



Number: CTSO-C63f
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Approved by: Xu Feng

China Civil Aviation Technical Standard Order

This China Civil Aviation Technical Standard Order (CTSO) is issued according to Part 37 of the China Civil Aviation Regulations (CCAR-37). Each CTSO is a criterion which the concerned aeronautical materials, parts or appliances used on civil aircraft must comply with when it is presented for airworthiness certification.

Airborne Weather Radar Equipment

1. Purpose.

This China Civil Aviation Technical Standard Order (CTSO) is for manufacturers applying for a CTSO authorization (CTSOA). This CTSO specifies the minimum performance standards (MPS) that the airborne weather radar equipment must meet for approval and identification with the applicable CTSO marking. This CTSO addresses weather detection and ground mapping, forward looking windshear detection, forward looking turbulence detection, and atmospheric threat awareness capability. It does not include flight guidance system functionality in support of an approved windshear detection and avoidance system.

2. Applicability.

This CTSO affects new applications submitted after its effective date.

a. As of the effective date of this CTSO, any applicant seeking a CTSOA for airborne weather radar shall submit an application in

accordance with this CTSO. Nevertheless, if within one month following the effective date of this CTSO, the applicant can demonstrate to the authority that its development work has been conducted in compliance with the minimum performance standards of the previous version prior to the entry into force of this new version, the applicant may file the application against the previous edition of the CTSO.

b. Airborne weather radar equipment approved under a previous CTSO may still be manufactured under the provisions of its original approval.

c. Major design changes to article approved under this CTSO will require a new authorization of CTSO in accordance with section 21.353 of CCAR-21-R5.

3. Requirements.

New models of airborne weather radar identified and manufactured on or after the effective date of this CTSO must meet the MPS qualification and documentation requirements set forth in RTCA Document, DO-220A, Change 1 (dated August 17, 2018), Minimum Operational Performance Standards for Airborne Weather Radar Systems, as well as the supplementary provisions set forth in Appendix 1 and Appendix 2 to this CTSO (where applicable). Equipment types are defined in Table 1.

Table 1 – Airborne Weather Radar Equipment Classes and Applicable MPS

Equipment Class	Equipment Type	Minimum Performance Standards
A	Forward-Looking Windshear Detection Capability	RTCA/DO-220A, Change 1, section 2.2, with the following exclusions: paragraphs 2.2.1.3.6, 2.2.1.3.7, 2.2.2, 2.2.4, and 2.2.5.
B	Forward-Looking Turbulence Detection Capability	RTCA/DO-220A, Change 1, section 2.2, with the following exclusions: paragraphs 2.2.1.3.5, 2.2.1.3.7, 2.2.2, 2.2.3, and 2.2.5.
C	Airborne Weather and Ground Mapping Radar	RTCA/DO-220A, Change 1, section 2.2, with the following exclusions: paragraphs 2.2.1.3.5, 2.2.1.3.6, 2.2.1.3.7, 2.2.3, 2.2.4, and 2.2.5.
D	Atmospheric Threat Awareness Capability	RTCA/DO-220A, Change 1, section 2.2, with the following exclusions: paragraphs 2.2.1.3.5, 2.2.1.3.6, 2.2.2, 2.2.3, and 2.2.4.

a. Functionality.

This CTSO applies to equipment intended to:

- (1) Provide airborne windshear detection (Equipment Class A).

Equipment Class A provides forward-looking windshear detection functionality. However, this CTSO does not include flight guidance system functionality in support of an approved windshear detection and avoidance system.

- (2) Provide advanced and advisory indication of potentially hazardous turbulence conditions detectable by radar, together with other

flight information, to assist pilots with turbulence avoidance decisions (Equipment Class B).

(3) Detect and display echoes from precipitation to assist in flight crew analysis of weather. Maintain contact with geographic features such as international shoreline boundaries as a supplement to navigational orientation (Equipment Class C).

