English Translation Version for Reference Only

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Approved by：Xu Chaoqun

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.

Required Navigation Performance (RNP) Equipment Using Multi-sensor Inputs

1. Purpose.

This China Civil Aviation Technical Standard Order (CTSO) is for manufacturers applying for required navigation performance (RNP) equipment using multi-sensor inputs CTSO authorization (CTSOA). this CTSO prescribes the minimum performance standards (MPS) that required navigation performance (RNP) equipment using multi-sensor inputs must first meet for approval and identification with the applicable CTSO marking.

2. Applicability.

(a) This CTSO affects new application submitted after its effective date. Major design changes to article approved under this CTSO will require a new authorization in accordance with section 21.353 of CCAR-21-R4.

(b) This CTSO supports performance-based operations using RNP values from RNP 0.3 through RNP 4.0 and advanced RNP functions.

(c) This CTSO does not address RNP operations with authorization required (RNP AR), localizer performance without vertical guidance/localizer performance with vertical guidance (LP/LPV), ground-based augmentation system landing system (GLS) approach operations or the positioning requirements to support ADS-B out capability. See applicable CTSOs and advisory circulars for information on these operations.

3. Requirements

New models of RNP equipment, identified and manufactured on or after the effective date of this CTSO must meet the MPS qualification and documentation requirements for Class A or Class B specified in Sections 2.1 and 2.2 of RTCA/DO-283B, *Minimum Operational Performance Standards for Required Navigation Performance for Area Navigation,* December 15, 2015, as modified by appendix 1 of this CTSO. Requirements applicable to Class A and Class B equipment are specified in RTCA/DO-283B, Table 2-13.

a. Functionality.

This CTSO's standards apply to RNP equipment intended to provide a navigation function outputting deviation commands keyed to a desired

flight path. Pilots or autopilots will use the deviations output by the RNP equipment to guide the aircraft. The applicant shall specify whether they are seeking Class A or Class B recognition for their RNP equipment.

b. Failure Condition Classifications.

(1) RNP 0.3 through 4.0 including Advanced RNP functions.

(a) Failure of the function defined in paragraph **3.a** resulting in misleading lateral or vertical guidance is a major failure condition.

(b) Loss of the function defined in paragraph **3.a** is a major failure condition for lateral guidance and a minor failure condition for vertical guidance provided by barometric-vertical navigation (baro-VNAV) equipment.

(c) Loss of the function defined in paragraph **3.a** is a major failure condition for lateral guidance and a major failure condition for vertical guidance provided by satellite-based augmentation system (SBAS) equipment.

Note 1: Both baro-VNAV and SBAS are eligible to provide vertical guidance on an RNP approach to lateral navigation (LNAV)/VNAV minima. Baro-VNAV is not acceptable on LPV minima.

Note 2: Loss of function for vertical guidance is a major failure condition when using SBAS equipment because lateral and vertical guidance are not independent (see the latest revision of AC 20-138 paragraph 12-2.a).

(2) Design the RNP equipment to the appropriate failure condition classifications consistent with the sensor used.

c. Functional Qualification.

Demonstrate the required functional performance under the test conditions specified in Section **2.4** of RTCA Inc. Document No. RTCA/DO-283B, *Minimum Operational Performance Standards for Required Navigation Performance for Area Navigation,* dated December 15, 2015.

d. Environmental Qualification.

Demonstrate the required performance under the test conditions specified in Section **2.3** of RTCA Inc. Document No. RTCA/DO-283B, *Minimum Operational Performance Standards for Required Navigation Performance for Area Navigation,* dated December 15, 2015, 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-160D, Change 3, provided the standard is appropriate for the RNP equipment.

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/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.

Note: The certification liaison process objectives will be considered satisfied after CAAC reviews 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/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.

