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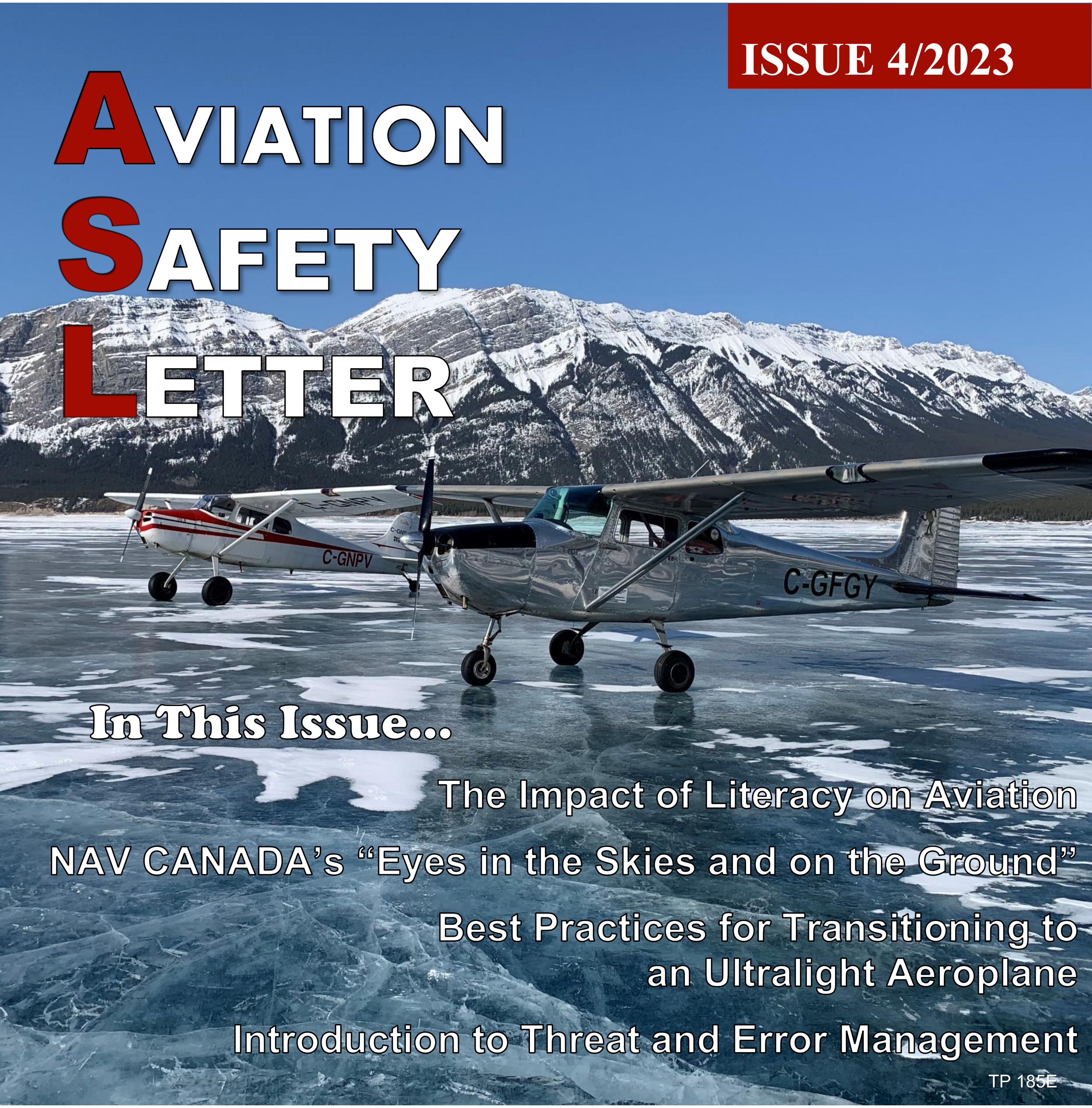

ISSUE 4/2023

AVIATION SAFETY LETTER

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TP 185E

Cover photo submitted by Robert Jaap

Canada

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INSTRUCTOR'S CORNER

The Impact of Literacy on Aviation

by Daniel Gustin, Chief Instructor at Canadian Flight Trainers*, a modern online ground school dedicated to providing positive learning experiences and solutions for flight schools, private pilots, commercial pilots and flight instructors. Daniel is also a scholar of aviation education with experience as an aerobatic instructor, airline pilot and simulator instructor*

Whether we consciously think about it or not, literacy plays an important role in a pilot's life. When you first think of literacy, you likely think about reading sentences and writing out the alphabet. While literacy skills do involve that, the discussion goes much deeper. In a classical sense, literacy is the ability to interpret text, but more broadly, literacy is a function of understanding languages and communications.

Novel media, like video, podcasts and texts from various sources, help us prepare for our flights, make sound decisions during our flights, and help us post-flight as we reflect on our overall performance. For example, pilots will use graphical images from graphic area forecasts (GFAs) or other weather products when making decisions about flight safety; student pilots may refer to online ground school videos for explanations on turbine engines; airline instructors may supplement simulator training with interactive FMS apps; or a pilot flying instrument flight rules (IFR) will brief their area navigation (RNAV) approach using the chart on their tablet. Although each of these leverage very different media platforms, they all involve literacy-related skills which challenge us to break down and use what is being communicated to us.

SMOKE / FUMES / AVNCS SMOKE

Applicable to:

LAND ASAP

IF PERCEPTIBLE SMOKE / FUMES APPLY IMMEDIATELY:

CREW OXY MASKS (if required).... USE/100%/EMERG
VENTILATION BLOWER.................................... OVRD
VENTILATION EXTRACT.................................... OVRD
CAB FANS.. OFF
GALY & CAB... OFF
SIGNS.. ON
CKPT / CAB COM.................................... ESTABLISH

- **If smoke/fumes source immediately obvious, accessible, and extinguishable:**

Figure 1: Smoke/Fumes/Avionics smoke, check list

Part of literacy is understanding the origins, design and intent of literature/media which is presented to us. The size of the lettering is intentionally larger in this checklist in the event the cockpit is filled with smoke. This procedure also helps pilots isolate systems one by one to determine the smoke's origin. However, not all media, policies or procedures are as well-intentioned as this checklist.

Credit: Daniel Gustin

Figure 2: Image of an Airbus 320 cockpit

This photo from an airline's SOPs illustrates how literature defines the roles in the cockpit of an Airbus A320. In other instances, literature can also create different classes within a company, introduce hierarchies, define power dynamics and create social practices.

Credit: Daniel Gustin

In our highly regulated environment, we are required to read, interpret and appropriately apply many forms of literature prior to and during a flight. Some of these forms of literature are the *Canadian Aviation Regulations* (CARs), your company's standard operating procedures (SOPs), a flight school's operations manual, a Maintenance Control Manual or even a uniform policy. These examples have the power to dictate and control how a pilot executes their desired flight. Our policies, regulations and SOPs construct and control the environment you fly in. This may sound very scary, but it certainly does not have to be. Let's look at a few made up examples together.

The CARs state that you cannot fly over built-up areas at less than 1 000 ft above ground level. Keeping this regulation in mind, a pilot may opt to fly another route for their flight, which may be slightly longer but will be ultimately safer for them. Meanwhile, in Winnipeg, a student presents themselves to the flight school and expresses their interest in going for a flight. The weather is below the flight school minima, so the flight instructor decides to conduct instrument training in the simulator instead. The pilots are spared the wintery conditions of Manitoba, but they can still make progress with the student's training.

Policies and literature can protect and guide us as they did in these two examples. But they can also have unintended consequences in an organization. Take, for example, an air operator whose SOPs state that only captains are allowed to make announcements to the passengers. Such a written procedure may devalue the first officer, cause captain upgrade training to be more difficult and reinforce a more vertical hierarchy in the cockpit. Elsewhere in a large aviation college, students are afraid to speak up against oppressive policies which severely restrict their freedom, because they fear having a target put on their backs. Because of the nature of their flying program, students are afraid to explore, make mistakes and be assertive for what they may feel is right.

Literacy is more than just words and pictures. It constructs our society, our flight schools, our flight operations and our air operators. It differentiates a first officer from a captain, a flight instructor from a student and an airline pilot from a private pilot. Your ability to be literate in your role as a chief flight instructor, a chief pilot, a student pilot, etc. impacts your ability to carry out your duties. Pilots who are more aware of the laws, the social constructs of their organizations and the literature which guides them have a broader skill set, better decision-making abilities and a deeper understanding of aviation principles and safety.

To reflect on this, I ask you to spend some time thinking about a few points:

- How do you incorporate literacy into your teachings?
- Think of a school or company policy you are familiar with and brainstorm the unintended consequences of that policy.
- How good are you at finding information that is relevant to your role as a pilot?
- Are you aware of any policies that introduce different power dynamics or classes within your organization? What role do you play in that? △

Submission of Instructor's Corner Articles

The purpose of the ASL instructor's corner is for instructors to share past instructing/teaching experience with the ASL readership.

Submitted articles can be addressed to a variety of readers, instructors, student pilots, private pilots, and glider, ultralight or commercial pilots. In fact, this issues's article is for any type of student that an instructor may encounter in the course of their career, whether it be for a licence or a rating. The most important thing is that, at the end of the article, a lesson has been learned.

Your submissions can be as basic as attitude and movement for private pilot training, to night rating, multi-IFR or seaplane rating, teaching tips for instructors. It can also be tips to increase aviation safety or to be better prepared for a flight.

It's up to you, as long as you have your instructor's hat when you're writing your piece.

If you would like to submit an article or would like more information, please send an email to the following address: jim.mulligan@tc.gc.ca △

NAV CANADA’s “Eyes in the Skies & on the Ground”

by James Kerwin, Unit Operations Specialist, Langley Tower, NAV CANADA

NAV CANADA distinguishes between “the big four” instrument flight rules (IFR) control towers, which are Toronto (YYZ), Vancouver (YVR), Calgary (YYC) and Montreal (YUL), and “the rest” of the visual flight rules (VFR) towers. Many people do not realize that these smaller towers offer tours of their facilities, which is an invaluable way for pilots to gain a new perspective on operations at their home airports. Seeing the operation from both sides of the mic benefits local and general understanding of the airspace and airport. That understanding is vital for the safety of the aviation system.

Flight safety is key, and in our business, communication is king

Flight schools should encourage their students to try a tour of the local tower early in their flight training and to bring their instructors along. Seeing the tower operation in person gives the student pilots the ability to meet the typically friendly airport controllers and to see the operations from the tower's perspective. We are people and not just a voice on the radio. A little familiarity can reduce the anxiety of student pilots when they are doing their first few radio transmissions. Less anxiety leaves more brain power available to focus on important things, like flying the aircraft. Additionally, controllers gain from meeting pilots. It is beneficial when they hear the pilot’s experiences, especially the controllers who have never flown an aircraft. It is harder for controllers to understand the pilot’s perspective if they have never flown themselves. They learn the impact their clearances and instructions can have. On the other hand, some air traffic controllers are also pilots, and it is easy for them to forget what it is like in the cockpit versus in the tower. With that said, giving pilots and controllers an opportunity to discuss procedures and to ask each other questions reduces confusion and enhances understanding, which ultimately increases flight safety.

Control zones

Airspace immediately surrounding or adjacent to a control zone can be a grey area for pilots. It feels like “no man’s land.” However, the important thing is that pilots contact the tower in a timely manner when they are looking to enter the control zone. This gives the controller time to talk to the pilot and figure out where the pilot is and what their intentions are. This, in turn, allows the controller to make a plan that includes the pilot.

Some airspace in Canada is very condensed, and there are a lot of different frequencies being used in a very small geographical area. For example, there are six Class C (control zones) within 25 nautical miles of the Greater Vancouver Area, and even more Class F (advisory areas), and each of these has different frequencies.

