



**Summary of the Ninety-Sixth Meeting**

**Special Committee 159**

**Navigation Equipment Using the Global Navigation Satellite System (GNSS)**

The ninety-sixth Plenary meeting of SC-159 was held October 21<sup>st</sup>, 2016 at RTCA Headquarters, 1150 18<sup>th</sup> Street NW, Suite 910, Washington, D.C. 20036. The attendees were the following:

Christopher Hegarty (Co-Chair)	The MITRE Corporation
George Ligler (Co-Chair)	PMEI
Ken Alexander (Designated Federal Official)	Federal Aviation Administration

NAME	COMPANY
Ashley, John	The MITRE Corporation
Ashton, Ken	Nu-Approach Ltd.
Azoulai, Laurent	Airbus
Bouvet, Dennis	Thales Group
Brenner, Mats	Honeywell International, Inc.
Bridges, Kevin	Federal Aviation Administration
Caizzone, Stefano	German Aerospace Center DLR
Clark, Barbara	Federal Aviation Administration
Dennis, Jed	NAVTAC
Ding, Yi	Esterline CMC Electronics
Divis, Dee Ann	Inside GNSS
Foley, John	Garmin Corporation
Harris, Matt	The Boeing Company
Hiliuta, Adrian	Esterline CMC Electronics
Iatsouk, Victor	Geyser-Telecom Inc.
Kalyanaraman, Sai	Rockwell Collins, Inc.
Latev, Vladimir	Universal Avionics Systems Corp.
Morrison, Rebecca	RTCA (active)
Moses, Harold	RTCA (retired)
Owen, John	Defence Science Technology Laboratory (DSTL)

Parikh, Ajay  
Pennington, Darrell  
Rodriguez, Catalina  
Roy, Andrew  
Savoy, John  
Shimizu, Tetsu  
Skubii, Oleg  
Stearn, Geoff  
Studenny, John  
Swanson, Dale  
Trautenberg, Hans  
Van Dyke, Karen  
Wichgers, Joel  
Williams, James

Ligado Networks  
Air Line Pilots Association  
CNES for GSA  
Aviation Spectrum Resources, Inc.  
Honeywell International, Inc.  
Japan International Transport Institute, USA  
Research Design Lab NAVIS  
Ligado Networks  
Esterline CMC Electronics  
The MITRE Corporation  
European Aviation Safety Agency (EASA)  
US Department of Transportation  
Rockwell Collins, Inc.  
Dentons

The agenda for the meeting was as follows:

1. Introductory Remarks: DFO, RTCA, and Chairmen
2. Approval of the Summary of the Ninety-Fifth Meeting held March 11<sup>th</sup>, 2016, RTCA Paper No. 189—16/SC-159-1050.
3. Final Review and Comment (FRAC) activities
  - a. DO-229E Update
  - b. GPS/GLONASS MOPS
4. Review Working Group (WG) Progress and Identify Issues for Resolution
  - a. GPS/WAAS (WG-2)
  - b. GPS/GLONASS (WG-2A)
  - c. GPS/Inertial (WG-2C)
  - d. GPS/Precision Landing Guidance (WG-4)
  - e. GPS/Interference (WG-6)
  - f. GPS/Antennas (WG-7)
5. Review of EUROCAE Activities
6. Action Item Review
  - a. DME Interference to GNSS Signals in the Future
  - b. Draft formal communication to SBAS providers and other standards bodies informing them of SC-159 work products and efforts
7. Assignment/Review of Future Work
8. Other Business
9. Date and Place of Next Meeting
10. Adjourn

\*\*\*\*\*

In accordance with the Federal Advisory Committee Act, Ken Alexander, Federal Aviation Administration (FAA), was the Designated Federal Official for this meeting.

\*\*\*\*\*

**Agenda Item 1. Introductory Remarks: DFO, RTCA, and Chairmen**

At the suggestion of SC-159 Co-Chair Chris Hegarty, attendees introduced themselves. Ken Alexander, the meeting's Designated Federal Official, read the meeting announcement. Rebecca Morrison, SC-159's RTCA Program Director, summarized the RTCA Special Committee Membership and Proprietary Reference Policies. The Co-Chairs and meeting acknowledged with appreciation the attendance of Hal Moses, SC-159's long-standing Program Director, who had recently retired from RTCA.

**Agenda Item 2. Approval of the Summary of the Ninety-Fifth Meeting held March 11, 2016, RTCA Paper No. 189-16/SC159-1050.**

The summary of the ninety-fifth meeting of SC-159 was approved with an editorial correction with regard to the date on which that meeting was held and to add an individual to the attendance list.

