

RTCA Paper No. 063-16/SC209-033
February 1-5, 2016

FIFTEENTH MEETING

RTCA SC-209 & EUROCAE WG-49

ATCRBS / MODE-S TRANSPONDER

Held in Joint Session with the

THIRTY SIXTH MEETING

RTCA SC-186 WG-3 & EUROCAE WG-51 SG-1

ADS-B 1090 EXTENDED SQUITTER

DATE: February 1–5, 2016
PLACE: RTCA Conference Rooms,
1150 18th Street, NW, Suite 910,
Washington, D.C. 20036

The attendees included:

SC-209 Co-Chairs

Thomas Pagano The Regulus Group
Robert Saffell Rockwell Collins

WG-49 Chair

Eric Potier EUROCONTROL

SC-209 Designated Federal Official

John D. Fisher Federal Aviation Administration

SC-186 WG-3 Co-Chairs

Thomas Pagano The Regulus Group
Martin Gray Trig Avionics Limited

WG-51 SG-1 Chair

Jörg Steinleitner EUROCONTROL

SC-186 Designated Federal Official

Don Walker Federal Aviation Administration

SC-209 & SC-186 WG-3 Secretary

Timothy Steiner Federal Aviation Administration

Participants during part, or all, of the meeting (both present and on WebEx/Telecon):

| | |
|-------------------------|---|
| Doug Arbuckle | Federal Aviation Administration (FAA) |
| John Banzhaf | Jacobs Technology |
| Raymond Bayh | BAE Systems, Inc. |
| Miles Bellman | Volpe |
| Jason Berger | Harris Corporation |
| Terry Blumer | Aviation Management Associates, Inc. (AMA) |
| Dan Brudnicki | Aviation Management Associates, Inc. (AMA) |
| Paul Campbell | Federal Aviation Administration (FAA) |
| Joe Christman | UPS Airlines |
| Gary Church | Aviation Management Associates, Inc. (AMA) |
| Julien Damblement | Thales Group |
| Stephan Darr | Dynamic Aerospace Inc. |
| Garfield Dean | EUROCONTROL |
| Nickolas Demidovich | Federal Aviation Administration (FAA) |
| Ann Drumm | MIT Lincoln Laboratory |
| Jim Duke | Airline Pilots Association (ALPA) |
| Alex Engel | EUROCAE |
| Matt Erickson | Rockwell Collins |
| John Ferrara | John Ferrara Consulting |
| Jack Field | The MITRE Corporation |
| John Fisher | Federal Aviation Administration (FAA) |
| Amy Fritz | The MITRE Corporation |
| Michael Garcia | Aireon, LLC |
| Martin Gray | Trig Avionics |
| Douglas Guetter | L-3 ACSS |
| Kevin Hallworth | European Aviation Safety Agency (EASA) |
| Matt Haskin | Alion Science and Technology |
| Mathieu Hiale-Guilhamou | Airbus |
| Jeremy Holman | Garmin |
| Junichi Honda | Electronic Navigation Research Institute (ENRI) |
| Randy Jacobson | Rockwell Collins |
| Eric Jauny | Air Navigation Services Directorate (DSNA-DTI) |
| Edward Johnson | Federal Aviation Administration (FAA) |
| Larry Kenney | Raytheon |
| Dolores Le | US Department of Defense |
| Charlie Leeper | The Johns Hopkins University |
| Andy Leone | Federal Aviation Administration (FAA) |
| Ian Levitt | Federal Aviation Administration (FAA) |
| Johan Martensson | EUROCONTROL |
| Stuart McKay | NATS UK |
| Dennis Nichols | US Air Force |
| Alan Olejnik | US Air Force |
| Takuya Otsuyama | Electronic Navigation Research Institute (ENRI) |
| Tom Pagano | The Regulus Group |
| John Paranzino | The Regulus Group |
| Darrell Pennington | Airline Pilots Association (ALPA) |
| Bob Pomrunk | The Regulus Group |
| Eric Potier | EUROCONTROL |
| Alex Rodriguez | Federal Aviation Administration (FAA) |

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|-------------------|--|
| Bill Rogoza | Raytheon |
| Bob Saffell | Rockwell Collins |
| Brian Sanderson | The MITRE Corporation |
| Kurt Schueler | Garmin |
| Stuart Searight | Federal Aviation Administration (FAA) |
| Albert Secen | RTCA, Inc. |
| Ashutosh Sharma | Boeing |
| Todd Skoog | Garmin |
| Milan Sopata | Honeywell International, Inc. |
| Boris Stallings | US Navy |
| Tim Steiner | Federal Aviation Administration (FAA) |
| Bill Stine | National Business Aviation Association (NBAA) |
| Rocky Stone | United Airlines, Inc. |
| Wes Stoops | The Regulus Group |
| William Thedford | Jacobs Technology |
| Chris Tourigny | Federal Aviation Administration (FAA) |
| Mie Utsunomiya | International Civil Aviation Organization (ICAO) |
| Oscar Valle Colon | Federal Aviation Administration (FAA) |
| Don Walker | Federal Aviation Administration (FAA) |
| Lesley Weitz | The MITRE Corporation |
| Kevin Wilson | Honeywell |
| Sandra Wright | Federal Aviation Administration (FAA) |
| Wen-Hai Yang | Saab Sensis Corporation |
| Ray Young | The Northeast UAS Airspace Integration Research Alliance (NUAIR) |

