

RTCA Paper No. 127-15/SC135-702
June 24, 2015

SUMMARY OF THE SIXTY-FIFTH MEETING

RTCA SPECIAL COMMITTEE 135
ENVIRONMENTAL CONDITIONS AND TEST
PROCEDURES FOR AIRBORNE EQUIPMENT

The Sixty-fifth meeting of RTCA/SC-135 was held April 14th through 16^h at NIAR in Wichita, KS.

The following were in attendance:

Bradley Green, RTCA SC-135 Chairman
Gary Smith, SC-135 Secretary

Ballard, Brett
Beard, Susan
Bertoldi, Massimiliano
Borgstrom, Erik
Cook, Steve
Cummings, Elysabeth*
Davidson, Steve*
Falzone, Mike*
Fletcher, Tim*
Hattlestad, Jim
Kerr, David
Koepp, Ron
Kumbasar, A. Hakan
MacDonald, Donald*
Mantis, Cos*
Marotta, Joe
Martin, Billy
Mavier, Jerome
McAdams, Brian
McMullen, Kyle
Nguyen, Lee
Peruchi, Francisco*

Honeywell International, Inc.
Honeywell International, Inc.

MidContinent Instruments
Rockwell Collins, Inc.
CELAB
Environ Laboratories
DNB Engineering
Rosen Aviation
UTC Aerospace
Garmin
Bell Helicopter Textron
Boeing
Garmin Ltd.
National Institute for Aviation Research
STM
Gables Engineering
UTC Aerospace
Honeywell International, Inc.
National Institute for Aviation Research
Airbus
Honeywell International, Inc.
National Institute for Aviation Research
FAA
Embraer

Phillips, Jeff
Poncon, Marc*
Press, Jim
Sharpe, Harlan
Steinbach, Tim
Thompson, Alan
Tsuchiyama, Randy
Unal, Ayhun
VanDyke, Jacob
Vaughan, Merrill*
Walen, David
Walton, Derek
Webb, Ken
Williams, Ted
Wills, Matthew
Zimmerman, David

National Institute for Aviation Research
Airbus Helicopter
DNB Engineering
National Institute for Aviation Research
Rockwell Collins, Inc.
Environ Laboratories
Teledyne
STM
Honeywell International, Inc.
Boeing Commercial Airplanes
FAA
LF Research
Rockwell Collins, Inc.
National Institute for Aviation Research
National Institute for Aviation Research
Spectrum EMC

* via Conference Bridge

In Accordance with the Federal Advisory Committee Act – Mr. Lee Nguyen of the Federal Aviation Administration was the designated Federal Employee for this meeting.

The agenda for the meeting was as follows:

1. Chairman's Opening Remarks, Introductions
2. Approval of Summary from the Sixty-Fourth Meeting - RTCA Paper No. 021-15/SC135-700
3. Review Revised Terms of Reference
4. Review DO-160H/ED-14H Schedule
5. Present New Change Proposal Forms
6. Review New Change Proposals
7. Review Working Group Activities
8. New / Unfinished Business
9. Establish Date for Next SC-135 Meeting
10. Closing and adjourn.

Agenda Item 1 **Chairman's opening remarks, Introductions, Recognize Federal Representative**

The Sixty-fifth meeting of RTCA/SC-135 was called to order at 9:13 AM on the 16th of April, 2015. Mr. Bradley Green opened the meeting by welcoming those in attendance. Mr. Lee Nguyen was introduced as the FAA representative for SC-135. Mr. Green reviewed the agenda for the meeting, and invited attendees in the room to introduce themselves.

Agenda Item 2 **Approval of the Summary from the Sixty-Fourth Meeting**

SC-135 Secretary Gary Smith read the previous meeting's minutes, RTCA Paper No. 022-15/SC135-700. The meeting minutes were accepted as presented.

Agenda Item 3 **Review Revised Terms of Reference**

Chairman Brad Green presented the revised Terms of Reference (TOR) for SC-135, which were approved by the Program Management Committee (PMC) in December, 2014, and were published as RTCA Paper No. 273-14/PMC-1283.

The Deliverables are a revision to DO-357, an updated User Guide for DO-160H, and revision H to DO-160. Both are scheduled to be completed in December, 2019.

