not surprisingly, human factors.

Traffic Volume—From 1996 to 1999, the average traffic volume at Canadian aerodromes increased by approximately 9.3%. Some airports have recorded even higher rates of growth, especially at peak hours.

But the Transport Canada study team concluded that the relationship between volume and incursion *potential* is not so simple.

Using a single-runway model, the possible number of runway incursion scenarios can be calculated for a given number of aircraft on the manoeuvring surface.

Number of Aircraft	Number of Incursion Scenarios
1	0
2	1
3	4
4	10
5	24

Table 1*—Runway Incursion Potential, Single-runway Operation*

As shown in Table 1, it becomes immediately apparent that the *potential* for a runway incursion increases more rapidly than traffic volume. For example, a 20% increase in volume (four to five aircraft)—typical of the volume increase since 1996—represents a 140% increase in runway incursion potential.

In keeping with the laws of probability, and in the absence of significantly improved safeguards, an increase in the *potential* for runway incursions can be expected to be associated with an increase in *actual* runway incursion events.

Capacity-enhancing Procedures

To accommodate the increase in traffic, procedures such as parallel runway operations, simultaneous intersecting runway operations (SIRO) or land and hold short operations (LAHSO) and intersection departures were introduced at many airports.

Once the effect of these procedures was computed, it was found that *capacity-enhancing* procedures have a compounding effect on runway incursion potential.

By virtue of their complexity, these procedures offer more ways in which a conflict can develop, as illustrated in Figure 2. Though not shown here, intersection departures and/or a three-runway SIRO will further increase the complexity and create yet more opportunities for a runway incursion.

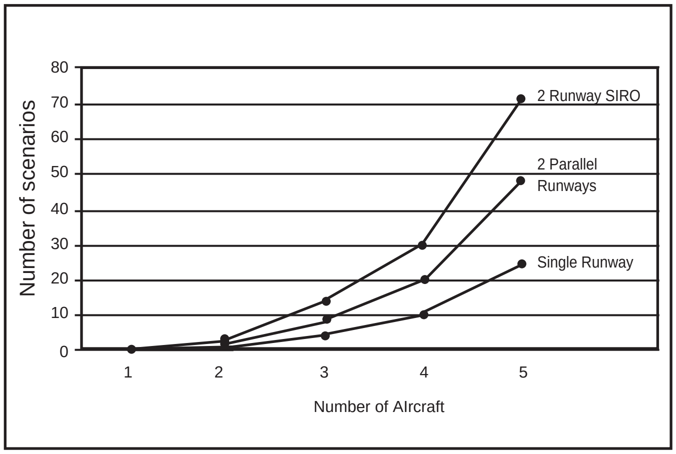

Figure 2

Two conclusions can be drawn from this analysis. First, as traffic volume increases, runway incursion *potential* increases more rapidly when capacity-enhancing procedures are in effect than when they are not. Second, if traffic remains the same, the *potential* for runway incursions increases when capacity-enhancing procedures are put into operation.

Airport Layouts

To absorb current and forecast increases in traffic, many airports have embarked on ambitious projects to improve existing infrastructure. But in many instances, these have resulted in a yet more complex aerodrome environment. This, the study team concluded, is further exacerbated by inadequate aerodrome design, marking and lighting standards; the lack of standard taxi routes; and the availability of improved aerodrome diagrams.

Complexity

The effects of increased traffic volume, capacity-enhancing procedures and physical layout may simultaneously exacerbate the runway incursion potential at a particular aerodrome.

There is some evidence to suggest, however, that the combined influence of these factors—the overall *complexity*—is greater than the sum of its parts. It is typically against a backdrop of high complexity that *second-order effects*, such as reduced visibility, unfamiliarity or momentary distraction, become the last link in the chain of events that could lead to a runway incursion.

Human Performance

While traffic volume, capacity-enhancing procedures and aerodrome layout may increase the *potential* for a runway incursion, *human error* is the mechanism that translates this potential into an actual occurrence.