**** Note: All files named herein can be downloaded from the RTCA workspace at:
<http://workspace.rtca.org/apps/org/workgroup/combsurvcomm/>**

The fifteenth meeting of RTCA Special Committee 209 was held in joint session with EUROCAE Working Group 49 during the week of 1–5 February 2016. Due to the related nature of the material that is covered by the Mode-S Transponder and Automatic Dependent Surveillance Broadcast (ADS-B) 1090 Extended Squitter committees, it was agreed that they meet jointly. Therefore, in addition to WG-49, the meeting was held in joint session with RTCA Special Committee 186, Working Group 3 & EUROCAE Working Group 51, Sub-group 1.

The structure of the meeting was split so as to focus solely on transponder related material during the first two days of the meeting, 1–2 February. The remainder of the week, 3–5 February, covered ADS-B material as well as joint ADS-B and transponder related subject matter.

The meeting was called to order by SC-209 Co-Chair Thomas Pagano of the Regulus Group at about 9:00 AM, 01 February 2016. The purpose of the meeting being to update and revise the RTCA & EUROCAE Minimum Operational Performance Standards (MOPS) for both the Mode-S transponder and the ADS-B 1090 Extended Squitter.

1. Introduction and Welcome for SC-209 / WG-49

- 1.1 As the Designated Federal Official for SC-209, John D. Fisher read the Public Meeting Announcement. (*SC-209 Feb 2016 Opening Slides.pdf*)
- 1.2 Al Secen, the RTCA Program Director for SC-209, welcomed all participants. He then reviewed the RTCA policies and reiterated the importance, and confidential nature, of the work to be performed through the reading of the proprietary notes.
- 1.3 Tom Pagano began the meeting with a welcome to everyone present, both in person and on the phone. He spoke about the uniqueness of four groups meeting concurrently. This was followed by an explanation of how the schedule would be split between the Mode-S transponder material and the ADS-B 1090 ES material which would begin on Wednesday, February 3rd.

Mr. Pagano stated the intent to restart SC-209 Working Group 1 for future work on the Mode-S transponder material, with periodic plenaries to report progress back to the committee.

Personnel changes were covered next by Mr. Pagano. He introduced Al Secen as the new RTCA Program Directory, replacing Hal Moses who recently retired. Tom thanked Hal (not present) and wished him the best in his retirement. Mr. Pagano also welcomed and introduced Tim Steiner as the replacement for the previous Secretary – Gary Furr. Heartfelt thanks were given to Mr. Furr (also not present) for all of his hard work in the past.

A roll-call of all attendees (previously listed) was then requested by Mr. Pagano. Asking that all participants, both on the phone and in person, announce themselves and the organization they represented.

After the attendance was complete, WG-49 Chair Eric Potier welcomed all participants and highlighted the importance of maintaining harmonization between the RTCA and EUROCAE transponder MOPS.

2. Review of Agenda

- 2.1 Tom Pagano reviewed the meeting agenda. He covered the joint nature of the subject matter (transponder and ADS-B) as well as the joint nature of the committees. To suit the combined work of both EUROCAE and RTCA, the future face-to-face meetings will be hosted, alternately, by the US and European organizations. Tom then reiterated Mr. Potier's point on the importance of maintaining harmonization between all documents.
- 2.2 Mr. Steiner then presented a joint workspace from which all four committees can work. This was followed by an overview of file naming conventions and locations for committee-specific work.

3. Discussion of Transponder Material – Day 1

- 3.1 Overview of issues driving update of transponder MOPS for WG-49.
(*SURV-WP01-21_S - Overview of issues driving the update of Transponder MOPS for WG49.pdf*)

Eric Potier provided a high level overview of what EUROCAE wanted from this meeting. It was requested by Kevin Hallworth and seconded by Randy Jacobson to maintain as an appendix, a list of changes from DO-181E to DO-181F and (ED-73E to ED-73F). Mike Garcia requested clarification on potential spectrum issues with phase modulation. Specifically, whether International Telecommunication Union (ITU) approval was necessary. It was decided he would speak offline with Chris Tourigny from the FAA spectrum office to further define his concerns.

- 3.2 Editorial corrections to MOPS since publication of DO-181E / ED-73E.
(*SURV-WP01-02_S - Editorial corrections to the Transponder MOPS.pdf*)
(*SURV-WP01-23_S - Editorial corrections to the Transponder MOPS for WG49.pdf*)

A list of editorial errors, along with the appropriate corrections, since the publication of DO-181E was presented by Tim Steiner. Clarification was made by Tom Pagano and Martin Gray that this would be a review only, with any decisions postponed until meeting #2 when a draft version of the MOPS would be presented. Eric Potier then presented a list of editorial issues discovered by WG-49 with appropriate corrections for each.

- 3.3 Removal of requirement for Acquisition Squitter.
(*SURV-WP01-18_S - Removal of the requirement to suppress the Acquisition Squitter.pdf*)

Alex Rodriguez presented a paper proposing the removal of the requirement to suppress the Acquisition Squitter. It was clarified that this proposal would not change the function, but rather just remove the one provision and that this is not an air/ground issue, but strictly about the switch connected to the acquisition inhibit. It was agreed that the full nature of the change may not have been captured and that Alex would complete a text change with accompanying test procedures to be assigned.

