RAA
RECREATIONAL AIRCRAFT ASSOCIATION
RÉSEAU AÉRONEFS AMATEUR CANADA

The Leading Edge

Monthly Newsletter of the Kitchener-Waterloo RAA

- April 2019 -

Mike Thorpe returned for the third year to the Toronto International Sportsman show with his HighMax single place ultralight. Mike does an amazing job of informing people about the joys of building and flying aircraft. Lee and I were lucky enough to get to join Mike there and talked to dozens of people about RAA, COPA, UPAC and of course our own aircraft when the opportunity arose. We applaud Mike on his endeavour to promote recreational aviation.

President's Message

At the March meeting Harish Jadeja conducted a very informative presentation on drone operation and training opportunities.

We also had a show and tell, with some interesting items brought. Ed Welfred showed us a carbon fibre door frame that he built for his Bearhawk.

Lisa Beiler brought in a set of hand-crafted snow shoes. If these are an indication of the aircraft she will build, it will be a showpiece.

At the April meeting Pat Hannah showed us some new products and Lee talked about a crash in BC. In this newsletter, Lee explores the recent TSB report on a crash in BC, recounts his own experience flying in the mountains and makes some insightful recommendations.

2019 is going to be another great year for KWRAA.
- Dan

ELTs, ADS-B and Position Tracking Update after TSB Investigation Report A17P0170

The tragic events of a crash in 2017 in BC highlight a number of issues including the need for adequate pilot training, proper decision making both pre-flight and in-flight, as well as, the need for adequate safety equipment to assist in the decision making process (ADS-B and obstacle warnings) and better SAR location details (ELT) in the event of a crash. Sadly, the recommendations of this TSB investigation were based only on their factual report and they did not comment on the corrective measures that may have prevented this crash in the first place, but let us look at this accident in more detail.

