Department of Transportation
Federal Aviation Administration
Aircraft Certification Service
Washington, D.C.

TSO-C196

Effective
Date: 09/21/09

Technical Standard Order

Subject: Airborne Supplemental Navigation Sensors for Global Positioning System Equipment Using Aircraft-Based Augmentation

1. **PURPOSE.** This technical standard order (TSO) is for manufacturers applying for a TSO authorization (TSOA) or letter of design approval (LODA). In it, we (the Federal Aviation Administration, or FAA) tell you what minimum performance standards (MPS) your airborne global positioning system (GPS) sensor equipment using aircraft-based augmentation for supplemental navigation must first meet for approval and identification with the applicable TSO marking. This TSO is an alternative to TSO-C129 (all revisions) Class B and C equipment. TSO-C196 encompasses many of the technical performance improvements in TSO-C145c; but, does not include the satellite-based augmentation system (SBAS) technical requirements and SBAS operational advantages.

2. **APPLICABILITY.**

a. This TSO affects new applications submitted after its effective date.

b. This TSO **does not** replace TSO-C129a. New applications can still be submitted for approval according to TSO-C129a.

c. Airborne navigation equipment previously approved under all revisions of TSO-C129 may still be manufactured under the provisions of their original approval.

d. Major design changes to airborne GPS sensors approved under this TSO will require a new authorization. See Title 14 of the Code of Federal Regulations (14 CFR) 21.611(b).

3. **REQUIREMENTS.** New models of TSO-C196 airborne GPS sensors using aircraft-based augmentation identified and manufactured on or after the effective date of this TSO must meet the MPS qualification and documentation requirements in RTCA, Inc. document RTCA/DO-316, *Minimum Operational Performance Standards for Global Positioning System/Aircraft-based Augmentation System Airborne Equipment* dated April 14, 2009, Section 2.

a. Functionality. This TSO's standards apply to equipment intended to provide position information to a navigation management unit that outputs deviation commands keyed to a desired flight path. Pilots or autopilots will use the deviations output by the navigation management unit to guide the aircraft. Except for automatic dependent surveillance, these TSO standards do not address integration issues with other avionics, such as how to preclude an inadvertent autopilot hardover.

(1) TSO-C196 equipment has limitations that require the aircraft to have other navigation equipment available appropriate to the operation except for oceanic and remote areas. These limitations must be documented in the installation/instruction manual (see paragraph 5.a).

b. Failure Condition Classification.

(1) Failure of the function defined in paragraph **3.a** of this TSO is a *major* failure condition for malfunction of oceanic/remote, en route and terminal navigation, and lateral navigation (LNAV) approaches.

(2) Failure of the function defined in paragraph **3.a** of this TSO is a *minor* failure condition for loss of navigation of oceanic/remote, en route and terminal navigation, and lateral navigation (LNAV) approaches.

(3) Develop the system to, at least, the design assurance level equal to this failure condition classification.

c. Functional Qualification. Demonstrate the required performance under the test conditions in RTCA/DO-316, Section 2.3.

d. Environmental Qualification. Test the equipment according to RTCA/DO-316, Section 2.2 and RTCA/DO-160F, *Environmental Conditions and Test Procedures for Airborne Equipment*, dated December 6, 2007, Sections 4.0 through 8.0 and 10.0 through 25.0.

e. Software Qualification. If the article includes a digital computer, develop the software according to RTCA/DO-178B, *Software Considerations in Airborne Systems and Equipment Certification*, dated December 1, 1992, Sections 2 through 12 and Annex A. The software design assurance level should be consistent with the failure condition classification defined in paragraph **3.b** of this TSO.

f. Electronic Hardware Qualification. If the article includes a complex custom micro-coded component, develop the component to the guidance in FAA Advisory Circular (AC) 20-152, *RTCA, Inc. Document RTCA/DO-254, Design Assurance Guidance for Airborne Electronic Hardware.* The hardware design assurance level should be consistent with the failure condition classification defined in paragraph **3.b** of this TSO.

g. Barometric-Aided Fault Detection and Exclusion (FDE). If the equipment uses barometric-aiding to enhance the availability of FDE, then the equipment must meet the requirements in RTCA/DO-316, Appendix G.

h. Deviations. We have provisions for using alternate or equivalent means of compliance to the criteria in the MPS of this TSO. If you invoke these provisions, you must show that your equipment maintains an equivalent level of safety. Apply for a deviation under 14 CFR 21.609 before submitting your data package.