- 3.4 Removal of Mode A/C/S/ All Call.
(*SURV-WP01-19_S - Removal of Mode A-C-S All-Call Interrogation.pdf*)
- A proposal was presented by Alex Rodriguez to remove the requirement to reply to Long P4 interrogations. The intent of removing this requirement would be to reduce the amount of 1090 FRUIT. A discussion ensued concerning the potential changes to the handling and/or characteristics of the P4 pulse. Don Walker stated a need to ensure that any change be a software change and not a retroactively forced hardware change. Concerns regarding change timelines and compatibility were raised by Matt Haskin and Randy Jacobson, respectively. Don confirmed a post 2020 implementation timeline and Bob Saffell confirmed version 2 acceptability for the ADS-B rule. It was agreed that, prior to making any change, the TCAS/ACAS group should be queried for their use of the P4 pulse in order to check for any potential issues. Finally, Tom Pagano agreed to help Alex with rework an expanded proposal with P4 pulse considerations included.
- 3.5 Corrections to test procedures from WG-49.
(*SURV-WP01-22_S - Proposed corrections to existing test procedures in the transponder MOPS.pdf*)
- Eric Potier presented a list of proposed changes to test procedures for DO-181E and ED-73E. Various changes were discussed. Among these were the proposal to remove the appendix dealing with Hijack mode and a proposal to add a requirement to retain the 4096 code through a power cycle.
- 3.6 Removal of TCS, RCS, and SAS commands.
(*SURV-WP01-20_S – Removal of TCS,RCS,SAS Transponder Commands.pdf*)
- A proposal was presented by Alex Rodriguez to remove the subfields for Type Control, Rate Control, and Surface Antenna for the radar command capability using the Special Designator interrogation field. The justification being that these commands are not used by ground stations and, therefore, are unnecessary. Don Walker stated the general desire not to have ground determination of things that are better suited to air implementation such as the determination of air/ground state. It was agreed that corresponding test procedures should be analyzed and that this issue should be presented to ICAO in order to ensure that this capability is not used elsewhere.

4. Discussion of Transponder Material– Day 2

- 4.1 Need for a Mode-S Limiter.
(*SURV-WP01-24_S - Activity on 1030 and need for a Mode S limiter.pdf*)
- Eric Potier presented a paper which discussed activity on 1030 where interrogations and/or transmissions exceed the capabilities of the MOPS. When this happens, in order to prevent a transponder shutdown, he proposes using a rate limiting capability. Bob Saffell agreed that this is an issue that needs addressed.
- 4.2 Transponder updates for ACAS downlink.
(*SURV-WP01-26_S - Transponder updates for ACAS downlink data.pdf*)
(*SURV-WP01-27_S - Transponder updates for ACAS downlink data - Presentation.pdf*)
- Garfield Dean presented a proposal for additional transponder capabilities to provide for downlink of data for the analysis of and enhancements to ACAS functionality. An

accompanying working paper (WP01-26) was not covered, but was submitted to provide further details on the presentation subject matter for those interested. Don Walker and Jim Duke questioned the need for this capability and Don requested a justification for the use of BDS 3,0 for downlink data. This was explained via the need to coordinate ACAS and TCAS systems using a silent RA, to which Don expressed some reservations. It was agreed that Garfield would return with a briefing providing further clarification. Further, a desire was expressed by Garfield for extra squitters and more registers for ACAS use. A discussion was held on the potential impact to 1030/1090. Tom Pagano reiterated the “wish list” nature of Garfield’s request and the need to further assess the impact to the transponder. The need for more realistic scenarios was also requested. Don suggested, as an alternate mechanism, the use of on-board storage of data for post operational maintenance download. Bob Saffell raised the concern that this may impact ICAO as well. Finally, it was agreed that a conversation was necessary between SC-147 and SC-209 to coordinate efforts more fully with respect to implementation and timelines.

4.3 Example implementation of a Mode-S limiter.
(*SURV-WP01-25_S - Mode-S Limiter.pdf*)

Jean-Rene Gely from Thales detailed an example implementation of a Mode-S rate limiter. Tom Pagano explained that this was a method to perform limiting, but we must first decide if this is something that is desired and, if so, work to define specifications. Eric Potier suggested creating a focused subgroup to look into this further and define requirements. Bob Saffell raised concern that the event that was the source of this concern was a unique case and may not warrant a large-scale change to accommodate. Further stating that it is a ground station issue and not a transponder issue. Tom voiced concern about the vulnerability that was exposed. Bob pointed out that it was an issue with interrogation spacing and agreed to the need for a focused subgroup.

4.4 Proper implementation of register 40₁₆.
(*SURV-WP01-17_S - Guidance for the Implementation of Register 4,0.pdf*)

A clarification of the coding and interpretation of vertical intent information contained in Register 40₁₆ was provided by Alex Rodriguez. While no intention of making this a mandate currently exists, the capability and guidance is desired to be set up in order to allow manufacturers to take advantage of it. Don Walker stated that it would be capable to get immediate benefit without 100% equipage (for example, in conflict detection) and that guidance would potentially be added to an Advisory Circular. Randy Jacobson expressed concern about registers being defined with no interface. Jim Duke questioned the completeness of the example scenario. Don and Alex agreed to work with Jim to ensure transition states were accounted for in the example.

