



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

TSO-C198

Effective

Date: 06/02/2011

Technical Standard Order

Subject: Automatic Flight Guidance and Control System (AFGCS) Equipment

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, (FAA)) tell you what minimum performance standards (MPS) your Automatic Flight Guidance and Control System (AFGCS) equipment 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. TSO-C9c, *Automatic Pilots*, dated September 15, 1960, TSO-C52b, *Flight Director Equipment*, dated May 30, 1995, and all prior revisions to these TSOs 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 effective date of this TSO, if we know that you were working against the prior MPS before the new change became effective.
 - b. Automatic Pilots and Flight Directors approved under a previous TSOA may still be manufactured under the provisions of its original approval.
3. **REQUIREMENTS.** New models of AFGCS equipment identified and manufactured on or after the effective date of this TSO must meet the MPS qualification and documentation requirements in RTCA Document No. RTCA/DO-325, *Automatic Flight Guidance and Control Systems and Equipment*, dated December 8, 2010, sections 2.1.1 through 2.1.6, section 2.2, and all sections and subsections of section 2.2 listed in table 1 for the specified functional class or classes.

Table 1

AFGCS Equipment Functional Class	AFGCS Functional Equipment Class Description	Applicable Requirements in RTCA/DO-325
A1	Autopilot for Fixed Wing Airplane	Sections and subsections of 2.2.1, 2.2.7, 2.2.8, 2.2.9, 2.2.10, 2.2.11, and 2.2.12
A2	Autopilot for Rotorcraft	Sections and subsections of 2.2.1, 2.2.3, 2.2.4, 2.2.7, 2.2.8, 2.2.9, 2.2.10, 2.2.11, and 2.2.12
B	Yaw Damper	Sections and subsections of 2.2.2, 2.2.7, and 2.2.12
C	Flight Director	Sections and subsections of 2.2.5, 2.2.7, 2.2.9, 2.2.10, 2.2.11, and 2.2.12
D	Autothrust / Autothrottle	Sections and subsections of 2.2.6, 2.2.7, 2.2.9, 2.2.10, 2.2.11, and 2.2.12

a. Functionality. This TSO's standards apply to equipment intended to assist the pilot(s) in the basic control and guidance of the aircraft. The equipment may also provide workload relief to the pilot(s) and provide a means to fly a flight path more accurately to support specific operational requirements.

b. Failure Condition Classifications. There is no standard minimum failure condition classification for this TSO. The failure condition classification appropriate for the equipment will depend on the intended use of the equipment in a specific aircraft. You may utilize the functional hazard assessment process outlined in SAE ARP 4761, *Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment*, to determine the appropriate failure condition classification. Document the failure condition classification for which the equipment is designed in accordance with paragraph **5.a.(4)** of this TSO.

c. Functional Qualification. Demonstrate the required functional performance for the applicable class(es) of the AFGCS under the applicable test conditions specified in RTCA/DO-325, Section 2.4.

d. Environmental Qualification. Demonstrate the required performance for the applicable class(es) of the AFGCS under the applicable test conditions specified in RTCA/DO-325, Section 2.3, 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-160G, provided the standard is appropriate for AFGCS equipment.

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 RTCA/DO-178B 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* to the design assurance level consistent with the failure condition classification defined in paragraph **3.b** of this TSO.

Note: The RTCA/DO-254 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.

4. MARKING.

a. Mark at least one major component permanently and legibly with all the information required by 14 CFR § 45.15(b). The marking must include the serial number and functional equipment class(es) in accordance with paragraph **3**.

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 AFGCS equipment, when installed according to the installation procedures, still meets this TSO's requirements. Installation instructions must include all information from RTCA/DO-325 section 3.2.3. Limitations must identify any unique aspects of the installation and include limitations from RTCA/DO-325 section 3.2.4. 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 AFGCS equipment.

(7) List of replaceable components, by part number, that make up the AFGCS equipment. Include vendor part number cross-references, when applicable.

b. Instructions covering periodic maintenance, calibration, and repair, for the continued airworthiness of AFGCS equipment. 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 § 21.607, 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 online 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 AFGCS equipment.

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., 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 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 <http://rgl.faa.gov/>. You will also find the TSO Index of Articles at the same site.



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