Complexity, lack of familiarity with airport layout, communications difficulties, distractions and other factors all contribute to making flight crew and air traffic controllers more vulnerable to committing errors.

Is There Hope?

The Transport Canada study team made 23 recommendations to reduce the frequency of runway incursions. NAV CANADA also conducted a study to identify actions the industry could take to prevent runway incursions. Its study generated 27 recommendations.

Many of the recommendations from both reports have been implemented or are being implemented. Some require institutional changes, such as rules and standards, and will take some time to take effect. Others, such as air traffic control procedures, have already been implemented.

The Incursion Prevention Action Team

To oversee the implementation of the common recommendations from both studies, monitor and analyze runway incursions and remedial actions, and develop an awareness program, NAV CANADA and Transport Canada formed the Incursion Prevention Action Team (IPAT).

The aforementioned incursion awareness campaign (of which this article is part) is being designed to inform all sectors of the industry of the hazard of runway incursions and to publicize measures that can be taken to prevent them. Watch for more articles and updates in upcoming issues of the ASL.

In time, it is hoped these efforts will reduce the probability and consequences of runway incursions. Transport Canada's complete report can be viewed or downloaded from < *http://www.tc.gc.ca/aviation/syssafe/runway_incursions/english/index_e.htm* >. NAV CANADA's report can be read or downloaded from its Web site at < *http://www.navcanada.ca/navcanada.asp* >. △

Glider Tow Planes Collide

AP Photo/Emiliano Grillotti

Two L5 glider tow planes lie stuck to one another on the grounds surrounding Rieti airfield in central Italy, Aug. 1, 2001, after they collided while flying over the area. The two pilots survived the crash with minor injuries.

When the Boss Doubles as a Line Pilot

On August 15, 1999, a Eurocopter AS350BA helicopter departed Squamish, British Columbia, for a 30-min sight-seeing tour to a glacier and lake, Lake Lovely Water, in high terrain to the west of the airport. The aircraft became overdue and, after a search that was hampered by low cloud, rain, fog, and darkness, the wreckage was found the next day about three miles west of Squamish Airport. The helicopter struck a rock formation in a steep, narrow ravine in mountainous terrain below the tree line, at about 3800 ft ASL. The aircraft struck the terrain at low speed, broke apart, and fell down the ravine. The pilot and four passengers were fatally injured. This synopsis is based on Transportation Safety Board of Canada (TSB) Final Report A99P0105.

Weather in the local area was being influenced by a cold front with cloud ceilings at 3000 to 5000 ft ASL and frequent precipitation reducing visibility to six miles in light rain and showers. A few ceilings of 800 to 2000 ft ASL, with visibility of two to six miles in rain showers and mist, were also forecast for the period.

A company pilot who had conducted a tour that morning from Squamish Airport in a Cessna 206 airplane reported low clouds in rain with a ceiling of about 800 ft AGL and a light inflow wind at about five knots from the inlet. The pilot recalled the weather to the north was better and some of the mountain ridges were visible. At that time, the accident helicopter was operating to the west of Squamish, but the Cessna pilot was not conducting tours in that area because the weather was not good enough for fixed-wing operations. While in flight, the pilot of the accident helicopter communicated by radio with the Cessna pilot, discussed the weather, and showed some concern about operating the Cessna 206 in the prevailing weather conditions.

The occurrence pilot had flown three flights in the morning and had flown to the glacier each time. However, before the accident flight he indicated that if he could not reach the glacier he would go to Lake Lovely Water. Other helicopter operators in the area cancelled operations that day because of poor weather conditions.

"While the helicopter chief pilot is responsible for . . . supervising flight crews, he is also a subordinate of the operations manager, in this case the accident pilot."

The *Canadian Aviation Regulations* (CARs) stipulate that for visual flight rules (VFR) flight in visual meteorological conditions (VMC) the minimum visibility should be no less than one mile unless authorized otherwise in an air operator certificate (AOC). In all cases, aircraft are to be operated clear of cloud. The company AOC permitted operations in flight visibility of less than 1.0 mi. but not less than 0.5 mi. provided the pilot met the standards set out by TC. The accident pilot did not meet the standards because he had not spent enough time on helicopters.