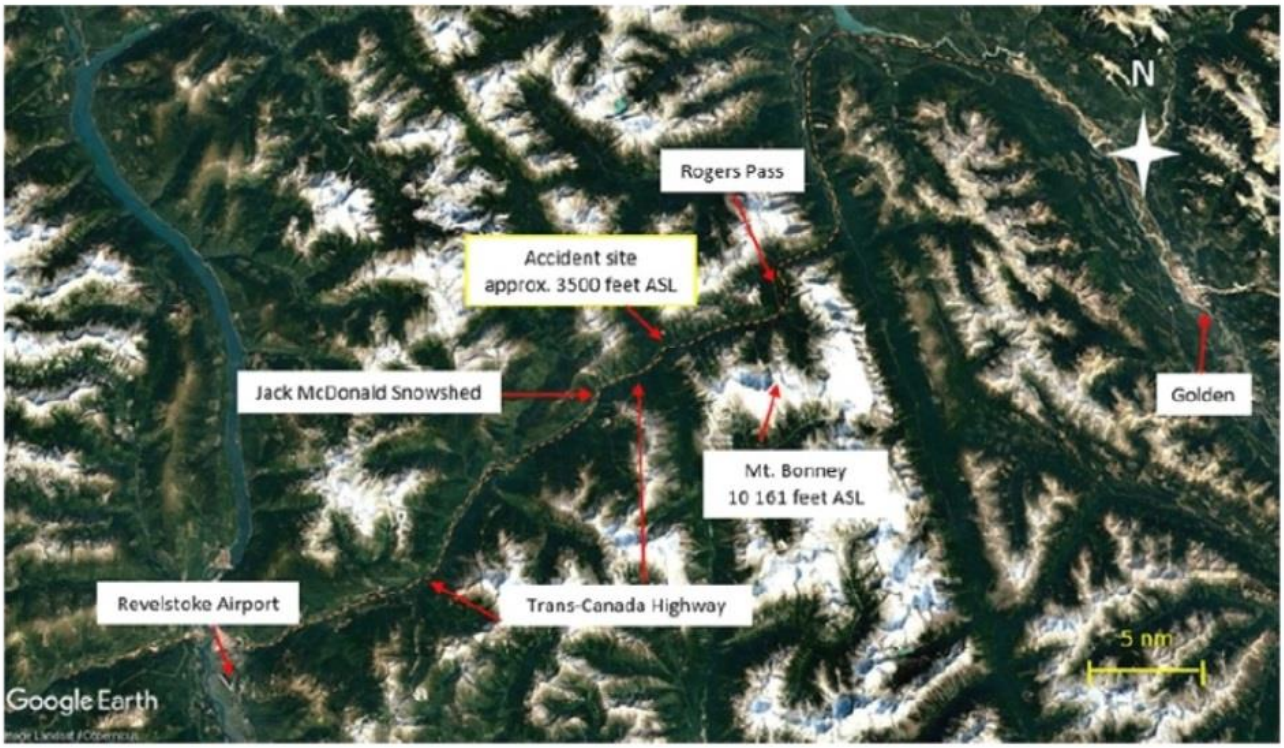
Aviation Investigation Report A17P0170

The TSB report for the Mooney that was lost between Revelstoke and Golden, B.C. during November 2017 highlighted yet another failure of an ELT. We all knew at the time that the ELT didn't function and that telephone CEL towers were receiving something, but not enough to be found. It took 9 months for a passing helicopter to see the crumpled wreckage. The irony was that the aircraft impacted just 150 m away from the TransCanada Highway near the Rogers Pass.

The flight started out from Penticton at 14:22 local time (PST) with 2 people on board, possibly with an accelerated agenda to get back to Edmonton before dark. The investigation was unable to determine the pilot's exact number of flight hours at the time of the occurrence. According to the logbook, up to 28 May 2017, the pilot had accumulated 122.2 total flight hours, with 1.1 hours on type and 29.8 hours as pilot-in-command. The pilot didn't get a weather briefing and didn't file a flight plan, but must have had a flight itinerary. The online weather products for this region were indicating localized ceilings forecast at 1500 feet AGL with light rain. An area near Glacier National Park and Rogers Pass was forecast to have intermittent ceilings at 800 feet AGL with mist and light rain, and the visibility was forecast to vary between 5 miles and greater than 6. Sunset for Revelstoke on 25 November 2017 was at 15:54. The aircraft got to Revelstoke at 15:10 but then impacted about 4 km from the Rogers Pass, 150 m from the highway at 15:27, 30 mins before sunset. While the aircraft was following the highway, its height above ground level (AGL) varied between 1200 feet and 3300 feet. At approximately 15:27, the aircraft passed the Jack McDonald Snowshed at 5200 feet ASL (approximately 2300 AGL), travelling at 131 knots. The final 2 GPS track points, which were very close to the accident site, indicated that the aircraft's airspeed had slowed from 147 knots to 82 knots and the aircraft had climbed from approximately 1710 feet AGL to 2550 feet AGL in 11 seconds. Examination of the wreckage indicated that the aircraft struck the terrain in a steep, nose-down attitude. The slope of the hillside was approximately 25°. The flaps were found in the fully retracted (up) position. SAR was advised at 22:40, about 7 hours after the crash. The weather at that time prevented a search. There were no survivors.

The report defers to a much more thorough accident report (AH13001) of a helicopter flying into terrain and the ELT failing to operate. There are similarities but there is much more to consider. Why would the accident end this way? The report touches on the surface of a number of factors but does not go into detail about why it may have happened or how it could have been prevented. Unfortunately, this is the final report on this accident.

Figure 1. Aircraft's last known position and the accident site (Source: Google Earth, with TSB annotations)



I have taken a personal interest in this accident because I have flown this area and have experienced the frustration of navigating in the mountains. In 2013 on a trip between Calgary and Vancouver in my Piper Warrior, my co-owner and I were blocked in the Rogers and Kicking Horse passes by weather. These narrow passes seem to make their own micro climates and hence their own rules. We weren't experienced with mountain flying but had taken training at the Springbank Flying Club and timidly ventured forth. It did take two of us to convince ourselves of the various options. We felt fortunate to make it through but not without help.

