

**MEETING MINUTES
MEETING OF SPECIAL COMMITTEE 231**

Terrain Awareness Warning System (TAWS)

RTCA Paper No. 230-19/SC231-030

Date: Sep 24-25, 2019

Time: 0900 EDT to 1700 EDT

Place: RTCA Office, Washington DC

Co-Chairs: Yasuo Ishihara Rick Ridenour

Government Authorized Representative: Charisse Green

Attendees:

Name	Company/Agency	Attendance Day 1	Attendance Day 2
Adler, Richard	Federal Aviation Administration (FAA)	Attended in person	Attended in person
Baker, James (Kirk)	Federal Aviation Administration (FAA)		
Bleakley, Timothy	General Atomics Aeronautical Systems, Inc.		
Blom, Stefan	Saab Group	Attended in person	Attended in person
Bradley, Capt. Mark	Delta Air Lines, Inc.		
Bulger, Chip	Federal Aviation Administration (FAA)		
Burgeles, Mr. Brett	The Boeing Company		
Bykov, Vladimir	International Aeronavigation Systems (IANS Inc.)		
Caporaletti, Stephanie	The Johns Hopkins University	Attended on phone for GCAS presentation	
Caruhel, Mrs. Camille	Airbus		
Chism, Linda	Alaska Airlines	Attended in person	Attended in person
Cros, Xavier	Airbus		
Dean, Mr. Garfield	EUROCONTROL		
Dhulipudi, Mr. Durga	Honeywell International, Inc.		
Duke, Rune	Aircraft Owners and Pilots Association	Attended in person	

Name	Company/Agency	Attendance Day 1	Attendance Day 2
Dunagan, Mr. Joseph	Raytheon		
Farjon, Julien	Safran Avionics	Attended on phone for GCAS presentation	
Fisch, Wayne	Universal Avionics Systems Corp.		
Fleury, Stephane	Thales Group		
Forrest, Joseph	Collins Aerospace		
Franzen, Mr. Paal	Astronautics Corporation of America		
Froehlich, Donna	Aurora Innovations	Attended on phone for GCAS presentation	
Geoghagan, William L	National Air Traffic Controllers Association (NATCA)	Attended on phone for GCAS presentation	
Goddard, David	Garmin Ltd.		
Gosselin, Eustis	Jacobs Technology		
Green, Charisse	Federal Aviation Administration (FAA)	Attended in person	Attended in person
Guendel, Randal	MIT Lincoln Laboratory	Attended on phone for GCAS presentation	
Hogestad, Marie	Federal Aviation Administration (FAA)		
Hughes, Rob	Northrup Grumman	Attended on phone for GCAS presentation	
Ishihara, Yasuo	Honeywell International, Inc.	Attended in person	Attended in person
Jacky, Tom	NTSB	Attended in person	Attended in person
Jain, Ravi	FAA - AIR	Attended on phone for GCAS presentation	
Johnson, Steve	Honeywell International, Inc.		
Johnson, Chuck	NASA	Attended on person for GCAS presentation	
Judge, John	Sikorsky	Attended on phone	Attended on phone
Kapytov, Vasily	International Aeronavigation Systems (IANS Inc.)		

Name	Company/Agency	Attendance Day 1	Attendance Day 2
Kindred, Rob	National Air Traffic Controllers Association (NATCA)		
King, Mr. Matt	Alaska Airlines		
Kirtz, Jon	Collins Aerospace	Attended on phone	Attended on phone
Koffink, Michael	Intertek Testing Services NA		
Korns, Peter	National Business Aviation Association	Attended in person	Attended in person
Kuffner, Maria	MIT Lincoln Laboratory	Attended on phone for GCAS presentation	
Labay, Mr. Marcus	Federal Aviation Administration (FAA)	Attended on phone	Attended on phone
Lawrence, Mr. Tom	Universal Avionics Systems Corp.	Attended in person	Attended in person
Lombard, Kolie	Science Applications International Corporation (SAIC)	Attended on phone for GCAS presentation	
Lokatt, Mikaela	Saab Group	Attended in person	Attended in person
Lorey, Janiece	Gulfstream Aerospace Corporation	Attended in person	Attended in person
Matuson, Michael	RDRTec	Attended on phone for GCAS presentation	
Morrison, Rebecca	RTCA, Inc.	Attended in person	Attended in person
Mulkins, Jim	Honeywell International, Inc.		
Ostrom, Gary	Honeywell International, Inc.		
Parikh, Mr. Ajay	Ligado Networks		
Philbin, Mr. John	Northrop Grumman Corporation		
Pippard, Mr. Nigel	Saab Group		
Price, Ricardo	Genesys Aerosystems	Attended on phone	Attended on phone
Prosser, Kevin	Gulfstream Aerospace Corporation	Attended in person	Attended in person
Reed, Mark	ALPA		
Resnick, Mr. Boris	International Aeronavigation Systems (IANS Inc.)		Attended on phone
Reynolds, Zach	L3 Technologies	Attended in person	Attended in person

