



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

TSO-C164a

Effective
Date: 10/02/15

Technical Standard Order

Subject: Night Vision Goggles

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 night vision goggles (NVG) (portable imaging components of night vision imaging systems (NVIS)) 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-C164 will remain effective until April 1, 2017. After this date, we will no longer accept applications for TSO-C164. *Exception: TSO-C164 applications after the effective date of this TSO must meet the marking requirements in paragraph 4.b. of this TSO.*

b. Night vision goggles approved under a previous TSOA may still be manufactured under the provisions of its original approval.

c. Battery standards are not part of this TSO. Commercially available AA or smaller batteries may be used as long as the NVG meets the requirements in paragraph 3.c with them. Larger batteries, external power sources, or charging batteries on the article while in use require approval through the deviation process in paragraph 3.g.

3. REQUIREMENTS. New models of night vision goggles meeting the design assumptions of Section 1 of RTCA Document No. (RTCA/DO)-275, *Minimum Operational Performance Standards for Integrated Night Vision Imaging System Equipment*, dated October 12, 2001, identified and manufactured on or after the effective date of this TSO must meet the MPS qualification, and documentation requirements in Section 2 and the continued airworthiness requirements of Section 5 of RTCA/DO-275, as modified by appendix 1 of this TSO. NVG meeting these performance standards must be head-mounted and provide binocular vision. The chromacity and performance of the vision tubes must match, but the medium for image presentation may be monochromatic, traditionally a green-phosphor, or achromatic, such as white-phosphor. Monocular NVG are not permitted under this TSO.

a. Functionality. This TSO's standards apply to equipment intended to provide the pilot with an image intensified view of the existing scene outside the aircraft in night visual meteorological conditions (VMC) operations, conducted under the basic visual flight rules (VFR) weather minimums specified in Title 14 of the Code of Federal Regulations (14 CFR) § 91.155 as envisioned in RTCA/DO-268, *Concept of Operations—Night Vision Imaging System for Civil Operators*, dated March 27, 2001. Note that the equipment is portable (battery powered), with no interface with aircraft systems. Manufacturers wishing to develop night vision goggles that utilize alternate power sources must apply for a deviation as defined in paragraph **3.g** of this TSO.

b. Failure Condition Classifications.

(1) Total loss of the function defined in paragraph **3.a** when operating with the night vision goggles under the premise of RTCA/DO-268, is a major failure condition.

(2) Design the system to at least this failure condition classification.

Note: The premise of RTCA/DO-268 is that the goggles are to be used as an aid to night VFR flight where the safety of the flight path does not depend solely upon the external view through the night vision goggles. For missions and tasks that rely solely upon the night vision goggles for safe flight operations, a higher failure classification may be required.

c. Functional Qualification.

(1) Demonstrate the required functional performance under the test conditions specified in RTCA/DO-275, Section 2.4.

(2) Design the night vision goggle power source to minimize simultaneous loss of battery power to both tubes using one of the two methods below:

(a) Provide separate and independent power sources to each tube, or

(b) Provide the user with a visual-alert of pending power loss. If you meet this requirement by providing a visual-alert, then the time available between the alert and actual loss of power to the tubes must be a minimum of 30 minutes. You must demonstrate that performance of this alert requirement is not affected when the night vision goggles are operated or stored within the environmental conditions for which the equipment is qualified.

(3) Battery technologies utilizing different chemical compositions have significantly different discharge characteristics. Manufacturers must specify which battery types of battery chemistry were evaluated in meeting the above requirements. You may demonstrate the required performance with multiple types of batteries but mixing of battery types is prohibited. For example, NVG may be approved with alkaline, lithium and nickel cadmium as authorized battery types, but when used, all installed batteries must be of the same type with no mixing of different types (i.e., no alkaline with lithium, or carbon zinc with nickel cadmium, etc.). You

must document which battery types are authorized in the manuals required by paragraph **5.a.(1)** and **5.k** of this TSO.

d. Environmental Qualification. Demonstrate the required performance under the test conditions specified in RTCA/DO-275, Sections 2.3 and 2.5 using standard environmental conditions and test procedures appropriate for airborne equipment in RTCA/DO-160D with Change 3 or in Military Standards (Mil-Std) 810C and 461. You may use subsequent versions of RTCA/DO-160 or its EUROCAE equivalent standard environmental conditions and test procedures provided the standard is appropriate for the night vision goggles.

Note 1: The use of RTCA/DO-160D (with Changes 1 and 2 only, without Change 3 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.

Note 2: RTCA/DO-275, Sections 2.3 and 2.5 also provide guidance for environmental testing to Military Standards (Mil-Std) 810C and 461. In this case you must provide an environmental qualification form similar to that required by paragraph **5.a.(5)** of this TSO.

e. Software Qualification. If the article includes software, develop the software according to RTCA, Inc. document 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.b** of this TSO. You may also develop the software according to RTCA, Inc. document RTCA/DO-178B, dated December 1, 1992, if you follow the guidance in AC 20-115C, *Airborne Software Assurance*, dated July 19, 2013.

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 at least 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.

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).

b. Mark Heads Up Display (HUD) compatible NVGs “Modified Class B” for NVGs with a modified Class B filter designed to allow their use with a HUD.

c. 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 to include replaceable tubes.

d. 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.

e. 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. Include notes with the following statements:

“Night vision imaging systems (NVIS) are an aid to night VFR flight. NVIS systems consist of a set of night vision goggles (NVG) and NVG compatible aircraft lighting systems.”