4.5 Use of II=0 lockout to reduce 1090 frequency congestion.
(*SURV-WP01-33_S - Use of II=0 and II=0 Lockout.pdf*)

Lt. Alan Olejnik proposed an interim solution to prevent Mode A/C/S All Call replies through the use of the II=0 lockout. Bill Thedford noted the potential to reduce spurious replies to long P4, with TCAS targets unaffected since they use short P4. This issue was presented to the ICAO TSG meeting the week prior with resulting tasking to do analysis and gauge interest. Live testing is desired by Lt. Olejnik at the William J. Hughes Technical Center. Tom Pagano reviewed data that he has collected related to this issue and concluded that this approach may not solve the problem, but would help to alleviate it. Mr. Thedford and Don Walker both agree that this could be used as an interim measure, prior to the removal of Mode A/C/S All Call. Alan stated the need to link both All Call and II=0

in future discussion. Bob Saffell proposed disabling P4 long in order to solve both sides of the issue. Action was deferred on this issue due to an existing action with ICAO.

4.6 Requirements for ELS and EHS.

(SURV-WP01-31_S - Alleviation for Transponders Broadcasting Inessential EHS DAPS in Europe.pdf)

John Banzhaf presented a paper discussing the use of ELS and EHS in Europe versus the United States. He and Bill Thedford requested a clarification of the definitions for ELS and EHS. Also requesting that if bits are not used, to make them optional. Eric Potier confirmed use by some states. It was agreed an investigation was necessary into what is currently being used. Research into what changes to the definitions would be necessary was also deemed appropriate.

4.7 Changes since publication of 181E.

(SURV-WP01-03_S - Transponder related changes already initiated in ICAO.pdf)

A review of changes to the transponder MOPS that have been discussed at ICAO meetings since the publication of DO-181E was presented by Tom Pagano. Tom stated that this was a high level review of issues with decisions to be made at a later date. The second point raised a discussion on the use of the language “until engine stop”. Don Walker stated a need to retain the flight ID during taxi.

4.8 Issues discovered since the publication of 181E.

(SURV-WP01-04_S - Transponder related changes with proposed resolutions.pdf)

Mr. Pagano next presented a review of issues, since the publication of DO-181E, that have been highlighted as in need of discussion. He indicated that some of these issues may go away in the future, as they depend on higher-level discussions that are yet to be resolved.

4.9 Design Assurance Level for transponders with TCAS II.

(SURV-WP01-10_S - Clarification of DAL for Transponders Used with TCAS II.pdf)

A brief presentation was provided by Steve Plummer on the need to add clarifying language to the MOPS in order to ensure a Level B interface for transponders with TCAS II.

4.10 Tom Pagano verbal discussion on transponder reply monitoring.

(No WP)

Tom Pagano asked the question if the committee would entertain an idea from the ICAO TSG to require the transponder to report transponder over reply events. He requested a means in extended squitter to broadcast this information when such an event occurs. Alex Rodriguez, Chris Tourigny, and Amy Fritz agreed to form a focused subgroup in order to draft a proposal.

4.11 Matt Haskin DoD Table of Issues.

(No WP)

Matt Haskin reviewed a list of proposed changes brought forth by the Department of Defense. These issues include use of DF 19, II = 0, as well as:

- Matt raised a concern regarding a verification test for All Call with $CL > 4$, to ensure that a Level 2 and higher transponder will not reply. While the requirement is that the transponder not respond to something that is undefined, Matt will review the test procedures for any potential gaps. If gaps are discovered, he will draft new tests.

- Next, Matt asked for clarification on whether register 5F was optional or required. Bob Saffell confirmed that it is implicitly required. Matt was not comfortable with the clarity of the terminology and therefore agreed to draft a paper with a suggested resolution.
- Matt then asked for more detail on the rationale for 0.130 microseconds for the Differential Reply Delay. This was traced back to cable delay and antenna port jitter from a 747. Don Walker stated the need to check with SC-147 in order to get their input on any proposed changes since this is more of an issue for TCAS issue than for the transponder. Jack Field agreed to draft a paper with a proposal for lengthening this delay.
- The following editorial changes were then presented by Mr. Haskin:
 - In section §2.2.6, Dynamic Range of MTL +1 dB is different than the +3dB found in the rest of the MOPS. Tom Pagano suggested that this may come directly from the ICAO SARPS.
 - A typographical error in section 2.2.13.1.2.a was found and agreed to be corrected.
 - Table B-3-16 contains a shall statement. Matt asked for clarification on whether or not this was a requirement. Bob Saffell clarified that this was included verbatim for harmonization with ICAO 9871. Tom Pagano agreed that it was a fair observation, but not a high priority. Don Walker added more clarity by stating that the TSO only recognizes requirements from shalls in section 2.2.

4.12 Other Business – SC-209

After all transponder related working papers were discussed, the floor was opened for other business.