The accident site was not on the normal or expected route for transit to or from the glacier or Lake Lovely Water, nor were there any apparent tourist attractions in the ravine. Examination of trees in the vicinity of the initial impact area revealed damage consistent with that made by a hovering helicopter. Examination of the wreckage indicated that the main rotor blades were damaged at initial impact from contact with rock, about two feet from the blade tip. The main rotor blades then contacted the helicopter fuselage and trees in that order. There were no signs of any pre-existing mechanical deficiency.

The company was a family-owned business and the accident pilot was the son of the company founder. He was also the operations manager, as well as the chief pilot of the fixed-wing side of the operation. He had a total of about 6800 hr., most of which were fixed-wing aircraft hours. He received a commercial helicopter pilot licence in February 1999 and had 300 hr. on helicopters and 145 hr. on the AS350 type. Standards to the CARs for air taxi helicopter operations require a chief pilot to have at least one year of experience within the preceding three years as pilot-in-command (PIC) of a helicopter. Therefore, he did not meet the requirements to act as chief pilot for the helicopter operation, and a separate helicopter chief pilot had been appointed.

The helicopter chief pilot was not present at the company's base of operations on the days leading up to or on the day of the accident. While the helicopter chief pilot is responsible for the flight crews' professional standards, developing and maintaining standard operating procedures, and supervising flight crews, he is also a subordinate of the operations manager, in this case the accident pilot. Therefore the accident pilot was the supervisor of the operation and, as such, was responsible for operational decisions.

The Safety in Air Taxi Operations (SATOPS) report acknowledged that "many controlled flight into terrain (CFIT) accidents have occurred when the visibility was lower than the minimum allowable and the pilot continued to fly into instrument meteorological conditions (IMC). The decision to continue flight into deteriorating weather conditions may be caused by operational pressures that the air operator or client are imposing on the pilot, because of pressure the pilot is putting on himself, or because flying in marginal VFR conditions, often IMC, has become the accepted way of operating." Considering that the pilot was well aware of the existing marginal VFR weather conditions, it can be safely concluded that some pilots are still pushing the weather.

Enforcement of regulations is only one option available to TC and, increasingly, it has been supplemented with efforts to educate this industry in safe recommended practices. Annual pilot decision-making courses for all pilots and safety officer training for managers and chief pilots are being promoted for air taxi operators. These initiatives are intended to help pilots conducting VFR operations make the right decisions and not continue flight in deteriorating weather, especially when the visibility is lower than VFR minima.

Because the accident pilot was the senior person in the organization, there was little direct supervision of his operational activities. On the day of the occurrence, the pilot had to rely on his own judgment and abilities to assess the safety of operating a helicopter in poor or changing weather conditions versus the operational necessity to complete the mission. While we will never know if the presence of the chief pilot would have affected the outcome of the accident, these events highlight the challenge of hierarchical conundrums in small operations, where the boss often doubles as a relatively inexperienced line pilot. △

Send us Your Stories

In the spirit of sharing our experiences, we would like to print more of your personal aviation experiences for the benefit of others. We therefore encourage you to send us your stories, no matter how incredible they may seem! As usual, we offer anonymity on request. Send your stories in English or French by e-mail (preferred) to marqupj@tc.gc.ca, *by fax at (613) 991-4280, or by mail at: Editor,* Aviation Safety Letter, *Transport Canada, AARQ, Place de Ville, Ottawa, Ontario K1A 0N8.*

From the Investigator's Desk: Underwater Locator Beacons

by Paul Traversy, Transportation Safety Board of Canada, Atlantic Region

On May 10, 2000, a Canadian Coast Guard Bell 212 helicopter crashed while resupplying a lighthouse on Cabot Island, Newfoundland. There were no witnesses to the crash; however, workers on Cabot Island reported spotting wreckage floating not far offshore of the island. The pilot was fatally injured. The investigation into the accident (A00A0076) is ongoing.