**Agenda Item 3. Final Review and Comment (FRAC) activities**

Agenda Item 3a, DO-229E Update, was discussed under Agenda Item 4a. Agenda Item 3b, GPS/GLONASS MOPS, was discussed under Agenda Item 4b.

**Agenda Item 4. Review Working Group (WG) Progress and Identify Issues for Resolution**

**a. GPS/WAAS (WG-2)**

Laurent Azoulai and John Studenny provided a summary of WG-2 activities. The working group covered the following topics, annotated with WG-2 paper numbers (for further details, please download the WG-2 Presentation to the Plenary from the RTCA Workspace):

- 2.a WAAS Update
- 3.a EGNOS Performance and Program Status
- 7.a Review and closure of DO-229E FRAC comments
- 7.b RTCA paper justifying I<sub>GNSS</sub> values for DO-229E
- 10.a Optional ADS-B Traffic Situation Awareness with Alerting (TSAA): Proposal of draft optional requirement that limits velocity jitter for GNSS user equipment
- 11.a Antenna Group Delay Bias
- 12.a DFMC SBAS MOPS ATLAS project
- 12.b Accuracy Designators for the DFMC SBAS MOPS
- 12.c Satellite Selection Process
- 12.d DFMC Definition document update
- 12.e DFMC ConOp update
- 12.f Work Plan discussion.

With regard to the DO-229E Final Review and Comment, Laurent Azoulai reviewed the primary reason that DO-229E had been undertaken: requests for PRN codes for SBAS satellites greatly exceed the 19 codes reserved for this purpose in DO-229D. DO-229E development had been undertaken in

coordination with the ICAO Navigation Systems Panel, and only equipment developed post DO229E publication would be affected. The SC-159 Plenary had further agreed in March 2016 that DO-229E should also incorporate Change 1 to DO-229D as well as validated errata to DO-229D.

Mr. Azoulai reviewed further work that had been added to the DO-229E effort. While most of this work was directly related to the SBAS PRN code expansion, a new requirement had been added to prevent the use of the Navigation Message Correction Table, information was added to advise which version of applicable and reference standards should be used, and clarifying text was added to enhance understanding of, for example, IPP computations and the possibility to enable graceful degradation to RAIM/FDE upon the occurrence of certain SBAS system failure modes. Notes about antenna group delay and  $I_{GNSS}$  were also added, and a non-concur comment about the lack of clear definitions for in-band, near-band, and out-of-band frequencies was addressed.

Mr. Azoulai reported that 10 teleconferences were held to develop DO-229E, with multiple additional teleconferences on specific issues. 72 FRAC comments were received, and all had been addressed. The only non-concur comment was that discussed in the previous paragraph: it was agreed that the resolution to this non-concur comment needed to be reflected in the forthcoming GPS/GLONASS and GPS/LAAS MOPS, and would also be reflected in the GPS/ABAS MOPS (DO-316) the next time that that document was reopened.

Please refer to Agenda Item 9 for the proposed scheduling of WG-2 meetings at the SC-159 meetings during the week of March 13<sup>th</sup>, 2017.

**After discussion, the Plenary unanimously approved the transmittal of the draft RTCA DO-229E to the RTCA Program Management Committee for final approval.**

#### **b. GPS/GLONASS (WG-2A)**

Victor Iatsouk reported on the FRAC process for a single frequency GPS/GLONASS receiver MOPS undertaken with the approval of SC-159 at its March 2016 meeting. Mr. Iatsouk indicated that while a number of FRAC comments had been resolved by WG-2A, a cluster of comments about integrity issues should be addressed by a small task group, with results to be presented to the SC-159 Plenary at its March 2017 meeting. Mr. Iatsouk undertook to finalize the FRAC comments spreadsheets prepared by WG-2A and provide a consequently updated MOPS draft to the RTCA Secretariat within approximately one week. Non-concur commenters and other interested members were asked to convey their willingness to participate in the above-mentioned task group to the SC-159 Co-Chairs and WG-2A Chair within two weeks. Mr. Iatsouk agreed to develop a near-term task group work plan for distribution to the potential participants.

Please refer to Agenda Item 9 for the proposed scheduling of WG-2 meetings at the SC-159 meetings during the week of March 13<sup>th</sup>, 2017, and to the RTCA Workspace for Victor Iatsouk's presentation.