- Don Walker spoke of a proposal for ETA registers to support advanced Interval Management operations. Stated that Lesley Weitz would provide background on IM and that he would bring more detail on his proposal to the next meeting. He communicated the concept of operations is solid and that the implementation details will be worked out with the IM team whose scope and timeline are tied to that for the transponder and 1090 extended squitter.
- Eric Potier spoke of a need to harmonize the language of “jitter” between DO-181 and ED-73.
- In addition, Eric also spoke of a desire to add tests to the MOPS that provides interrogation scenarios representative of live environments, perhaps using real world data in the lab.
- Chris Tourigny agreed to help Alex Rodriguez with the interrogation monitoring of over reply conditions
- Bob Saffell voiced concerns about Mode-S Limiting and the difficulty in maintaining harmonization of the various standards documents.

4.13 Future Meetings for SC-209 and adjournment for the day.

Tom Pagano adjourned the day by speaking of the intent to continue holding joint meetings for the duration of this work and reminded everyone that work will continue on the next day with joint transponder and ADS-B 1090 material.

5. Introduction and Welcome for SC-186 WG-3 / WG-51 SG-1

- 5.1 Tom Pagano began the meeting with a welcome to everyone present, both in person and on the phone. He then provided an explanation for the combined meeting and that the Chair of EUROCAE WG-51 SG-1, Jörg Steinleitner, was unable to attend due to another previously scheduled WG-51 meeting.

Personnel changes were announced with the introduction of Martin Gray of Trig Avionics as the Co-Chair for SC-186 WG-3. Tim Steiner was introduced as the new Secretary, replacing Gary Furr, who recently retired. This was followed by a roll-call of all participants.

Mr. Pagano then spoke to the reason the committee had convened. Namely, the update to DO-260 and ED-102 MOPS. The intent of this meeting being to consider updates to the MOPS and review briefings from members and presentations from supporting committees. This was followed by a review of the proposed schedule. Tom proposed covering first, the changes discussed at ICAO since the last MOPS publication as well as a discussion of phase modulation. Eric Potier requested to add a review of corrections found by WG-51 to the agenda.

John Fisher covered the file naming conventions used and the joint workspace which is to be used for collecting working papers.

- 5.2 After Mr. Pagano, Martin Gray talked about the rationale behind why the committee was meeting. He stated three high level goals to be accomplished: maintenance of the MOPS, introduction of new things to the standards such as MET data and TABS, and the consideration of updates to squitter rates along with phase overlay.
- 5.3 Tom thanked Martin, then reiterated that the SC-186 Terms of Reference (TOR) was the driving force behind the work, i.e. to support FIM applications. In addition, Mr. Pagano also highlighted: issues addressed by ICAO, phase modulation, and preparations for future data requirements. He made clear that this would be a lengthy undertaking, covering 2 to 3 years. Finally, Tom stated the expectation to finish discussions mid-day Friday the 5th, while maintaining the flexibility to adjust the timeline as needed.

6. Discussion of Joint Transponder/ADS-B Material – Day 3

- 6.1 Editorial corrections to MOPS since publication of DO-260B / ED-102A.
(*SURV-WP01-05_A - Editorial corrections to the ADS-B MOPS.pdf*)

A list of editorial errors, along with the appropriate corrections, since the publication of DO-260B was presented by Tim Steiner. Additional corrections from WG-51 to be presented later by Eric Potier. In conclusion, Tom requested from manufacturers any additional corrections they may have found.

- 6.2 Changes since publication of DO-260B.
(*SURV-WP01-06_A - ADS-B related changes already initiated in ICAO.pdf*)

Since publication, ADS-B 1090 ES discussions continued in ICAO. Tom Pagano presented some proposed changes that may result from that work. Mr. Pagano clarified that ICAO 9871 and the requirements for 1090 ES need to remain harmonized. Therefore,

the changes discussed at ICAO that impact 9871, need to be brought before this committee for inclusion into the MOPS.

6.2.1 Broadcast of Surveillance Status Subfield

Kevin Wilson asked for clarification as to whether or not this was a requirement. It was agreed that the changes made via the Corrigenda should be reviewed for Notes that contain implied requirements.

6.2.2 Loss of Flight ID

This issue was previously discussed as related to the (WP01-03) “engine stop”, which according to Tom, would be good information to know.

6.2.3 Clearing of NIC Supplement Bits

Kevin reiterated the need to review the Notes for implied requirements.

6.2.4 Height Above Ellipsoid

This issue would remove the use of Mean Sea Level in order to be consistent with the Advisory Circular.

A comment was made, with no resolution, regarding the desire to remove Appendix A from the MOPS if possible. Tom finished this presentation by asking Eric Potier for additional changes from WG-51 and clarifying that this list contained the “agreed upon” changes.

6.3 Issues discovered since the publication of 260B.

(SURV-WP01-07_A - ADS-B related changes with proposed resolutions.pdf)

After reviewing the list of agreed upon changes, Tom Pagano reviewed a list of proposed changes for issues that had been uncovered since the publication of DO-260B. Two issues were discussed relating to the need for an Air/Ground Status and the addition of a Duplicate Address Flag. No additional issues were received.