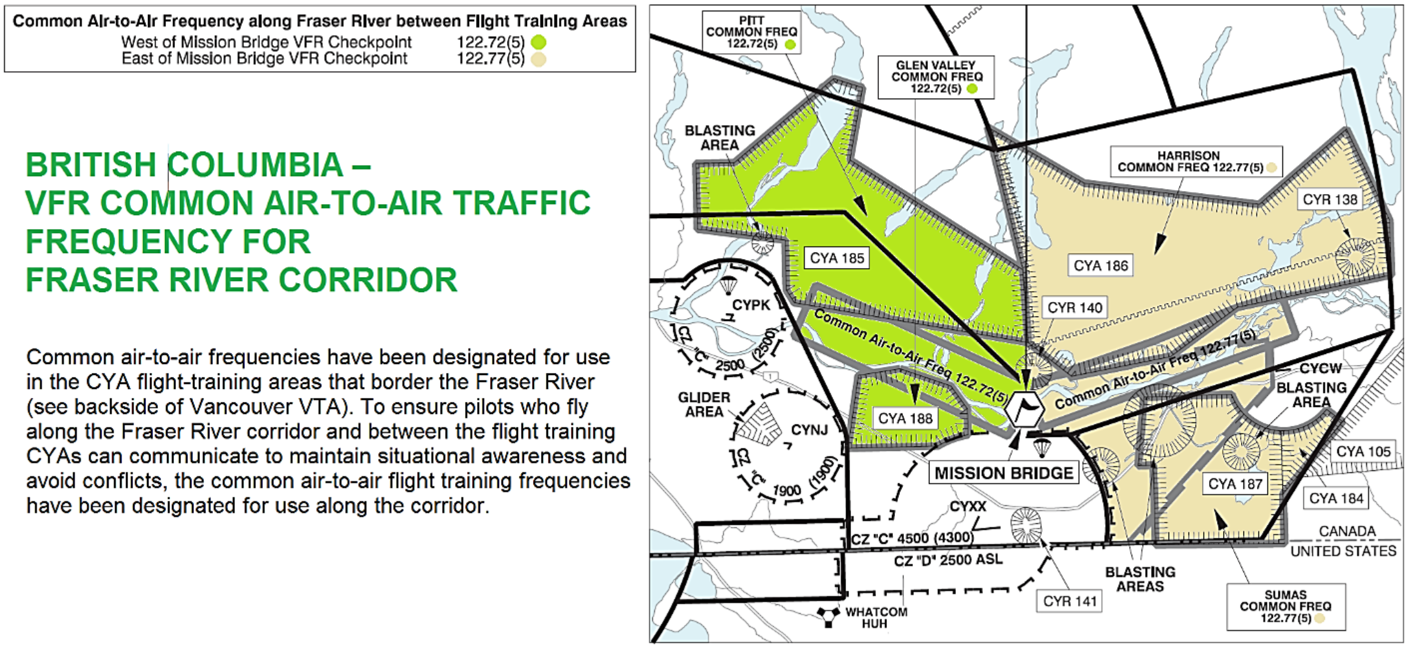

Figure 1: example of the eastern side of the Fraser Valley

See the image (Figure 1) for an example of the eastern side of the Fraser Valley. Keep in mind that the west side of the valley not shown contains the Vancouver, Boundary Bay and Vancouver Harbour towers.

The airspace between the control zones can often be just as busy as the control zones themselves. These tend to be the areas where flight schools' visits to the tower shine, as their instructors will be able to pass along the local expertise at an early stage. For general aviation (GA) pilots who learned to fly in a different region, the challenge is greater. GA pilots will have to study the VFR terminal areas (VTAs) and VFR navigation charts (VNCs) closely and hopefully supplement their knowledge with their visit to their "home tower."

Airport controllers will show what they see out the window and on the situational display (radar screen). They also tell pilots some of the best practices to help navigate through congested airspace. In the Greater Vancouver Area, if a pilot calls two or three nautical miles away, they might be in the wrong control zone, in a Class F practice area or on a different frequency than all the other pilots in their vicinity. The call up location is a fine line because if they call too late, they might accidentally enter a control zone or be in a direct conflict with traffic leaving that control zone. If they call too early, a pilot may miss important traffic information in the immediate vicinity. It is always preferrable for pilots to call early if they are in doubt and to let the controller know that they are unfamiliar with the area. If they have done their due diligence studying the local charts, they will be fine, but they should never hesitate to ask for additional assistance and guidance. Most importantly, if they are unsure of where they are, they should let the controller know.

Phraseology guides

NAV CANADA has published a VFR phraseology guide that is available as a PDF, which can be found on their Website. The guide is meant for general purposes and doesn't include all the useful tidbits you would get from stepping foot into the tower cab. Some of the tips you will get on a tower visit include but are not limited to:

1. The difference between "say again" and "I don't understand": There is a difference between not hearing what the controller said and not understanding what the controller said.
2. If a pilot is lost or unsure, they should let the controller know. If the controller knows that they are unfamiliar, they will have different clearances and instructions to help them gain situational awareness.
3. Pilots are NAV CANADA's customers; we have their best interests in mind and work to give them what they want, but it's a delicate balance with what everyone else wants, too. Controllers prioritize requests based on two general principles: 1) first come first served, and 2) least average delay to the system.
4. Pilots should keep the local control tower phone numbers saved in their phone in the event they experience a NORDO situation. A tower can give a clearance to enter the control zone and land over the phone. This is usually simpler and safer than flying a full NORDO approach procedure.
5. If we pass traffic information to two aircraft and one pilot reports the other in sight, it becomes that pilot's responsibility to maintain separation from the other aircraft. Of course, if the situation isn't clear, don't guess; tell the controller and get clarification.

Not an aviator? There is something for you too!

Lastly, tower tours are not just for aviators or aviation enthusiasts. We welcome everyone to see what we are all about. Not many people get to see what air traffic controllers do and how they interact with aircraft. The experience can be very memorable, especially for kids and teens. NAV CANADA is hiring, and the more people that are exposed to what we do, the better it is for us now and for the future.

Unfortunately, not all towers can accommodate tours due to available staffing, training in the tower cab, or the facility location may preclude tours entirely. Each tower has a different operation and flow of traffic. However, there may be other towers and flight service stations in the area that can accommodate a tour.

To set up a tower tour, email NAV CANADA's customer service at service@navcanada.ca to arrange a date and time for the tour. Hope to see you soon!△

REGULATIONS AND YOU

Transport Canada documents published recently

Document number (R-Revised)	Issue number (Date issued)	Subject
AC 803-001	Issue 14 2024-01-01	Transport Canada Publication TP308/GPH209—Change 9.0 Criteria for the Development of Instrument Procedures
AC 705-012	Issue 01 2023-11-10	Stowage of Disposable In-flight Service Waste in Aircraft Lavatories
AC 549-001	Issue 01 2023-10-01	Amateur-built Aircraft Fuel Systems
AC 605-006	Issue 01 2023-09-30	Pre-approved Aircraft Maintenance Schedule Tolerance
CASA 2023-06	Issue 01 2023-11-24	Potential Risk of Interference of 5G Signals on Radio Altimeter
CASA 2023-05	Issue 01 2023-10-19	Suspected Unapproved Parts Distributed by AOG Technics Limited
CASA 2023-04	Issue 01 2023-09-29	Suspected Unapproved Parts from a Bell Helicopter Textron Model 206B, Aircraft Registration N536T, Serial Number 3195

TIPS AND TOOLS

Best practices for transitioning to an ultralight aeroplane

by Gordon Dyck, Director of UPAC and member of the Ultralight Working Group

The lack of transition training has been cited as a factor in many aviation accidents. These accidents often result from pilots being unprepared for the challenges of flying new or different aircraft than they're used to. Some pilots may believe that training isn't needed, because ultralight planes seem so simple.

If you've decided to start flying ultralights, this article includes information that will help you become a safe and competent ultralight pilot, regardless of what planes you're used to.

In this article:

What is "transition training"?

The goal of transition training is for you to become comfortable in a different aircraft so that your reactions are automatic. In an emergency, you may not have the time to think about what to do. It's important you get to know your ultralight before you fly, in case things go wrong. This way, you'll be able to react quickly.

Ultralight aeroplanes—the lighter side of flying

In Canada, all ultralights need to be registered. Canadian ultralights may be registered as either a **basic ultralight aeroplane** or an **advanced ultralight aeroplane.** Although not all ultralights can be registered as advanced ultralights, in some cases, the same model of plane could be registered as either a basic or an advanced ultralight aeroplane.

Ultralights are powered aeroplanes and have 1 to 2 seats. In addition to being registered, they must be insured. You need an ultralight aeroplane pilot permit or some other aeroplane pilot permit or licence to fly one. They can only be used for daytime visual flight rules (VFR) flying.

Basic ultralight aeroplane (BULA)

- Max take-off weight 1 200 lbs
- Max stall speed of 39 kts (45 mph) indicated air speed
- No min useful load requirement
- No regulatory requirements for construction or manufacturing
- Maintained by their owner
- Anyone in the plane must wear a helmet
- No passengers allowed—only instructor and student or 2 licenced aeroplane pilots

Advanced ultralight aeroplane (AULA)

These are ultralights that meet the Light Aircraft Manufacturers Association of Canada (LAMAC) design standards (LAMAC DS 10141).

- Max take-off weight of 1 232 lbs
- Min useful load
- Kits or complete planes from manufacture
- Maintenance by owner as per manufacturer guidelines
- Helmets not required, but are strongly recommended
- Passengers allowed as long as the pilot has a license, permit or rating that allows passengers

How are ultralights mechanically different?

Before you fly that new ultralight, you need to understand and mentally prepare to fly the aircraft you're about to transition to.

Construction

There's no international certification standard for ultralights. Basic ultralights don't have to meet any material or construction standards and don't need to get a "fit for flight" status. Transport Canada strongly recommends that basic ultralight manufacturers use accepted design criteria, materials and practices.

Advanced ultralights do need to meet the LAMAC's design standards and appear on Transport Canada's list of accepted aircraft.

Engines

You should understand the limits of and how to use your ultralight's engine. Many ultralights use two-stroke engines. These are less mechanically reliable than four-stroke engines and need more attention to keep running properly.

Two-stroke engines are lighter and have a greater power-to-weight ratio. Most pilots will know the typical horizontally opposed, air-cooled engines. Ultralights usually have newer engines with new features and technology, including:

- liquid vs. air-cooled mode,
- geared drives, and
- electronic ignition

Some ultralights use converted car engines, like a Volkswagen (VW) engine or a half VW engine. Some have electric motors, like the Icaro2000 and the Pipistrel Velis Electro.

Credit: Gord Dyck
Pipistrel Sinus Aircraft

Technology

The technology used on ultralights can vary greatly. Some have no instruments; in this case, your airspeed is indicated by the wind in your face and the flapping of your pant legs. Others, like those with a glass cockpit, are more technologically advanced than some common general aviation aircraft.

Control

Pilots transitioning from tricycle landing gear aeroplanes to older tailwheel aeroplanes often need to get used to heel brakes. Many ultralights use a simple hand braking system, heel or toe brakes, or sometimes no brakes at all.

Ultralights usually include a rudder bar instead of pedals, which have a different feel. Ultralights have no standard rudder pedal arrangement.

Ultralights have no standard throttle arrangement. Some have a vernier throttle or a lever-style throttle. On a powered paraglider, the throttle is controlled by squeezing your hand, and on a trike, you'll control the throttle with your feet.

Many side-by-side planes share a single center mounted control stick between the seats. It might feel a bit like riding side saddle when you first begin, especially if you're used to a normal stick and rudder airplane. Very few ultralights have control wheels. If you're used to an aircraft with a control yoke, it's going to feel different.

Maintenance

Maintenance will differ between types and, in some cases, the owner's preference. Unlike type certified aircraft, basic ultralights have no maintenance requirements. This means that you'll have to do a detailed inspection on your pre-flight, and it is up to the owner to determine a suitable maintenance schedule, if none is available.

Advanced ultralights must be maintained according to the manufacturer's requirements. The maintenance can be done by the owner or delegated to someone skilled in aircraft maintenance. All maintenance is signed off by the owner. While many pilot/owners have the skills to do routine and in-depth maintenance on their aircraft, the average owner doesn't have the same level of experience as an aircraft maintenance engineer (AME).

