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Special Committee 147

MINIMUM OPERATIONAL PERFORMANCE STANDARDS FOR TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEMS AIRBORNE EQUIPMENT

The 105th meeting of RTCA SC-147 and 74th meeting of EUROCAE WG-75 was held on 16 March 2023; this Plenary was a virtual-only meeting with WebEx provided by RTCA.

The following Leadership was present:

J. Stuart Searight	Co-Chair, Federal Aviation Administration
Ruy Brandao	Co-Chair, Honeywell International
Guido Manfredi	Chair, EUROCAE WG-75
vacant	SC-147 Recording Secretary
Matt Haskin	Government Authorized Representative
Brandi Teel	Program Director RTCA
Alex Engel	Tech PM EUROCAE

1 Chairmen's Opening Remarks / Introductions

Mr. Stuart Searight opened the meeting by welcoming everyone and announcing the primary purpose of the meeting was to consider the approval of Revision A for the ACAS Xa/Xo MOPS (DO-385A/ED-256A). Stuart also recognized Guido Manfredi from Volocopter as the new Chair for WG-75 and asked if he would like to offer any opening remarks. Mr. Manfredi briefly stated his excitement to be a part of WG-75 and to be involved in the development of the ACAS Xr MOPS.

2. Anti-Trust Statement & RTCA Policy

Brandi Teel and Alex Engel presented all RTCA and EUROCAE policy statements regarding membership, participation in meetings, and use of proprietary information in approved documents. Ms. Teel concluded these statements with instruction for everyone to record their attendance via RTCA AerOpus.

3. Approval of Minutes from 104th Plenary of SC-147, 15 November 2022

Mr. Searight asked for approval of minutes from the November Plenary that focused on the final scope for Revision A for DO-385/ED-256. . Stuart reminded everyone that these minutes were produced largely by himself and that there was still a need for someone to serve from either SC-186

or WG-75 as secretary for future Plenary sessions. A motion was made, and the Minutes were approved without comment

4. Approval of Agenda

   Mr. Searight asked for a quick review of the agenda for the meeting, noting that while the meeting will mostly be about the results of the FRAC/OC process for DO-385A/ED-256A and the final system assessments, there will also be a briefing from Garfield Dean summarizing recent analysis of ACAS Xu and EUDAAS systems in European airspace as part of a SESAR work package. A motion was made to approve the agenda and was agreed to unanimously.

5. Brief Review of the FRAC start / Nov

   Stuart began the review of the recently concluded FRAC/OC process for Revision A of the Xa/Xo MOPS with a quick recap of the primary objective for this update and the accelerated schedule that was followed. Mr. Searight reminded everyone that this Revision was requested by EASA to facilitate a cleaner process for them to work on European rulemaking and ETSO development recognizing ACAS Xa as a safe and acceptable alternative to TCAS II for Collision Avoidance on aircraft. Stuart thanked the Program Office team for being so prepared to implement all agreed upon Change Proposals and to have the draft available for review and comment so quickly. Stuart concluded with observing if this meeting was successful in approval of Revision A, both RTCA and EUROCAE were on track to approve and publish DO-385A/ED-256A prior to July 1, which was the requested delivery date from EASA.

6. Review of Volume I Updates

   Alan walked through many of the Volume I changes that were requested as part of the scope agreements on Rev A based on the errata of changes documented in Change 1 and the set of Change Proposals agreed to in the November Plenary. (DO-385A Volume 1 Changes) This brief showed how the Change Proposals were implemented in the MOPS and reminded all committee members of the key changes to Volume I for Revision A as compared to the original DO-385/ED-256.

7. Review FRAC/OC comments

   a. Summary of all comments received

      Mr. Ruy Brandao opened the FRAC/OC review briefing with a quick overview on the entire set of comments received, the process the Surveillance and Threat Working Groups had followed between the comment period closing and this week's meetings. Ruy reminded everyone that there was an all-day meeting yesterday in which most of the major comments were discussed in detail. Ruy concluded saying the next set of comment briefings would recap those deliberations, but encouraged everyone to ask questions or request more detail if needed.

b. Vol I - SWG Summary

Mr. Brandao then moved on to a high level review of the comments received and assigned to the Surveillance Working Group. (DO385A FRAC SWG Comment Resolution Summary 20230316) There were 72 total, 7 of which were "High" and 27 of which were "Medium". 11 of the Medium comments were related to Tests. Ruy noted that one "High" comment withdrawn by the submitter after the SWG agreed it was more appropriately addressed at the Advisory Circular level and perhaps directly in the ACAS Xr MOPS currently under development.