6.4 Enhanced Reception Techniques.

(SURV-WP01-08_A - Enhanced Reception Techniques for Operation in High Density Environments.pdf)

A discussion on enhanced reception techniques was presented by Milan Sopata. This paper discussed alternate decoding techniques as compared to the baseline receiver for improving detection and decoding of 1090 ES messages. Mr. Sopata clarified for Brian Sanderson that, while the model applies to all 1090 messages, the focus was on DF17 ADS-B messages. In addition, Milan clarified for Larry Kenney that the techniques presented were improvements beyond the techniques listed in Appendix I of the MOPS. Finally, Tom Pagano highlighted the potential for increased squitter capacity that these techniques could provide.

6.5 Receiver improvements.

(SURV-WP01-12_A - Receiver improvements for high density airspace.pdf)

Don Walker presented a paper which included a chart showing air-to-air update rates between an A3 transmitter and A3 receiver. Mr. Walker then asked the committee to further investigate receiver improvements in order to allow for IM initiation at larger ranges. The need was voiced by Tom to be careful about too aggressive reception error detection and correction techniques that could result in an increase in undetected error rate.

It is important that system integrity performance is not affected by any considered enhancements.

6.6 Phase Modulation.

(SURV-WP01-09_C - Phase Modulation on 1090MHz.pdf)

John Paranzino and Tom Pagano, next presented the phase modulation technique as a candidate for inclusion in the MOPS. After an overview of the technique and a discussion on the state of development by John, Tom explained that this stems from an ICAO action to develop the capability as a way to increase capacity on the 1090 MHz link. Don Walker asked for clarification on any potential interference with the military Mode 5. While John's testing has not shown any issues, Matt Haskin agreed to work with Tom and John to ensure that there would be no problems. Martin Gray asked for clarification on how the phase modulation requirements would be treated in the MOPS. Don and Tom, replied that the idea is to include this as an optional 1090 ES capability. The message content is yet to be determined but is envisioned to be designed to support future ADS-B IN applications.

6.7 1090 Spectrum Congestion Analysis.

(SURV-WP01-13_C - 1090 Spectrum Congestion Analysis - Overview and Status.pdf)

Jim Baird presented a review of a study being performed to analyze the usage of 1090 MHz spectrum and its impact on air and ground systems. This is a simulation which uses an existing MITRE modelling environment to predict congestion; looking out to 2035. While Mr. Baird did not think it a good idea to increase the squitter rate, he pointed out that TCAS activity, not a small increase in messages per second, has the greatest impact on the spectrum usage. The concern was raised by Randy Jacobson about including UAS in the calculations. While UAS were not considered in this study, it was agreed that UAS have the potential to be a disruptive force in the NAS and alternate spectrum usage must be considered for that type of air vehicle. The discussion also mentioned that, while hybrid TCAS would help, failure modes must be considered and the fall back to TCAS operating without hybrid surveillance must be considered.

6.8 Transponder changes to support ACAS.

(SURV-WP01-29_S - Proposed Transponder changes to ensure robust TCAS air-to-air coordination.pdf)

A proposed transponder change was presented by Ann Drumm which would ensure the delivery of TCAS/ACAS Coordination messages regardless of the number of broadcast messages received. Bob Saffell warned that the ARINC bus between the transponder and the TCAS unit may be the real limiting factor. An example TCAS message overflow scenario was presented by Ann in which a loss of coordination messages resulted. One proposed change being offered was the creation of a high-priority queue for TCAS messages. It was agreed that the specific test case (which showed dropped messages) should be presented to manufacturers in order to determine if any transponders are, in actuality, affected. It was also agreed that an investigation into the use of the ARINC bus by TCAS/ACAS was warranted in order to ensure optimal efficiency.

6.9 Interval Management Overview.

(SURV-WP01-34_A - Interval Management (IM) Overview - Concept and Standards.pdf)

A review of the current state and future direction of Interval Management was provided by Lesley Weitz. A presentation of Advanced Interval Management, ADS-B IN applications was detailed with an explanation of the complexity involved in the calculations. In

response to Bob Saffell's question on whether this would be hardware or software based, it was made clear that the calculations could be performed in software, using the current hardware. The desire would be to reduce the complexity of the calculations by providing ETA and MET data from the target aircraft. This would remove any guess work in the 4D trajectory calculations and also provide for more complex operations. The need also exists for a standardization of format and transmission methodology of the shared data. Don Walker explained that the development work would occur concurrently with the ADS-B 1090 ES and Transponder work, and therefore would be better able to match implementation details with the requirements provided by the IM working group. In response to Mathieu Hiale-Guilhamou's implementation question, Don clarified that the idea would be to use broadcast messages for MET data, but cross-link between the aircraft involved for the IM operations. Don also clarified that there would be no mandate until the applications are more mature. In answer to Alan Olejnik's query on operations between aircraft with differing final approach speeds, Don stated that in order to support such operations that Final Approach speed would be an additional candidate for inclusion in the shared data.