(4) Provide timely and advisory information to pilots to enhance their situational awareness of atmospheric activity and assist with atmospheric threat avoidance decisions (Equipment Class D).

b. Failure Condition Classifications.

(1) Failure of the function defined in paragraphs 3.a(2) or 3.a(4) resulting in unannunciated malfunction or missed detection of the function is a minor failure condition.

(2) Failure of the function defined in paragraph 3.a(1) or 3.a(3) resulting in unannunciated malfunction or missed detection of the function is a major failure condition.

(3) Loss of the functions defined in paragraph 3.a is a minor failure condition.

(4) Design the system to at least these failure condition classifications.

c. Functional Qualification.

Demonstrate the required functional performance under the test conditions specified in RTCA/DO-220A, Change 1, as well as the supplementary provisions set forth in Appendix 1 and Appendix 2 to this CTSO (where applicable), for each included equipment class, as specified in Table 2.

Table 2 – Airborne Weather Radar Equipment Classes and Applicable Test Requirements

Equipment Class	Performance Test Requirements
A	RTCA/DO-220A, Change 1 paragraphs 2.4.3.1, 2.4.3.3, and 2.4.4.1 in section 2.4.
B	RTCA/DO-220A, Change 1 paragraphs 2.4.3.1, 2.4.3.4, and 2.4.4.2 in section 2.4.
C	RTCA/DO-220A, Change 1 paragraphs 2.4.3.1 and 2.4.3.2 in section 2.4.
D	RTCA/DO-220A, Change 1 paragraphs 2.4.3.1, 2.4.3.5, and 2.4.4.3 in section 2.4.

d. Environmental Qualification.

For all equipment classes, demonstrate the required performance under the test conditions specified in RTCA/DO-220A, Change 1, Section 2.3, using standard environmental conditions and test procedures appropriate for airborne equipment. You may use different standard environmental conditions and test procedures than specified in RTCA/DO-220A, Change 1, provided the standard is appropriate for the airborne weather radar.

Note: 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 CTSO.

e. Software Qualification.

If the article includes software, develop the software according to RTCA, Inc., document 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 CTSO. 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 20-115D, Airborne Software Development Assurance Using EUROCAE ED-12() and RTCA DO-178(), dated July 21, 2017, or latest revision.

f. Electronic Hardware Qualification.

If the article includes complex custom airborne electronic hardware, then develop the component according to RTCA Inc., Document, 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.b of this CTSO. For custom airborne electronic hardware determined to be simple, RTCA/DO-254, paragraph 1.6 applies.

g. Deviations.

For using alternative or equivalent means of compliance to the criteria in the MPS of this CTSO, the applicant must demonstrate that the

equipment maintains an equivalent level of safety. Apply for a deviation pursuant to 21.368(a) in CCAR-21-R5.

4. Marking.

a. Mark at least one major component permanently and legibly with all the information in 21.423(b) of CCAR-21-R5. The marking must include the serial number.

b. 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.

c. 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 CAAC a statement of conformance, pursuant to section 21.353(a)(1) in CCAR-21-R5 and one copy each of the following technical data to support your design and production approval.

a. Manuals containing the following:

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

(2) For Equipment Class B, identify the installation instructions for the identified Aircraft Class selected from RTCA/DO-220A, Change 1 paragraph 2.2.4.1, Table 2-4.

(3) Expected radome performance for the electromagnetic signals passing through it (paragraph 2.2. of RTCA/DO-213A, Change 1, *Minimum Operational Performance Standards for Nose-Mounted Radomes*, dated June 21, 2018).

(4) Weather performance index (range) in accordance with the requirements of RTCA/ DO-220A, Change 1.

(5) Windshear detection range in accordance with the requirements of RTCA/DO-220A, Change 1.

(6) Detailed description of any deviations.

(7) Installation procedures and limitations sufficient to ensure that the airborne weather radar, when installed according to the installation or operational procedures, still meets this CTSO's requirements. Limitations must identify any unique aspects of the installation. The limitations must also include a note with the following statement:

“This article meets the minimum requirements of CTSO-C63f. Installation of this article requires separate approval.”