Situational Awareness: The VFR sectionals identify mountain routes with paths marked with triangles. This helps in planning routes but the paper maps aren't much help in the cockpit. The triangles clutter the map and obscure town names and geographic features. We found that an EFB can take those same maps and zoom in to reveal the hidden detail with your own GPS position. We had tested this in our mountain training and Foreflight in particular would show the position and the predicted turn radius in these canyons. Our litmus test happened in the Kicking Horse Pass in Yoho National Park. The cloud and mist obscured a good view ahead. We placed ourselves on one side of the canyon and did a racetrack path as we slowed down and tried to contact flight service on the Golden RCO. The EFB showed accurately where we were and gave us some confidence as the mist changed. Flight service contact was intermittent but did indicate that Golden was open. Our aviation GPS was also loaded with waypoints to avoid significant terrain as we made our way through the valleys. Uncertainty in these conditions is really disturbing and the thought of doing this at dusk is overwhelming. It took two of us to keep our eyes outside and reference the EFB and GPS. We also had our paper maps but their importance was only good for flight planning or maybe a survival fire. Also, you could be one battery failure (GPS, EFB) from an aircraft mishap. Navigation backups are good and depending upon one single technology is risky. Unfortunately, it is difficult to determine what the Mooney had beyond an aviation GPS. These units do not have detailed terrain maps. The GPS data showed that it was

screaming through the area at 131 kts, with speeds up to 147 kts.

Figure 2 EFB Display of Sectional (ForeFlight shown)

The EFB in the mountains also helps to identify the right mountain pass. Often a slow-down is necessary and an orbit is helpful to keep on the right track.

Collison Avoidance in the Mountain Routes: Luckily, there isn't a lot of traffic through the canyons but if everyone is staying on one side of the canyon, mostly because of wind direction, then there could be a problem. Travelling in this area there is a need to monitor and provide position reports on 126.7 MHz. You need to know exactly where you are and be able to read the place names on the maps. Again, EFB zoomed maps are best! Pilots should respond to each other's position reports to resolve conflicts. Better yet, an ADS-B in/out system could make a lot of difference to identify traffic relative to you in position and height. But the ADS-B needs to be affordable and non-complex, available to everyone. An audio warning may also be necessary to trigger extra awareness. The caution is that this technology does not constitute a collision avoidance (CA) system. It is necessary to negotiate a resolution by radio. With my ADS-B, I am always amazed at the amount of traffic I don't see by eyeball, especially when visual contrast is poor. I can see situations on my ADS-B way before they turn into something serious. There were no reports of other aircraft hearing the Mooney on 126.7, but with low ceilings in the pass, there may not have been any other GA traffic at the time, with the possible exception of some experienced helicopter operators who seem to have a sixth sense in the mountains.

Flight Service Support: Although the Kamloops FSS can monitor 126.7, they only respond on the official RCO frequency. The RCOs in that area are at Revelstoke and Golden, strategically providing service at both ends of the mountain route. There are weather stations at both of these locations but there are no NavCan facilities along the route and the VHF coverage doesn't extend very far into the passes. The weather could be fine at both ends but the micro climates in between may differ. The FSS specialists have tools that we don't have on our devices. Besides offering better weather packages, they can also see the BC Highway cameras along the route. I checked with Kamloops FSS and they do routinely look and will provide an insight into these camera images giving estimates of visibility and ceiling. A ground briefing followed up by an update on the RCO is always a good strategy. Further, NavCan flight plans can now have references made to subscription satellite tracking products like Spot or InReach, so that they can monitor the active position of the aircraft. Radar displays are also available at most FIC units with mosaic targets distributed from the local ATC Centre (CYVR). The closest radar is west of Salmon Arm at 5900 ft ASL. It may have seen the aircraft enter the canyon at Revelstoke if the transponder was functioning. However, the FSS was unaware of the Mooney as there was no flight plan and no position reports made.

What about ADS-B weather?