c. Vol I – TWG Summary

Mr. Stacey Rowlan then led a review of the comments assigned to the Threat Resolution Working Group. (DO385A FRAC TWG Comment Resolution Summary 20230316) Stacey noted 3 of the comments were focused on rotorcraft operations and have been written up as Action Items/Gaps for the ACAS Xr MOPS which satisfied the commenter without direct action on this Revision A for ACAS Xa/Xo. Stacey also pointed out that an additional comment had been added and its resolution left open so that any final changes required from final stress testing and Test Suite development could be documented and traceable to the approval process.

d. Vol I – Editor Comments

Mr. Alan Sigman's next briefing was a summary of the editorial changes made in response to mostly "Editorial" or "Low" comments. Alan stressed that the set of comments submitted primarily from Matt Haskin regarding references to other documents or sections/tables from other document were, while editorial in nature when looked at individually, actually a somewhat major issue when taken as a whole. It was agreed that Alan would work with Matt, and a few key industry members to make sure all of these reference checks and updates were done deliberately and correctly. Alan also has recognized some formatting and enumeration issues that he will be working carefully with Brandi to resolve before final submission to RTCA.

e. Vol II Comments

Ms. Margarete Groll gave a quick overview of the Volume II Comment Spreadsheet and the comments received, pointing out that there were only 10 comments submitted, 6 of which were Editorial and 4 which were "Medium". Maggie did note that the set of ADD changes cited in DO-385/ED-256 Change 1 were still being incorporated into the final document.

8. Analyses Summaries

Mr. Josh Silberman briefing set up the next set of briefings from the FAA ACAS Program Office on the final DO-385A/ED-256A system performance, and asked Ms. Groll to begin with a briefing on the Operational Validation.

a. Operational Validation

- Ms. Groll then continued with a presentation on the Operational Validation assessment performed by the FAA Program Office (DO-385A OpVal Summary for Mar16 Plenary v2) Maggie began with an overview of key changes introduced to DO-385A/ED-256A and reported no significant differences between Safety and

Alerting tradeoffs between baseline DO-385+ CP001 and Revision A. Ms. Groll showed all of the analyses performed and the encounter sets used and continued by showing a significant reduction in the probability of an NMAC for DO-385A as compared to TCAS II for multiple encounter sets. Also presented was a reduction in the amount of alerts across many encounter sets.

- Ms. Groll noted that some of the comparative analysis with historical results was not perfectly compatible due to the inability to duplicate results from old TCAS simulation runs. Some reasons for this were:
  - LL Supercomputing Center updated MATLAB version from 2019b to 2022a
  - LL Supercomputing Center upgraded processors from xeon-e5 to xeon-p8 type
  - LL Supercomputing Center upgraded Ubuntu operating system
  - Numerous changes to CSIM simulation framework, which may have had an indirect impact on results
- Safety Set Comparison: Across the LLCEM2, SA01, and SAVAL encounter sets, it was shown that significant improvement remains for pNMAC as compared to TCAS II, with differences between DO-385A+CP01 and DO-385A to be minimal and almost in the noise. Similar results were shown for the FTEG and EU encounter sets.
- Maggie then went on to examine differences between baseline DO-385+CP01 vs the DO-385A system relative to TCAS performance. Quick Reversals were one area among a few other Operational Suitability results in which there was a minor to moderate difference in performance, but this was driven by the inability to duplicate the historical TCAS results and not to significant differences between DO-385+CP01 and DO-385A. Other areas of difference included reduced alert complexity, and increased percentage of Clear of Conflicts issues with 5 seconds of closest point of approach, and a reduction in RAs that last less than 10 seconds.
- At Mr. Dean's request, Ms. Groll showed direct safety and alerting comparisons between DO-385+CP01 and DO-385A without reference to TCAS, with the caution that they could not be perfectly compared due to the differences in computing environment previously discussed. Even so, the minimal nature of the differences (both slightly positive and slightly negative) were deemed acceptable by Mr. Dean.

b. Stress Testing

- Ms. Samantha Smearcheck then gave a briefing on the stress testing done of the final version of the logic for DO-385A/ED-256A. (Xa_385aFRAC_StressTesting_PlenaryBrief_March2023_Final)
- Ms. Smearcheck began an executive summary of the Stress Testing conclusions: Overall the Stress Testing activity is supportive of Approval of Revision A, as no major safety concerns were identified in comparing results from DO-385+CP01 to the DO-385A system. Ms. Smearcheck further reported that some areas of minor degradation observed in the analysis findings does indicate continued examination and validation of CP02 should be pursued.
- Sam placed some perspective around the stress testing work and reminded everyone some scenarios are not realistic real word geometries, and the results are not meant to represent real-world probabilities of occurrence, but are rather used to identify areas of the logic or system performance that might need closer examination. This was followed with a more detailed look at the methodologies followed, the encounter sets used, and the TCAS II and DO-385+CP01 baseline versions used for comparison against DO-385A.
- Ms. Smearcheck then presented a closer look at representative encounters for a few areas of performance in which there was minor increases in NMACs as compared to

the baseline DO-385A/ED-256A logic. These included weaker initial RAs in which a later strengthening, crossing, or reversal RA was issued too late to avoid an NMAC, late reversals by the Master CA system when the Slave system issued initial RA first, and ineffective crossing or reversal RAs in cases with a non-responsive Master aircraft.