Name	Company/Agency	Attendance Day 1	Attendance Day 2
Ridenour, Rick	L3 Technologies	Attended on phone	Attended on phone
Ringnes, Mr. Erik	Honeywell International, Inc.		
Romero, Leroy	Honeywell / Bendix King	Attended on phone	Attended on phone
Rossi, Mr. Angelo	The MITRE Corporation		
Ryan, Wes	FAA		
Sadilov, Mr. Vsevolod	International Aeronavigation Systems (IANS Inc.)		
Sauter, Michael	Lufthansa		
Sheng, Randy	Honeywell International, Inc.		
Skoog, Mark	NASA		
Smearcheck, Samantha	The Johns Hopkins University	Attended on phone for GCAS presentation	
Stevens, Aubrey	Delta Air Lines, Inc.		
Stone, Capt. Rocky	United Airlines, Inc.		
Sun, Hui	Honeywell International, Inc.		
Thurling, Andy	NUAIR	Attended on phone for GCAS presentation	
Tubb, Nick	The Boeing Company		
Vafiades, Monica	U.S. Air Force		
Vogl, Tom	Rockwell Collins	Attended on phone for a short time at start	
Williams, Shaun	NTSB		
Wilson, Garry	Gulfstream Aerospace Corporation		
Winkel, DJ	Garmin Ltd.	Attended on phone for GCAS presentation	
Zapoluch, Steve	Garmin Ltd.	Attended on phone	Attended on phone

Plenary Discussion:

Wednesday, Sep 24:

A slide presentation was provided to the group to develop on the initial agenda. This is attached.

Yasuo discussed upcoming plans. We are planning on reviewing current white papers in preparation for a next meeting that may take place with operators in Alaska. Our next face-to-face meeting is tentatively planned with operators in Alaska, with confirmation needed.

A presentation was provided by Mark Skoog of NASA on the GCAS TAWS design and demonstrations. See July 2019 telecon notes for presentation summary. Further information on the Resilient Autonomy program was also provided, with a web reference to this location given:

<https://www.astm.org/Standards/F3269.htm>

Questions and answers from this meeting are included below.

Kevin asked a training question where operators would need to familiarize themselves with lateral maneuvers and lateral escape. There has been a training mode one can enter which describes a scenario. There was a 25 pilot evaluation at AirVenture 5 years ago. There was a simulation from 2 years ago; Vy speed target is set for a 30 degree bank. Several pilots were not used to conducting a Chandelle maneuver. To emphasize how easy the maneuver is, a scenario was played with 5 year olds who would fly to the arrow in several demonstrations that Mark participated in.

Another question on how accurate the terrain must be in order to accurately develop predictions, nuisance free. Mark indicated that the SRTM data most TAWS provider are using was developed in 2000. Twenty years have passed since then, better covering the regions North and South of 60 degrees of latitude, at the very least. There are now at least 2 separate sources (USGS-NED, 0.5 meter accuracy by an unnamed source). Mark mentions how SRTM is now being compared to more recent map data. These integrity checks have revealed 9 places where SRTM data is incorrect.

John Judge asked if the GCAS is applicable for a helicopter. Yes, Mark indicates that a transition vehicle (like an Osprey) will be a future trial for the system. Mark has indicated that a theoretical rotorcraft model exists but is not yet funded by the Army. This model will be a kinematic model.

Yasuo asks, as system doesn't account for obstacles, how does system respond when an obstacle appears? Mark states that a wings level recovery is prioritized which tends to naturally avoid obstacles. The lateral escape option does involve obstacles however. Mark feels that the current TAWS uses inaccurate obstacles which in his opinion makes the current TAWS less safe in obstacle scenarios. Mark admits that this is not a 100 % complete system due to drawbacks such as this. However, flying towards an obstacle field would have at least some opportunity for survival as compared to a terrain wall.

Linda asked about what is being done to address terrain North of 60 degrees. Other commercially available sources can address this, including USGS-NED, but is limited to North America. There may be other sources upcoming. AOPA may have potential to provide browsers that point to database companies. Mark also mentions that a realtime upload on the ground could be made available in the future.

Rick stated that one of the assumptions is that the three maneuvers have an implied climb with each. He asked how applicable the GCAS would be in an environment such as Alaska, where icing conditions make pull up maneuvers prohibitive. Mark said that with a press of a button a

“no climb” option could be enacted. Rich Adler felt that another enhancement would be an entry of a ceiling level that could be entered to allow an adaptation for some climbs when applicable but also to limit to a no climb when at this limit.