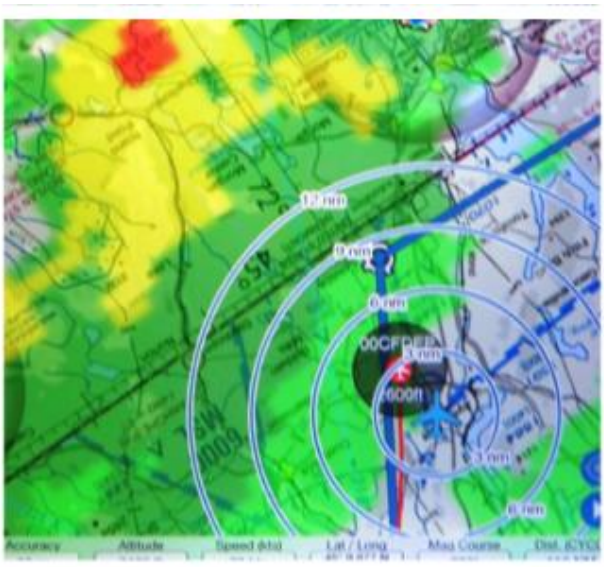


Fig. 3. ADS-B weather screenshot for illustration only

What if ADS-B weather products had been available in the cockpit from the local RCO sites, similar to what is provided by the FAA?

The ADS-B weather in aircraft has proven very useful in avoiding weather when I travel near the border. Weather is loaded from the ground stations and retained in the display memory. If this service were available, the latest METAR, TAF and regional WX radar could be available from the Revelstoke RCO. The weather radar could have been useful in alerting the pilot of what was ahead. This radar is located 80 nm to the southwest near Silver Star Mountain at 6200 feet ASL. WX radar in the mountains is deceiving as there is almost always a lot of stationary clutter. A call to Flight Service could provide clarity.

We can only speculate on the actions taken by the Mooney pilot, but as a low time pilot without even a night rating, his instrument flying time would be minimal, likely only the few short hours of time under the hood in obtaining his PPL. Flying into IMC conditions without any experience and proper training is deadly as historical crash statistics show. Flying into IMC in a narrow mountain pass is a recipe for disaster as the canyon walls may not provide enough turn radius. The sudden climb and slowing of the airspeed of the Mooney along with its steep impact would seem to indicate a stall or other unusual event just before impact. The report falls far short of providing any insight on what likely happened and how it could have been avoided, instead focusing on ELT issues.

Crash Locating:

The wreckage of a 1963 Mooney M20D that went missing in B.C.'s mountains last November was found by a passing helicopter 10 months later. The cost was enormous in resources, but the distress of the families was incalculable.

"RCAF SAR and Parks Canada aircraft had flown 120 hours over an area of over 22,000 square kilometres of very rugged terrain before calling off their search after nine days. The search area had been narrowed down to an area of 18 kilometres outside Revelstoke based on information from radar and a cellphone tower that picked up a signal from the pilot's phone". COPA 2014/9/13.

Fig. 4. Remains of the Mooney when finally found

The TSB reported… "The aircraft's 121.5 MHz ELT was also recovered at the accident site. The ELT's antenna was found detached from the connector, and the batteries had been ejected from the battery enclosure during the impact sequence. When initial power was applied to the ELT, it started to transmit a strong signal, which confirmed that the inertia switch was in the activated state."

As a result they pulled out some previous safety recommendations:

TSB Recommendation A16-01

…the Department of Transport require all Canadian-registered aircraft and foreign aircraft operating in Canada that require installation of an emergency locator transmitter (ELT) to be equipped with a 406 MHz ELT in accordance with International Civil Aviation Organization

TSB Recommendation A16-05

…the Department of Transport establish rigorous emergency locator transmitter (ELT) system crash survivability requirements that reduce the likelihood that an ELT system will be rendered inoperative as a result of impact forces sustained during an aviation occurrence

The newer 406 MHz ELT to TSO-C126 are more robust, with newer technology batteries and smaller transmitters. The 406 antenna is also shorter and potentially more crashworthy. At very least the batteries are unlikely to fall out as in the crash aircraft. There are other features in some 406 models that could have been a game changer for this accident:

- GPS - An internal GPS is powered up after the crash to provide a more accurate

position, and quicker than the ELT satellite network can provide. There are other models that have a GPS interface but that external device must be operational after the crash.

  - Wouldn't 20m accuracy be better than 1 nm uncertainty?

- Internal 406 Antenna -.If the external antenna system is damaged, the internal antenna takes over. This is an important feature as it seems that most airframe mounted ELT antenna systems fail due to crash forces. This type of ELT can be treated as autonomous and be removed to aid in the location of survivors.

The cost of these features brings the ELT equipment purchase to about $1600 compared to under $1000 for basic 406 models, but these features are worth the added investment in safety and survivability.