6.10 Message changes to support ACAS Xa.
(*SURV-WP01-28_A - Messaging Changes for ACAS Xa.pdf*)

Charlie Leeper and Ann Drumm gave a briefing describing additional message capabilities that would be needed for future ACAS operations. The three categories covered were: Operational Coordination Message, additional CA Coordination Capability bits, and the Differentiation of Xo suppressed RAs. Bob Saffell indicated that the requested rate for Operational Coordination message of 5Hz uses most of the 6.2 messages per second allocated to ADS-B Out. It was clarified that this rate is flexible and only are necessary when an RA event occurs. The request for additional registers/bits was determined to need further definition as to content and quantity. As for the redefinition of currently reserved registers for ACAS support, Don Walker offered to work with SC-147 in order to determine the needs. The register content being differentiated as separate from the registers themselves, and of importance primarily to SC-147 for ACAS use.

7. Discussion of Joint Transponder/ADS-B Material – Day 4

7.1 Military use of DF 19.
(*SURV-WP01-32_A - Clarification that DF=19 is exclusively for military use.pdf*)

Jack Field and Bill Thedford gave a briefing which requested a clarification on the use of DF19, namely that it's use be solely for military operations. Inconsistencies between various standard documents were highlighted with the wish to harmonize the language in order to remove any ambiguity. The primary concern being the situation where civilian operators may be using military messages which have content that is not always consistent with ADS-B messages. Tom Pagano indicated the need to check with manufacturers to determine if this is indeed an option that is offered. Eric Potier and John Fisher offered to contact manufacturers in this regard. Matt Haskin made clear that the military did not have intentions of using DF19 for compliance purposes. Sandra Wright proposed making clear that DF 19 is not a means for compliance and stressed the need to have a clearer understanding of the potential impact of a change to the downlink format.

7.2 Clarification of Flight ID usage and operational needs.
(*SURV-WP01-35_C - Flight Id in BDS 2,0 and BDS 0,8 discussion.pdf*)

Mathieu Hiale-Guilhamou presented a paper on an issue seen with Airbus where an aircraft's Flight ID was cleared while still moving on the airport surface, thus causing a situational awareness problem for controllers. This stems from differences in the definition and implementation of BDS registers 0,8 and 2,0. A request for justification of differences was made, to which Bob Saffell referred to ARINC 718A. This is related to the "engine stop" issue (WP01-03 and WP01-06) that Tom Pagano and Eric Potier had presented earlier. The proposed solution from Mathieu would be to add a requirement to maintain the ID until a specific time after the aircraft had come to a stop. Bob Saffell stated that this could be implemented in many ways and needs to be determined if the Transponder or FMS is the better place to make a change. Martin Gray agreed that his was something that needs attention.

7.3 Vertical intent information in register 6,2.
(*SURV-WP01-14_A - Guidance for the Implementation of Register 6,2.pdf*)

A briefing on improvements to the encoding of register 6,2 – vertical intent - was provided by Alex Rodriguez. It was agreed that Jim Duke would work together with Alex to review the register description in order to provide a more complete example scenario.

7.4 Addition of airspeed to Aircraft Status Squitter.
(*SURV-WP01-15_A - Addition of Airspeed to Aircraft Status Squitter.pdf*)

Alex Rodriguez then presented a proposal for the addition of airspeed to the aircraft status message (Register 6,1: Type 28, subtype 001) which would enable full time reporting of airspeed for use by ADS-B IN applications. The update rate, tentatively 5 seconds, is to be determined by the Advanced IM needs from SC-186 WG-4. The other outstanding issue that needed clarification was how to access this information. Bob Saffell and Mathieu Hiale-Guilhamou agreed to look into the availability of the data from both Airbus and ARINC. Finally, Tom Pagano indicated that this needs to be included in the overall discussion on the potential for increasing the squitter rate.

7.5 Removal of airspeed from Velocity Message.
(*SURV-WP01-30_A - Removal of BDS 0,9 Subtype 3 and 4.pdf*)

The next paper which was presented by Alex Rodriguez, was directly tied to the previous paper on airspeed. This being the removal of airspeed from Velocity message (Reg 0,9: Subtype 3 and 4). Assuming the airspeed were to be added to the Aircraft Status squitter, it would no longer be necessary in this message. While acknowledging the benefit case, Tom Pagano cautioned on the far reaching nature of the change and the need to address Appendix N for backward compatibility. Don Walker clarified that with GNSS input, that position and velocity were no longer independent values, so the original intent of separating them was no longer applicable. Some questions arose over the need and/or ability for civilian GPS to report speeds over 1000kts. Martin Gray clarified that ITAR restrictions had changed and that civilian GPS can do so now. The decision was made to delay further discussion until after the briefing from Commercial Space. Randy Jacobson agreed to work with Alex to cover manufacturer concerns and Don agreed to contact Navigation personnel to further research this issue.

- 7.6 Incorporation of weather data needs into existing registers.
(*SURV-WP01-16_C - Review of Weather Data Needs for Future ADS-B In Applications.pdf*)

Don Walker reviewed the state of MET registers that currently exist and the need to analyze their sufficiency and content. He stressed the need for wind data. Rocky Stone agreed to provide information on humidity sensors and further updates from the Wake Vortex Tiger Team. It was left to be determined what would be the best mechanism for generating and providing the data. A low-rate broadcast of approximately once every 15 seconds was presented as a preferred method.