The Scope of the revised TOR is as follows:

Special Committee 135 will work collaboratively with EUROCAE WG-14 for the following:

- a. Develop a new revision to DO-357 and produce an update to RTCA/DO-160G and EUROCAE/ED-14G. The new revision will include rationale, procedures, guidance and background information for the environmental test requirements, and the updated user guide.
- b. Maintain an active group of DO-160() Change Coordinators to propose recommendations for user guide material to RTCA/DO-160G (DO-357) and to collect change proposal's to RTCA/DO-160G.
- c. Continue coordination with EUROCAE Working Group 14 to develop new revisions to DO-160G and the User Guide for DO-160G (DO-357).
- d. Coordinate with RTCA SC-159, Global Positioning System (GPS), and the appropriate working groups to develop harmonized requirements for radio frequency emissions in the GPS related frequency bands.

- e. Coordinate with the FAA and Flammability Harmonization Working Group on potential new alternative flammability test methods and procedures including testing whole components instead of breaking down electronic devices into individual material samples as currently required.
- f. Chair a working group to work with industry representatives on requirements and testing of the continually changing aircraft power systems. This working group is to propose test conditions for 540 volt dc generators, and to break section 16 into multiple sections one for AC power systems and the other for DC power systems, and to break sections into emissions and susceptibility.
- g. Coordinate with the SAE AE-2, Lightning Committee, to address hybrid wire bundle testing.
- h. Coordinate with the SAE AE-4, Civil Aircraft Electromagnetic Compatibility (EMC) Working Group, on equipment EMC qualification.
- i. Coordinate with the Airline Passenger Experience Association (APEX) Technology Committee and EUROCAE WG-99 on investigating whether new requirements are needed for higher frequency test for RF Susceptibility, to address new WiGig and determine who should drive those requirements.
- j. Chair a working group to work with industry representatives on requirements for aligning Audio Susceptibility requirements to that of MIL STD-461 and to bridge the frequency gap between audio frequency susceptibility and RF frequency susceptibility
- k. Chair a working group to work with industry representatives on requirements for developing a proposal developing a method on a faster alternative to the current reverb chamber uniformity calibration.
- l. Chair a working group to work with industry representatives and EUROCAE WG-14 on considering requirements for volcanic ash qualification.
- m. Investigate specific aspect of carbon dust (due to its conductivity) which is now widely present in the aircraft industry.
- n. Setup a new section and a new Working Group to address Ground Reference Fluctuation which is a phenomenon aggravated by the combination of more composite structure and more electrical aircraft.
- o. Address specific aspects of testing of Integrated Modular Avionics. As being a versatile platform for which the supplier may only provide for generic hardware and firmware, with

the intent that the end user will implement its own hardware configuration and application software, the hardware and software configuration issues question the ability of the supplier to claim for a DO-160/ED-14 compliance.

- p. Investigate to replace 19.3.5 with a test procedure similar to MIL STD 461 CS115.

Some discussion arose during this Agenda Item, with questions about RTCA coordination with the APEX Technical Committee and the SAE AE-4, Civil Aircraft EMC Working Group.

Additional comments were offered on the idea of breaking Section 16 into two sections, one for DC power and one for AC power. Comments were that there is an “alphabet soup” of subsections which should be made simpler, and that certain instructions are repeated too many times.

Agenda Item 4 **Review DO-160H/ED-14H Schedule**

Chairman Green showed the schedule for preparing the next revisions of DO-160 and DO-357. The key dates are:

- submit draft revisions to RTCA Program Manager – January, 2019
- releasing the draft revisions for Final Review and Comment (FRAC) - March, 2019
- meet to review ballots and resolve FRAC – August/September, 2019
- provide final updates to RTCA – October, 2019
- PMC meeting to release DO-160H and DO-357A – December, 2019

Agenda Item 5 **Present New Change Proposal Forms**

Chairman Green displayed the revised Change Proposal forms for both DO-160H and DO-357. These will be uploaded to the RTCA Workspace.

Agenda Item 6 **Review New Change Proposals**

Agenda Item 7 **Review Working Group Activities**

Discussions about change proposals were included in the respective sections, which follow in the order in which they occurred.

Section 21 - Matt Wills, Change Coordinator

Change proposals were suggested regarding cable bundling, dwell times and scan times, and antenna

factors.

Sections 9, 10 and 11 – Kyle McMullen for Harlan Sharpe, Change Coordinator

Section 9 - The use of the term “hermetically sealed” needs to be addressed due to the lack of an absolute definition of the term. There was some discussion of adding an altitude requirement to the test, similar to MIL-STD-810, and a question arose as to whether corona discharge could be considered an ignition source. A comment was made that 3 minutes of circulation may not be enough time to create a uniform explosive mixture. Also, hexane may be on the EPA radar for restrictions.