Documents

If you learned to fly on certified aircraft, you'll be used to having a detailed pilot operating handbook (POH). When it comes to ultralights, the plane might be all you get. This lack of documents can sometimes be scary.

How are ultralights different to fly?

Drag

Many ultralights lose energy faster than other aeroplanes. Ultralight wings tend to create high lift at low speed. To keep the wing light but also strong, kingposts, struts and flying wires will create drag that you may not be used to.

Some ultralight aeroplanes have wing tips that can be added or removed depending on whether you want to go fast or have more lift. Other ultralights are available in standard or clipped wing versions.

The thrust/drag couple in a high wing pusher

A large number of ultralights are considered "high wing pushers." Not only do these craft look different, but they also fly very differently.

When drag and thrust are in line, there's no real change in pitch with power changes. Most pushers have the engine (thrust) above the fuselage (drag). Drag and thrust are parallel but not in line; this means they are a "couple." Applying power pushes the engine and wing forward, while drag holds the fuselage back and causes the nose to pitch down. Similarly, when power is reduced, the nose pitches up.

Stability

Certified light general aviation aircraft are designed to handle in the same way from one type to another. It should be pretty simple for a pilot with average skill and ability to move between types, although a thorough check out is always recommended and is usually required by insurance.

There's no formal approval or certification process for basic ultralights. The level of testing for advanced ultralights is determined by the manufacturer, in conjunction with the LAMAC's requirements. Transport Canada doesn't test or certify the quality of ultralight design or construction.

Many aeroplane pilots aren't used to using the rudder much in the air. Some ultralights will need you to use the rudder to fly properly and safely. Good stick and rudder techniques are key in these light planes.

Yaw instability

Many ultralights don't have the same yaw stability as other general aviation aeroplanes. This isn't necessarily dangerous, but you should know about it and how to use the ultralight's controls to compensate for it.

The side area ahead and behind the center of gravity will affect yaw stability. For this example, we'll call the center of gravity the "pivot point." This is the point around which the plane moves on its vertical axis.

If there's more side area ahead of the pivot point when yaw is induced, you'll need to add rudder input to keep the plane going straight ahead. The amount of yaw in some ultralights is no more dangerous than the yaw in a certified aircraft; they simply require more use of rudder.

Useful load

In some cases, the weight of people on board an ultralight can double the weight of the aircraft! The aircraft handling characteristics can change depending on the size and weight of the pilot. Climb performance will dramatically change if the aircraft is solo or has two people on board.

How you load your plane is **very important**. A big factor for weight is its location within the plane, especially with tandem seating, as this can affect the plane's center of gravity (C of G). This difference will be even more noticeable if one person is much heavier than the other.

Remember that some aircraft use the pilot's weight to balance the aircraft. The front seat has an upper and lower weight limit. If the person in the front is too heavy or too light, the aircraft won't be properly balanced.

Wind

Light weight and light wing loading make a difference in ultralights. If you've flown other type of aircraft, you should already know how the wind can affect your flying. Wind will have a bigger effect on an ultralight and on your flight experience. Let's look at how headwinds, crosswinds and turbulence can affect these aircraft.

Headwinds

When you're cruising at 75 mph or less (as many ultralights do), a 20-mph headwind can have a major impact on the aircraft. This is important to keep in mind as you plan your flight.

Crosswinds

The best and safest time to fly ultralights is earlier and later in the day, when the winds are calmer.

Before flying, you'll need to identify your limits for wind conditions. A rule of thumb is that ultralights should not fly when there's a 10-kt gust differential or a crosswind component of 10 kts.

Turbulence

The lighter wing loading makes many ultralights behave like a kite when they fly in turbulent air. This can make it difficult to hold an altitude, make your flight unpleasant and make them harder to control close to the ground, like during landing, due to thermals.

Thrust

One huge benefit to ultralights is their high power-to-weight ratio. Because of this, many ultralights can quickly accelerate during take-off and have impressive climb performance. One of the big cautions with this feature is that the aircraft will not be able to maintain these dramatic climb angles if there's a power loss, and a pilot could quickly find themselves on the backside of the lift/drag curve.

Speed and speed range

Some ultralights fly at very low speeds, while others are capable of flying well over 100 mph.

On some ultralights, the difference between stalling speed and cruise speed can be 20 to 25 mph. Because they can have high drag and low power, their airspeed can drop quickly and recover slowly.

Flight manoeuvres

Most ultralights have high-lift, low-speed airfoils that also create a lot of drag. With a big thick wing, a power loss on an ultralight can lead to poor performance: much more than on a typical general aviation plane. Simply reducing power in a turn can move you from flying normally to descending fast.

Take-off

Expect quite a steep take-off: much steeper than a typical aircraft. If there's a power loss, you'll need to quickly bring the nose down to reduce your angle of attack and maintain flying speed.

Flying at lower speeds

It's here when pilots can get into trouble. Low and slow are not great a combination: even moreso in an ultralight.

Landing

As the high-drag wing gets closer to its critical angle of attack, drag increases greatly. In some aircraft in certain conditions, you may not have enough power to stop the descent when you get behind the power curve.

Engine failure or loss of power

Just because ultralights are small and light doesn't mean they will glide farther. The amount of drag an airframe produces is a factor of the gliding ratio. While a Cessna 150 may have a 9:1 glide ratio, most ultralights perform much worse due to higher airframe drag. If you lose your engine, your ultralight will descend slowly but won't glide too far.

How to prepare mentally for the transition to an ultralight

Take time to sit in the cockpit and become familiar with the layout. Where is everything? Touch the controls, move them and get a feel for them. Where is the neutral position on the stick for the elevator and the ailerons? Note the location of fuel tank levers, flap controls, fuel pumps, brakes, etc.

Run through the take-off sequence and landing sequence. Run through some basic emergency drills so that you can find the switches quickly, if needed. Get comfortable. You'll need to be familiar with these things when you're distracted by other tasks.

While you're sitting there, take some time to look at the sight picture. For some ultralights, everything is in the open. This is both good and bad. Physical controls and cables, cotter pins, the engine, etc. are exposed and easier to check. On the other hand, everything (including you) is exposed to wind, oil, dirt, insects and other debris.

Many pilots find that taking some time to maneuver the aircraft on the ground from slow to fast (but below take-off speeds) can help them prepare for how the aircraft will behave during take-off and landing.

Need more help?

It's helpful to find a flight instructor who knows your ultralight aircraft well. Your insurance company may require this. Sometimes it's not possible and, for single-seat ultralights, it's impossible to have someone else fly with you.

If you can't find an instructor, look for someone who knows your aircraft's make and model, or a similar make and model. In some cases, these pilots may have much more experience than an instructor!

If you don't have someone to fly with or talk to, at the very least, sit and read through whatever information you can find, such as:

- the pilot's operating handbook (POH)
- operating instructions
- FAA AC No. 90-89C Subject: Amateur-Built Aircraft and Ultralight Flight Testing Handbook
- UPAC Ultralight and Light Plane Condition Manual

Another source of information may be aircraft forums dedicated to your type of aircraft. These forums provide lots of information, but be aware that they will include lots of personal biases and opinions. These forums usually don't have any oversight on the info they contain.

At the end of the day, be conservative. If you can't be trained on your ultralight model, look for training on a similar aircraft and then apply that knowledge to your aircraft.

Transitioning to ultralight aeroplanes can open up a new world of flying for you! Floats, skis and tailwheel flying can be fun and can expand your abilities. But be careful, and get trained when moving to a different, unfamiliar aircraft configuration.

Related links

For more information, please contact one of the Directors of the Ultralight Pilots Association of Canada △

Introduction to Threat and Error Management

Information gathered from SKYbrary

Threat and error management (TEM) is an overarching safety concept regarding aviation operations and human performance. TEM is not a revolutionary concept, but one that has evolved gradually as a consequence of the constant drive to improve the margins of safety in aviation operations through the practical integration of human factors knowledge.

TEM was developed as a product of collective aviation industry experience. Such experience fostered the recognition that past studies and, most importantly, operational consideration of human performance in aviation had largely overlooked the most important factor influencing human performance in dynamic work environments: the interaction between people and the operational context (i.e., organizational, regulatory and environmental factors) within which people discharged their operational duties.

The recognition of the influence of the operational context in human performance further led to the conclusion that study and consideration of human performance in aviation operations must not be an end in itself. In regard to the improvement of margins of safety in aviation operations, the study and consideration of human performance without context address only part of a larger issue. TEM therefore aims to provide a principled approach to the broad examination of the dynamic and challenging complexities of the operational context in human performance, for it is the influence of these complexities that generates consequences directly affecting safety.

TEM in Flight Operations

There are three basic components in the TEM model, from the perspective of flight crews: threats, errors and undesired aircraft states (UAS). The model proposes that threats and errors are part of everyday aviation operations that must be managed by flight crews, since both threats and errors carry the potential to generate undesired aircraft states. Flight crews must also manage undesired aircraft states, since they carry the potential for unsafe outcomes. Undesired state management is an essential component of the TEM model, as important as threat and error management. Undesired aircraft state management largely represents the last opportunity to avoid an unsafe outcome and thus maintain safety margins in flight operations.

- Threats—generally defined as **events or errors that occur beyond the influence of the line personnel, increase operational complexity and which must be managed to maintain the margins of safety**. During typical flight operations, flight crews have to manage various contextual complexities. Such complexities would include, for example, dealing with adverse meteorological conditions, airports surrounded by high mountains, congested airspace, aircraft malfunctions, errors committed by other people outside of the cockpit, such as air traffic controllers, flight attendants or maintenance workers, and so forth. The TEM model considers these complexities as threats because they all have the potential to negatively affect flight operations by reducing margins of safety.

Anticipated Threats

Some threats can be anticipated since they are expected or known to the flight crew. For example, flight crews can anticipate the consequences of a thunderstorm by briefing their response in advance, or they can prepare for a congested airport by making sure they keep a watchful eye for other aircraft as they execute the approach.

Unexpected Threats

Some threats can occur unexpectedly, such as an in-flight aircraft malfunction that happens suddenly and without warning. In this case, flight crews must apply skills and knowledge acquired through training and operational experience.

Latent Threats

Lastly, some threats may not be directly obvious to or observable by flight crews immersed in the operational context and may need to be uncovered by safety analysis. These are considered latent threats. Examples of latent threats include equipment design issues, optical illusions or shortened turn-around schedules.

Regardless of whether threats are expected, unexpected or latent, one measure of the effectiveness of a flight crew's ability to manage threats is whether threats are detected with the necessary anticipation to enable the flight crew to respond to them through deployment of appropriate countermeasures.

Threat management is a building block to error management and undesired aircraft state management. Although the threat–error linkage is not necessarily straightforward, although it may not always be possible to establish a linear relationship or one-to-one mapping between threats, errors and undesired states, archival data demonstrate that mismanaged threats are normally linked to flight crew errors, which, in turn, are oftentimes linked to undesired aircraft states. Threat management provides the most proactive option to maintain margins of safety in flight operations by voiding safety compromising situations at their roots. As threat managers, flight crews are the last line of defense to keep threats from impacting flight operations.

Table 1 presents examples of threats, grouped under two basic categories derived from the TEM model. Environmental threats occur due to the environment in which flight operations take place. Some environmental threats can be planned for, and some will arise spontaneously, but they all have to be managed by flight crews in real time. Organizational threats, on the other hand, can be controlled (i.e., removed or at least minimized) at the source by aviation organizations. Organizational threats are usually latent in nature. Flight crews still remain the last line of defense, but there are earlier opportunities for these threats to be mitigated by aviation organizations themselves.

