



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

**TSO-C87a**

Effective  
Date: 5/31/12

# Technical Standard Order

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**Subject: Airborne Low-Range Radio Altimeter**

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 airborne low-range radio altimeter 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. Airborne low-range radio altimeters approved under a previous TSO authorization may still be manufactured under the provisions of its original approval.
3. **REQUIREMENTS.** New models of airborne low-range radio altimeters identified and manufactured on or after the effective date of this TSO must meet the applicable MPS qualification and documentation requirements in EUROCAE document ED-30, *Minimum Performance Standards for Airborne Low-Range Radar Altimeter Equipment*, Edition 2, dated March 1980, as modified by Appendix 1 of this TSO. The applicable Chapter 2 and Chapter 3 requirements are defined in Table 1 for the appropriate functional class.

Table 1

Low-Range Radio Altimeter Functional Class	Low-Range Radio Altimeter Class Description	Applicable Requirements in ED-30
A	Approach and landing	2.1-2.8, 3.1.1, 3.2.1 (all), 3.3.1
B	Terrain Avoidance (ground proximity warning systems)	2.1-2.8, 3.1.2, 3.2.3 (all), 3.3.2

**Note:** It is possible for a radio altimeter to meet both functional classes.

**a. Functionality.** This TSO's standards apply to equipment intended to operate in applications which provide measured height above terrain for clearance and landing data.

**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. Document the loss of function and malfunction failure condition classification for which the equipment is designed.

**c. Functional Qualification.** Demonstrate the required functional performance under the test conditions specified in chapters 4 and 5 of EUROCAE ED-30.

**d. Environmental Qualification.** Demonstrate the required performance under the test conditions specified in chapter 4 of EUROCAE document ED-30 using standard environmental conditions and test procedures appropriate for airborne equipment.

**Note:** The use of RTCA/DO-160A, as prescribed in ED-30, or any DO-160 revision earlier than RTCA/DO-160D Change 3 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 at least the software 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. 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.

**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 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 airborne low-range radio altimeter, 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; 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 airborne low-range radio altimeter.

(7) List of replaceable components, by part number, that makes up the airborne low-range radio altimeter. Include vendor part number cross-references, when applicable.

b. Instructions covering periodic maintenance, calibration, and repair, for the continued airworthiness of airborne low-range radio altimeters. 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 simple or 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. A drawing depicting how the article will be marked 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, failure condition classifications, 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. Article 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. For simple custom airborne electronic hardware, the following data: test cases or procedures, test results, test coverage analysis, tool assessment and qualification data, and configuration management records, including problem reports.
- 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 airborne low-range radio altimeter.
- 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](http://www.rtca.org).
- b. Order SAE documents from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001. Telephone (724) 776-4841, fax (724) 776-0790. You can also order copies online at [www.sae.org](http://www.sae.org).
- c. Order copies of 14 CFR 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](http://www.access.gpo.gov). Select “Access,” then “Online Bookstore.” Select “Aviation,” then “Code of Federal Regulations.”

d. 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.

e. Order EUROCAE documents from EUROCAE, 102 rue Etienne Dolet, 92240 Malakoff France. Telephone 33 (0) 1 4092 7930, fax 33 (0) 1 4655 6265. You can also order from the EUROCAE Internet website at [www.eurocae.net](http://www.eurocae.net).



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**APPENDIX 1.**  
**MODIFICATIONS AND ADDITIONS TO EUROCAE ED-30 for**  
**MINIMUM PERFORMANCE STANDARDS FOR LOW RANGE RADIO ALTIMETERS**

**1.0. ED-30 REQUIREMENT MODIFICATIONS.**

**1.1. ED-30 Paragraph 1.3 (Radio Altimeters with Auto-Surveillance).** TSO-C87a does not include a separate category for monitoring. Design the radio altimeter to support the failure condition classification of the intended installation.

**1.2. ED-30 Paragraph 2.2 (Transmitter Operating Frequency).** Add the following requirement to ED-30 paragraph 2.2: The radio altimeter shall meet Federal Communication Commission regulations if applicable.

**1.3. ED-30 Paragraph 2.5 (Failure Warning).** Add the following sentence to the beginning of ED-30 paragraph 2.5 to clarify that a failure detection system is required: “A failure detection system must be incorporated in the equipment to indicate to the pilot, and to any systems utilizing the radio altimeter data, of a failure of the radio altimeter to accomplish its intended function because of the following conditions: (1) Loss of power, and (2) Loss of signal or altitude sensing capability when within the manufacturer’s stated operating altitude range.”

**1.4. ED-30 Paragraph 3.2.2 (Category A2).** TSO-C87a does not include Category A2. If alternate accuracy requirements not meeting the requirements of paragraph 3.2.1 are desired, the applicant should apply for a deviation in accordance with paragraph 3.g. of this TSO.

**1.5. ED-30 Paragraph 3.2.4 (Category C).** TSO-C87a does not include Category C. If the radio altimeter has been designed and tested to tighter accuracy requirements, include the design information, test results, and limitations with the application for TSO and document the performance in the installation manual.

**1.6. ED-30 (Appendix).** The ED-30 appendix references TSO-C87 and RTCA/DO-123 for external loop loss standards. Because TSO-C87 and DO-123 are longer current, reference RTCA/DO-155, *Minimum Performance Standards Airborne Low-Range Radar Altimeters*, Appendix B, for external loop loss standards.

**2.0. ADDITIONAL REQUIREMENT to ED-30: Rate Data.** The equipment need not provide a rate data output as a condition of compliance with this minimum performance standard. Altimeters with rate outputs must meet the following accuracy requirements for at least 95 percent of all observations for heights from the terrain to the antenna:

**RATE DATA**

<i>Height (ft)</i>	<i>Range (ft/sec)</i>	<i>Accuracy (ft/sec)</i>
3-100	0-15	$\pm(1.5\text{ft.}+0.01\text{h}+0.1/\text{r}/)$
100-200	0-20	$\pm(2.0\text{ft.}+0.01\text{h}+0.1/\text{r}/)$

Where: h = altitude in feet; and /r/ = absolute value of rate (feet/sec.)