CAAC has provisions for using alternate or equivalent means of compliance to the criteria in the MPS of this CTSO. If the applicant invoke these provisions, the applicant must show that equipment maintains an equivalent level of safety. Apply for a deviation Apply for a deviation under the provisions of section 21.368 (a) CCAR-21-R4.

4. Marking.

a. Mark at least one major component of the RNP equipment permanently and legibly with all the information in section 21.423 (b) CCAR-21-R4.

b. Also, mark the following permanently and legibly, with at least the manufacturer's name, subassembly part number, and the CTSO 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. The applicant 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.

The applicant must furnish the responsible certification personnel with the related data to support design and production approval, as specified in section 21.353 (a) 1 of CCAR-21-R4 and one copy each of the following technical data.

a. A Manual(s) containing the following:

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

(2) Identify the RNP equipment class; Class A or Class B.

(3) Describe in detail any deviations.

(4) Installation procedures and limitations sufficient to ensure that the AMSS AES equipment, 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 include a note with the following statement:

"This article meets the minimum performance and quality control standards required by a China technical standard order (CTSO). Installation of this article requires separate approval."

(5) 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.

(d) Failure condition classification.

(6) 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, Appendix A.

(7) Schematic drawings, wiring diagrams, and any other documentation necessary for installation of the AMSS AES equipment.

(8) List of replaceable components, by part number, that makes up the AMSS AES equipment. Include vendor part number cross-references, when applicable.

b. Instructions of continuous airworthiness, covering periodic maintenance, calibration, and repair, to ensure that the equipment 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 software accomplishment summary.

d. If the article includes a simple or complex electronic hardware: a plan for hardware aspects of certification (PHAC), hardware verification plan, top-level drawing, and hardware accomplishment summary.(or the

similar instruction, as appropriate)

e. A drawing depicting how the article will be marked with the information required by paragraph **4** of this CTSO.

f. Identify functionality or performance contained in the article not evaluated under paragraph **3** of this CTSO (that is, non-CTSO functions). Non-CTSO functions are accepted in parallel with the CTSO authorization. For those non-CTSO functions to be accepted, The applicant must declare these functions and include the following information with 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 performance data defined in paragraph **5.f.(1).**

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

(6) Test plans, analysis and results, as appropriate, to verify 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 CCRA-21-R4, 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 CTSO MPS, and reject the article accordingly.

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 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. 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 CTSO.

g. If the article includes software, the appropriate documentation defined in RTCA/DO-178B/C, including all data supporting the applicable objectives in RTCA/DO-178B/C Annex A, *Process Objectives and Outputs by Software Level*.

h. If the article contains non-CTSO function(s), you must also make available items **6.a** through **6.g** as they pertain to the non-CTSO function(s).

7. Furnished Data Requirements.

a. If 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 for continued airworthiness with the CTSO, of the RNP 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).**

8. Availability of Referenced Documents.

Order RTCA documents from:

Radio Technical Commission for Aeronautics, Inc.

1828 L Street NW, Suite 805, Washington D.C. 20036

Telephone (202) 833-9339, Fax (202) 833-9434.

You may also order them online from the RTCA Internet website at:

www.rtca.org.

APPENDIX 1. EXCEPTIONS TO RTCA/DO-283B REQUIREMENTS

Scope.

This appendix describes modifications and additions to the requirements found in RTCA/DO-283B the RNP equipment shall meet for compliance with this CTSO. The CAAC expects the RNP equipment to execute published instrument procedures designed to provide maximum efficiency, flexibility, and aircraft eligibility. These instrument procedure designs may include RNAV components and/or leg types associated with conventional procedures. The modifications and additions below are necessary to ensure RNP equipment can properly execute current and future instrument procedure designs.

2.2.1.2.1 Leg Types.

Add the following required leg types to Table 2-1:

FM	Fix to Manual Termination
VA	Heading to Altitude Leg
V	Heading to Intercept
VM	Heading to Manual Termination
CA	Course to Altitude Leg

Add the following requirement and note after the sentence “Refer to

Appendix D for additional details for each of the leg types”:

The equipment shall have the ability to use an IF that is a fly-by waypoint, fly-over waypoint, or the initial fix defining an RF leg segment. Additionally, the equipment shall have the ability to proceed “direct to” an IF.

