



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

TSO-C159b

Effective
Date: 09/29/14

Technical Standard Order

Subject: Next Generation Satellite Systems (NGSS) 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 Next Generation Satellite Systems (NGSS) 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-C159a will remain effective until *{18 months after publication date}*. After this date, we will no longer accept applications for TSO-C159a.
 - b. NGSS equipment approved under previous versions of this TSOA may still be manufactured under the provisions of their original approval.
3. **REQUIREMENTS.** New models of NGSS equipment (including the Aircraft Earth Station (AES) transceiver equipment, auxiliary equipment, and associated antenna) 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-262B, *Minimum Operational Performance Standards for Avionics Supporting Next Generation Satellite Systems (NGSS)*, dated June 17, 2014; except that they are not required to meet any requirement of RTCA/DO-326, Information Security, in Normative Appendix D or E (as applicable) where referenced.

Note: There are no MPS security requirements for the NGSS equipment. However, a security risk assessment may be required at the time of installation, and if needed, security controls may be implemented in connected aircraft systems or addressed by flight crew procedures.

- a. The MPS allows for different equipment classes and subclasses as defined by RTCA/DO-262B. There are 6 applicable equipment classes and 13 equipment subclass components identified (see RTCA/DO-262B, appendix D and appendix E). The manufacturer must declare the equipment class requirements from those identified in the applicable appendix.

The equipment configuration shall satisfy the relevant requirements of RTCA/DO-262B minimum operational performance standards (MOPS) as identified in tables 1 and 2 of this TSO.

Table 1. Equipment Class Identifiers

Equipment Class Identifier	Description	Requirement
AES1	AES using a single channel Satellite Data Unit (SDU) that contains one transceiver for data only applications. AES1 is a Short Burst Data (SBD)-only transceiver and cannot support voice calling. A passive Low Gain Antenna (LGA) is required for use with the AES1.	Appendix D, Section 2.2.1.1
AES2	AES2 is capable of multiple services using a single or dual channel SDU that contains one or two transceivers for data and/or voice applications. A passive LGA is required for use with the AES2.	Appendix D, Section 2.2.1.2
AES3	AES using two or more transceivers for multiple data and/or voice applications. Passive or active (powered) antennas may be configured such as a LGA Omni, Intermediate Gain Antenna (IGA) switched beam or IGA/High Gain Antenna (HGA) phased steering array.	Appendix D, Section 2.2.1.3
AES4	AES using an Enhanced Low Gain Antenna (ELGA). AES4 is configured as a complete system.	Appendix E, Section 2.2.1.1.1
AES6	AES using an HGA, transceiver, and Diplexer Low Noise Amplifier (DLNA).	Appendix E, Section 2.2.1.1.2
AES7	AES using an IGA, transceiver, and DLNA.	Appendix E, Section 2.2.1.1.3

Table 2. Equipment Sub-Class Identifiers

Sub-Class Identifier	Description	Requirement
LGA	Passive LGA for use with AES1, AES2 or AES3.	Appendix D, Section 2.2.3.1.1
IGA	Active IGA for AES3.	Appendix D, Section 2.2.3.1.1
HGA	Active HGA for AES3.	Appendix D, Section 2.2.3.1.1
HGA	HGA for AES6.	Appendix E,

Sub-Class Identifier	Description	Requirement
		Section 2.2.3.1.2
IGA	IGA for AES7.	Appendix E, Section 2.2.3.1.2
6MA	Transceiver, SDU Configuration Module (SCM), SDU, Modified Type A (DMA) DLNA, and HGA for use with AES6.	Appendix E, Section 2.2.1.1.5
7MA	Transceiver, SDU, SCM, DMA DLNA, and IGA for use with AES7.	Appendix E, Section 2.2.1.1.7
6D	Transceiver and DLNA combination includes SDU, High Power Amplifier (HPA), DLNA, SCM, and HGA functions for use with AES6.	Appendix E, Section 2.2.1.1.9
7D	Transceiver and DLNA combination includes SDU, HPA, DLNA, SCM, and IGA functions for use with AES7.	Appendix E, Section 2.2.1.1.10
6F	Transceiver and Type F (DF) DLNA includes SDU, HPA, SCM, and HGA functions for use with AES6.	Appendix E, Section 2.2.1.1.6
7F	Transceiver and DF DLNA includes SDU, HPA, SCM, and IGA functions for use with AES7.	Appendix E, Section 2.2.1.1.8
DMA	DLNA with standard Transmitter (Tx) filter configures with 6MA transceiver and HGA for use with AES6, or 7MA transceiver and IGA for use with AES7.	Appendix E, Section 2.2.1.1.11
DF	DLNA with enhanced Tx filter configures with 6MA or 6F transceiver and HGA for use with AES6, or with 7MA or 7F transceiver and IGA for use with AES7.	Appendix E, Section 2.2.1.1.12