Immediately after the accident, the Coast Guard initiated a search for the downed helicopter. The search involved surface ships, underwater remotely operated vehicles (ROV) and a towed magnetometer. Despite the fact that the general location of the accident was known, locating the pilot and helicopter proved difficult. After ten days of searching, the first piece of subsurface wreckage was found, and recovery operations followed. The underwater search was hampered by strong currents, weather, varying water depths, and a rocky ocean bottom; but perhaps the greatest hindrance was the lack of an underwater locating device on the downed helicopter.

The expeditious location of underwater aircraft wreckage is not only important for humanitarian reasons, but it is also usually essential for investigative purposes. Examination of aircraft wreckage is a fundamental part of an accident investigation, and it is particularly important in those accidents where a recorder has not been installed on an aircraft and/or the crew do not survive. Had this helicopter been fitted with an underwater locating device, it is likely that the search would have been greatly expedited.

The installation of an underwater locating device is not dependent upon the level of exposure to over-water operations. Underwater locator beacons are only mandated for aircraft fitted with an on-board flight data recorder and, in certain instances, a cockpit voice recorder. Multi-engined aircraft, including the Bell 212, that can carry more than ten passengers are required to have an on-board recorder. Associated with the recorder is the requirement to have an underwater beacon. However, paragraph 605.33(1)(*c*) of the *Canadian Aviation Regulations* (CARs) provides an exclusion from the recorder requirement for aircraft manufactured before October 12, 1991. Because the accident aircraft was manufactured in 1974, it was exempted from the requirement to carry a recorder. Unfortunately, this also excluded the aircraft from the requirement to carry an underwater beacon.

Since this accident, Transport Canada, Aircraft Services, has begun to install underwater beacons on all helicopters that operate in support of the Coast Guard, regardless of passenger seating capacity. Other carriers with a high level of exposure to over-water operations may also wish to consider the installation of an underwater locator beacon in their non-recorder-equipped aircraft. △

Upcoming Regional Events

The following schedule for upcoming workshops is tentative. Please contact your regional office for exact location and cost.

Atlantic Region

HPIAM November 20–21 Goose Bay, Labrador February 13–14, 2002 Saint John, New Brunswick

For information or to register, please contact Anne McCallum at (506) 851-7110 or e-mail mccalla@tc.gc.ca.

Quebec Region

Skills Review Seminar November Sherbrooke
CASO October 30–31 Montreal
PDM November 21 Montreal (Helicopter PDM) **HPIAM** October 16–17 Quebec City

All Quebec events are in French unless specified. For information or to register, please call (514) 633-3249 or e-mail qcsecursys@tc.gc.ca.

Ontario Region

HPIAM October 17–18 Toronto November 7–8 Thunder Bay December 5–6 Ottawa February 5–6, 2002 Sioux Lookout

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)

No workshops scheduled for this period.

For information, 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 at the Pacific Flying Club, Boundary Bay Airport. (Pre-registration required by e-mailing *pkennedy@pacificflying.com* or by calling (604) 278-9871).

CRM	October 15–16	Richmond	**HPIAM**	October 15–16	Richmond
PDM	October 18	Richmond		October 31–Nov. 1	Richmond
CASO	October 17–18	Richmond		November 28–29	Prince Rupert
				December 12–13	Abbotsford