ELT Background:

ELTs have been in use in Canada since the 1970s. The 121.5/243 ELT to TSO C91 have evolved over that time with better batteries and packaging but the basic trouble is that they were a compromise from the original concept of an ejectable Crash Position Indicator (CPI). The FAA forced the ELT regulation as key accident cases in Alaska drove the introduction into "new" aircraft in the 1970s. At first they were installed at the rear of the aircraft, very close to the tail empennage, considered the most survivable part of the airframe. As time went on, people moved them to more convenient locations in the rear of the cabin. A great number of high wing Cessna models now have the ELT and antenna behind the rear window.

Fig. 5 Illustration of the tail crumple zone on a Cessna

When NASA did crash worthiness tests, this airframe location turned out to be a structural weak point, causing the ELT and antenna to be caught in the middle. The FAA and Transport Canada provide little guidance in locating ELT components, so the TSB Recommendation A16-05 needs attention. More needs to be addressed than just the removal of hook and loop fasteners highlighted by Transport Canada in ASL Issue 1/2017.

Future of ELTs:

According to the TSB in 2016, more than half of the 27,000 civil aircraft in Canada aren't equipped with the 406 MHz ELT, "that could save lives by allowing search and rescue crews to more easily find potential crash survivors". This was reported in "*Why do some planes in Canada lack potentially life-saving emergency beacons?*" by the David Burke, November 8, 2018. This is a very comprehensive article on the subject, taken from TSB reports and is worth reading.

Can ADS-B Replace an ELT?:

Automatic Dependent Surveillance - Broadcast is a system designed to locate and identity aircraft traffic for aircraft to aircraft avoidance and ATC surveillance. Aircraft positions are sent out twice a second and are received by other aircraft and either ground stations or satellite. At first glance it would seem that ADS-B has the capability to replace ELTs but the international standard 1090ES uses the same frequencies as the existing secondary radar system and transponders. This is both a benefit and shortcoming. UAT or Universal Access Transceiver operates on 978 MHz on lower power and provides more services, making it very useful for GA airplanes by providing weather and NOTAMs in-flight. The FAA allows either system in their airspace to meet the ADS-B- OUT mandate starting January 1, 2020, but Canada has not endorsed the use of UAT here. The FAA ADS-B system is a ground-based system as it enhances the existing radar services so almost every ADS-B GA aircraft has a conventional bottom mount antenna to comply.

Given the lower cost associated with UAT vs. 1090ES, many Canadian pilots install UAT hardware to get TIS-B and receive FIS-B as an added bonus if they are within range of US ground stations. Upgrading to 1090ES requires

throwing away the old transponder and replacing it with a compliant 1090ES transponder and often expensive WAAS GPS. There is no quick or inexpensive add-on solution for most of the older GA aircraft. Since the additional UAT ADS-B transmitter and GPS can be located remote from the panel, a complete overhaul of the panel is not needed. Most of these UAT add-on units run autonomously, requiring no operator intervention, which is an operational advantage.

Nav Canada has implemented an ADS-B mandate for surveillance based upon the Iridium low earth orbit satellite system called Aireon. This system will provide complete coverage of the world but that comes at a cost to Canadian GA. The mandate will affect GA after 2023 in what now is "transponder-only" airspace. The proposed requirement is for 1090ES operation with top and bottom mount antennae (diversity) with a minimum of 125W of power. There is also no support for UAT and no uplink services planned.

Advocacy groups lead by AOPA responded to the diversity requirement on March 6th 2019…

"Industry Challenges Canada ADS-B Mandate – Required Antenna Diversity Solutions Scarce, Expensive" – AOPA website (March 6, 2019)... Their letter focused upon the expensive and rare diversity antenna equipment for GA aircraft since the proposed requirement is incompatible with the majority of FAA 2020 compliant 1090ES transponder installations, which may cause cross border safety issues. Also, the details were revealed too late for manufacturers to make compatible solutions. 1090ES aircraft, with a bottom mount antenna may work intermittently with Aireon with an effective power of about one watt referenced to the top of the airframe, after starting with 125W, especially on aluminum-skinned aircraft.