b. Functionality. This TSO's standards apply to equipment intended for long-range communication services, aeronautical mobile satellite (route) services (AMS(R)S) by means of satellite communications between AES, corresponding satellites, and ground earth stations (GES). The NGSS supports data communications, or data and voice communications, between aircraft users and ground-based users, such as air navigation service providers (ANSP) and aircraft operators. Equipment class AES1 supports data communications only. All other equipment classes support both data and voice communications.

(1) The functionality of NGSS supports four categories of communication service. Two are in the safety of flight category: air traffic services (ATS) and aeronautical operational

control (AOC). The other two are in the non-safety of flight category: aeronautical administrative communication (AAC) and aeronautical passenger communication (APC).

(2) NGSS equipment is intended for procedural airspace area operations. We determined the failure condition specified in paragraph 3.c of this TSO based on NGSS equipment operating as an approved Long-Range Communication System (LRCS) in oceanic airspace area environments. Use of NGSS equipment in other operating environments (for example, high-density terminal/en route domestic airspace) may impact equipment performance and safety considerations.

c. Failure Condition Classifications. Failure of the function defined in paragraph 3.b of this TSO is a *minor* failure condition. Loss of the function as defined in paragraph 3.b of this TSO is a *minor* failure condition. Develop the system to, at least, the design assurance level equal to this failure condition classification.

d. Functional Qualification. Demonstrate the required functional performance under the test conditions specified in the Normative Appendix D or E (as applicable), section 2.4, of RTCA/DO-262B.

e. Environmental Qualification. Demonstrate the required performance under the test conditions specified in the Normative Appendix D or E (as applicable), section 2.3, of RTCA/DO-262B 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 the NGSS equipment.

Note: The use of RTCA/DO-160D, *Environmental Conditions and Test Procedures for Airborne Equipment* (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.h of this TSO.

f. Software Qualification. If the article includes software, develop the software according to RTCA/DO-178C, *Software Considerations in Airborne Systems and Equipment Certification*, dated December 13, 2011, including referenced supplements as applicable, to at least the software level consistent with the failure condition classification defined in paragraph 3.c of this TSO. You may also develop the software according to RTCA/DO-178B, dated December 1, 1992, if you follow the guidance in Advisory Circular (AC) 20-115C, *Airborne Software Assurance*, dated July 19, 2013.

g. Electronic Hardware Qualification. If the article includes complex custom airborne electronic hardware, develop the component according to RTCA/DO-254, *Design Assurance Guidance for Airborne Electronic Hardware*, dated April 19, 2000, to at least the design assurance level consistent with the failure condition classification defined in paragraph 3.c of this TSO. For custom airborne electronic hardware determined to be simple, RTCA/DO-254, paragraph 1.6 applies.

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

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 the provision of Title 14, Code of Federal Regulations (14 CFR) § 21.618.

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, TSO number, class, and subclass identification:

- (1) Each component that is easily removable (without hand tools); and,
- (2) Each subassembly of the article that you determined may be interchangeable.

Note: The NGSS class and subclass markings should include the complete equipment identifier reference (such as AES1, AES4, or AES7). An example subclass component (such as HGA, Transceiver, or DLNA) marking would display AES6-2/HGA, Type A Transceiver AES7-7/7MA, or Type F Diplexer AES6-3/DF, etc. For valid combinations of system component marking, see table 3.

Table 3. Valid Combinations of System Components

Valid Combinations	System	Transceiver						Transceiver & DLNA		DLNA		Antenna					Complete System	
		S B D	L B T	6 M A	6F	7 M A	7F	6D	7D	DMA	DF	LGA (passive)	IGA switched beam	IGA/HGA phased steering array	H G A	I G A		
AES1	1	Appendix D																X
	2	Appendix D	X									X						
AES2	3	Appendix D																X
	4	Appendix D		X								X						
AES3	5	Appendix D																X
	6	Appendix D	X	X								X						

Valid Combinations	System	Transceiver						Transceiver & DLNA		DLNA		Antenna					Complete System
		S B D	L B T	6 M A	6F	7 M A	7F	6D	7D	DMA	DF	LGA (passive)	IGA switched beam	IGA/HGA phased steering array	H G A	I G A	
	7	Appendix D	X	X									X				
	8	Appendix D	X	X										X			
AES4	1	Appendix E															X
AES6	2	Appendix E			X					X						X	
	3	Appendix E				X					X					X	
	4	Appendix E						X								X	
	5	Appendix E			X						X					X	
	6	Appendix E															X
AES7	7	Appendix E					X			X							X
	8	Appendix E						X			X						X
	9	Appendix E							X								X
	10	Appendix E					X				X						X
	11	Appendix E															X

c. If the article includes software and/or airborne electronic hardware, 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.f of this TSO) 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) A detailed description of any deviations.