Note: This requirement is needed to support RNP departure procedures, particularly those with an RF leg as the first leg segment, where the IF defines the beginning of the RF leg. With LNAV available immediately after takeoff, the equipment should provide guidance direct to the IF and sequence the next leg; particularly when the IF is the initial fix of an RF leg).

2.2.1.2.2 Flight Planning.

Insert a new paragraph and note between the last paragraph and next to last paragraph as follows:

The equipment shall have the ability to use a single waypoint supporting multiple

RNP terminal procedures (SID, DP, STAR) and multiple approach procedures using different tracks. When a single waypoint supports an arrival and an RNP instrument approach using different tracks, the equipment shall continue following the arrival procedure to the procedure’s termination fix and shall not automatically sequence onto the RNP approach procedure using that same waypoint.

Note: Some waypoints may serve as: a transition fix for an instrument approach; an initial approach fix (IAF) for an instrument approach; the first fix in a terminal arrival procedure; and an intermediate waypoint on a terminal RNP procedure (SID, DP or STAR) (see Figure 1 below). This requirement ensures the equipment completes RNP procedures as assigned by ATC, and loaded by the flight crew into the active flight plan from the onboard navigation database.

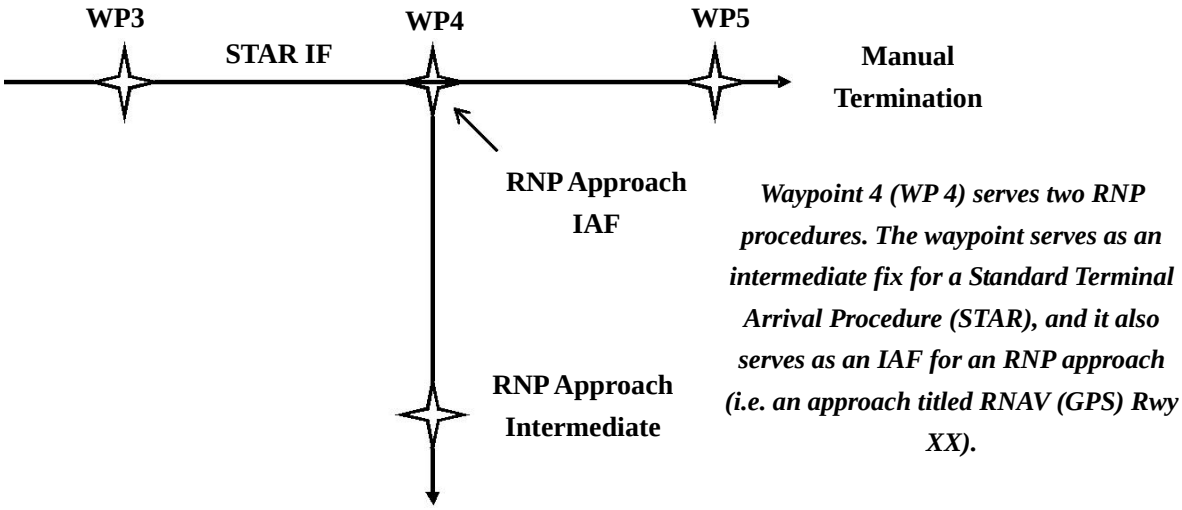

Figure 1. Single Waypoint Serving Multiple RNP Procedures.

Add the following requirement and note after the last paragraph in the section 2.2.1.2.2:

The equipment shall not permit the flight crew to select a procedure or route, either manually or automatically, that is not supported by the equipment. For example, a procedure is not supported if it incorporates advanced RNP functions and the equipment does not provide those advanced RNP functions.