- 7.7 Findings from the Wake Vortex Tiger Team.
(*SURV-WP01-36_C - Wake Vortex Tiger Team - Findings and Recommendations.pdf*)

Rocky Stone presented findings from the Wake Vortex Tiger Team and addressed the current state of and needs for weather data. He stressed the global importance and consist nature of the type of data being discussed. He highlighted that the nature of the data stands above any individual application since it has the potential to benefit a large range of air and ground applications. Rocky explained that DO-339 work being headed by Stephen Darr is a refinement of what was found in DO-260B App. V and the interest to continue working together in order to further define weather related parameters. There was a general consensus that more coordination needs to be done between working groups, the FAA, and industry in order to better define applications and data performance requirements. Bob Saffell indicated the need to review registers 44 and 45 as well, for ensuring update rates are sufficient.

- 7.8 Improved availability of geometric altitude in ADS-B messages.
(*SURV-WP01-11_A - Geometric Type Codes and Improved Availability of Geometric Altitude.pdf*)

Don Walker provided a brief on the need for improved availability of geometric type codes so that geometric altitude data would no longer be limited to the highest precision type codes. The solution contained in the proposal was to report geometric altitude in 25 foot accuracy all of the time. Randy Jacobson raised some concerns about backward compatibility. Tom Pagano and Mr. Walker both confirmed that compatibility is desired and will be maintained to the extent possible for mixed equipage operations. The determination was made that there yet exists a need to validate with Commercial Space the sufficiency of the proposed altitude range. The far reaching nature of this change was highlighted by Don as well.

- 7.9 Current state of Commercial Space.
(*SURV-WP01-39_A - Considerations for use of ADS-B OUT for Commercial Space.pdf*)
(*SURV-WP01-40_A - ADS-B Technology for Commercial Space.pdf*)

Nick Demidovich from the FAA Commercial Space office provided a briefing on the current state and future direction of commercial space. This briefing covered the various use cases for operations above 60,000 feet as well as transitions through Class A airspace. Also included, was a discussion of position, navigation, and timing needs for the diverse range of vehicles. Operational difficulties and safety goals were covered as well, including issues of exit and re-entry safely through controlled airspace. A discussion was held on the nature of CPR encoding and potential issues with its use for position determination of these vehicles. The need to further discuss and clarify the integration of supersonic aircraft

and aircraft operating above 60,000 feet was agreed upon, with the FAA and military expressing interest in potentially regulating that same airspace.

7.10 Broadcast rates for Mode A 1000.
(*SURV-WP01-37_A - Broadcast Rates for Mode A Code 1000.pdf*)

Bob Saffell presented a briefing on the implementation details regarding what should happen versus what does happen when changing the Mode A code to that of 1000. He clarified that the intended operation was to stop transmitting in order to alleviate congestion, but that there is some ambiguity in the language which left some manufacturers to implement a 24 second waiting period. Tom Pagano stated that this issue may go away if other changes are implemented. It was agreed that, should this requirement remain in the next version, it should be reviewed to clarify the language.

8. Discussion of Joint Transponder / ADS-B Material – Day 5

8.1 Corrections to ADS-B 1090 Extended Squitter MOPS.
(*SURV-WP01-38_A - ED102A-DO-260B additional clarifications - corrections.pdf*)

Eric Potier presented a collection of necessary corrections to the DO-260B and ED-102A discovered by WG-51 SG-1 since publication of these documents. Among these were:

- Issue 119 – Verification of Type Codes with GNSS/Baro Altitude. It was noted that since supporting UTC coupled mode is not a requirement in ED-102A, a portion of the test procedure was not applicable to all equipment. Don Walker further explained that the utility of the UTC coupled mode was reduced due to changes made from DO-260A to DO-260B. It was agreed that there may need to be a discussion on whether to use T=1 operations and if so, how. Martin Gray confirmed use of T=1 in Europe, but investigation needed into how it is used. Don stated the need to maintain functionality and mode, but to clarify how the metrics are calculated.
- Issue 123 – Time requirements for power on initialization. It was agreed that the time requirement needs further discussion as to whether 2.0s or 20s is more appropriate.

9. Future Meetings

With all currently available issues discussed, the focus was directed toward the determination of dates and locations for the next few meetings. The results of this discussion yielded the following meeting schedule, with further details to be determined:

- **Telecon**
Date: April 18, 2016
Time: 0900 – 1200 hrs (Eastern)
- **Meeting #2**
Date: 20-24 June 2016
Location: EUROCONTROL: Brussels, Belgium
Host: Eric Potier
- **Meeting #3**
Date: 17-21 October 2016
Location: RTCA: Washington, DC
Host: Tom Pagano
- **Meeting #4**
Date: 23-27 January 2017
Location: Melbourne, Florida
Host: Bob Saffell

10. Action Item Review

All action items were reviewed and discussed, with the addition of new actions. Refer to *Action Item Log - Combined Surveillance Meeting #1.pdf* for a complete list of action items.

11. Adjournment

With no other business before the committee, Eric Potier and Tom Pagano thanked all participants. Eric pointed out that the long list of actions validated the need to reopen these MOPS and followed this by adjourning WG-49. Tom thanked EUROCAE for their participation and adjourned SC-209 and the meeting at 12:25 PM.

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Timothy Steiner
Secretary, SC-209

CERTIFIED as a true and accurate summary of the meeting.

- S -

Thomas Pagano
Co-Chair, SC-209

- S -

Robert Saffell
Co-Chair, SC-209