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

Answers for Self-paced Study Program

1. Stalling speed or minimum steady flight speed in the landing configuration
2. 113.55 litres
3. The pilot has received runway, wind and altimeter information
4. For stopping purposes only in the case of an abandoned takeoff
5. 15 kt or more
6. map; GPS
7. 310° at 36 kt, temperature -7°C
8. 1/4 SM
9. Light rain and fog
10. Vertical visibility 100 ft
11. METAR or SPECI by a qualified human observer
12. Short-term; hazardous weather
13. 200 ft overcast
14. After 1300Z
15. 6+ SM
16. 4; 12; 12
17. A; B; C
18. 2200
19. 3; 1 mi.; 500 ft
20. 1 hr.; 3 hr.
21. In the CFS
22. 25; a VFR flight plan or a VFR flight itinerary
23. The total time to the final destination, including the duration of the intermediate stop
24. Prior to contacting either the ground control or tower on departure, prior to contacting the tower on arrival
25. Does not constitute
26. 5
27. Report intentions prior to moving onto the runway; report departing the aerodrome circuit
28. Maintain a listening watch, report joining the circuit, report on downwind if applicable, report established on final, and report clear of the active runway after landing
29. 121.5
30. Position, altitude and time when the signal was first heard;
    ELT signal strength; position, altitude and time when contact lost; and whether the ELT signal ceased suddenly or faded
31. Ensure the signal is not coming from your own ELT
32. 1 hr.; the SAR time specified or 24 hr. after the duration of the flight or the ETA specified
33. NOTAMs; the CFS
34. The certificate of airworthiness (C of A) is out of force, and the aircraft is not considered to be airworthy.
35. Increase the stall speed
36. *The Pilot's Guide to Medical Human Factors*
37. Slowed reaction time, reduced concentration, and errors of attention

to the letter

Views from a Far Horizon

When does a circuit become a cross-country, or is it vice versa? It's hard to tell sometimes at the Brampton Flying Club. A stranger approaching this field can be forgiven for wondering what is going on.

I can recall my first visit well; my radio was working that day, so I knew what runway was in use, but where was the traffic? Someone reported turning downwind, but I couldn't see him. Peering through vibrating goggles and a bug-spattered windshield, I finally spotted a speck in the hazy summer sky—my goodness, is that him, I wondered. He must be two concessions from the field—have I got the right aircraft? Another aircraft reported turning base. I saw a flash of wings in an abrupt turn; good lad, got him, but he is No. 2—where is No. 1? Ah, there he is, a mile back on final, down in the weeds on a graveyard approach, I thought to myself. Because this is a training field, among other things, one must expect anything.

I have often pondered the question of the cross-country circuit. WHY? It doesn't seem to matter whether there is one aircraft or many in the circuit—it is always too wide. Are they taught this way? Surely this isn't a cunning scheme to extract more flying time per pupil? Or maybe the lads are practising for the day when they will be 747 captains! Maybe they are using ground references, which is not a good idea at any time, but the Snelgrove Water Tower seems like a magnet, so maybe they are.

I know I come from a different era of flying and things always change, but some things are worth keeping. My elementary flying was from a circular grass field. Circuits were tight so that if the engine quit you could always turn into the field, landing always into wind or any space not littered with Tiger Moths doing the same thing. True, circuits were sometimes a shambles with parallel approaches and simultaneous landings, but we didn't use much airspace for the number of aircraft flying. Later, with Harvards, it was easy—at the correct circuit height you just put the wingtip on the runway on downwind and you had the right distance for a proper turn onto base and final.

All of the above brings us to the present and the Brampton Flying Club. Here there is a mixture of different aircraft with different approach requirements. First of all, the high-wing Cessnas, etc., who can see all before and below them and nothing above, don't seem to mind how long the final is, and fly long, stabilized airline approaches. Then we have the fast biplanes and low-wing monoplanes, whose requirements are probably similar to the slow replica fighters at the Great War Flying Museum, all of whose forward and downward visibility ranges from almost NIL to non-existent. They drop like rocks when the power is off and are best flown on a short-curved base and final for visibility and safety.

So here comes our boy in his high-wing Cessna who has turned onto final at the water tower, seeing all ahead below, a nice slow and gentle-powered descent, and he's number one, or so he thinks. Hello, what is this? A scarlet triplane, the Red Baron reincarnated, turned in front; good job he is not behind—the guns might be real! However, the Fokker is down quickly and has cleared the runway. Better speed up your approach, lad, or the other verdammter Deutscher, the Baron's wing man, might nip in front of you as well and really spoil your day!