Table 1. Examples of threats (List not inclusive)

Environmental Threats	Organizational Threats
• **Weather:** thunderstorms, turbulence, icing, wind shear, cross/tailwind, very low/high temperatures. • **ATC:** traffic congestion, TCAS RA/TA, ATC command, ATC error, ATC language difficulty, ATC non-standard phraseology, ATC runway change, ATIS communication, units of measurement (QFE/meters). • **Airport:** contaminated/short runway; contaminated taxiway, lack of/confusing/faded signage/markings,	• **Operational pressure:** delays, late arrivals, equipment changes. • **Aircraft:** aircraft malfunction, automation event/anomaly, MEL/CDL. • **Cabin:** flight attendant error, cabin event distraction, interruption, cabin door security. • **Maintenance:** maintenance event/error. • **Ground:** ground handling event, de-icing, ground crew error.

birds, aids U/S, complex surface navigation procedures, airport constructions. • **Terrain:** high ground, slope, lack of references, "black hole." • **Other:** similar call-signs.	• **Dispatch:** dispatch paperwork event/error. • **Documentation:** manual error, chart error. • **Other:** crew scheduling event.

- Errors—generally defined as **actions or inactions by the line personnel that lead to deviations from organizational or operational intentions or expectations**. Unmanaged and/or mismanaged errors frequently lead to undesired states. Errors in the operational context thus tend to reduce the margins of safety and increase the probability of an undesirable event.

Errors can be spontaneous (i.e., without direct linkage to specific, obvious threats), linked to threats or part of an error chain. Examples of errors would include the inability to maintain stabilized approach parameters, executing a wrong automation mode, failing to give a required callout or misinterpreting an air traffic control (ATC) clearance.

Regardless of the type of error, an error's effect on safety depends on whether the flight crew detects and responds to the error before it leads to an undesired aircraft state and to a potential unsafe outcome. This is why one of TEM'S objectives is to understand error management (i.e., detection and response) rather than to solely focus on error causality (i.e., causation and commission). From a safety perspective, operational errors that are timely detected and promptly responded to (i.e., properly managed) do not lead to undesired aircraft states, do not reduce margins of safety in flight operations, and thus become operationally inconsequential. In addition to its safety value, proper error management represents an example of successful human performance, presenting both learning and training value.

Capturing how errors are managed is then as important, if not more important, than capturing the prevalence of different error types. It is of interest to capture if and when errors are detected and by whom, the response(s) upon detecting errors and the outcome of errors. Some errors are quickly detected and resolved, thus becoming operationally inconsequential, while others go undetected or are mismanaged. A mismanaged error is defined as an error that is linked to or induces an additional error or undesired aircraft state.

Table 2 presents examples of errors, grouped under three basic categories derived from the TEM model. In the TEM concept, errors have to be "observable," and the TEM model therefore uses the "primary interaction" as the point of reference for defining the error categories.

The TEM model classifies errors based upon the primary interaction of the pilot or flight crew at the moment the error is committed. Therefore, in order to be classified as aircraft handling error, the pilot or flight crew must be interacting with the aircraft (e.g., through its controls, automation or systems). In order to be classified as procedural error, the pilot or flight crew must be interacting with a procedure (e.g., checklists; Standard Operating Procedures (SOPs); etc.). In order to be classified as communication error, the pilot or flight crew must be interacting with people (ATC; ground crew; other crewmembers; etc.).

Aircraft handling errors, procedural errors and communication errors may be unintentional or involve intentional non-compliance. Similarly, proficiency considerations (i.e., skill or knowledge deficiencies, training system deficiencies) may underlie all three error categories. In order to keep the approach simple and avoid confusion, the TEM model does not consider intentional non-compliance and proficiency as separate categories of error, but rather as subsets of the three major error categories.

Table 2. Examples of errors (List not inclusive)

Aircraft handling errors	Manual handing/flight controls: vertical/lateral and/or speed deviations, incorrect flaps/speedbrakes, thrust reverser or power settings. Automation: incorrect altitude, speed heading, autothrottle settings, incorrect mode executed, incorrect entries. Systems/radio/instruments: incorrect packs, incorrect anti-icing, incorrect altimeter, incorrect fuel switches settings, incorrect speed bug, incorrect radio frequency dialled. Ground navigation: attempting to turn down wrong taxiway/runway, taxi too fast, failure to hold short, missed taxiway/runway.
Procedural errors	SOPs: failure to cross-verify automation inputs. Checklist: wrong challenge and response; items missed, checklist performed late or at the wrong time. Callouts: omitted/incorrect callouts. Briefings: omitted briefings; items missed. Documentation: wrong weight and balance, fuel information, ATIS or clearance information recorded, misinterpreted items on paperwork; incorrect logbook entries, incorrect application of MEL procedures.
Communication errors	Crew to external: missed calls, misinterpretations of instructions, incorrect read-back, wrong clearance, taxiway, gate or runway communicated. Pilot to pilot: within crew miscommunication or misinterpretation.

- **Undesired states**—generally defined as **operational conditions where an unintended situation results in a reduction in margins of safety**. Undesired states that result from ineffective threat and/or error management may lead to compromised situations and reduce margins of safety aviation operations. This is often considered the last stage before an incident or accident.

Examples of undesired aircraft states would include lining up for the incorrect runway during approach to landing, exceeding ATC speed restrictions during an approach or landing long on a short runway requiring maximum braking. Events such as equipment malfunctions or ATC controller errors can also reduce margins of safety in flight operations, but these would be considered threats. Undesired states can be managed effectively, restoring margins of safety, or flight crew response(s) can induce an additional error, incident or accident.

Table 3 presents examples of undesired aircraft states, grouped under three basic categories derived from the TEM model.

Table 3. Examples of undesired aircraft states (List not inclusive)

Aircraft handling	• Aircraft control (attitude). • Vertical, lateral or speed deviations. • Unnecessary weather penetration. • Operation outside aircraft limitations. • Unstable approach. • Continued landing after unstable approach. • Long, floated, firm or off-centerline landing.
Ground navigation	• Proceeding towards wrong taxiway/runway. • Wrong taxiway, ramp, gate or hold spot.
Incorrect aircraft configurations	• Incorrect systems configuration. • Incorrect flight controls configuration. • Incorrect automation configuration. • Incorrect engine configuration. • Incorrect weight and balance configuration.

An important learning and training point for flight crews is the timely switching from error management to undesired aircraft state management. An example would be as follows: a flight crew selects a wrong approach in the flight management computer (FMC). The flight crew subsequently identifies the error during a crosscheck prior to the final approach fix (FAF). However, instead of using a basic mode (e.g., heading) or manually flying the desired track, both flight crew become involved in attempting to reprogram the correct approach prior to reaching the FAF. As a result, the aircraft “stitches” through the localizer, descends late and goes into an unstable approach. This would be an example of the flight crew getting "locked in" to error management rather than switching to undesired aircraft state management. The use of the TEM model assists in educating flight crews that, when the aircraft is in an undesired state, the basic task of the flight crew is undesired aircraft state management instead of error management. It also illustrates how easy it is to get locked into the error management phase.

Also, from a learning and training perspective, it is important to establish a clear differentiation between undesired aircraft states and outcomes. Undesired aircraft states are transitional states between a normal operational state (i.e., a stabilized approach) and an outcome. Outcomes, on the other hand, are end states, most notably reportable occurrences (i.e., incidents and accidents). An example would be as follows: a stabilized approach (normal operational state) turns into a destabilized approach (undesired aircraft state) that results in a runway excursion (outcome).

The training and remedial implications of this differentiation are of significance. While at the undesired aircraft state stage, the flight crew has the possibility, through appropriate TEM, of recovering the situation, returning to a normal operational state, thus restoring margins of safety. Once the undesired aircraft state becomes an outcome, recovery of the situation, return to a normal operational state and restoration of margins of safety is not possible.

Countermeasures

Flight crews must, as part of the normal discharge of their operational duties, employ countermeasures to keep threats, errors and undesired aircraft states from reducing margins of safety in flight operations. Examples of countermeasures would include checklists, briefings, callouts and SOPs, as well as personal strategies and tactics. Flight crews dedicate significant amounts of time and energies to the application of countermeasures to ensure margins of safety during flight operations. Empirical observations during training and checking suggest that as much as 70 % of flight crew activities may be countermeasures-related activities.

All countermeasures are necessarily flight crew actions. However, some countermeasures to threats, errors and undesired aircraft states that flight crews employ build upon “hard” resources provided by the aviation system. These resources are already in place in the system before flight crews report for duty and are therefore considered as systemic-based countermeasures. The following would be examples of “hard” resources that flight crews employ as systemic-based countermeasures:

- Airborne Collision Avoidance System (ACAS);
- Ground Proximity Warning System (GPWS);
- Standard operation procedures (SOPs);
- Checklists;
- Briefings;
- Training;
- Etc.

Other countermeasures are more directly related to the human contribution to the safety of flight operations. These are personal strategies and tactics, individual and team countermeasures, that typically include canvassed skills, knowledge and attitudes developed by human performance training (most notably by crew resource management [CRM] training). There are basically three categories of individual and team countermeasures:

- **Planning countermeasures**: essential for managing anticipated and unexpected threats;
- **Execution countermeasures**: essential for error detection and error response;
- **Review countermeasures**: essential for managing the changing conditions of a flight.

Enhanced TEM is the product of the combined use of systemic-based and individual and team countermeasures. Table 4 presents detailed examples of individual and team countermeasures. △

Table 4. Examples of individual and team countermeasures

Planning Countermeasures		
SOP BRIEFING	The required briefing was interactive and operationally thorough	• *Concise, not rushed and met SOP requirements* • *Bottom lines were established*
PLANS STATED	Operational plans and decisions were communicated and acknowledge	• *Shared understanding about plans – "Everybody on the same page"*
WORKLOAD ASSIGMENT	Roles and responsibilities were defined for normal and non-normal situations	• *Workload assignments were communicated and acknowledged*
CONTINGENCY MANAGEMENT	Crew members developed effective strategies to manage threats to safety	• *Threats and their consequences were anticipated* • *Used all available resources to manage threats*
Execution Countermeasures		
MONITOR/CROSS-CHECK	Crew members actively monitored and cross-checked systems and other crew members	• *Aircraft position, settings and crew actions were verified*
WORKLOAD MANAGEMENT	Operational tasks were prioritized and properly manages to handle primary flight duties	• *Avoided task fixation* • *Did not allow work overload*
AUTOMATION MANAGEMENT	Automation was properly managed to balance situational and/or workload requirements	• *Automation setup was briefed to other members* • *Effective recovery techniques from automation anomalies*
Review Countermeasures		
EVALUATION/MODIFICATION OF PLANS	Existing plans were reviewed and modified when necessary	• *Crew decisions and actions were openly analyzed to make sure the existing plan was the best plan*
INQUIRY	Crew members asked questions to investigate and/or clarify current plans of action	• *Crew members not afraid to express a lack of knowledge – "Nothing taken for granted" attitude*
ASSERTIVENESS	Crew members stated critical information and/or solutions with appropriate persistence	• *Crew members spoke up without hesitation*

Submission of Aviation Safety Letter (ASL) articles

Do you have an aviation safety topic you are passionate about? Do you want to share your expert knowledge with others? If so, we would love to hear from you!

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General information and guidance

The ASL's primary objective is to promote aviation safety. It includes articles that address aviation safety from all perspectives, such as safety insight derived from accidents and incidents, as well as safety information tailored to the needs of all holders of a valid Canadian pilot licence or permit, to all holders of a valid Canadian aircraft maintenance engineer (AME) licence and to other interested individuals within the aviation community.

If you are interested in writing an article, please send it by e-mail to TC.ASL-SAN.TC@tc.gc.ca in your preferred language. Please note that all articles will be edited and translated by the Transport Canada Civil Aviation (TCCA) Aviation Terminology Standardization Division and will be coordinated by the ASL team.

Photos

In order to captivate our readers' interest, we recommend that you include one or two photos (i.e., photo, illustration, chart or graphic) for each article, if possible. Please send us your photos as an e-mail attachment (preferably as a jpeg).

We look forward to receiving your articles! △

TSB FINAL REPORTS SUMMARIES

The following summaries are extracted from final reports issued by the Transportation Safety Board of Canada (TSB). They have been de-identified. Unless otherwise specified, all photos and illustrations were provided by the TSB. For the benefit of our readers, all the occurrence titles are hyperlinked to the full report on the TSB Web site. —Ed.

