TERMS OF REFERENCE

Special Committee SC-159
Navigation Equipment Using the Global Navigation Satellite System (GNSS)
(Version 26)

SC LEADERSHIP:

Position	Name	Affiliation	Telephone	Email	Change
Co-Chair	Christopher Hegarty	The MITRE Corporation	781-271-2127	chegarty@mitre.org	
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Secretary	TBD				

BACKGROUND:

Since it was established in 1985, RTCA SC-159 has produced and maintained a suite of minimum operational performance standards (MOPS) and minimum aviation system performance standards (MASPS) for aviation equipment using the Global Positioning System (GPS) and its augmentations, specifically aircraft-based (ABAS), ground-based (GBAS), and satellite-based (SBAS) augmentation systems, using a single GPS signal, the GPS coarse/acquisition (C/A) code that is modulated on the link 1 (L1) carrier frequency of 1575.42 MHz. Similarly, the International Civil Aviation Organization (ICAO) has produced various aviation and equipment standards for GPS and its augmentations. All of these standards are in global use today.

The world is entering a new era of the Global Navigation Satellite System (GNSS) with new constellations and a variety of new, civil, safety-of-life signals. Consideration for use requires that the carrier frequencies be at 1575.42 MHz and at 1176.45 MHz with a usable signal bandwidth of no more than +/-12MHz around the carrier frequency. Other conditions may apply, such the signal being open and being supported by the service provider for safety-of-life use.

The current GNSS status is that GPS is presently being modernized, and the constellation is being populated with three new civil signals (L5, L2C, and L1C) on multiple frequencies with three of the four end-state civil signals (L1 C/A, L5, and L1C) being located within bands allocated for aeronautical radio navigation services (ARNS). SBASs, such as the Wide Area Augmentation System (WAAS) in North America, are evolving to support dual-frequency user equipment. Additionally, other GNSS core constellations have been deployed (Russia's GLONASS) or are

being deployed (Europe's Galileo and China's BeiDou).

ICAO's Navigation System Panel (NSP) is updating Standards and Recommended Practices (SARPs) contained within Annex 10 to the International Convention on Civil Aviation to incorporate GPS and GLONASS modernization as well as the new core constellations. Aviation equipment standards are/will be required for safety-of-life use. A GPS/GLONASS L1 MOPS was produced and adopted in 2017 as a first step towards standardization of multi-constellation equipment.

PRODUCT DELIVERABLES:

Product	Description	FRAC Completion Due Date*	Projected Publication Date**	Change
DO-401A/ED-259B Minimum Operational Performance Standards (MOPS) for Dual-Frequency Multi-Constellation Satellite-Based Augmentation System Airborne Equipment	Update to GPS/Galileo/SBAS MOPS for dual-frequency equipment	March 2027	June 2027	
DO-XXX Minimum Operational Performance Standards (MOPS) for Dual-Frequency Multi-Constellation Ground-Based Augmentation System Airborne Equipment	MOPS for dual-frequency equipment.	June 2027	September 2027	Moved to September 2027
DO-246F GNSS-Based Precision Approach Local Area Augmentation System (LAAS) Signal-in-Space Interface Control Document (ICD)	ICD revision for minor corrections and integration of needs for the DFMC GBAS MOPS	June 2027	September 2027	Moved to September 2027

Product	Description	FRAC Completion Due Date*	Projected Publication Date**	Change
DO-YYY - Minimum Operational Performance Standards (MOPS) for Single Frequency GPS/Galileo (L1/E1) nulling CRPA	MOPS for Single frequency nulling CRPA	Mar 2027	Jun 2027	
DO-ZZZ - Minimum Operational Performance Standards (MOPS) for Dual Frequency GPS/Galileo (L1/E1/L5/E5a) nulling CRPA	MOPS for dual frequency nulling CRPA	Dec 2029	Mar 2030	
DO-XYZ/ED-XXX - Minimum Operational Performance Standards (MOPS) for Dual-Frequency Multi-Constellation (DFMC) GNSS Aided Inertial Systems	MOPS for dual frequency aided inertial systems	Jun 2028	Sep 2028	New

*Note: Final Review and Comment (FRAC) Completion Due Date refers to the date that the committee plenary approves the document after completing the FRAC Process. SCs should submit the final document at least 45 days before the PMC meeting where it will be considered for approval.