4. MARKING.

a. Mark at least one major component permanently and legibly with all the information in 14 CFR 21.607(d).

b. Also, mark the following permanently and legibly, with at least the manufacturer's name, subassembly part number, and the TSO number:

(1) Each component that is easily removable (without hand tools),

(2) Each interchangeable element, and

(3) Each subassembly of the article that you determined may be interchangeable.

c. If the component includes a digital computer, then the part number must include hardware and software identification. Or, you can use a separate part number for hardware and software. Either way, you must include a means to show the modification status.

> **NOTE:** Similar software versions, approved to different software levels, must be differentiated by part number.

5. APPLICATION DATA REQUIREMENTS.

As a TSO manufacturer-applicant, you must give the FAA aircraft certification office (ACO) manager responsible for your facilities a statement of conformance, as specified 14 CFR 21.605(a)(1) and one copy each of the following technical data to support our design and production approval. Under 14 CFR 21.617(a)(2), LODA applicants submit the same data through their civil aviation authority.

a. Operating instructions and equipment limitations in an installation/instruction manual (IM), sufficient to describe the equipment's functional capability and performance. Describe any deviations in detail. If needed, identify equipment by part number, version, revision, criticality level of software/hardware, classification for use, and environmental categories. Specifically, the following limitation must be documented in the installation/instruction manual for inclusion as part of the installation approval:

Aircraft installations with the GPS capabilities of the *<insert equipment model>* navigation equipment for use under Instrument Flight Rules must be equipped with an approved and operational alternate means of navigation appropriate to the intended operation with the exception of oceanic and remote areas.

b. Installation procedures and limitations in an IM, sufficient to ensure that the GPS sensor, when installed according to the installation procedures, still meets this TSO's requirements. Limitations must identify any unique aspects of the installation.

(1) If the equipment can only satisfy the requirements of RTCA/DO-316 when used with a particular antenna, make the use of that antenna (by part number) a requirement on the installation. Include this requirement in the IM as a limitation.

(2) Include adequate specifics on the interface between the GPS sensor and other systems in the IM to ensure proper functioning of the integrated system. Include maximum tolerable currents and voltages into the antenna port if the equipment is installed with a standard antenna.

(3) If the equipment depends on any inputs (like baro-aided FDE) to satisfy the requirements of RTCA/DO-316, make those inputs a requirement in the installation. Include this requirement in the IM as a limitation.

(4) If the software qualification limits eligibility of the equipment to certain aircraft types, identify the qualification level, and that the equipment is not eligible for all aircraft types in the IM. For example, AC 23-1309-1D, Equipment, Systems, and Installations in Part 23 Airplanes, states that the RTCA/DO-178B Level D software may be associated with a major failure condition for certain aircraft types. Identify other limitations applicable to the failure condition classification, for example, that two installed units are necessary.

(5) If the equipment has not been demonstrated as compatible with satellite communications (SatCom), include a note stating that the equipment should not be installed in SatCom-equipped aircraft in the limitations section of the IM.