TSB Final Report A21Q0087—Runway overrun

History of the flight

On 12 September 2021, the two pilots of the Pilatus PC-12/47E aircraft (PC-12 NG) went to the Montréal/St-Hubert Airport, Quebec (CYHU) to begin their workday at 06:00. That day, they were scheduled to conduct a series of five flights between six airports in Quebec (Figure 1).

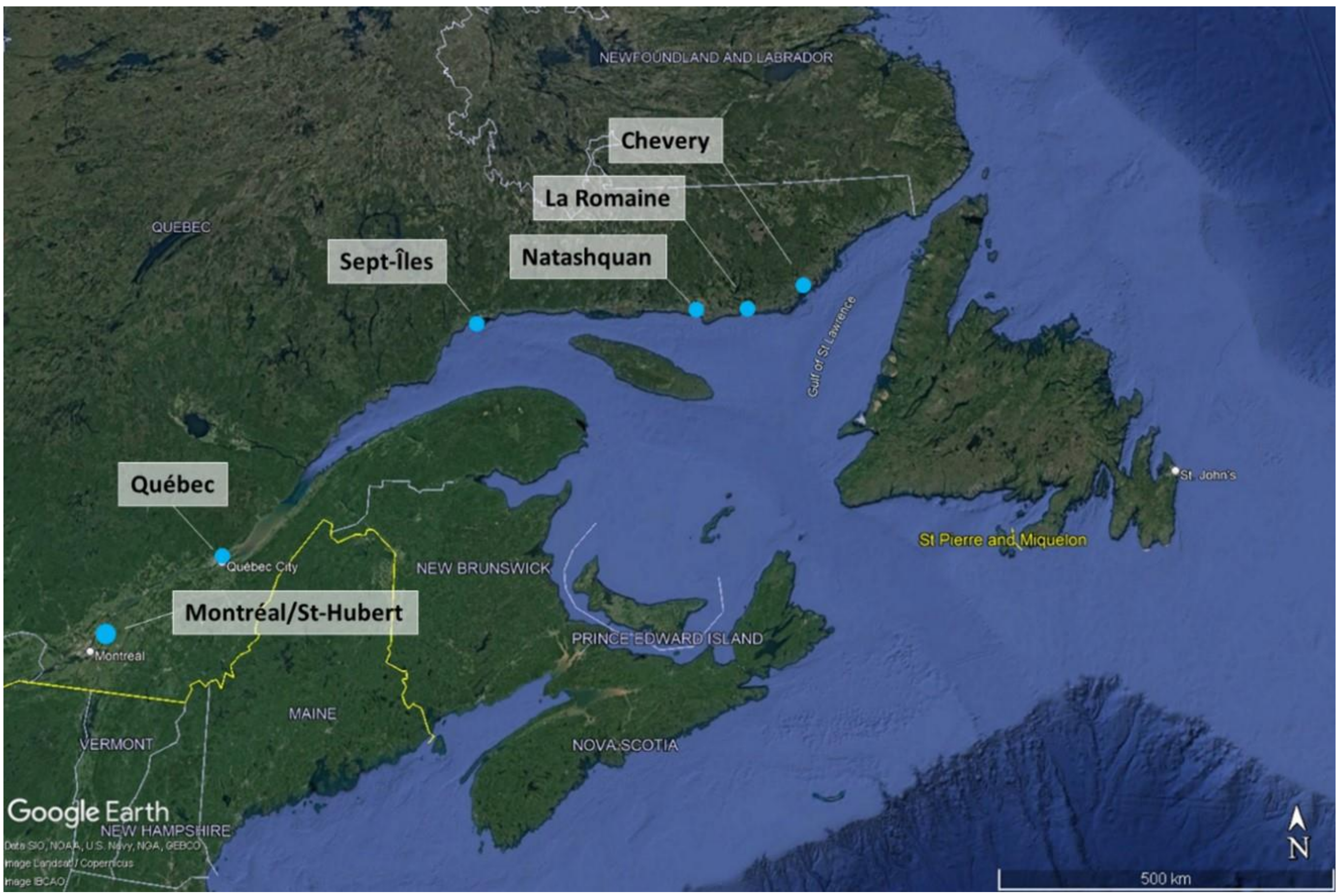

Figure 1: Map showing the six airports in the series of flights conducted on the day of the occurrence flight (Source: Google Earth, with TSB annotations)

The flights were scheduled in the following order:

- from CYHU to the Chevery Airport (CYHR);
- from CYHR to the Natashquan Airport (CYNA);
- from CYNA to the Québec/Jean Lesage International Airport (CYQB);
- from CYQB to the Sept-Îles Airport (CYZV);
- from CYZV to La Romaine Airport (CTT5).

The first three flights proceeded without incident. The aircraft landed at CYQB at 13:46.

At 16:00, the aircraft took off from CYQB, bound for CYZV with no passengers on board. The captain was sitting in the left seat and was the pilot flying (PF). The first officer (FO) was sitting in the right seat and was the pilot not flying (PNF).

Shortly before initiating the descent from flight level 270, the crew began its preparation for approach and landing at CYZV. The captain told the FO that he was going to show him that it was possible to conduct a late descent at a rate of descent of approximately 3 000 feet per minute (fpm) with the Pilatus PC-12.

The crew obtained the weather conditions from the information Kilo message issued by the automatic terminal information service (ATIS) at CYZV, which indicated visual flight conditions with moderate rain showers, mist and variable winds from the west at 8 kt, gusting to 15 kt.

The captain told the FO that he wanted to conduct the straight-in approach to Runway 09 despite the tailwind. He then gave his approach briefing for a Runway 09 area navigation (RNAV) approach using the global navigation satellite system (GNSS) (Appendix A). The briefing indicated that the flaps would be set to 15° and the landing reference speed (V_{ref}) would be 95 kt indicated airspeed (KIAS).

The descent was initiated at approximately 16:50, and at 17:03, the FO contacted the CYZV flight service specialist on mandatory frequency (MF) 118.1 MHz. The crew was informed that the winds were from 220° magnetic (M) at 6 kt.

At 17:05, the aircraft crossed the ETBAR initial approach waypoint at 5 078 ft above sea level (ASL), which was approximately 250 ft above the 3° approach slope, at 213 KIAS. The crew had Runway 09 in sight, and the captain decided to accelerate to conduct a high-speed final approach, decelerating just before reaching the runway. Incorrectly believing that the airspeed limit of 210 kt published on the approach chart for the IGSUK and VOKON waypoints also applied to the straight-in approach via ETBAR, the captain asked the FO to cancel the instrument flight rules (IFR) flight plan so that they could continue the approach under visual flight rules (VFR), which have no airspeed limit.

The captain then increased power without consulting the FO. The aircraft's speed increased to 240 KIAS, the manufacturer's maximum operating speed (V_{mo}). The FO called out high speed. The captain reduced power to stabilize the speed around 230 KIAS. At that point, the FO expressed his discomfort with the high speed. However, the captain stated that he was going to continue the high-speed approach. At approximately 6 nautical miles (NM) from the runway, the FO expressed his doubts that the landing would be successful, and the captain repeated that he was going to continue the high-speed approach.

At 17:07:33, the aircraft crossed the DENEZ final approach fix on the 3° approach slope at 233 KIAS.

At 17:08:08, the aircraft descended through 1 000 ft above ground level (AGL) at 236 KIAS in clean configuration (landing gear and flaps retracted), and 17 seconds later, it descended through 500 ft AGL, for the first time, at 238 KIAS. One second later, the aircraft exceeded the V_{mo} of 240 KIAS and remained in overspeed for 3 seconds. The captain reduced power and the speed reached 244 KIAS before dropping back below the V_{mo}. Two seconds later, the captain initiated a climb to reduce the aircraft's speed more quickly. When the aircraft was at 195 KIAS, the captain called "gear down" to have the FO lower the landing gear. At that point, the FO called out high speed, given that the maximum landing gear operating speed is 180 KIAS. The captain repeated "gear down." The landing gear extension was initiated at 188 KIAS, 8 kt above the maximum speed of 180 KIAS. The FO then asked the captain to confirm the flap selection of 15° given that the aircraft's speed was then around 185 KIAS, which was 20 KIAS greater than the maximum speed with flaps extended. The captain replied that the landing would be conducted without flaps.

Figure 2: Photo of the left tire (rear view)

At 17:08:53, the aircraft crossed the runway threshold at 200 ft AGL, at 180 KIAS (ground speed of 191 kt); its rate of descent was 2 000 fpm, the landing gear was in transit, and the flaps were in the fully retracted position.

At 17:09:02, the aircraft touched down fairly smoothly on the wet runway, approximately 2 525 ft beyond the runway threshold, at 159 KIAS (ground speed of 167 kt). The brakes were then forcefully applied, and reverse thrust was applied the way the captain normally would (i.e., in idle reverse).

At 17:09:17, realizing that a runway overrun was imminent, the captain increased the reverse thrust to 48 % of the maximum and, 6 seconds later, the aircraft overran the runway at a ground speed of 57 kt.

The aircraft veered slightly to the left to avoid the approach lights. After travelling 590 ft in the grass at the end of the runway, the captain reversed course to the right, around an approach light and increased power to return to the runway. After the runway overrun, the crew informed the flight service specialist that the aircraft had not hit anything and that there was no damage. The aircraft then taxied normally to its parking stand. The crew was not injured.

Damage to aircraft

The aircraft was not damaged; however, the tires on the main landing gear showed signs of rubber reversion (figures 2 and 3).

Personnel information

The flight crew held the appropriate licences and ratings for the flight in accordance with existing regulations.

Meteorological information

The graphic area forecast Clouds and Weather chart for the region, issued at 13:28 on 12 September 2021 and valid from 14:00, indicated the presence of a low-pressure system north-northwest of CYZV and a cold front to the west, which was moving eastward at 30 kt. According to wind and temperature aloft forecasts, winds from 240° true (T) at 23 kt were forecast for CYZV between 1 300 and 1 700 at 3 000 ft ASL.

The aerodrome forecast for CYZV, updated at 10:56 on 12 September 2021 and valid from 10:00 on 12 September until 08:00 the next day, indicated the following as of 16:00:

- winds from 220°T at 12 kt;
- visibility of 6 SM;
- light rain showers and mist;
- scattered clouds at 600 ft AGL;
- overcast ceiling at 2 000 ft AGL.

Between 16:00 and 20:00, there was a 30 % chance of the following conditions:

Figure 3: Photo of the right tire (front view)

- visibility of 2 SM;
- thunderstorms, moderate rain showers and mist;
- broken ceiling at 600 ft;
- overcast cloud layer at 2 000 ft with cumulonimbus.

The crew obtained updated weather conditions from the ATIS information Kilo message, which had been issued at 16:00 and indicated the following:

- variable winds from 220°M to 280°M at 8 kt, gusting to 15 kt;
- visibility of 3 SM;
- moderate rain showers and mist;
- scattered clouds at 900 ft AGL;
- broken ceiling at 2 000 ft AGL;

- broken cloud layer at 4 000 ft AGL;
- overcast cloud layer at 7 500 ft AGL;
- temperature 14°C, dew point 13°C;
- altimeter setting 29.59 in of mercury (inHg).

The aerodrome routine meteorological report issued at 17:00 on 12 September 2021 for CYZV was the following:

- winds from 190°Tat 6 kt;
- visibility of 20 SM;
- light rain showers;
- few clouds at 900 ft AGL;
- few clouds at 2 000 ft AGL;
- broken ceiling at 4 500 ft AGL with towering cumulus;
- broken cloud layer at 8 000 ft AGL;
- temperature 13°C, dew point 12°C;
- altimeter setting 29.57 inHg.

At 17:19, 10 minutes after landing, an aerodrome special meteorological report (SPECI) was issued for CYZV, indicating the following:

- winds from 230°T at 10 kt;
- few clouds at 400 ft AGL;
- few clouds at 900 ft AGL;
- broken ceiling at 4 000 ft AGL with towering cumulus;
- broken cloud layer at 10 000 ft AGL;
- temperature 14°C, dew point 12°C;
- altimeter setting 29.57 inHg.

