



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

TSO-C115c

Effective
Date: 01/09/12

Technical Standard Order

Subject: TSO-C115c, FLIGHT MANAGEMENT SYSTEM (FMS) USING MULTI-SENSOR INPUTS

1. **PURPOSE.** This technical standard order (TSO) is for manufacturers applying for a TSO authorization or letter of design approval (LODA). In it, we (the Federal Aviation Administration, (FAA)) tell you what minimum performance standards (MPS) your Flight Management System (FMS) Using Multi-Sensor Inputs must first meet for approval and identification with the applicable TSO marking.

2. **APPLICABILITY.** This TSO affects new applications submitted after its effective date.

a. All prior revisions to this TSO are no longer effective. Generally, we will not accept applications for the previous revision after the effective date of this TSO. We may do so, however, up to six months after it, if we know that you were working against the prior MPS before the new change became effective.

b. Flight Management Systems Using Multi-Sensor Inputs approved under a previous TSO authorization may still be manufactured under the provisions of their original approval.

Note: The FAA has cancelled TSO-C129a, "Airborne Supplemental Navigation Equipment Using The Global Positioning System (GPS)", effective October 21, 2011. However, Class B and C sensors previously approved under TSO-C129/129a are still eligible for integration with FMSs approved according to this TSO.

c. This TSO does not address LP/LPV capability; see TSO-C146c, "*Stand-Alone Airborne Navigation Equipment Using the Global Positioning System Augmented By The Satellite-Based Augmentation System,*" dated May 9, 2008.

d. This TSO does not address the positioning requirements to support ADS-B Out capability.

3. REQUIREMENTS. The minimum requirements for new models of Flight Management Systems Using Multi-Sensor Inputs identified and manufactured on or after the effective date of this TSO must meet the MPS qualification and documentation requirements in Section 2 of RTCA, Inc. Document No. RTCA/DO-283A, “*Minimum Operational Performance Standards for Required Navigation Performance for Area Navigation,*” dated October 28, 2003, as modified by paragraph 3.h of this TSO. An FMS intending to support vertical navigation (VNAV) operations must also meet the requirements in Appendix H of RTCA/DO-283A.

a. Functionality. This TSO’s standards apply to equipment intended to provide a navigation management function outputting deviation commands keyed to a desired flight path. Pilots or autopilots will use the deviations output by the flight management system to guide the aircraft.

b. Failure Condition Classifications. The failure condition of the function defined in **3.a** of this TSO is as follows. Design the system to the appropriate failure condition classification(s).

(1) $RNP \geq 0.3$.

(a) Malfunction is a major failure condition for misleading lateral or vertical guidance. Loss of the function defined in paragraph **3.a** of this TSO is a *major* failure condition for lateral guidance and a minor failure condition for vertical guidance.

(2) $RNP < 0.3$.

(a) Malfunction is a *hazardous (severe-major)* failure condition for misleading lateral or vertical guidance. Loss of the function defined in paragraph **3.a** of this TSO is a *hazardous (severe-major)* failure condition for lateral guidance and a *minor* failure condition for vertical guidance.

c. Functional Qualification. Demonstrate the required functional performance under the test conditions specified in Section 2.4 of RTCA, Inc. Document No. RTCA/DO-283A, “*Minimum Operational Performance Standards for Required Navigation Performance for Area Navigation,*” dated October 28, 2003.

d. Environmental Qualification. Demonstrate the required performance under the test conditions specified in Section 2.3 of RTCA, Inc. Document No. RTCA/DO-283A, “*Minimum Operational Performance Standards for Required Navigation Performance for Area Navigation,*” dated October 28, 2003, using standard environmental conditions and test procedures appropriate for airborne equipment. You may use a different standard environmental condition and test procedure than RTCA/DO-160D change 3, provided the standard is appropriate for the Flight Management System (FMS) Using Multi-Sensor Inputs.

Note: The use of RTCA/DO-160D (with Changes 1 and 2 only, incorporated) or earlier versions is generally not considered

appropriate and will require substantiation via the deviation process as discussed in paragraph **3.g** of this TSO.

e. Software Qualification. If the article includes software, develop the software according to RTCA, Inc. document RTCA/DO-178B, *Software Considerations in Airborne Systems and Equipment Certification*, dated December 1, 1992 to the design assurance level consistent with the failure condition classification defined in paragraph **3.b** of this TSO.

Note: The certification liaison process objectives will be considered satisfied after FAA review of the applicable life cycle data.

f. Electronic Hardware Qualification. If the article includes complex custom airborne electronic hardware, develop the component according to RTCA, Inc. Document RTCA/DO-254, *Design Assurance Guidance for Airborne Electronic Hardware*, dated April 19, 2000 to the design assurance level consistent with the failure condition classification defined in paragraph **3.b** of this TSO.

Note: The certification liaison process objectives will be considered satisfied after FAA review of the applicable life cycle data.

g. 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 the provision of 14 CFR § 21.618.

h. Exceptions. Add the following system performance requirement, consistent with the desired RNP capability, to DO-283A paragraph 2.2.5.2:

When using GNSS, the aircraft navigation system shall provide an alert when the probability of signal-in-space errors causing a lateral position error greater than two times the desired RNP (2 X RNP) exceeds 1×10^{-7} per hour.

Note: This exception supports international harmonization of requirements for RNAV and RNP. The exception is comparable to the TSO-C115b exception that invoked TSO-C129 system performance requirements when integrating GNSS as part of a multi-sensor navigation solution.