This is of course fictitious, but next time some visiting biplane or even a local resident cuts you off on your five-mile final, instead of cursing the pilot, just be thankful you are not hearing the rumble of his aircraft engine above you because, believe me, if you can hear another engine above the noise of your own, it is too close and not by intent. The pilots can't see you and you can't see them, and you haven't got long to live unless you do something very quickly.

Jerry Fotheringham,
Caledon East, Ontario

Call for Nominations for the 2002 TC Aviation Safety Award

Do you know someone who deserves to be recognized?

The Transport Canada Aviation Safety Award is presented annually to stimulate awareness of aviation safety in Canada by recognizing persons, groups, companies, organizations, agencies, or departments that have contributed in an exceptional manner to this objective.

You can obtain an information brochure explaining award details from your Regional System Safety Offices or by visiting the following Web site:
< http://www.tc.gc.ca/aviation/syssafe/brochures/tp8816/english/index_e.htm >.

The closing date for nominations for the 2002 award is December 31, 2001. The award will be presented during the fourteenth annual Canadian Aviation Safety Seminar, which will be held in Calgary, Alberta, March 18 to 20, 2002. △

Fuel Exhaustion Leads to Stall

While on final to the Toronto City Centre Airport, the pilot of a Piper Aztec lowered the landing gear, extended full flaps, and slowed the aircraft to 90 kt in order to sequence his aircraft behind a DHC-7. Because he was too close, he applied full power, initiated a go-around and, at the tower controller's suggestion, started a 360° turn to increase the spacing from this traffic. The landing gear and flaps were not retracted. During the left turn, the left engine quit and the propeller stopped turning. The pilot noted that the airspeed was low and that he was descending, so he maintained full power on the right engine and decided to ditch the aircraft into the Toronto Harbour. The pilot, uninjured, exited the aircraft before it submerged and was rescued by members of the Toronto Police Marine Unit. This synopsis is based on the Transportation Safety Board of Canada Final Report A98O0313.

The pilot had 355 hr. of flying time, approximately 40 hr. on multi-engine aircraft, 35 of which were on Piper Aztecs. His last multi-engine aircraft flight was three months before the occurrence in the same aircraft. The pilot reported that before his flight from Toronto City Centre Airport to Centralia and back, the inboard fuel tanks were approximately half full and the outboard fuel tanks appeared to be full. He did not fuel the aircraft before departing. When full, the aircraft's inboard tanks had a combined capacity of 260 L of useable fuel, while the outboard tanks had a combined capacity of 411 L of useable fuel. The pilot performed the engine run-ups, takeoff, and flight to Centralia with the outboard tanks selected, and he stated that he logged 1.2 hr. total for the flight. The return flight from Centralia was flown with the inboard tanks selected; the flying time was approximately one hour.

The pilot reported using a power setting of 24 in. of manifold pressure and 2400 rpm for his cruise power setting throughout the flight to Centralia and the return flight. The *Piper Aztec Manual* indicates that the combined fuel consumption at that power setting is approximately 115 L per hour, under ideal conditions.

The critical engine for an aircraft is defined as the engine whose failure would most adversely affect the performance or handling qualities of an aircraft. For the Aztec, the critical engine is the left engine because the right engine produces more asymmetrical thrust. The loss of the hydraulic system with the left-engine failure further complicates operation of the aircraft, especially with the landing gear and flaps extended, because hydraulic power is not available to quickly retract the landing gear and wing flaps.

Minimum control airspeed (V_{mc}) is defined as the lowest indicated airspeed at which the airplane can always be flown safely after the failure of the critical engine. In the case of the PA-23-250 Aztec aircraft with the flaps retracted, V_{mc} is 70 kt at the maximum gross weight of 5200 lb. Stalling speed for the same aircraft is 61 kt with the landing gear and flaps extended and wings level; however, the stalling speed of an aircraft in a turn is increased in proportion to the angle of bank. For level turns using 30° and 45° of bank, the stall speeds would be approximately 63 kt and 70 kt respectively. The Aztec is equipped with an audible stall warning horn to warn the pilot of an approaching stall. Before descending to the water, the pilot transmitted to the tower that he had experienced an engine failure and was ditching the aircraft. The aircraft's stall warning horn was heard in the background during the transmission.