Note: Procedures (approaches, arrivals, departures, routes) are defined by a series of waypoints and leg types.

2.2.1.2.9 Transitions Between Legs.

Change the first paragraph and note 1 as follows:

The navigation system shall provide a means to automatically transition from one leg to another. Three categories of transition between fixed path segments can be defined:

- Fly-by transitions;
- Fly-over transitions; and
- Fixed radius transitions.

The navigation system shall be capable of accomplishing all three transitions. Fly-by transitions shall be the default transition when the transition type is not specified.

Note 1: For fly-by and fly-over transitions, no predictable and repeatable path is specified because the optimum path varies with airspeed and bank angle. Fly-by and fly-over transitions use a transition area. The aircraft should remain within the transition area for fly-by transitions.

2.2.1.2.9.1.1 Fly-Over Transitions.

Insert a new section 2.2.1.2.9.1.1 after section 2.2.1.2.9.1 Fly-By Transitions as follows:

The navigation system shall define a path to accomplish fly-over transitions that passes through the transition waypoint. There are no requirements that apply to the transition area, as the equipment provides guidance relative to the two straight segments to and from the transition waypoint (see figure 2-4.1).

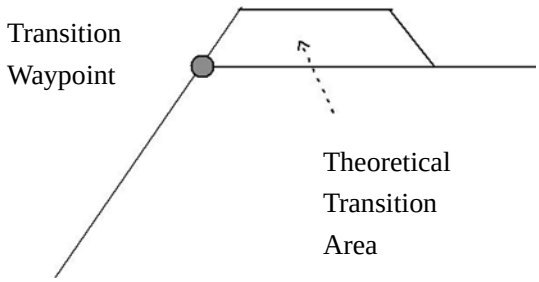

Figure 2-4.1: Fly-Over Theoretical Transition Area

2.2.1.4. Displays and System Alerting.

Add the following second sentence to the paragraph and note 2:

If the equipment incorporates an electronic map display to provide a graphical depiction of navigation information, it shall meet the requirements of RTCA/DO-257A *Minimum Operational Performance Standards for the Depiction of Navigational Information on Electronic Maps.*

Note2: Manufacturers should use RTCA/DO-257A with RTCA/DO-283A, appendix K until RTCA/DO-257B is published.

2.2.2.2.6.1 Descent Path Construction.

Add the following requirement and notes to the list of general

requirements:

6. The RNP equipment shall always use the procedure-defined flight path angle to define the final approach segment of an RNP instrument approach procedure offering vertical guidance (RNP procedures offering LNAV/VNAV minima).

Note 1: Some RNP instrument approach procedures define the final approach fix with an 'AT' altitude constraint ("hard" altitude") and the intent of this requirement is to use the published FPA, the designated end of the runway (DER) and the threshold crossing height for vertical path construction. The equipment should ***not*** *generate a geometric, point-to-point vertical path between two 'AT' constraints on a final approach segment.*

Note 2: This requirement is not intended to prohibit the optional use of baro-VNAV temperature compensation as described in RTCA/DO-283B Appendix H.

2.4.3.1 Test Scenario(s).

Add the following leg types to the list in paragraph (a):

FM, VA, VI, VM, CA.

Appendix D.

Add the following leg type definitions to Appendix D:

D.10 Fix to Manual Termination (FM).

An FM leg defines a specified track over the ground from a database

fix until a manual termination of the leg.

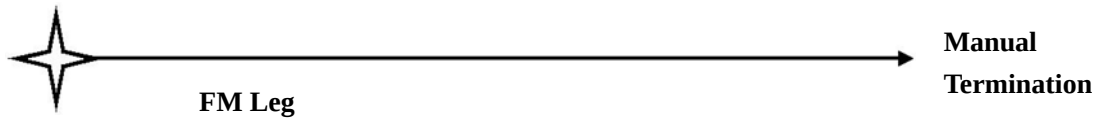

Figure D-6: Fix to Manual Termination (FM) Leg

D.11 Heading to Altitude (VA).