(3) Installation procedures and limitations sufficient to ensure the NGSS equipment class and subclass components, when installed according to the original equipment manufacturers (OEM) installation manual or operational procedures, still meet this TSO's requirements for NGSS equipment. Limitations must identify any unique aspects of the installation, according to the valid combination of system components identified in RTCA/DO-262B. The OEM's installation manual should identify the components to be installed based on the valid combination of system class. For example—

Appendix E:

- High Gain Antenna (HGA) is combined with the AES6 class systems.
- Intermediate Gain Antenna (IGA) is combined with AES7 class systems.
- DMA diplexer is used with AES6-2 and AES7-7 class systems.
- DF diplexer is used with AES6-3/5 and AES7-8/10 class systems.
- 6MA transceiver is used with AES6-2/5 class systems.
- 7MA transceiver is used with AES7-7/10 class systems.
- 6F transceiver is used with AES6-3 class system.
- 7F transceiver is used with AES7-8 class systems.
- Transceiver & DLNA Combination 6D is used with AES6-4 class system.
- Transceiver 7D will be used with AES7-9 class systems.

Appendix D:

- Short Burst Data (SBD) and L Band Transceivers (LBT) can be configured with a passive (LGA) AES1-2, AES2-4, and AES3-6 or active switched beam AES3-7 or phased steering array AES3-8.

See Table 3 for the valid combinations of components used for complete system installation and marking. 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 class and subclass 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; and,

(c) Functional description.

(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 NGSS equipment.

(7) List of major components, such as an antenna, transceiver, or diplexer by part number, that make up the aircraft earth station, complying with the standards prescribed under this TSO. Include vendor part number cross-references, when applicable. If the equipment can satisfy the requirements of RTCA/DO-262B, only when used with a particular component, make the use of that component (by part number) a requirement on the installation. If the equipment is installed with standard components applicable only to single operational class equipment, include these requirements in the installation manual as a limitation.

(8) List of replaceable class and subclass components, by part number, that make up the NGSS equipment. Include vendor part number cross-references, when applicable.

b. Instructions covering periodic maintenance, calibration, and repair, for the continued airworthiness of NGSS. 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. A drawing depicting how the article will be marked with the information required by paragraph 4 of this TSO.

e. 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, failure condition classifications, software, hardware, and environmental qualification levels. Include a statement confirming that the non-TSO function(s) do not interfere with the article's compliance with the requirements of paragraph 3 of this TSO.

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

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

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

(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.e.(1) of this TSO.

f. The quality system description required by 14 CFR § 21.608, including functional test specifications. The quality system should ensure 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.)

g. Material and process specifications list.

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

i. Manufacturer's TSO qualification report showing results of testing accomplished according to paragraph 3.d 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.e of this TSO.

g. If the article includes software, the appropriate documentation defined in the version of RTCA/DO-178 specified by paragraph **3.f** of this TSO, including all data supporting the applicable objectives in Annex A, *Process Objectives and Outputs by Software Level*.

h. If the article contains non-TSO function(s), you must also make available the items in paragraphs **6.a** through **6.g** of this TSO 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 NGSS equipment.

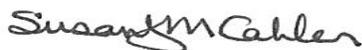
b. If the article contains declared non-TSO function(s), include one copy of the data in paragraphs **5.e. (1)** through **5.e. (4)** of this TSO.

8. HOW TO GET REFERENCED DOCUMENTS.

a. Order RTCA documents from RTCA, Inc., 1150 18th Street NW. Suite 910, Washington, DC, 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.access.gpo.gov.

c. You can find a current list of TSOs and ACs on the FAA Regulatory and Guidance Library at <http://rgl.faa.gov/>. You will also find the TSO Index of Articles at the same site.



Susan J. M. Cabler
Acting Manager, Design, Manufacturing, &
Airworthiness Division
Aircraft Certification Service