Section 10 - There was a suggestion to consider making the drip plate for the Waterproofness test the same as that used in MIL-STD-810. Another suggestion was to include an improved drawing of the showerhead to enable fabrication by 3-D printing

Section 11 - There is a need to better describe under which circumstances different fluids may be combined for the Fluids test. The existing language is not clear enough. The question about fluid temperature when the fluid is sprayed onto the EUT was discussed, and the definition of spray was questioned.

It was suggested that guidance about the sequence of tests which appears in Section 3.2 be repeated in the applicable sections as well. E.g., the statement that fluids testing should not be conducted prior to the fungus test should appear in the Section 11 (Fluids) as well.

Sections 7 and 8 – Merrill Vaughan, Change Coordinator

Section 7 and 8 historical notes from previous Boeing Change Coordinators are available, and are being uploaded to the RTCA SC-135 workspace. Two documents have been uploaded, with more to be added.

With the potential changes for the shock and vibration sections, it is anticipated that monthly meetings are required in order to meet the revision schedule. These are planned to start in May, and invitations will be extended to the full SC-135 roster in order to promote greater participation.

Several change proposals have been suggested over the past year or two which can now be addressed for revision H. All were deferred for now. Suggested changes include:

- allowing an exception to the “equipment operating during vibration” requirement for rotating machinery when operating such machinery would be impractical (e.g., APUs, large generators, etc.); Gary Smith (Honeywell) to submit Change Proposal

- address High Level Short Duration vibration requirements as proposed by Gulfstream
- add tolerances to the Helicopter sine-on-random levels and revise the procedure; Tim Fletcher (Bell Helicopter) to submit Change Proposal
- address frequency reporting requirements for the Environmental Qualification Form; Mike Falzone (Garmin) to submit Change Proposal
- address analog & digital control requirements to reflect current vibration test technology; Gary Smith to investigate.
- address Section 7 Shock Response Spectrum (SRS) shock method; Merrill Vaughan (Boeing) to investigate
- revise Section 7 to recommend the use of the 11 ms pulse for EUT resonance > 50 Hz, the use of the 20 ms pulse for EUT < 50 Hz, delete the 100 ms pulse, and update Note 1 with a caveat. Merrill Vaughan to submit Change Proposal.
- revise Section 7 statement about dynamic tests not used as substantiation for sustained acceleration or vice versa; Merrill Vaughan to submit Change Proposal
- update all graphics and figures for Revision H into digital format

Sections 4 and 5 – Jake VanDyke, Change Coordinator

Section 4 – for the High and Low Temperature Ground Survival tests, the need for the 30 minute soak before the performance test was questioned.

Section 5 – there was much discussion in the Working Group meeting about the lag between the EUT temperature and the chamber ambient temperature, and how the overall temperature variation rate is determined. It was suggested that a tolerance band be established for the actual temperature transient time, to limit gross temperature overshoots or undershoots. Also, there may be a need to add a test with a -1500 foot altitude.

Section 16 – Ken Webb for Joe Marotta, Change Coordinator

No Change Proposals for Section 16 were presented at this time. The idea of breaking Section 16 up into AC and a DC sections was discussed, and the consensus was that this is a good idea. There was

also a suggestion to re-examine the category designations as part of a revision.

Additional suggestions and comments were offered:

- Test type II current harmonics needs clarity. Consider clipping the waveform for high power UUT; suggested circuit in DO-160G will not work for high power.
Consider adding frequencies or a specific time domain plot for consistency
- Consider putting a LISN schematic back in the User Guide for allowing users to simulate tests, to help in simulations of power converter
- Consider adding tolerances to tests
- Lightning issues associated with Section 16 power filter: consider adding a visual inspection to Lightning testing and re-run ATP
- Consider making Lightning injection testing the first test, since latent damage can occur and may not be detected.
- Consider adding an isolation spec in DO-160 for AC systems
- Dielectric Withstand and Insulation Resistance is more of a materials and design issue than a test method
- Address multiple inputs and pass through

Sections 15 and 18 – Ken Webb, Change Coordinator

- Section 15 – consider adding new methods of compass measurement
- Section 18 – consider probe saturation; looking at AFCS and RFCS

Sections 19 and 20 – Jim Hatlestad, Change Coordinator

Section 19 – The working group discussed replacement test procedures for the Induced Spike test. The goal is to provide a procedure that provides for clear / achievable criteria for waveshapes, and provides equivalent susceptibility stress to equipment. One proposal is similar to MIL-STD 461 CS115. Another potential proposal might be based on EN 61000-4-4. The group would like to find or create a unit that is known to be susceptible to the existing Induced Spike test, and verify that unit is also susceptible to the proposed replacement test, to verify the tests' equivalency in stressing the unit.