Post-incident inspection

The captain, who had managed to avoid the ODALS (*this system is a configuration of seven omnidirectional, variable-intensity, sequenced flashing lights*) before turning around to return to the runway, informed the flight service specialist that the aircraft had not hit anything and that there was no damage. Seeing that the aircraft was taxiing normally toward the apron, the flight service specialist did not immediately inform the airport operator but did make a detailed aviation occurrence report at the time. The post-incident inspection of the installations at the end of Runway 09 was carried out the next day, when the airport operator learned that a runway overrun had occurred. No damage was found.

Runway surface conditions

CYZV assesses runway conditions based on Global Reporting Format[1] criteria during published hours of operation and only on request from a flight service specialist or an air operator outside of those hours. Given that the occurrence aircraft landed outside of the airport staff's working hours, runway conditions were not assessed and were therefore not available to the crew for landing.

Organizational and management information

Operator

At the time of the occurrence, its fleet consisted of three helicopters and six airplanes (Pilatus PC-12s operated under Subpart 703, Air Taxi Operations, of the *Canadian Aviation Regulations* [CARs]).

The operator flight operations manual

The operator's flight operations manual includes the requirements and training needed for crews to conduct non-precision approaches using the stabilized constant descent angle (SCDA) approach. However, the manual does not contain any general or specific policies regarding the requirement to conduct a stabilized approach or to conduct a go-around if the approach is unstable.

Company guidelines

A few months before the occurrence, the company received a passenger complaint regarding another crew that had made a deceleration manoeuvre resulting in a high rate of descent (which triggered a ground proximity warning system alert) and a mid-runway landing after a high-speed final approach.

In response to this complaint, the company met with and reprimanded the captain of that flight, and in August 2021, it issued an internal memorandum to inform pilots that these types of manoeuvres were inappropriate. The memorandum explained why these manoeuvres were not to be executed. It also reminded pilots of the standard operating procedure (SOP) sections that applied to that case. According to this section, pilots who are preparing to conduct a visual approach must configure the aircraft for landing and complete the before-landing checklist before crossing 1 000 ft AGL.

Civil Aviation Safety Alert on stabilized approaches

Transport Canada Civil Aviation (TCCA) issued Civil Aviation Safety Alert (CASA) 2015-04, the purpose of which was "to stress the importance of and to outline the elements of a stabilized approach." The alert stated the following:

Stabilized approach criteria should be defined for all approaches and should include that:

- Approaches be stabilized by no lower than 1 000 ft above aerodrome elevation (AAE) when in instrument meteorological conditions (IMC);
- All approaches be stabilized by no lower than 500 ft AAE in visual meteorological conditions (VMC);
- A call be made upon reaching 1 000 ft AAE in IMC or 500 ft AAE in VMC as to whether the approach is stabilized or not;

[1] The Global Reporting Format (GRF) was implemented in Canada on 12 August 2021.

- The approach remain stabilized until landing;
- If an approach is not stabilized in accordance with these requirements, or has become destabilized afterwards, a go-around is required.

Decision-making and situational awareness

Decision-making is a cognitive process used to choose a plan of action from several possibilities. The process involves identifying issues and threats and assessing options, taking into account the associated risks. Crew decision-making is carried out in a dynamic environment. It requires constant communication and consists of four steps: gathering information; processing information; making decisions; and acting on decisions. Decision-making may be biased if the information gathering step is not done properly and if the information gathered is inaccurate; therefore, communication between the pilots of a crew is vital. Pilots must communicate available information to have the same understanding of the situation and be able to make the best decision.

Situational awareness is key to pilot and crew decision-making. Situational awareness is the perception of the elements in the environment, the comprehension of their meaning and the projection of their status in the future.[2] In a dynamic environment, situational awareness requires "continuous extraction of environmental information, integration of this information with previous knowledge to form a coherent mental picture and the use of that picture in directing further perception and anticipating future events."[3] Shared situational awareness[4, 5] between the pilots of a crew depends on the extent to which the respective situational awareness of each pilot is similar. Crew members who have a shared situational awareness can anticipate and coordinate their actions and therefore act with cohesion and efficiency.

Pilots work in a complex environment that requires monitoring multiple sources and types of information. It has been shown that several cognitive biases, including the following, affect how information is interpreted and heeded in complex environments:

- Plan continuation bias, which is a form of confirmation bias, is described as a "deep-rooted tendency of individuals to continue their original plan of action even when changing circumstances require a new plan." Once a plan has been established and put into action, it becomes more difficult to recognize stimuli or conditions in the environment that may be cues for change than it is when no plan has been established. To recognize that a change of plan is needed and to react in time, a pilot must perceive the condition or stimulus as important enough to warrant immediate action. Plan continuation bias becomes even stronger when the task (e.g., a landing) is on the verge of being completed.
- People have a limited capacity to focus their attention and process information. As a result, they may fall into the trap of "attentional narrowing" or tunnelling. They focus on certain

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[2] M. R. Endsley, "Design and Evaluation for Situation Awareness Enhancement," in Proceedings of the Human Factors Society: 32nd Annual Meeting (Santa Monica, California: 1988), pp. 97–101.

[3] C. Dominguez, "Can SA Be Defined?", Situation Awareness: Papers and Annotated Bibliography (June 1994), p. 11.

[4] M. R. Endsley, "Toward a Theory of Situation Awareness in Dynamic Systems," *Human Factors*, vol. 37, issue 1 (1995), pp. 32–64.

[5] E. Salas, C. Prince, D. P. Baker, and L. Shrestha, "Situation Awareness in Team Performance: Implications for Measurement and Training," Human Factors, vol. 37, issue 1 (1995), pp. 123–136.

cues in the environment, which they attempt to process, intentionally or unintentionally diverting their attention from other cues or tasks. For example, pilots in high workload conditions may focus on certain indicators to the detriment of others.

- Workload depends on the number of tasks to be completed within a certain period. If the number of tasks to be completed increases, or if the time available decreases, the workload rises. Task saturation occurs when the number of tasks to be completed within a certain period exceeds pilots' capacity to complete them, and some tasks are missed or delayed.

Mental models

A mental model is an internal structure that enables people to describe, explain and predict events and situations in their environment. When a mental model is adopted, it is resistant to change. New convincing information must be assimilated in order to change the mental model. An inaccurate mental model will interfere with the perception of critical elements or the comprehension of their importance.

Crew resource management

Crew resource management (CRM) is the effective use of all available resources—human, hardware and information—to conduct flights safely and efficiently. CRM includes skills, abilities, attitudes, communication, situational awareness, problem solving and teamwork. CRM is linked to the cognitive abilities and interpersonal skills required to manage a flight. These cognitive abilities include the mental processes needed to establish and maintain accurate situational awareness, solve problems and make decisions. Interpersonal skills are linked to communications and behaviours associated with teamwork. Effective risk management in the cockpit is intrinsically linked to effective CRM.

Authority gradient

Authority gradient refers to the decision-making hierarchy between the captain and the FO. This gradient is characterized by several factors, including each person's experience. A strong authority gradient may be a barrier to the decision-making dynamics of a crew and may discourage the FO from expressing disagreement due to their experience. In this occurrence, the captain had accumulated 2 867 flight hours on type, and the FO had 280 flight hours on type. The two pilots had been paired up in the past with no issues reported.

Escalation of assertiveness by first officers

Assertiveness can be defined as the ability to express one's opinions in a calm and firm manner and to not accept what appears to be incorrect. Escalation can be progressive or immediate depending on the severity of the threat. An example of a CRM communication tool is the Probing, Alerting, Challenging and Emergency Warning (PACE) model.[6] The PACE model provides pilots, especially FOs, with a series of communication strategies designed to allow for a natural escalation of assertiveness, depending on the circumstances at the time.

[6] R. O. Besco, "To Intervene or Not To Intervene? The Co-Pilot's Catch 22," in Proceedings of the 25th International Seminar of the International Society of Air Safety Investigators, Vol. 27, No. 5, pp. 94–101.

Airspeed limitation according to the *Canadian Aviation Regulations*

According to the CARs 602.32(1), no person shall

(b) operate an aircraft at an indicated airspeed of more than 200 kt if the aircraft is below 3 000 ft AGL within 10 NM of a controlled aerodrome unless authorized to do so in an air traffic control clearance.

Furthermore, the CARs define a controlled aerodrome as "an aerodrome at which at an air traffic control unit is in operation." The CARs also define an air traffic control unit (ATC unit) as follows:

> **(a)** an area control centre established to provide air traffic control service to IFR aircraft,
>
> **(b)** a terminal control unit established to provide air traffic control service to IFR aircraft while they are being operated within a terminal control area, or
>
> **(c)** an air traffic control tower established to provide air traffic control service at an aerodrome.

The interpretation becomes ambiguous when an aerodrome such as CYZV, which does not have an air traffic control tower, is located in Class E controlled airspace, where separation between IFR aircraft is provided by the area control centre. To clarify this ambiguity, a request for interpretation was sent to TCCA.

Finding: Other

According to TCCA's interpretation, CYZV is an uncontrolled airport because it does not have a control tower. As a result, the airspeed limitation of 200 kt stipulated in paragraph 602.32(1)(b) of the CARs does not apply.

Risk factors

The Flight Safety Foundation (FSF) analyzed the data on runway overruns that had occurred over a period of 14 years and determined that "the risk of a runway excursion increases when more than one risk factor is present. Multiple risk factors create a synergistic effect (i.e., two risk factors more than double the risk)."

To provide "ways for pilots and airplane operators to identify, understand and mitigate risks associated with runway overruns during the landing phase of flight,"[7] the U.S. Federal Aviation Administration (FAA) published Advisory Circular (AC) 91-79A in 2014 (amended in 2018). The AC indicates the following:

A study of FAA and NTSB [U.S. National Transportation Safety Board] data indicates that the following hazards increase the risk of a runway overrun:

- Unstabilized approach[*];
- High airport elevation or high density altitude (DA), resulting in increased groundspeed;
- Effect of excess airspeed over the runway threshold[*];
- Airplane landing weight;
- Landing beyond the touchdown point[*];

[7] Federal Aviation Administration (FAA), Advisory Circular (AC) 91-79A: Mitigating the Risks of a Runway Overrun Upon Landing, Change 2 (20 February 2018), Section 1: Purpose of this advisory circular (AC), p. 1.

- Downhill runway slope;
- Excessive height over the runway threshold[*];
- Delayed use of deceleration devices[*];
- Landing with a tailwind[*]; and
- A wet or contaminated runway.[8]

Standard operating procedures

SOPs, including standard calls and checklists, are vital sources of information that provide pilots with guidelines on general use of the aircraft. They assist pilots with decision-making and coordination between crew members.

To reduce the risk of approach and landing accidents, the International Civil Aviation Organization (ICAO), the FSF, the FAA, the NTSB, TCCA and the TSB have all, on numerous occasions, stressed the importance of having clear, complete, precise and unambiguous SOPs, and the need to comply with SOPs during critical phases of flight. Furthermore, from 1994 to 2022, inconsistent or missing procedures were identified in 39 (various) findings in TSB air transportation safety investigation reports. The deficiencies identified were mainly associated with an absence of specific guidelines and discrepancies in procedures.

Analysis

There was no indication of an airframe, engine or system failure during the occurrence flight. Aircraft performance was also not a contributing factor in this occurrence.

Decision to conduct a high-speed final approach

During the approach briefing before the descent from flight level 270, the captain told the FO that he was going to show him that the Pilatus PC-12 was able to perform a late descent at a rate of descent of approximately 3 000 fpm. The automatic terminal information service message for the Sept-Îles Airport indicated visual flight conditions, moderate rain showers and winds from the west at 8 kt, gusting to 15 kt. These conditions were favourable for a landing on Runway 27; however, the captain told the FO that they were going to conduct a straight-in approach for Runway 09 via the ETBAR initial approach waypoint, and a landing with the flaps set to 15°, with a landing reference speed (V_{ref}) of 95 kt.