If the Mooney's transponder had been replaced with a 1090ES ADS-B unit, using the existing bottom mount antenna, then there may have been a chance to track it, but the likelihood of a solid signal to Aireon would be extremely low. If a top mount antenna had been present then it would have been tracked to the limits of aircraft maneuvering as long as the antenna has the view of the Aireon and GNSS satellites. Target reports are about twice a second for 1090ES and about 3 times a second for UAT. The reports that get through will be affected by antenna shadowing and any 1090 MHz interference just prior to the crash. The WAAS position accuracy should normally be well within 100 m ignoring the final maneuvering affecting both ADS-B and GPS performance.

So, the short answer as to whether ADS-B could replace an ELT is "maybe, or maybe not". There would likely be a need for either a top-mounted transponder antenna or expensive diversity system, the latter of which would never be installed on the vast majority of GA aircraft due to extreme cost. Additionally, tracking is one thing, but alerting the necessary services is another. The Aireon ALERT service promises it has detection features to detect a crash event, but it is still not clear if this will only be available while using NavCanada services such as flight following or a flight plan. In any case, at this juncture, the ALERT service is not available for most of us, only to ATC service providers, airlines and SAR agencies. Unfortunately, NavCanada has encouraged the idea that ELTs can be replaced by ADS-B, leading to the following statement from COPA after the Mooney crash… "COPA continues to advocate for the use of satellite-based ADS-B OUT technology to replace ELTs in aircraft." - COPA (March 2019)

I believe that ELTs have a place in today's satellite environment. The complementary technologies like ADS-B can provide a safety net that reduces the chances of an accident. COPA's counterpart in the US, AOPA states on their website "…the FAA stated they determined that the ADS-B system cannot replace the ELT function. They noted the ADS-B system is not required to be crashworthy and, thus, may not be operable or able to transmit following an aircraft accident". Since 406 ELTs are triggered automatically by integral g-switches, feature long life batteries and use different satellites that are not fully dependent upon GNSS technology, "AOPA supports the installation of these more advanced ELTs on a voluntary basis."

Other useful tracking options:

There are other satellite-based tracking services that have the ability to alert the Rescue Coordination Centre, while also providing track position reports to people on your friends' list. These services include SPOT, INREACH and Spider Tracks, all of which have options for messaging and different tracking intervals. I have used SPOT on a lot of my trips with the 10 minute tracking service and I have found it adequate for alerting friends and family as to my whereabouts. The later generation products have better tracking and battery life. Luckily, I have not had to use the emergency alert features which are manually activated.

Conclusion:

It surprises me that the TSB did not make a more thorough report for this unfortunate accident. There were items, which should be considered as "Watchlist" issues for the GA community. The ELT failures were covered mostly, but it is becoming more apparent that even the most rugged and self-contained 406 ELT requires the internal antenna and GPS. ELTs have had bad press within the pilot community so a way forward is needed to improve our attitudes and SAR outcomes. In all of the TSB accident reports I have read the 406 ELT was operational but a broken antenna system prevented full operation. The other item that has shown up on other TSB reports is the issue of Flight Data Recorders. The Mooney had a GPS that recorded the tracks, but what if the GPS were some other type that did not survive the crash or did not provide a useful track log? At least tell us what model was used and whether the TSB would prefer a video or audio recording to go along with it to reconstruct an accident in more detail.

ADS-B tracking doesn't replace a properly installed 406 ELT, but there currently is no single answer to emergency location. Situational awareness, weather knowledge and traffic avoidance help to avoid accidents are available now in the FAA concept of ADS-B, using UAT to deliver those services. Aireon ADS-B is too limited and expensive for GA and does not provide or encourage in-flight services that help prevent accidents. Finally, I believe the TSB should be looking more at the cause of incidents like this and providing recommendations or at least guidance on prevention rather than focusing on the ELT and SAR aspect. Given the lack of factual evidence regarding the pilot's actions prior to the incident, and the timeframe before it was discovered, I understand that this is challenging to present in a factual report. So, let's at least remediate the ELT installation issues and move on.