“Modifications to the aircraft cockpit lighting and displays are often required to allow the use of night vision goggles. Such aircraft modifications require separate approval.”

“Use of installed NVIS requires additional flight crew/crew member training and operations approvals.”

“CAUTION: Some LED lighting systems that are clearly visible to the naked eye are not visible to NVGs, including some red LED

obstruction lights. See Safety Alert for Operators (SAFO) 09007 for additional information.”

(2) Describe in detail any deviations.

(3) Installation procedures and limitations sufficient to ensure that the night vision goggles, when installed according to the installation or operational procedures, still meet 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 night vision goggles.

(7) List of replaceable components, by part number, that makes up the night vision goggles. Include vendor part number cross-references, when applicable.

b. Instructions covering periodic maintenance, calibration, and repair, to ensure that the night vision goggles continue to meet the TSO approved design. Include recommended inspection intervals and service life, as appropriate. Inspection intervals must meet the minimum requirements of RTCA/DO-275.

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.

k. A Pilot/Operator Operating Manual containing the following;

(1) The statements and data from **5.a.(1)**.

(2) Inspection and maintenance requirements from **5.b**.

(a) Include procedures to accomplish the items in table 5-1, Appendix 1

(b) Do not include procedures in this Operating Manual that the Pilot/Operator is not authorized to perform.

(3) List authorized battery types from **3.c.(3)**.

(4) Other necessary Pilot/Operator instructions.

(5) If the article contains declared non-TSO function(s), include the data in paragraphs **5.f.(1)** through **5.f.(4)** the Pilot/Operator needs to operate and maintain the article to perform the non-TSO function(s).

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 or RTCA/DO-178C specified by paragraph **3.e** of this TSO, 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. Provide at least one copy of the Pilot/Operator Operating Manual in paragraph **5.k** of this TSO with each article.

b. 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 night vision goggles

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.

c. Order copies of 14 CFR parts 21 and 45 from the Superintendent of Documents, Government Publishing 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.

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.



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APPENDIX 1
 MODIFICATIONS TO RTCA DO-275
 MINIMUM OPERATIONAL PERFORMANCE STANDARDS FOR INTEGRATED NIGHT
 VISION IMAGING SYSTEM EQUIPMENT

The following sections of RTCA DO-275 are updated with these revised standards:

2.2.1.1 System Resolution

The system resolution shall be a minimum of 1.3 cycles per milliradian (cy/mrad) on-axis under optimum light conditions using a nominal 100% contrast dark bar on white background resolution target chart. At 14 degrees off-axis, the resolution shall be not less than 0.81 cycles per milliradian. If each monocular has a variable focus objective lens, then it shall focus through infinity, and at the through-infinity mechanical stop shall maintain an on-axis resolution of not less than 0.49 cycles per milliradian. If each monocular has a fixed focus objective lens, then 1.0 cycle per milliradian will be maintained at infinity.

2.2.1.2 System Luminance Gain

At 1×10^{-4} footlamberts input light level, the luminance gain shall not be less than 4,000 footlamberts (fL) per footlambert. The output luminance averaged across the full field of view shall not exceed 4 footlamberts. Output brightness uniformity shall be such that the ratio of the maximum to minimum brightness variation over the useful image area shall not exceed 3:1. The ratio of luminance gain between any two channels shall not exceed 1.5.

2.2.1.8 Image Cosmetic Defects (Table 2-1 Spot Criteria)

Diameter of Spots (inches)	Quantity of spots allowed within 0.22 inch diameter circle	Quantity of spots allowed within annulus bounded by 2 circles 0.22 and 0.58 inch diameter circle	Quantity of spots allowed within the annulus bounded by 2 circles 0.58 inch diameter circle and total screen diameter
>.009 & larger	0	0	0
.006 - .009	0	1	1
.003 - .006	0	2	2

Note: The circles on the image screen, defined in the table above, shall be concentric and centered on the optical axis of the assembly. Spots smaller than .003 inches shall be ignored.

2.2.1.10 Halo Size

Halos shall be no greater than 1.0 mm in diameter at the output of the image intensifier tube.

5.2.1 Description of Maintenance Performed

Change second paragraph to read: . . . preventative maintenance (Pilot/ Crew Member performed preventative maintenance exempt from record keeping except for Removing or Installing Helmet or Headband Mounting Assembly), and alteration . . .

5.4 (Table 5-1 Authorized Preventative Maintenance Allocations)

TYPE	Preventative Maintenance	Preventative Maintenance	Preventative Maintenance	Preventative Maintenance	Preventative Maintenance	Preventative Maintenance
	Functional/ Preflight Check	Battery Replacement	Cleaning with no disassembly required	Cleaning of Power Sourced Battery Contacts	Removing or Installing Helmet or Headband Mounting Assembly	Minor Adjustments for fit, focus, or other adjustments required to complete functional check
*Pilot/ Crew Member	Yes	Yes	Yes	Yes	Yes	Yes
Airframe Mechanic	Yes	Yes	Yes	Yes	Yes	Yes
Repair Station	Yes	Yes	Yes	Yes	Yes	Yes

* Pilot/Crew Member performed preventative maintenance exempt from record keeping requirement of 5.2.1 except for Removing or Installing Helmet or Headband Mounting Assembly.

5.4.1 (Table 5-2) Change “Pilot” to read “Pilot/Crew Member”