The airplane crossed the ETBAR waypoint at approximately 250 ft above the 3° approach slope at 213 KIAS. The crew had Runway 09 in sight, and the captain decided to accelerate to conduct a high-speed final approach, decelerating just before reaching the runway. However, given that he believed that the airspeed limit of 210 kt published on the approach chart for the IGSUK and VOKON waypoints also applied to the straight-in approach via ETBAR, he asked the FO to cancel the IFR flight plan. The captain then increased power without consulting the FO. The aircraft's speed reached the V_{mo} of 240 KIAS. The FO called out high speed. The captain reduced power to stabilize the speed at approximately 230 KIAS. At that point, the FO expressed his discomfort with the high speed. However, the captain confirmed that he was continuing the high-speed approach. The aircraft was then 3 NM from the runway at 1 000 ft AGL (stabilized approach gate according to the SOPs) in clean configuration at an airspeed of 236 KIAS.

8 The seven factors with an asterisk [*] were present during the occurrence approach.

A few months before the occurrence, a similar high-speed final approach had been conducted by another crew, and the deceleration with a rapid descent close to the runway had resulted in a passenger complaint. The company had reprimanded the pilot involved and issued a memorandum to crews to formally notify them that these manoeuvres were inappropriate and should not be conducted.

The decision to conduct a high-speed final approach, despite the company's instructions to the contrary, was likely influenced by the fact that there were no passengers on board and by the fact that the crew was unaware of the engine condition trend monitoring (ECTM) system's actual recording abilities. Therefore, the crew most likely assumed that the company's management team would not be aware of the deviations from the SOPs and that there would be no risk of administrative penalties.

Finding as to causes and contributing factors

During the occurrence flight, the captain, who was paired with an FO with little experience on the Pilatus PC-12, decided to demonstrate a high-speed final approach, decelerating just before reaching the runway. As a result, the stabilized approach gate indicated in the SOPs (1 000 ft AGL) was crossed in clean configuration at an airspeed of 236 KIAS.

Stabilized approach gate

When the aircraft crossed the stabilized approach gate indicated in the SOPs, it could still reach the runway threshold at 50 ft AGL at a V_{ref} of 95 kt, in a landing configuration with flaps set to 15°, by decelerating in a climb then descending at a high rate before reaching the runway threshold.

According to calculations made using data from the aircraft manufacturer, the normal landing distance is 2 945 ft with the flaps set to 15° and in the conditions of the occurrence flight. This landing distance includes 1 707 ft for the landing roll with average braking conditions and no reverse thrust.

Knowing that he could land on short runways with the Pilatus PC-12, and having the runway in sight, the captain was confident that he could land within the first ⅓ of the runway (first 2 184 ft) and, therefore, believed that he had more than 4 300 ft of runway for the landing roll. The captain was convinced that he could stop on the wet runway, despite the tailwind.

Authority gradient and assertiveness

When the aircraft was approximately 6 NM from the runway, it was flying at an airspeed of 230 KIAS. The FO expressed his doubts that the landing would be successful, and the captain confirmed his intention to continue the high-speed approach. However, given that the captain had not communicated to the FO his intention to deviate from the SOPs—neither for the configuration at 1 000 ft AGL nor for the deceleration and aircraft configuration before reaching the runway threshold—it is likely that the FO had a different understanding of the situation. Therefore, the two pilots no longer had a shared situational awareness of the approach that was being executed outside of SOP-defined parameters or of the upcoming manoeuvre to conduct the landing as described in the briefing, i.e., at a V_{ref} of 95 KIAS with the flaps set to 15°.

The two pilots knew each other well, but given that the captain had three times more total flying experience than the FO and ten times more flying experience on the Pilatus PC-12, the authority gradient was high for flying experience on the Pilatus PC-12. During the approach, the FO voiced his discomfort, and then his doubt about a successful landing. However, his communications were not actionable, as is the case with a go-around call. The FO felt he did not have enough experience to shift from a passive advisory role to strong enough assertiveness to convince the captain to conduct a go-around.

Finding as to causes and contributing factors

During the high-speed approach, the FO had doubts that the aircraft could land successfully; however, due to the authority gradient, he deferred to the captain's experience and did not feel comfortable making the actionable go-around call.

Continuation of the high-speed approach

After crossing 1 000 ft AGL, the high-speed (236 KIAS) approach continued for 17 seconds, until the aircraft crossed 500 ft AGL (238 KIAS) at approximately 1.7 NM from the runway. During those 17 seconds, the captain, who was focused on the approach, likely experienced attentional narrowing, hindering him from having full awareness of the speed so close to the runway.

One second later, the airspeed exceeded the V_{mo} of 240 KIAS and the captain immediately reduced the power to minimum. Four seconds after the reduction in power, the captain initiated a climb to reduce speed more quickly. Despite this manoeuvre, the aircraft was 28 seconds from the runway threshold, while the theoretical deceleration time required to reach the V_{ref} of 95 kt was 35 seconds. As a result, it was no longer possible to slow the aircraft, configure it for landing and reach the V_{ref} of 95 KIAS, while at the same time descending to cross the runway threshold at 50 ft AGL. However, perceiving that it was still possible to land within the first ⅓ of the runway, the captain continued with the approach.

Finding as to causes and contributing factors

When the aircraft was approximately 1.7 NM from the runway, flying at an airspeed of 238 KIAS at 500 ft AGL, it was no longer possible to decelerate and continue the descent to reach the runway threshold at 50 ft AGL in a stabilized landing configuration at the V_{ref} of 95 KIAS. However, perceiving that it was still possible to land within the first ⅓ of the runway, the captain continued with the approach.

Decision to land

Generally, a high workload tends to cause attentional narrowing. Under these circumstances, some tasks may be missed or not performed in the right order, and some critical information may not be captured or taken into account.

Given the aircraft's high speed when it was approximately 1.7 NM from the runway at 500 ft AGL, the pilots had very little time to perform the tasks required to decelerate and configure the aircraft before landing. This high workload so close to the runway influenced the decision not to respect the airspeed limit for extending the landing gear, and to ignore the effect that the tailwind component combined with high speed can have when braking on a wet runway. In addition, given that the captain had created a mental model in which it was possible to land within the first ⅓ of the runway, his perception and understanding of the critical elements may have been clouded.

During the deceleration manoeuvre, the captain made the "gear down" call at approximately 195 KIAS, and the FO called out high speed, given that the maximum landing gear operating speed was 180 KIAS. The captain, focused on performing the tasks required for the landing, requested "gear down" again, thereby confirming to the FO his intention to land. Although the FO felt uncomfortable with the idea of continuing the approach and landing, he chose not to contradict the captain at this critical moment of flight, 0.5 NM from the runway threshold. He selected the landing gear extension at 188 kt. This action by the FO may have been interpreted by the captain as a validation of his decision. It should be noted that, at the time, the FO had very little time to analyze the situation and the options. The indication that the landing gear was extended and locked came only seven seconds before the aircraft touched down on the runway.

Even if it had been possible to conduct a go-around without too much difficulty before reaching the runway threshold, the go-around would have resulted in the flight service specialist submitting an aviation occurrence report and, very likely, the company following up with the pilots regarding the circumstances leading up to the go-around.

Given that the captain had already faced administrative penalties from the company for previous incidents, he may have reasonably believed that he would be facing new administrative and disciplinary measures if the company learned that he had conducted this high-speed approach, deviating substantially from the SOPs. It is therefore likely that this situation influenced his decision to continue with the approach to avoid an occurrence report being filed for a go-around.

Finding as to causes and contributing factors

When the aircraft was approximately 0.5 NM from the runway at 500 ft AGL, the captain was focused on conducting the landing within the first ⅓ of the runway, and insisted on the landing gear being extended even though the aircraft's speed exceeded the maximum landing gear operating speed at the time. The FO followed the order, and the landing gear was extended, which allowed the landing to continue.

According to the SOPs (before-landing checklist), the pilot flying calls "gear down, landing checks, flaps 15" when the airspeed is 170 KIAS or less and decreasing. In the occurrence flight, since the airspeed was approximately 185 KIAS after gear down was selected and the maximum speed with flaps extended was 165 KIAS, the FO asked the captain whether he should extend the flaps to 15°. The captain replied that the landing would be conducted without flaps. This decision was strategic within the context of his intention to land within the first ⅓ of the runway. However, landing without flaps increases the ground roll distance by approximately 680 ft on a dry runway, and only if the speed is stabilized at a V_{ref} of 115 KIAS without flaps.

The aircraft crossed the runway threshold at 200 ft AGL, at 180 KIAS (ground speed of 191 kt), with a rate of descent of 2 000 fpm, the landing gear was in transit, and the flaps were in the fully retracted position. In such a situation, even if the pilot manages the flight path for a landing within the first ⅓ of the runway, the aircraft has excessive vertical and horizontal speeds. To recognize that a change of plan is needed and to react in time, a pilot must perceive the condition or stimulus as important enough to warrant immediate action. Plan continuation bias becomes even stronger when a goal is on the verge of being achieved.

According to calculations, when the aircraft crossed the runway threshold with maximum braking on a dry runway and no reverse thrust or flaps, the landing distance was 7 170 ft, exceeding the length of the runway, which was 6 552 ft. Alternatively, maximum reverse thrust provided a theoretical margin of 157 ft. However, the runway was wet.

Finding as to causes and contributing factors

The aircraft crossed the runway threshold at 200 ft AGL at an airspeed of 180 KIAS, with a rate of descent of 2 000 fpm, the landing gear in transit and the flaps in the fully retracted position. Under such conditions, it was impossible to stop the aircraft on the wet runway. However, the captain continued the approach, influenced by plan continuation bias and focused on conducting the landing within the first ⅓ of the runway.

Landing and runway overrun

Runway conditions were not available at the time of the approach. However, the crew observed that the runway was wet. The tire inspection conducted after the flight found marks which confirmed that reverted-rubber hydroplaning had occurred while the aircraft was braking on the runway. Given that braking distance increases with hydroplaning, it is reasonable to conclude that the increase in braking distance on the wet runway exceeded the theoretical margin of 157 ft available for a landing on a dry runway with maximum reverse thrust.

The touchdown was relatively smooth, occurring approximately 2 525 ft beyond the runway threshold, at 159 KIAS (ground speed of 167 kt). The brakes were then forcefully applied, and reverse thrust was applied in the usual way (i.e., in idle reverse). The pilot did not use maximum reverse thrust and had never done so in the past. While braking, with the aircraft hydroplaning, the runway overrun was inevitable. Therefore, the usual use of reverse thrust was only a further contributing factor to the runway overrun. In reality, it only influenced the speed at which the airplane left the end of the runway and the distance travelled in the clearway.

The captain was focused on braking and maintaining lateral control of the aircraft on the wet runway and, therefore, did not immediately perceive that the runway overrun was likely. Fifteen seconds after touchdown, at approximately 750 ft from the end of the runway, when the crew realized that an overrun was imminent, the captain increased reverse thrust. Six seconds later, the aircraft overran the runway at a ground speed of 57 kt.

Finding as to causes and contributing factors

The aircraft landed on the runway approximately 2 525 ft from the threshold at 159 KIAS, i.e., a ground speed of 167 kt. Given that the excessive speed, combined with other factors, increased the landing distance, the aircraft overran the runway 21 seconds later, at a ground speed of 57 kt.

The flight data were compared with the data obtained during the certification flights conducted on a dry runway. The rate of deceleration obtained during the occurrence flight on the wet runway, with braking and usual use of reverse thrust (idle reverse), was slightly higher than the rates of deceleration obtained during the certification flight tests, with maximum braking and no reverse thrust. Before initiating the turn, the aircraft travelled approximately 600 ft in the clearway, which represents a landing distance of approximately 7 142 ft. This landing distance is similar to the manufacturer's estimated landing distance of 7 170 ft on a dry runway with maximum braking and no reverse thrust. It is therefore possible to conclude that usual use of reverse thrust (idle reverse) only offset the effects of hydroplaning.

Stabilized approaches

In AC 91-79A, the FAA states that "[a]dhering to the SOPs and best practices for stabilized approaches will always be the first line of defense in preventing a runway overrun." For its part, TCCA states that "[w]ith such significant weightage placed on the SOP it is incumbent on TCCA to review the operator's SOP for quality, consistency, accuracy, conciseness, clarity, relevancy and content."