My Recommendations:

1. Promote the TSB recommendation for 406 MHz ELTs, preferably with an internal GPS.
2. Promote the TSB recommendation for crash worthy installations, or replace the ELT with one that has an internal 406 antenna.
3. Promote periodic testing that does not compromise battery life. An emailed test report is required to confirm proper operation to the user.
4. Promote ELT maintenance procedures that reduce the amount of times the ELT is removed between battery changes. Promote cost effective battery packs. Publish battery and maintenance costs for users to select their best option.
5. Promote proper handling of ELTs to reduce the false alarm rate. This is still happening even for the newer 406 MHz ELTs.
6. Promote a layered approach to emergency location:
   a. File a flight plan with FSS. Include your tracker following information as a URL in it
   b. Consider a satellite subscription service (have spare batteries ready)
   c. Install ADS-B for traffic avoidance and potential target tracking by others
   d. Keep your ELT in service and your RCC information up-to-date
   e. Don't forget your cell phone
   f. Have an appropriate emergency kit. Keep it within easy reach or wear it!
   g. Consider a flight data recorder to review your trips and provide emergency logs (Foreflight provides this service)

7. Overhaul the ADS-B concept in Canada to enable a cost effective and progressive network that allows for free and safe movement of traffic across the US border using 1090ES and UAT services.
   a. Collision Avoidance - Air to air communication and Air to Ground for radar tracked aircraft.
   b. Situational Awareness - using GNSS technology along with subscription free in-flight weather services.
8. Carry your cell phone when travelling and consider a portable satellite-based signalling device and subscription for your aircraft.

Summary of Emergency Location Technologies:

Technology	***Activation***	***Power***	***Accuracy***	***Device Cost***	***Recurring Cost***	***Notes***
ELT	*Auto & Manual*	*Long life battery*	*<100m with GPS*	*$1600*	*Yearly $100, Batteries $150-$500 / 5 yr regulation but 2-4 yrs. actual life*	*Dual 406 and 121.5 MHz operation*
ADS-B Aireon	*Manual*	*Aircraft*	*<100m with GPS*	*$8K and up.*	*$600 for Pitot static/ 2 yr*	*Diversity (dual) antenna*
ADS-B FAA 1090	*Manual*	*Aircraft*	*<100m with GPS*	*$6K and up*	*$600 for Pitot static/ 2 yr*	
ADS-B FAA - UAT	*Manual*	*Aircraft*	*<100m with GPS*	*$2K and up*	*$600 for Pitot static/ 2 yr*	
Subscription SPOT, InReach etc.	*Manual*	*Battery*	*<100m with GPS*	*$150 - $500*	*$150 and up /yr*	*Loose in aircraft? GPS signal required*
CELL Phones	*Manual*	*Battery*	*General area near cell tower*	*$150 - $500*	*$50+ /mth*	*For WX, flight planning & emergency services*

Lee Coulman
VP KWRAA and Past Director of Flight Safety

Upcoming Events in 2019: (Highlighted lines are KWRAA Events*)

May 13	-	May Meeting at 7:30 in the Cadet building at CYKF
June 6-8	-	COPA National (Western) Convention in Innisfail, Alberta (CEM4)
June 15	-	KWRAA Largo Woods Fly-in near Winterbourne
July 6	-	KWRAA Fly-In – Jergenson Field – Arthur
July 13	-	Zenair Open House – Midland at CYEE - Huronia Airport
July 22-28	-	Air Venture Oshkosh in Wisconsin, USA
July 27	-	KWRAA Fly-In at Wilf Holyoake's near Belwood Lake (Tentative)
August 10-11	-	Gathering of the Classics in Edenvale
August 16-18	-	UPAC Convention – Lubitz Field, Plattsville
August 17	-	Aviation Fun Day at CYKF – Waterloo Region International Airport
August 22-24	-	COPA National (Eastern) Convention Cornwall Regional Airport (CYCC)
August 31	-	KWRAA Fly-In at Roger Deming's – Kenilworth
September 9	-	September Meeting at 7:30 in the Cadet building at CYKF
October 21	-	October Meeting at 7:30 in the Cadet building at CYKF
November 11	-	November Meeting at 7:30 in the Cadet building at CYKF
November 29	-	KWRAA Christmas Party – Details to follow later in 2019

* KWRAA events are fly-in and/or drive-in.

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