**c. GPS/Inertial (WG-2C)**

WG-2C Co-Chair Mats Brenner reported on WG-2C activities. WG-2C is working on a MOPS for GNSS-aided inertial systems (including AHRS/MEMS grade sensors). The group met for 2.5 days during the week of this SC-159 Plenary session, and additionally had had 6 teleconferences since the March 2016 SC-159 Plenary. A MOPS draft covering MOPS Sections 1 and 2 had been prepared, and Appendices A through N were also under development.

As a result of technical challenges faced by the Working Group and requested functionality from, for example, Airbus, Garmin, NG Litef, and Rockwell Collins, the Working Group proposed a 2-year extension to the schedule for the MOPS to October 2019. As the expansion in scope was requested by the industry and the Working Group indicated that it would object at this point to going back to the original scope of the MOPS (assisting only low-end inertial installations with GNSS), **the Plenary agreed to propose a 2-year extension to the schedule in the SC-159 Terms of Reference for the GNSS-aided Inertial Systems MOPS to a Plenary approval date of October 2019.** The SC-159 Co-Chairs agreed to take this proposal to the RTCA Program Management Committee at that body's December 15, 2016 meeting.

For further details, please download the WG-2C presentation from the RTCA Workspace. Additionally, please refer to Agenda Item 9 for the proposed scheduling of WG-2 meetings at the SC-159 meetings during the week of March 13<sup>th</sup>, 2017.

**d. GPS/Precision Landing Guidance (WG-4)**

Joel Wichgers and Matt Harris, WG-4 Co-Chairs, reported on WG-4 activities. Contingent on the ICAO Navigation Systems Panel approving the next edition of GBAS SARPs in December 2016, the Working Group recommended a January 2017 FRAC of a corresponding, updated LAAS MOPS (DO-253D) and an updated LAAS ICS (DO-246E) that also was in harmony with the SARPs, with Plenary approval to be sought at SC-159's March 2017 meeting. **The SC-159 Plenary agreed to this plan for FRAC and approval of these two documents, under the stated assumption that the SARPs work at ICAO would be approved by the NSP.**

The updates to the MOPS and ICD are planned to incorporate a GAST D Service capable of supporting GPS L1 LAAS-based Category II and III precision approach and takeoff operations. An update to the specification for the LAAS VHF Data Broadcast (VDB) will provide a revised link budget, definition of a second class of VDB receiver that accommodates aircraft with a larger aircraft installation loss, and an enhanced description of the VDB link budget rationale.

Per the SC-159 Terms of Reference, longer-term WG-4 work products were indicated to be further updates to DO-253 and DO-246 to reflect multi-constellation, multi-frequency GBAS as well as document maintenance updates.

Messrs. Wichgers and Harris also provided information on the agenda for WG meetings held during the week of this Plenary meeting. For further details, please download the WG-4 presentation from the RTCA Workspace. Additionally, please refer to Agenda Item 9 for the proposed scheduling of WG-4 meetings at the SC-159 meetings during the week of March 13<sup>th</sup>, 2017.

**e. GPS/Interference (WG-6)**

WG-6 Co-Chair Sai Kalyanaraman presented WG activities and plans. Dr. Kalyanaraman discussed the FAA formal request dated October 19, 2016 for RTCA to review Ligado Networks' (1) analysis of the compatibility between their proposed handsets and certified GPS receivers; and (2) proposal concerning the compatibility of their downlink with certified GPS receivers. With RTCA's review requested to be completed by mid-December 2016, Dr. Kalyanaraman indicated that WG-6 meetings had been set up for October 28 and November 17, 2016 to review comments on the Ligado documents and to develop a consensus review report. A third meeting would be scheduled if needed. The WG-6 input is scheduled to be provided to the SC-159 Plenary for its review by December 1, 2016. **The SC-159 Plenary approved this approach and indicated willingness to a two-week Plenary review period, December 1-December 15, 2016, to review and comment on the WG-6 work product.**

Dr. Kalyanaraman then indicated that WG-6's agenda had also included review of a new model for DME interference on Galileo/GPS, a more accurate evaluation of C/A code self-interference developed by A.J. van Dierendonck, and a schedule for updates to DO-235B and DO-292.

For further details, please download the WG-6 presentation from the RTCA Workspace. Additionally, please refer to Agenda Item 9 for the proposed scheduling of WG-6 meetings at the SC-159 meetings during the week of March 13<sup>th</sup>, 2017.