(6) The limitations must include a note with the following statement:

This article meets the **minimum** performance and quality control standards required by a Technical Standard Order (TSO). If you are installing this article on or in a specific type or class of aircraft, you must obtain separate approval for installation.

c. Schematic drawings of the installation procedures.

d. Wiring diagrams of the installation procedures.

e. List of major components (for example, antenna and sensor unit) by part number, that make up the GPS sensor complying with the standards prescribed under this TSO. Include vendor part number cross-references, when applicable.

f. A component maintenance manual (CMM), covering periodic maintenance, calibration, and repair, for the continued airworthiness of installed GPS sensor equipment. Include recommended inspection intervals and service life. Describe the details of deviations granted, as noted in paragraph **5.a**. of this TSO.

g. Material and process specifications list.

h. The quality control system (QCS) description required by 14 CFR §§ 21.143 and 21.605(a)(3), including functional test specifications. The QCS should ensure that you will detect any change to the equipment that could adversely affect compliance with the TSO MPS, and reject them accordingly. (Not required for LODA applicants.)

i. Manufacturer's TSO qualification test report.

j. Nameplate drawing with the information required by paragraph **4** of this TSO.

k. List of all drawings and processes (including revision level) that define the article's design. For a minor change, follow the directions in 14 CFR 21.611(a). Show any revisions to the drawing list only on our request.

l. An environmental qualifications form as described in the environmental qualifications document referenced in paragraph **3.d** of this TSO for each component of the system.

m. If the article includes a digital computer, a plan for software aspects of certification (PSAC), software configuration index, and software accomplishment summary. We recommend that you submit the PSAC early in the software development process. Early submittal allows us to quickly resolve issues, such as partitioning and determining software levels.

n. If the article includes a complex custom micro-coded component, a plan for hardware aspects of certification (PHAC), hardware verification plan, top-level drawing, and hardware accomplishment summary. We recommend that you submit the PHAC early in the hardware development process. Early submittal allows us to quickly resolve issues.

6. MANUFACTURER DATA REQUIREMENTS. Besides the data given directly to us, have the following technical data available for review by the responsible ACO or civil aviation authority:

a. Functional qualification specifications for qualifying each production article to ensure compliance with this TSO.

b. Equipment calibration procedures.

c. Corrective maintenance procedures in a CMM within 12 months after TSOA or LODA.

d. Schematic drawings.

e. Wiring diagrams.

f. Material and process specifications.

g. The results of the environmental qualification tests conducted per RTCA/DO-160F.

h. If the article includes a digital computer, the appropriate documentation defined in RTCA/DO-178B, including all data supporting the applicable objectives in RTCA/DO-178B Annex A, Process Objectives and Outputs by Software Level.

i. If the article includes a complex custom micro-coded component, the appropriate hardware life cycle data in combination with design assurance level, as defined in RTCA/DO-254, Appendix A, Table A-1.

7. FURNISHED DATA REQUIREMENTS. If furnishing one or more articles manufactured under this TSO to one entity (such as an operator or repair station), provide the following:

a. One copy of the data in paragraphs **5.a** through **5.f,** and **5.l** of this TSO. Add any other data needed for the proper installation, certification, use, or for continued airworthiness, of the GPS sensor.

b. If the article performs functions beyond those described in paragraphs **3** and **3.a** of this TSO, contact the ACO for guidance on additional data requirements.

8. HOW TO GET REFERENCED DOCUMENTS.

a. Order RTCA documents from RTCA Inc., 1828 L Street NW, Suite 805, Washington, D.C. 20036, telephone (202) 833-9339, fax (202) 833-9434. You can also order copies online at www.rtca.org.

b. Order copies of 14 CFR part 21, Subpart O from the Superintendent of Documents, Government Printing Office, P.O. Box 979050, St. Louis, MO 63197, telephone (202) 512-1800, fax (202) 512-2250. You can also order copies online at www.access.gpo.gov. Select "Access," then "Online Bookstore." Select "Aviation," then "Code of Federal Regulations."

c. You can find a current list of technical standard orders and advisory circulars on the FAA Internet website Regulatory and Guidance Library at www.airweb.faa.gov/rgl. You will also find the TSO Index of Articles at the same site.

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