c. Test Suite
   - Katherine Wu gave a presentation on the Test Suite, beginning with an overview of how it is set up and its purpose. (DO385 Test Suite Overview for March Plenary) Ms. Wu continued with an overview of the various Test Groups, and pointed out a few areas in which tests were still being developed to address Change Proposals incorporated into Revision A. Ms. Wu went into some detail on Test Group 80 which are new tests to address changes introduced in Revision A. In conclusion, Katherine explained why a few minor changes to Volume I will come in late and the schedule to complete all work on the test suite within the next week.

9. Remaining schedule for DO-385A/ED-256A publication

   - Mr. Searight then reminded everyone – assuming success in joint committee approval - of the remaining schedule for RTCA and EUROCAE management approval and publication of the MOPS. Important milestones included the completion of the Test Suite by March 24th, having all comment resolutions incorporated into Volumes I & II and sent to Brandi Teal and Alex Engel by May 1st for final review and formatting, and having all supplementary materials being uploaded to the RTCA share drive prior to the June 21 PMC meeting. Brandi and Alex confirmed that this schedule would be sufficient to have these documents published by July 1st to meet the request from EASA.
   - Brian Patterson stated he did not currently see a need to update the Safety Assessment from DO-385 for Revision A, but will look at the updated materials to confirm. There were no concerns raised about not having this document updated for Revision A.
   - Mr. Searight did want everyone to note that this process and schedule would not include a formal two-week verification review and committee 2nd approval that has been followed for the initial ACAS X MOPS documents since the amount of changes were much smaller and the need to meet EASA's requested schedule to support their rulemaking activities. There were no objections.

10. Motion to approve

    Mr. Searight asked if there were any final questions, concerns, or comments regarding the final Revision A of the ACAS Xa/Xo MOPS, the FRAC/OC process just followed, or the remaining schedule. Hearing none, Stuart asked for a motion to approve the document which was made by Mr. Wes Olsen and seconded by Garfield Dean. With no objections, DO-385A/ED-256A was approved jointly by SC-147 and WG-75. Mr. Searight concluded with his thanks and appreciation to Mr. Neal Suchy and his entire Program Office team for the remarkable job of preparing the draft Revision and performing all the analysis work on the updated system in such a short amount of time.

11. SESAR assessment results for ACAS Xu and EUDAAS in European Class A-C environments

- Mr. Garfield Dean presented a high-level overview of a SESAR project to assess ACAS Xu and EUDAAS systems in European Class A-C airspace. (ERICA solution 111 results v7 RTCA summary) The project is entitled "Enabling RPAS In Controlled Airspace" (ERICA) Solution 111.
- Mr. Dean noted the briefing slides were made to support a much longer and in-depth examination of the project, its findings and recommendations. Garfield suggested due to time constraints he give a much abbreviated summary of the presentation now, and that arrangements are made for a series of briefing to be given at the Working Group level in the coming months.
- Mr. Dean pointed out that this assessment looked at both the Remain Well Clear (RWC) and Collision Avoidance (CA) functionalities of the European Detect and Avoid (DAA) concepts.
- Among the conclusions for Safety Performance was that RWC and CA provide better safety performance than just CA alone, and that both ACAS Xu and EUDAAS performance better than TCAS II on the RPAS vehicle in two (2) and three (3) aircraft encounters. Garfield also reported that interoperability between ACAS Xu and ACAS Xa and interoperability between EUDAAS and TCAS II were promising, but that interoperability between ACAS Xu and EUDAAS on RPAS-RPAS encounters was not yet assessed.
- Some of the Operational Acceptability findings included the following:
    - Xu and EUDAAS considerably reduce the CA alert rates of TCAS II, presumably due to the effectiveness of RWC alerting and guidance;
    - Both ACAS Xu (85%) and EUDAAS (37%) had significant percentage of RWC alerts issued outside ATC separation minima, which should be looked at more closely;
    - Communication delays between the Remote Pilot and Controller may be unacceptable in high density airspace; and
    - EUDAAS RWC guidance appeared to be quite stable with very few updates to the guidance.
- Overall, both systems showed great promise, but further analysis is needed, adding items like wind, loiter operations, and the interoperability of EUDAAS with ACAS Xu and ACAS Xa.