**f. GPS/Antennas (WG-7)**

Sai Kalyanaraman presented an update on WG-7 activities. The WG-7 meeting during the week of this Plenary meeting included DL antenna work in support of SC-159, WG-7; group delay bounding for GBAS SF CAT III, and discussion of updates to the draft version of the dual frequency (L1/E1/L5/E5a) Antenna MOPS. For further details, please download the WG-7 presentation from the RTCA Workspace. Additionally, please refer to Agenda Item 9 for the proposed scheduling of WG-7 meetings at the SC-159 meetings during the week of March 13<sup>th</sup>, 2017.

**Agenda Item 5. Review of EUROCAE activities**

Laurent Azoulai presented an update of the activities of EUROCAE Working Groups 28 and 62. WG-62 now has an approved Terms of Reference for development of an SBAS dual-frequency, multiconstellation (GPS/Galileo) receiver MOPS. The SC-159 Co-Chairs indicated that discussions with EUROCAE WG leadership about such a joint activity were being begun within the next few months. WG-62's recent meeting had also included a discussion on a work plan from the Galileo Program to provide

the needed constellation data for the GNSS Table (“GNSS Scorecard”) that has been reviewed within both EUROCAE and SC-159 WG-2.

For further details, please download the EUROCAE WG-28 and WG-62 status update presentations from the RTCA Workspace.

**Agenda Item 6. Action Item Review**

**a. DME Interference to GNSS Signals in the future**

Please see the discussion of WG-6 activities with regard to DME interference to GNSS. The status of the FAA Navigation Programs coordinating with Spectrum to provide a briefing to RTCA, to take into account deployment, relocation, and signal strength, remains open.

**b. Draft formal communication to SBAS providers and other standards bodies informing them of SC-159 work products and efforts**

The “other standards bodies” portion of this action was seen to having been closed at the March 2016 SC-159 Plenary (Meeting Summary, page 6). With regard to formal communication to SBAS providers, Chris Hegarty indicated that he would pull together an address list of those providers, and George Ligler indicated that he would draft the requisite letter.

**Agenda Item 7. Assignment/Review of Future Work**

Nothing was added here to the items noted above in this meeting summary.

**Agenda Item 8. Other Business**

SC-159 DFO Ken Alexander provided a presentation on “GNSS Intentional Interference and Spoofing Detection—Preliminary Views.” SC-159 member feedback on the contents of this presentation was requested. Avenues for having increased industry participation in the activities of the FAA GNSS Intentional Interference and Spoofing Study Team (GIIST) were discussed. An industry advisory team, led by Boeing, has been formed and might be an appropriate vehicle for such increased participation. Mr. Alexander indicated that the intent of the GIIST preliminary views is to raise the bar on a receiver’s ability to detect intentional interference and spoofing without having substantial receiver cost impacts. A spirited discussion ensued on how high the bar ought to be raised and what techniques might be employed.

For further details, please download Mr. Alexander’s presentation from the RTCA Workspace.

**Agenda Item 9. Date and Place of Next Meeting**

DRAFT MEETING SUMMARY 19 FEBRUARY 2017

The 97<sup>th</sup> (presuming that no Special Plenary meeting needed to be called with regard to WG-6’s draft review of the Ligado documents—see the summary of WG-6 discussions, above) meeting of RTCA SC-159 will be held during the week of March 13<sup>th</sup>, 2017 at RTCA Headquarters. The proposed meeting schedule developed during this meeting was as follows:

	Friday, 3/10	Monday, 3/13	Tuesday, 3/14	Wednesday 3/15	Thursday, 3/16	Friday, 3/17
<b>WG-2 (GPS/WAAS)</b>		<b>All day</b>	<b>Morning</b>			
<b>WG-2A (GPS/GLONASS)</b>	<b>All day</b>		<b>Afternoon</b>	<b>All day</b>		
<b>WG-2C (GPS/Inertial)</b>			<b>All day</b>	<b>All day</b>		
<b>WG-4 (GPS/LAAS)</b>			<b>All day</b>	<b>All day</b>	<b>All day</b>	
<b>WG-6 (Interference)</b>				<b>All day</b>		
<b>WG-7 (Antenna)</b>					<b>All day</b>	
<b>Plenary Session</b>						<b>9:00 a.m.</b>

**Please Note: Final time slots for the Working Groups may be amended—please see the agenda announcement of the March 2017 meetings for finalized WG meeting schedules.**

The subsequent meeting of SC-159 was scheduled for the week of October 16<sup>th</sup>, 2017, with a Plenary session on October 20<sup>th</sup>, 2017, at RTCA Headquarters.

CERTIFIED as a true and accurate summary of the meeting.

--S--

Christopher Hegarty  
Co-Chair

--S--

George Ligler  
Co-Chair