(8) 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.

(9) 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.

(10) Schematic drawings, wiring diagrams, and any other documentation necessary for installation of the airborne weather radar.

(11) By part number, list of replaceable components that make up the airborne weather radar. Include vendor part number cross-references, when applicable.

b. Instructions covering periodic maintenance, calibration, and repair, to ensure that the airborne weather radar continues to meet the CTSO approved design. 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 a software accomplishment summary.

d. If the article includes simple or complex custom airborne electronic hardware: a plan for hardware aspects of certification (PHAC), a 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 CTSO.

f. Identify functionality contained in the article not evaluated under paragraph 3 of this CTSO (defined as non-CTSO functions). Non-CTSO functions can be accepted in parallel with the CTSOA. For those non-CTSO functions to be accepted, you must declare these functions and include the following information with your CTSO application:

(1) Description of the non-CTSO function(s), such as performance specifications, failure condition classifications, software, hardware, and environmental qualification levels. Include a statement confirming that the non-CTSO function(s) do not interfere with the article's compliance with the requirements of paragraph 3.

(2) Installation procedures and limitations sufficient to ensure that the non-CTSO 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-CTSO function(s) described in paragraph **5.f.(1)**.

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

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

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

g. The quality system description required by section 21.358 of CCAR-21-R5, including functional test specifications. The quality system must ensure that you will detect any change to the approved design that could adversely affect compliance with the CTSO MPS, and reject the article accordingly. Applicants who currently hold CTSOAs must submit revisions to the existing quality manual as necessary (not required for applicants that don't hold CTSOAs).

h. Provide a description of the organization as required by 21.355 of CCAR-21-R5.

i. Material and process specifications list.

j. A list of all drawings and processes (including revision level) that define the article's design.

k. Manufacturer's CTSO qualification report showing results of testing accomplished according to paragraph 3.c of this CTSO.

6. Manufacturer Data Requirements.

Besides the data given directly to CAAC, have the following technical data available for review by CAAC:

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

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 CTSO.

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

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 are

required: 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-CTSO function(s), you must also make items 6.a through 6.h available as they pertain to the non-CTSO function(s).

7. Furnished Data Requirements.

a. When furnishing one or more articles manufactured under this CTSO 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 CTSO. Add any other data needed for the proper installation, certification, use, or continued compliance with the CTSO, of the airborne weather radar equipment.

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

c. If the article contains software, include one copy of the Open Problem Report (OPR) summary to type certification, supplemental type certification, or amended type certification design approval holders.

8. Referenced Documents.

a. Order RTCA documents from RTCA Inc. 1150 18th Street NW, Suite 910, Washington, D.C. 20036. You can also order copies online at www.rtca.org.

Appendix 1: Equivalent to Airports for Clutter Recording and Equivalent to Radar Simulation Systems

1. Ground Clutter

Section 2.4.3.3.3 of the test procedures for the mandatory wind shear alert range specified in RTCA/DO-220A Change 1, Section 2.2.3.3, stipulates that the clutter database recorded at urban airport for real aircraft takeoff and landing must be used for wind shear detection performance verification. Section 2.4.3.3.6 of the test procedures for wind shear false alarms specified in section 2.2.3.6 stipulates that compliance verification for false alarm rates must demonstrate that the equipment does not generate false alarms in clutter environment at a stressing airport, and must demonstrate that the equipment employs effective clutter suppression technology. Appendix A.2 of RTCA/DO-220A Change 1 suggests introducing the collected clutter data into the ADWRS in the windshear detection performance verification. Appendix A.2 also presents the principles of recording urban airport clutter data, and the calculation of radar echo signals considering the collected clutter data. Appendix A.3 provides the windshear scenarios where the clutter models were applied. Appendix C provides analytical calculation techniques for missed detection events and nuisance alarm assessments. in which false alarms caused by clutter may be introduced or not introduced.