12. Future Meeting Scheduling

Mr. Searight noted that there are Working Group meetings scheduled for March 21-23 and June 13-15, 2023 to work on ACAS Xr. It was agreed that a need for a Plenary session was not anticipated until the Fall, and there will be schedule on the Thursday of the September ACAS Xr WG meetings to be scheduled at their upcoming meeting.

13. Action Items Summary

The actions recorded were as follows:

- All folks involved with finalization of the MOPS to meet the agreed upon schedule for their milestones;
- Ben Zintak and the ACAS Xr Working Groups to schedule a September/October meeting; and,
- Garfield Dean to coordinate a series of more in-depth briefings on the ACAS Xu and EUDAA assessment work from SESAR.

14. Close

Mr. Manfredi offered brief closing remarks from WG-75, thanking everyone and restating his excitement to be involved in ACAS Xr. Mr. Ruy Brandao concluded with a reiteration of sincere thanks and appreciation for all the hard work from the committee to complete DO-385A/ED-256A, and a recognition of the team members who still had important work to do in the next few months. Mr. Searight agreed with Ruy's assessment and formally closed the meeting.

Attendees:

Last Name	First Name	Company Name
Beckwith	Richard	Federal Aviation Administration (FAA)
Bender	Walter	Johns Hopkins University Applied Physics Laboratory
Berthier	Jean-Baptiste	Airbus
Brandao	Ruy	Honeywell International, Inc.
Carino	Joslin	Federal Aviation Administration (FAA)
Castle	Michael	Johns Hopkins University Applied Physics Laboratory
Ciaramella	Kathryn	Federal Aviation Administration (FAA)
Dean	Garfield	EUROCONTROL
Drumm	Ann	MIT Lincoln Laboratory
Dutle	Aaron	NASA
Edwards	Matt	MIT Lincoln Laboratory
Engel	Alexander	EUROCAE
Etterer	Kurt	MITRE
Froehlich	Donna	Aurora Innovations
Gardner	Ryan	Johns Hopkins University Applied Physics Laboratory
Govers	Francis	Bell Helicopter Textron, Inc
Groll	Margarete	MIT Lincoln Laboratory
Guendel	Randal	MIT Lincoln Laboratory
Harrison	Austin "AK"	Garmin Ltd.
Haskin	Matt	Federal Aviation Administration (FAA)
Hastie	Tom	Transport Canada
Hendrickson	Adam	Federal Aviation Administration (FAA)
Hirt	Ruth	Federal Aviation Administration (FAA)
Hette	Hoekema	
Hofmann	Frank	
Huck	Volker	EUROCONTROL
Jacobson	Randy	Collins Aerospace
Johnson	Rudy	Sagetech Corp.
Kobzik-Juul	Barbara	Johns Hopkins University Applied Physics Laboratory
Kuffner	Maria Picardi	MIT Lincoln Laboratory
Kuhlman	Kyle	Garmin Ltd.
Leeper	Charles	Johns Hopkins University Applied Physics Laboratory

Last Name	First Name	Company Name
Long	Anthony	Federal Aviation Administration (FAA)
Lorenzo	Edwin	Johns Hopkins University Applied Physics Laboratory
Manfredi	Guido	Volocopter
Marchese	Doug	Air Lines Pilot Association (ALPA)
Monk	Walter	Constellation Aviation Solutions, LLC
Muller	Rudy	uAvionix
Nakadate	Masaaki	
Nguyen	Lee	NUAIR, Inc.
Olson	Wesley	MIT Lincoln Laboratory
Panken	Adam	MIT Lincoln Laboratory
Patterson	Brian	MITRE
Piątkowska	Paulina	Airbus
Rahman	Mohammed	Federal Aviation Administration (FAA)
Rowlan	Stacey	Sagetech Corporation
Searight	Stuart	Federal Aviation Administration (FAA)
Shea	Byom	Air Lines Pilot Association (ALPA)
Sigman	Alan	Federal Aviation Administration (FAA)
Silbermann	Josh	Johns Hopkins University Applied Physics Laboratory
Sleight	Randy	Johns Hopkins University Applied Physics Laboratory
Smearcheck	Samantha	Johns Hopkins University Applied Physics Laboratory
Spaeth	Stefan	Airbus Helicopters
Spinks	Brian	L3 Harris Corporation
Stephens	Jonathan	Odys Aviation
Stouffer	Virginia	Aura Network Systems
Suarez	Brandon	Reliable Robotics
Suchy	Neal	Federal Aviation Administration (FAA)
Swider	Chris	Federal Aviation Administration (FAA)
Teel	Brandi	RTCA, Inc.
Wikle	Jared	MIT Lincoln Laboratory
Wu	Katherine	Johns Hopkins University Applied Physics Laboratory