Section 20 –

The working group addressed several subjects:

- 1) A proposal to change required wire length exposure from $\frac{1}{2}$ lambda to $\frac{1}{4}$ lambda. The group took action items to reconvene with data/analysis showing that a reduction of the length of exposed cable would not reduce the peak signals induced onto the wiring.
- 2) A proposal to modify LISN requirements. The proposal was made to modify the LISNs requirement to create a minimum insertion loss at ~22kHz. Additionally, a new curve is proposed for large transport aircraft. The group took action items to review this proposal with their respective companies.
- 3) A proposal to replace the set up figure for reverberation chamber testing. The proposal was accepted in principle, with only minor edits requested.

Sections 22 and 25 – Erik Borgstrom, Change Coordinator

Section 22 –

- The main work is done at the SAE AE-2 Committee. The Section 22 Working Group meets 3 times a year, coinciding with the AE-2 meetings. The next AE-2 meeting will be held in Memphis late in May.
- Changes to Waveform 2 are based on real-world AC data with a slower rise time.
- Problems with the pin injection test on AC circuits require re-writing this test.
- Waveform 5B has a lot of energy (high current and long duration) and the injection or monitor probe may saturate
- There is a continuing repeatability problem with combining waveforms 1 & 2 and 4 & 5A, and work continues to resolve the problem.

Section 25 – there are no Change Proposals so far.

Section 23 – Steve Cook, Change Coordinator

There are no Change Proposals so far. The two main issues are the use of digital cameras for the photographic spark detection test method along with the additional detail of the Nitrogen gas being used for the ignitable mixture spark detection. These will be worked on at the upcoming SAE AE-2 meeting in Memphis.

Agenda Item 8

New/Unfinished Business

Chairman Green announced that due to the retirement of Dr. Jim Lyall, a new Change Coordinator is needed for Sections 1, 2 and 3 and anyone interested should contact him.

Secretary Smith had two comments. First, he asked for all Change Coordinators to review the graphics in their respective sections and to update them in digital format for revision H. Many graphics in the earlier revisions are unclear and lack sharpness since they are nth-generation photocopies, and most originals are not available to RTCA.

Second, he stated that many of the existing DO-160 requirements were written around monitoring and recording equipment which are dated by today's standards. In particular, tests involving transients in temperature or pressures have no requirements to record environmental parameters continuously. In light of the current availability and modest cost of digital recording systems, the next revision of DO-160 should reflect and encourage the use of such equipment with how the requirements are written, e.g. with applying tolerances to transients.

Kyle McMullen of NIAR gave a brief presentation on RTCA SC-228, Minimum Operational Performance Standards for Unmanned Aircraft Systems. This is a new Special Committee established just 2 years ago, and they are currently developing Phase I MOPS.

Brad Green and Gary Smith next spoke about how Change Proposals will be tracked for the upcoming document revisions. All Change Proposals (CPs) for DO-160H and DO-357A should be forwarded to Gary or Brad from the Change Coordinators, and they will each be assigned a unique identification number. The CPs will be uploaded to the RTCA Workspace in read-only format to prevent any unintentional editing of the proposed changes prior to their review by the full SC-135 committee.

Brad Green announced that the DO-160G Errata Sheet had two recent additions, with the possibility of at least one more before it is finalized.

A question arose about the content of some CPs. One example was shown which addressed a broad change to DO-160, but it did not include any text with specific changes in requirements. Dave Walen (FAA) commented that this was a "conceptual" change, and strongly suggested that the Committee establish a date after which only CPs with specific changes would be accepted. Based on the Rev H schedule, the cutoff date for "conceptual" CPs was established as January, 2017

Agenda Item 9

Establish Date for Next SC-135 Meeting

The next SC-135 meeting is planned for October 27-29 at RTCA in Washington, DC.

Agenda Item 10

Closing and Adjourn

The meeting was adjourned at 1:55 PM on Thursday, April 16th, 2015.



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Certified as a true and accurate summary of the meeting.

-S-
Bradley Green
Chairman

-S-
Gary Smith
Secretary