Tom asked about the term “non resident” terrain database. Mark said this is only on the F-16, where a memory cartridge or for the phone app is an SD card, either of which is plugged in at the day of the flight. For other applications, such as the GA, the terrain database is resident.

Mark was asked if HUD applications have been studied. At this time, the answer is no.

A question was raised on the certification. Chuck Johnson remarked that industry is moving away from a process oriented approach to certification and more to a risk management approach for certification. The Non Required Safety Enhancing Equipment (NORSEE) project is a good example of the FAA changing the approach to certification. NORSEE only has limitations to Parts 23, 27 and 29.

A question was raised by Zach on the limitation for stale warnings. In today’s design, the maneuver, once begun, is assumed to be followed accurately. A potential enhancement is being contemplated for a case where the pilot is following the single last alternative, but is either late in starting or overcompensating. In an ideal case, a reversal logic may exist to refresh the scenario alternative.

Yellow means “caution – this maneuver has terrain” among the 3 option of Left, Center, Right and later “this is your only alternative left” which could be confusing in some contexts. In the answer it was pointed out that you can get down to a single arrow that is green also. Yellow is meant to convey a caution area of lesser clearance, but still possible.

Linda asked if past crashes can be played to study the alert timing. Mark mentioned that hand flying is possible in these cases but the playback of raw data is not a feature of the system at this time. Mark asked if specific cases are known. Linda mentioned that the NTSB studies of two Alaska crashes can be provided.

This presentation is going to be made available and posted via RTCA on each of the SC-147 and SC-231 websites. Permission has been granted to make use of the material in our minutes.

There was an add-on topic for autonomy vs. human decision in the loop. The Air Force F-16 policy would have prevented autonomy but they were lifted over the last several years and have saved 9 lives. A common question is raised: Is general aviation or commercial aviation ready for automation of such responses as autopullup and automaneuver? The Title 14, 91.3 regulation is difficult to get around but the subject is already addressed with UAVs.

Mark asked if the GCAS design would be applicable to this committee. Rebecca stated that this is best handled through the RTCA’s PMC if it is a request for formal support. If, as a member of SC-231, Mark provided the data for inclusion in the white paper, that is the prerogative of the committee. Yasuo felt that the concepts were applicable to our committee, but that the target audience is the Alaskan operators who are seeking a lower cost where this may not be

applicable.. There is an autopilot and queueing (smartphone) application, where the queueing is considered lower cost. This latter application may be applicable. Rebecca reminded the committee that this group captures technical requirements. The PMC asked for guidance evaluating technical options. It is not in scope of a special committee to make product decisions or product recommendations.

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The committee then walked through the series of white papers developed as assignments from the May 2019 plenary:

- TAWS Envelope changes, where a white paper realtime markup took place.
- Lateral Escape white paper, where a power point has been developed.
 - The group asked questions about overlap of this concept with GCAS.
 - While this concept does overlap, perhaps some portion is removed for a lower cost solution.

Wednesday, Sep 25

A discussion of what is to be presented in Alaska took place. It appears that we would appear in Anchorage and present. Then, a single set of documents, the white papers, could be provided via Google forms after the meeting and with the necessary disclaimers around these being concepts and not regulations. The Google forms will allow comments to be handled on-line. This would require more work to format these.

The committee then walked through the series of white papers developed as assignments from the May 2019 plenary where realtime updates took place during the meeting:

- Inhibit Changes Lateral Escape
- Off-Airport Mandatory Callout
- Pilot Selectable Height Callout
- Simple VSD
- Inhibition Changes
- Nuisance alerts less annoying
- New TAWS Class
- Allowing Class C settings for Class B operations
 - Within this discussion, Rich Adler noted that the petition to make this change is already moving through the approval process. This can be tracked via the below web reference:
 - <https://www.federalregister.gov/documents/2019/03/11/2019-04379/petition-for-exemption-summary-of-petition-received-alaska-air-carriers-association>
- Higher integrity, accuracy, resolution databases
- SVS addition

Updated white papers can be found in the 24-25 September directory.

An evaluation grid was then created, comparing development time, cost, effectiveness of each solution that then downselected the number of recommendations to 11. See attached for these results.

NEXT STEPS

A power point package is needed at least 6 weeks before the presentation in Alaska, by late October, 16 October. A disclaimer set of notes will be applied by RTCA, which should be effective by 15 October.

Action: See attached action log for some particular section rewrites requested within the white paper review.

A telecon is planned next for Wednesday, 23 October 2019 at 10:30 AM EDT to 12:30 PM to walk through the resulting Power Point.

For the next planned meeting, the SC-231 meeting is planned to be held in Anchorage on 4-5 December based on availability. Linda and Peter will begin coordinating this. There is still some confirmation needed on whether this can take place, where the Washington DC location is considered as a backup.

Plenary section closed with this remark.