4. MARKING.

a. Mark at least one major component permanently and legibly with all the information in 14 CFR § 45.15(b). The marking must include the serial number.

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); and,
- (2) Each subassembly of the article that you determined may be interchangeable.

c. If the article includes software and/or airborne electronic hardware, then the article part numbering scheme must identify the software and airborne electronic hardware configuration. The part numbering scheme can use separate, unique part numbers for software, hardware, and airborne electronic hardware.

d. You may use electronic part marking to identify software or airborne electronic hardware components by embedding the identification within the hardware component itself (using software) rather than marking it on the equipment nameplate. If electronic marking is used, it must be readily accessible without the use of special tools or equipment.

5. APPLICATION DATA REQUIREMENTS. You must give the FAA aircraft certification office (ACO) manager responsible for your facility a statement of conformance, as specified in 14 CFR § 21.603(a)(1) and one copy each of the following technical data to support your design and production approval. LODA applicants must submit the same data (excluding paragraph 5.g) through their civil aviation authority.

a. A Manual(s) containing the following:

(1) Operating instructions and equipment limitations sufficient to describe the equipment's operational capability.

(2) Describe in detail any deviations.

(3) Installation procedures and limitations sufficient to ensure that the Flight Management System Using Multi-Sensor Inputs when installed according to the installation or operational procedures still meets this TSO's requirements. Limitations must identify any unique aspects of the installation. 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).
Installation of this article requires separate approval.”

(4) For each unique configuration of software and airborne electronic hardware, reference the following:

- (a) Software part number including revision and design assurance level;
- (b) Airborne electronic hardware part number including revision and design assurance level;
- (c) Functional description; and,
- (d) Failure condition classification.

(5) A summary of the test conditions used for environmental qualifications for each component of the article. For example, a form as described in RTCA/DO-160G, *Environmental Conditions and Test Procedures for Airborne Equipment*, Appendix A.

(6) Schematic drawings, wiring diagrams, and any other documentation necessary for installation of the Flight Management System Using Multi-Sensor Inputs.

(7) List of replaceable components, by part number, that makes up the Flight Management System. Include vendor part number cross-references, when applicable.

b. Instructions covering periodic maintenance, calibration, and repair, for the continued airworthiness of Flight Management Systems Using Multi-Sensor Inputs. Include recommended inspection intervals and service life, as appropriate.

c. If the article includes software: a plan for software aspects of certification (PSAC), software configuration index, and software accomplishment summary.

d. If the article includes complex custom airborne electronic hardware: a plan for hardware aspects of certification (PHAC), hardware verification plan, top-level drawing, and hardware accomplishment summary (or similar document, as applicable).

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

f. Identify functionality or performance contained in the article not evaluated under paragraph 3 of this TSO (that is, non-TSO functions). Non-TSO functions are accepted in parallel with the TSO authorization. For those non-TSO functions to be accepted, you must declare these functions and include the following information with your TSO application:

(1) Description of the non-TSO function(s), such as performance specifications and software, hardware, and environmental qualification levels. Include a statement confirming that the non-TSO function(s) don't interfere with the article's compliance with the requirements of paragraph 3.

(2) Installation procedures and limitations sufficient to ensure that the non-TSO function(s) meets the declared functions and performance specification(s) described in paragraph 5.f.(1).

(3) Instructions for continued performance applicable to the non-TSO function(s) described in paragraph 5.f.(1).

(4) Interface requirements and applicable installation test procedures to ensure compliance with the performance data defined in paragraph 5.f.(1).

(5) Test plans, analysis and results, as appropriate, to verify that performance of the hosting TSO article is not affected by the non-TSO function(s).

(6) Test plans, analysis and results, as appropriate, to verify the function and performance of the non-TSO function(s) as described in paragraph 5.f.(1).

g. The quality system description required by 14 CFR § 21.608, including functional test specifications. The quality system should ensure that you will detect any change to the approved design that could adversely affect compliance with the TSO MPS, and reject the article accordingly. (Not required for LODA applicants.)

h. Material and process specifications list.

i. List of all drawings and processes (including revision level) that define the article's design.

j. Manufacturer's TSO qualification report showing results of testing accomplished according to paragraph **3.c** of this TSO.

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

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

b. Equipment calibration procedures.

c. Schematic drawings.

d. Wiring diagrams.

e. Material and process specifications.

f. The results of the environmental qualification tests conducted according to paragraph **3.d** of this TSO.

g. If the article includes software, 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.*

h. If the article includes complex custom airborne electronic hardware, the appropriate hardware life cycle data in combination with design assurance level, as defined in RTCA/DO-254, Appendix A, Table A-1.

i. If the article contains non-TSO function(s), you must also make available items **6.a** through **6.h** as they pertain to the non-TSO function(s).

7. FURNISHED DATA REQUIREMENTS.

a. If furnishing one or more articles manufactured under this TSO to one entity (such as an operator or repair station), provide one copy or on-line access to the data in paragraphs **5.a** and **5.b** of this TSO. Add any other data needed for the proper installation, certification, use, or for

continued compliance with the TSO, of the Flight Management Systems Using Multi-Sensor Inputs.

b. If the article contains declared non-TSO function(s), include one copy of the data in paragraphs **5.f.(1)** through **5.f.(4)**.

8. HOW TO GET REFERENCED DOCUMENTS.

a. Order RTCA documents from RTCA Inc., 1150 18th Street NW, Suite 910, 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 parts 21 and 45 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.gpo.gov. Or, go directly to the GPO bookstore at www.gpo.gov/fdsys.

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



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