This appendix stipulates that the recording of urban airport clutter data shall comply with appendix A.2.4 of RTCA/DO-220A Change 1. The airports suggested in appendix A.2.4, namely Newark Airport, Washington National Airport, and Denver Stapleton Airport, may be substituted with other airports. The applicant must demonstrate that the used airports shall produce the clutter with characteristics described in appendix A.2.4 of RTCA/DO-220A Change 1. In accordance with the windshear must-alert range test procedures specified in section 2.4.3.3.3, the actual collected urban airport clutter data must be used when conducting the compliance verification activities under section 2.4.3.3.3.

2. ADWRS (Airborne Weather Radar Simulation System)

The ADWRS developed by NASA Langley Research Center is a software system that implements comprehensive radar echo calculations and characterization for airborne coherent pulse-Doppler weather radar systems. Its early versions were used for simulation calculations of windshear detection, while later versions develop the capability of relevant simulation calculations for turbulence. section 2.4.3.3 (Forward-Looking Wind Shear Test Procedures) and section 2.4.3.4 (Forward-Looking Turbulence Test Procedures) of RTCA/DO-220A Change 1 both require the use of ADWRS to complete simulation verification of windshear and turbulence detection performance. Appendix A of RTCA/DO-220A Change 1 provides a detailed

introduction to ADWRS, as well as instructions on how to integrate collected urban airport clutter data into ADWRS for windshear detection performance simulation.

This appendix stipulates that the ADWRS software tool required in sections 2.4.3.3 and 2.4.3.4 of RTCA/DO-220A Change 1 may be substituted with other simulation tools, provided that the applicant demonstrates that the intended radar simulation software complies with section 2.4.3.4.1.2.2 of RTCA/DO-220A Change 1, i.e., validation of radar system simulator.

Appendix 2: Airborne Active Phased Array Weather Radar

1. Purpose

The airborne active phased array weather radar employs advanced active antennas, achieving beam steering by controlling the phase relationships of individual radiating elements. This enables forward-looking windshear detection, forward-looking turbulence detection, weather detection and ground mapping, and atmospheric threat awareness capabilities. Compared with traditional mechanically scanned weather radars, it has advantages such as faster scanning and higher integration level. This appendix stipulates the following requirements for airborne active phased array weather radars.

2. Electronically Scanned Antenna Requirements

Electronically scanned antennas are classified as active antennas and passive antennas. The airborne active phased array weather radar uses an active antenna, where each radiating element is connected to an independent active Transmit/Receive (T/R) module at its rear end. These modules can independently perform signal transmission and reception. The airborne active phased array weather radar shall meet the requirements for electronically scanned antennas specified in RTCA/DO-220A Change 1. While the radar antenna meets the azimuth and elevation coverage requirements set forth in sections 2.2.2.4 and 2.2.2.6, as well as the antenna control accuracy requirements specified in

section 2.2.1.1.1 of RTCA/DO-220A Change 1, its beam characteristics shall comply with those specified section 2.2.1.2.1. To verify that the airborne active phased array weather radar antenna meets the above requirements, the applicant shall complete the testing and verification of antenna characteristics in accordance with sections 2.4.3.1.2, 2.4.3.2.4, and 2.4.3.2.6.

3. Safety Requirements

The active phased array antenna is the key component of the airborne active phased array weather radar. The phased array antenna consists of a large number of array elements. The failure modes and the number of failed elements may affect the radiation characteristics of the antenna, leading to degradation of radar detection performance and even loss of functionality. The applicant shall conduct quantitative analysis of the airborne active phased array weather radar's antenna beam characteristics, forward-looking wind-shear detection, forward-looking turbulence detection, weather and ground mapping, and atmospheric threat awareness capabilities (if applicable) under conditions of array element failures, to ensure that the equipment achieves an equivalent level of safety.

(The English version is for reference only. In case of any discrepancy or ambiguity of meaning between this English translation and the Chinese version, the latter shall prevail.)