The aircraft was recovered and examined by the TSB, and no pre-impact mechanical discrepancies were identified with the engines or any of the aircraft's systems. Both fuel selectors were selected to the inboard tanks. The left wing-tip fuel tank separated from the aircraft on impact, and the left fuel cells contained only water. The fuel system on the right side was not compromised, and the inboard tank contained approximately 150 mL of fuel, which was drained from the tank. The right outboard tank contained a considerable amount of fuel and, using the aircraft's cross-feed system, the fuel from the right outboard tank was fed to the left engine. The engine was started and run for approximately 15 min before the fuel was exhausted.

The TSB determined that the left engine quit during the left turn because of fuel exhaustion and the propeller stopped turning because there was insufficient airspeed to keep it windmilling. Because the hydraulic pump is installed on the left engine, it was not operating after the engine stopped turning, and the pilot was unable to retract the landing gear and flaps. This contributed to the airspeed decreasing quickly. With the airspeed below V_{mc}, the power from the right engine steepened the aircraft's turn, and the aircraft stalled. There was insufficient altitude to recover from the stall before the aircraft struck the water. The slow speed of the aircraft and the pilot's shoulder and lap restraints probably contributed to the survivability of the impact. △

Transport Canada
Flight Crew Recency Requirements,
Self-Paced Study Program

Refer to para. 421.05(2)(*d*) of the *Canadian Aviation Regulations* (CARs).

*This self-paced study questionnaire is for use from October 4, 2001, to October 3, 2002. When completed, it meets the 24-month recurrent training requirements of CAR 401.05(2)(*a*). It is to be retained by the pilot.*

Note: *The answers may be found in the* A.I.P. Canada *or in the* Canada Flight Supplement *(CFS); references are at the end of the questions. Amendments to these publications may result in changes to answers, references, or both.*

1. Define V_{SO}. ____________________ (GEN 1.9.1)
2. Convert 30 U.S. gallons to litres. ____________ (GEN 1.9.2)
3. When communicating with air traffic control (ATC) or a flight service station (FSS), what is the meaning of the expression "Have numbers"? ____________________ (GEN 5.1)
4. Under what circumstances may a stopway marked with yellow chevrons be used by an aircraft? ____________________ (AGA 3.5, 5.4.3)
5. At a Transport Canada–certified airport, a dry wind direction indicator (windsock) that is horizontal means a wind speed of ____________________. (AGA 5.9)
6. When navigating under visual flight rules (VFR), the ____________ remains the primary tool, not the ____________. (COM 3.16.10)

FDCN CWAO 091920

6000	9000	12000
3123-01	3130-04	3142-10

7. Using the above forecast of winds and temperatures aloft (FD), interpolate the upper level wind and temperature forecast for 10,500 ft. ____________________ (MET 3.11)

METAR CCA SPECI CYJT 041121Z CCA 23011KT 1/4SM R27/2800FT -RA FG VV001 RMK FG8=

8. What is the visibility in the CYJT special? ____________________ (MET 3.15.3)
9. What is the weather being reported at CYJT? ____________________ (MET 3.15.3)
10. Decode *VV001* from the CYJT special. ____________________ (MET 3.15.3)
11. In the event of a discrepancy between the ceiling or visibility observed by an automated weather observation system (AWOS) and that observed by a human observer, what is the highest order of priority for aircraft operations? ____________________ (MET 3.15.5, page 3-38, Note 2)
12. SIGMETs are intended to provide ____________________warnings of certain potentially ____________________phenomena. (MET 3.18)