Interpreting ambiguities and contradictions found in SOPs is not unique to the occurrence flight. From 1994 to 2022, inconsistent or missing procedures were identified in 39 (various) findings in TSB air transportation safety investigation reports. In many cases, the procedures had been reviewed by TCCA and no irregularities had been identified. These inconsistencies and deficiencies give pilots an opportunity to interpret certain situations, at times reducing the safety margins.

The company flight operations manual does not contain a general policy on the requirement to conduct stabilized approaches or to conduct a go-around if the approach is unstable. The company SOPs do define the stabilized approach criteria, the calls required in the event of a deviation (speed margins and rate of descent), as well as the point where the approach "should" be stabilized. The SOPs are also clear enough regarding visual approaches: the aircraft "must be" configured for landing and the before-landing checklist "must be" completed before reaching 1 000 ft AGL. However, the use of the word "should" when the approach is not stabilized may give the impression that it is a suggestion rather than a formal directive, and that continuing with the approach is at the captain's discretion. Hence, believing that there is no formal obligation to conduct a go-around, pilots may rely on their experience and assessment of the situation at hand to determine whether a successful landing is still possible. In the occurrence flight, the captain was convinced that he could successfully land within the first ⅓ of the runway and continued with the approach and landing.

The company SOPs were reviewed by TCCA, which verified that topics required by the regulations were covered and issued a letter of compliance to the company. However, TCCA did not check the quality, consistency, accuracy, conciseness, clarity and relevance of the SOPs.

Finding as to risk

If TCCA does not assess the quality, consistency, accuracy, conciseness, clarity and relevance of an operator's SOPs, these procedures may not be effective, increasing the risks to flight operations.

The reactive process inspection (PI) conducted by TCCA after the occurrence resulted in an observation regarding the wording of the SOPs, which [translation] "do not provide standard calls at specific altitudes to determine whether or not stabilization criteria [read: stabilized approach criteria] are met" and which could [translation] "lead crew members to believe that they have discretion in applying stabilization criteria." To avoid a situation similar to that of the occurrence flight, some operators include an actionable go-around call in their SOPs if approach criteria are not met at the stabilized approach gate or later.

The captain of the occurrence flight, who had a high workload, was focused on the manoeuvre to be executed and was still convinced that it was possible to land successfully, was unable to take into consideration all of the runway overrun risk factors. At that point, the FO had doubts that the aircraft could land successfully after this unstable approach, but he did not have enough time to discuss the matter and convince the captain to conduct a go-around. Therefore, an actionable go-around call was the only solution to stop the landing after an unstable approach.

Finding as to risk

If SOPs do not include mandatory and actionable go-around calls when approaches become unstable, pilots may choose to continue with an unstable approach, increasing the risk of a runway overrun.

Management of higher-risk approaches

In August 2021, following a similar incident that took place a few months before this occurrence, the company had taken action to prevent this type of high-speed approach from happening again. However, in light of the occurrence flight, these actions did not prevent a repetition of this type of approach.

Lightweight data recorders and flight data monitoring

The company airplanes are equipped with a system that records certain flight data that are used for engine condition monitoring. However, the airplanes are not equipped with lightweight data recorders (LDRs), nor are they required to be by regulation. Just having an LDR on board can positively influence pilot behaviour. Flight data monitoring (FDM) provides the possibility of overseeing flight operations, i.e., checking compliance with company procedures and operational limits, and identifying high-risk manoeuvres so that corrective action can be taken before an accident occurs.

For decades, operators of multi-engine turbine-powered aircraft that are used to transport passengers have been using FDM systems for preventive safety management. On several occasions, TSB air transportation safety investigation reports have highlighted the potential of LDRs and FDM systems to help other operators proactively detect safety deficiencies before they cause an accident. In addition, the TSB has issued two recommendations related to the implementation of FDM and the installation of LDRs.

Transport Canada (TC) has indicated that it agrees in principle with these recommendations and, in 2021, it published a Notice of Proposed Amendment (NPA) on LDRs. Following this publication, TC received significant industry input and comments that resulted in a re-assessment of the approach and scope of the LDR requirements. A new and revised NPA is planned to be published in 2023. The revision of the NPA and additional consultation will delay the timelines for regulatory implementation as detailed in TC's Forward Regulatory Plan. Until the revised NPA is available for review, it is unclear if the previously proposed requirements will be preserved. However, within the context of proactively managing operational hazards, operators could take action without waiting to be forced to do so by regulations.

As seen in this occurrence, the company has access to certain data when a parameter exceedance is detected. However, the company does not have access to data in other cases and cannot follow up, if needed.

Finding as to risk

If operators do not have LDRs and FDM systems, they may not be able to oversee compliance with policies, procedures and operational limits, increasing the risk that discrepancies or unsafe practices will go undetected and continue happening.

Findings as to causes and contributing factors

These are conditions, acts or safety deficiencies that were found to have caused or contributed to this occurrence:

1. During the occurrence flight, the captain, who was paired with a first officer with little experience on the Pilatus PC-12, decided to demonstrate a high-speed final approach, decelerating just before reaching the runway. As a result, the stabilized approach gate indicated in the standard operating procedures (1 000 ft AGL) was crossed in clean configuration at 236 KIAS.
2. During the high-speed approach, the first officer had doubts that the aircraft could land successfully; however, due to the authority gradient, he deferred to the captain's experience and did not feel comfortable making the actionable go-around call.
3. When the aircraft was approximately 1.7 NM from the runway, flying at an airspeed of 238 KIAS at 500 ft AGL, it was no longer possible to decelerate and continue the descent to reach the runway threshold at 50 ft AGL in a stabilized landing configuration at the landing reference speed of 95 KIAS. However, perceiving that it was still possible to land within the first ⅓ of the runway, the captain continued with the approach.
4. When the aircraft was approximately 0.5 NM from the runway at 500 ft AGL, the captain was focused on conducting the landing within the first ⅓ of the runway, and insisted on the landing gear being extended even though the aircraft's speed exceeded the maximum landing gear operating speed at the time. The first officer followed the order, and the landing gear was extended, which allowed the landing to continue.
5. The aircraft crossed the runway threshold at 200 ft AGL at 180 KIAS, with a rate of descent of 2 000 fpm, the landing gear in transit and the flaps in the fully retracted position. Under such conditions, it was impossible to stop the aircraft on the wet runway. However, the captain

continued the approach, influenced by plan continuation bias and focused on conducting the landing within the first ⅓ of the runway.

6. The aircraft landed on the runway approximately 2 525 ft from the threshold at 159 KIAS, i.e., a ground speed of 167 kt. Given that the excessive speed, combined with other factors, increased the landing distance, the aircraft overran the runway 21 seconds later, at a ground speed of 57 kt.

Findings as to risk

These are conditions, unsafe acts or safety deficiencies that were found not to be a factor in this occurrence but could have adverse consequences in future occurrences:

1. If cockpit voice recordings are not available to TSB investigators, it is impossible to accurately assess the pilot's decision-making, crew resource management, workload management and standard operating procedure execution and compliance, which may limit the identification of safety deficiencies and the advancement of flight safety.
2. If standard operating procedures and training do not incorporate runway overrun risk factors, these risk factors may not be taken into consideration during approach, thereby increasing the risk of a runway overrun.
3. If TCCA does not assess the quality, consistency, accuracy, conciseness, clarity and relevance of an operator's standard operating procedures, these procedures may not be effective, increasing the risks to flight operations.
4. If standard operating procedures do not include mandatory and actionable go-around calls when approaches become unstable, pilots may choose to continue with an unstable approach, increasing the risk of a runway overrun.
5. If operators do not have lightweight data recorders and flight data monitoring systems, they may not be able to oversee compliance with policies, procedures and operational limits, increasing the risk that discrepancies or unsafe practices will go undetected and continue happening.

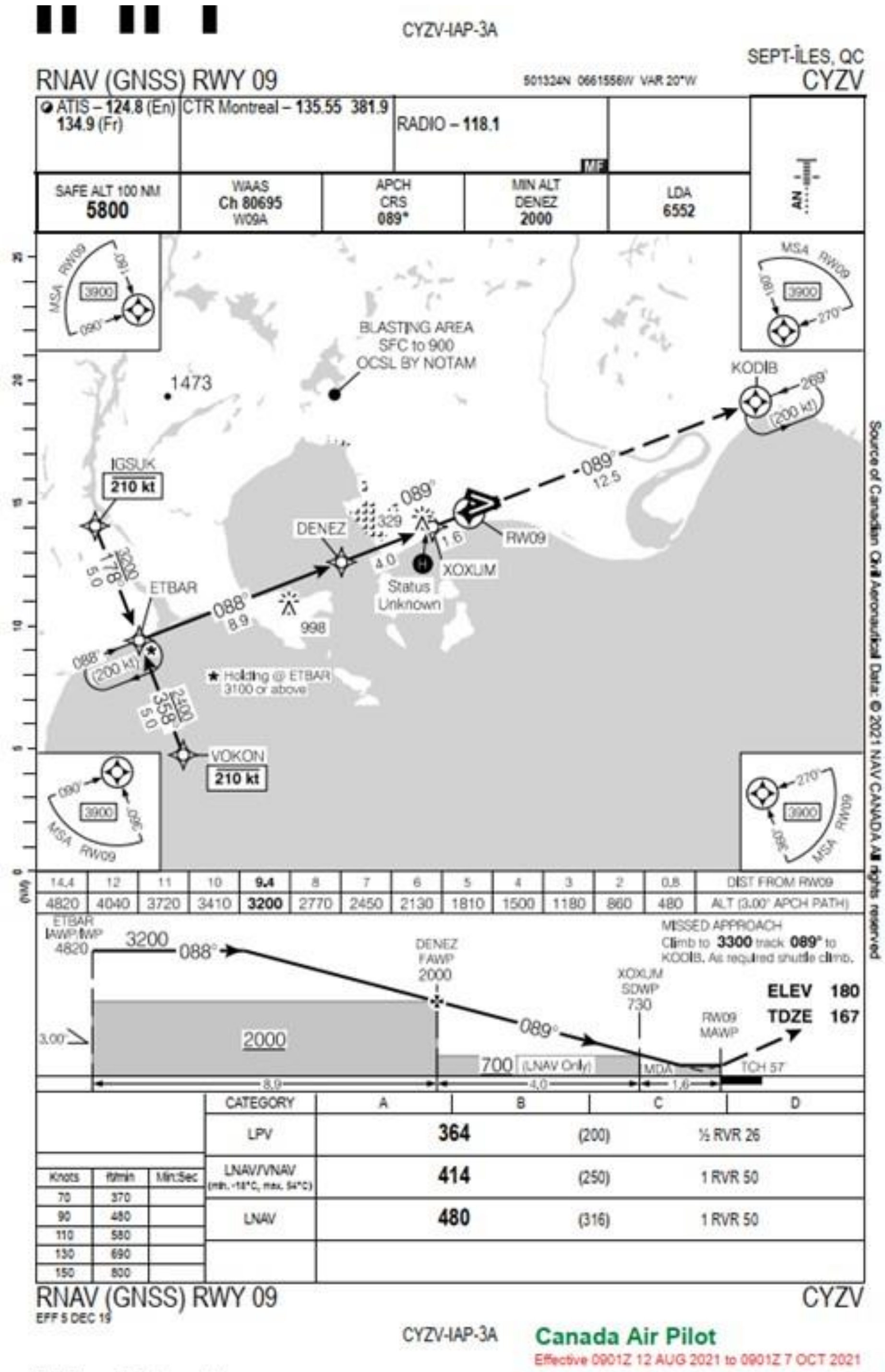
Other findings

These items could enhance safety, resolve an issue of controversy or provide a data point for future safety studies.

1. According to TCCA's interpretation, the Sept-Îles Airport is an uncontrolled airport because it does not have a control tower. As a result, the airspeed limitation of 200 kt stipulated in paragraph 602.32(1)(b) of the *Canadian Aviation Regulations* does not apply.

Appendices

Appendix A – Sept-Îles Airport approach chart



NOT FOR NAVIGATION
Source: NAV CANADA, Canada Air Pilot (CAP), CAP 5: Quebec,
effective 12 August 2021 to 07 October 2021

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