A VA leg defines a specified heading to a specific altitude termination at an unspecified position. No correction is made for wind.

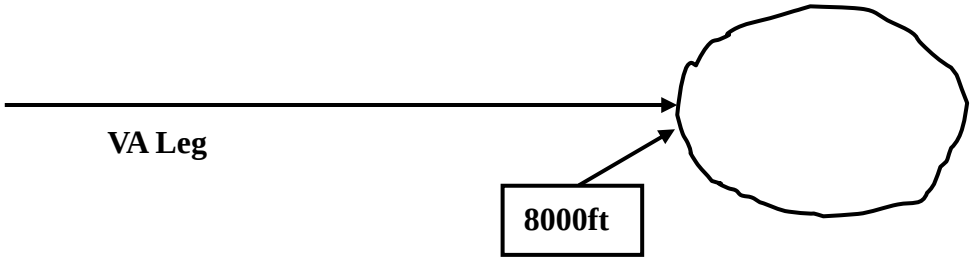

Figure D-7: Heading to Altitude (VA) Leg

D.12 Heading to Intercept (VI).

A VI leg defines a specified heading to intercept a subsequent leg at an unspecified position. No correction is made for wind.

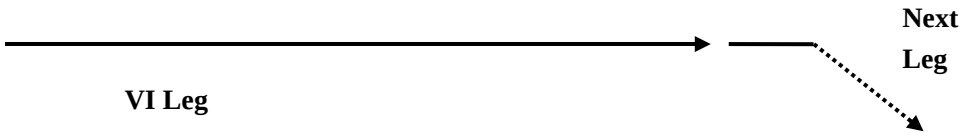

Figure D-8: Heading to Intercept (VI) Leg

D.13 Heading to Manual Termination (VM).

A VM leg defines a specified heading until a manual termination of the leg. No correction is made for wind.

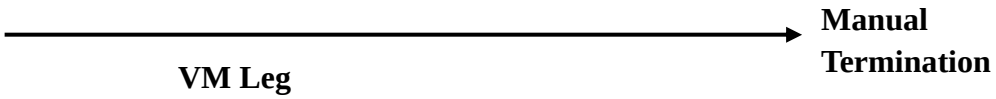

Figure D-9: Heading to Manual Termination (VM) Leg

D.14 Course to Altitude (CA).

A CA leg defines a specified course to a specific altitude at an unspecified position. The course is flown making adjustment for wind.

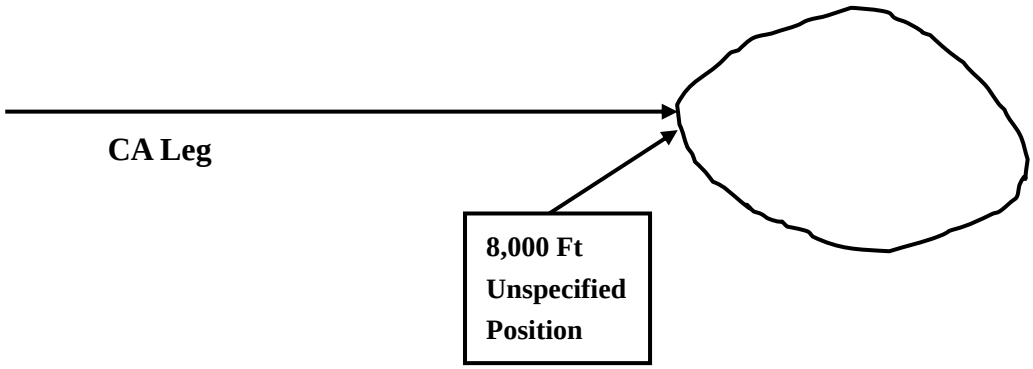

Figure D-7: Heading to Altitude (VA) Leg