**Note: Projected Publication Date refers to the date that the item will be approved by the PMC and officially published by RTCA.

SCOPE:

Requirements for core constellations in addition to GPS and Galileo will be dependent upon multiple prerequisites as discussed in the Specific Guidance Section below. Additionally, in the case of the GNSS (SBAS or GBAS) L1/L5 MOPS, constellation providers will be advised to provide final needed technical information at least two-years prior to the completion of the Updated MOPS in order to have their constellations included in the MOPS. This includes the official set of user interface definition, technical and performance information for the core constellations, technical service provisions for H-ARAIM, interference environment (RTCA DO-235C, DO-292A) and multi-constellation SBAS.

Operations targeted for this MOPS include, GPS / Galileo / SBAS L1&L5 supporting RNP operations from en route to Cat I and ADS-B, for certification, robustness requirements against jamming and spoofing threats, including radio-frequency interference detection. The MOPS will include integrated DO-229F requirements for class Beta, Delta and Gamma receiver classes, DFMC SBAS E1/L1/E5a/L5 requirements, including DF SBAS-Ranging, H-ARAIM requirements, GPS & Galileo L5 only modes, management of ICAO Institutional scenarios, PRN extension for GPS & Galileo satellites. Requirements will also be captured for Galileo OS NMA.

SC-159/WG-62 is considering additional requirements in a future revision including SBAS authentication, BeiDou as a core constellation, GPS L1C, and V-ARAIM.

To address the above scope, RTCA SC-159 shall develop equipment standards for GNSS augmented by ABAS, GBAS, and SBAS, as well as associated interference environment reports and interface control documents (ICDs).

The documents currently under development include

DO-401A/ED-259B, Minimum Operational Performance Standards (MOPS) for Dual-Frequency Multi-Constellation Satellite-Based Augmentation System Airborne Equipment, will address the following scope:

- Avionics with GPS/GAL/SBAS L1/SBAS L5 supporting RNP from ER to CAT-I and ADS-B
- H-ARAIM
- Robustness to Jamming and Spoofing including RFI detection
- Management of ICAO institutional scenarios
- Extended GPS PRN and GAL SVID
- SBAS authentication provisions
- OSNMA (Open Service Navigation Message Authentication)

DO-XXX, Minimum Operational Performance Standards (MOPS) for Dual-Frequency Multi-Constellation Ground-Based Augmentation System Airborne Equipment, has the following scope:

- Develop New MOPS for DFMC GBAS new PAN for DFMC
- The group will also consider where to do updates incorporating /integrating VDB, PAN GPS L1-only.

DO-246F GNSS-Based Precision Approach Local Area Augmentation System (LAAS) Signal-in-Space Interface Control Document (ICD) will address the following scope:

- Maintenance updates for existing content for L1.
- Updates to support DO-XXX DFMC GBAS MOPS.

The DO-YYY, Minimum Operational Performance Standards (MOPS) for Single Frequency GPS/Galileo (L1/E1) nulling CRPA (Controlled Reception Pattern Antennas) has the following scope:

- Standardize a nulling antenna solution with a goal to meet the immediate need of addressing GNSS L1/E1 band Jamming to the extent practicable and have minimal integration impacts to the certified airborne equipment solutions in the field.
- Intent of the standard will be to ensure that there is a minimum set of requirements in place to ensure required levels of integrity and applicable levels of continuity and accuracy to be achieved as observed at the output of GNSS airborne equipment.

DO-ZZZ will address DFMC. This will support at a minimum L1(E1)/L5(E5a) nulling.

Further consideration will be given to inclusion of BeiDou, additional beam forming, and DoA (direction of arrival) determination capabilities at L1(E1) and L5(E5a). This is expected to drive further impacts to the airborne equipment design and integration at the platform level.

DO-XYZ/ED-XXX, Minimum Operational Performance Standards (MOPS) for Dual-Frequency Multi-Constellation (DFMC) GNSS Aided Inertial Systems has the following scope:

- Develop a new MOPS (DO-XYZ/ED-XXX) for inertial systems, including attitude heading reference systems, aided by DFMC GNSS signals
- Aligned with DFMC SBAS MOPS (ED-259B/DO-401A), including definition of GNSS Jamming & Spoofing threats for detection and mitigation with standards for established (GPS L1 C/A) and new DFMC GNSS/inertial integration capabilities, as well as standards harmonized with H-ARAIM

The new DO-XYZ/ED-XXX MOPS will address the threats of GNSS signal interference and spoofing with corresponding performance standards for detection, mitigation, and recovery claims by GNSS-aided inertial systems. Additionally, standardized outputs will be defined for indicating when the system has detected these threats. The committee will identify potential updates to DO-384 as part of this activity.