TAF CYJT 041136Z 041212 24010KT 1/2 SM -SHRA -DZ FG OVC002 TEMPO 1213 3SM BR OVC 008 FM 1300Z 29012G22KT P6SM SCT 006 BKN 015 BECMG 2224 30010KT SCT 020 RMK NXT FCST BY 18Z=

13. What is the lowest forecast ceiling for CYJT? ____________________ (MET 3.9.3)
14. At what time period could you first expect to have VFR weather conditions at CYJT? ____________________ (MET 3.9.3)
15. After 1300Z, what is the forecast visibility at CYJT? ____________________ (MET 3.9.3)
16. Graphic area forecasts (GFA) are issued ____ times per day and cover a ____ hour period, with an instrument flight rules (IFR) outlook for ______ hours further. (MET 3.3.2)
17. What classes of airspace require the use of a functioning transponder? ____, ____, and ____. (RAC 1.10.2)
18. Low level airways are controlled low level airspace that extend upward from __________ ft AGL up to but not including 18,000 ft ASL. (RAC 2.7.1)

19. In controlled airspace, the minimum VFR flight visibility is _____ mi., and the minimum distance from cloud is ______ horizontally and ______ vertically. (RAC 2.7.3)

20. When using a GFA to determine weather for a VFR over-the-top (VFR OTT) flight, the destination weather must be suitable from _______ before to ________ after the estimated time of arrival (ETA). (RAC 2.7.4(e)(ii))

21. Where is the toll-free number of the nearest FSS listed? ______________________________ (RAC 3.4.1.)

22. Except when operating within _____ NM of the departure aerodrome, no pilot-in-command shall operate an aircraft in VFR flight unless ____ has been filed. (RAC 3.6.1)

23. When filing a flight plan with an intermediate stop, the total elapsed time to be entered on the flight plan is ____ ____. (RAC 3.10)

24. If automatic terminal information service (ATIS) broadcasts are available, when should they be accessed? ____ ____ (RAC 4.2, RAC 4.4)

25. An AWOS Voice Generator Module (VGM) broadcast at some remote airports ____________________ an official weather observation (METAR or SPECI). (RAC 4.5.1)

26. Where possible, pilots are required to report at least ________ minutes prior to entering a mandatory frequency (MF) or an aerodrome traffic frequency (ATF) area. (RAC 4.5.7)

27. What two radio transmissions are mandatory when departing from an uncontrolled aerodrome within an ATF area? ___________________________; and _______________________________________. (RAC 4.5.7)

28. In addition to reporting aircraft position, what action should a pilot take when arriving at an uncontrolled aerodrome with an MF or ATF?____ ____ ____ (RAC 4.5.7(a)(iii))

29. Pilots receiving a missing aircraft notice (MANOT) message are requested to maintain a radio watch on _______ MHz when operating in the vicinity of the missing aircraft's planned track. (SAR 2.3)

30. When an emergency locator transmitter (ELT) signal is heard in flight, the nearest ATC unit should be advised of what information? ______________________________________, _________________________, __________________________________, and____. (SAR 3.4)

31. If an ELT signal is heard in flight and remains constant, you should ______________________________ ____. (SAR 3.4)

32. If you have landed short of your destination for reasons other than an emergency and you are unable to advise ATC of your situation, a search will be initiated after _______ in the case of a flight plan or, in the case of a flight itinerary, ____ ____. (SAR 3.5)

33. Updates to the current VFR navigation charts (VNC) are first published in ________________________ and subsequently in ______________________. (MAP 2.4)

34. What is the consequence of not complying with an airworthiness directive (AD)? ____________________ ____.(LRA 2.7.1)

35. How is frost on the wings likely to affect the stalling speed of an aircraft? ____(AIR 2.12.2)

36. What reference is quoted in the AIR section of the A.I.P. to provide pilots information on the risks associated with flight operations at night? ____ (AIR 2.16)

37. List three likely effects you could expect if you were to fly while fatigued. _________________________ ____ (AIR 3.10)

Signature ____ Date ________________________