ENVISIONED USE OF DELIVERABLE(S)

The guidance developed by this special committee is envisioned to be referenced by the Federal Aviation Administration (FAA) and other State Authorities as appropriate in certification guidance material including Technical Standard Orders (TSOs) or other national documents.

DO-401A/ED-259B is expected to be validated and appropriate to support a Technical Standard Order Approval.

DO-XXX is expected to support verification and validation and is not expected to be used to support a Technical Standard Order Approval

DO-246F is expected to be consistent with its current use and suitable to be referenced in the new DO-XXX DFMC MOPS for GBAS.

DO-YYY, DO-ZZZ will be suitable to support Technical Standard Order Approval.

DO-XYZ/ED-XXX will be suitable to support Technical Standard Order Approval.

SPECIFIC GUIDANCE:

1. The following core constellations should be addressed:
    a. The U.S. Global Positioning System (GPS)
    b. The Russian Federation Global Orbiting Navigation Satellite System (GLONASS).
    c. Europe's Galileo
    d. China's BeiDou
2. The incorporation of the foreign core constellations listed above within equipment standards shall be contingent upon multiple prerequisites being satisfied for operational use.
3. The following augmentations should be addressed:
    a. Aircraft-based augmentation system – as defined by ICAO, this includes receiver autonomous integrity monitoring (RAIM), which uses GNSS information exclusively, and aircraft autonomous integrity monitoring (AAIM), which uses information from additional on-board sensors (e.g., barometric altimeter, clock and inertial navigation systems). Consideration should be given to advanced RAIM (ARAIM) methods currently under development.
    b. SBAS.
    c. GBAS.
4. Particular attention should be given to meeting integrity and availability requirements especially for all phases of flight.
5. New MOPS will address, to the extent practicable, the threats of interference and spoofing, impacting one or multiple frequencies and/or constellations.
6. New MOPS should address, to the extent practicable, the possibility of higher levels of adjacent-band interference in the future operational environment.
7. The work of the committee should be coordinated with the European Organization for Civil Aviation Equipment (EUROCAE) Working Groups 28, 62, and 133 as well as with ICAO's Navigation System Panel (NSP). The GNSS (SBAS) L1/L5 MOPS will be developed jointly with EUROCAE WG-62. (DO-YYY) Single Frequency GPS/Galileo (L1/E1) nulling CRPA MOPS and (DO-ZZZ) Dual Frequency GPS/Galileo (L1/E1/L5/E5a) nulling CRPA MOPS will be developed jointly with EUROCAE WG-133. The MOPS for DFMC GNSS aided inertial systems (DO-XYZ/ED-XXX) will be developed jointly with EUROCAE WG-62.

INITIAL DOCUMENTATION - the following documents should be made available to this committee.

Documents	**Intended Use**
DO-229F	Basis for updated GPS/SBAS MOPS.
DO-301	Basis for (DO-YYY) Single Frequency GPS/Galileo (L1/E1) nulling CRPA MOPS
DO-373A	Basis for (DO-ZZZ) Dual Frequency GPS/Galileo (L1/E1 and L5/E5a) nulling

	CRPA MOPS
DO-384	Basis for (DO-XYZ/ED-XXX) DFMC GNSS aided inertial systems MOPS
DO-401/EUROCAE ED-259A	Basis for updated GPS/Galileo/SBAS MOPS
ARAIM Reference Airborne ADD	Basis for updated GPS/Galileo/SBAS MOPS to incorporate ARAIM requirements
DO-245, -246E with Change 1, -253D with Change 1	Basis for updated GPS/GBAS MOPS and ICD.
DO-316	Basis for updated GPS/ABAS MOPS.
DO-235C, -292A, -327	Basis for updated interference environment assessments.

TERMINATION:

When the scope of this Terms of Reference is complete, the committee will recommend to the PMC that the committee Sunset, go into Active Monitoring Mode, or spend a period of time in Hiatus. Any change/extension in the committee's work program requires prior PMC approval.