

**Comments for Draft Revisions (Not Applicable to Directives; Refer to Directive Management Officer for Directive Comment Format)**

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<b>Comments Submitted By:</b>	Miller
<b>Organization:</b>	AIR-130
<b>Phone:</b>	

#	Document Name	Page Number	Paragraph Number	Referenced Text	Comment/Rationale or Question	Proposed Resolution	Comment Type (Conceptual, Editorial, or Format)	Disposition/Response to Comment
1	TSO-C115d	1		Title	Change TSO title to reflect terminology in DO-283B.	Change TSO Title to: REQUIRED NAVIGATION PERFORMANCE (RNP) EQUIPMENT USING MULTI-SENSOR INPUTS	Conceptual	<b>Accepted.</b>
2	TSO-C115d	General	All	FMS equipment	For consistency with the title change, refer to RNP equipment.	With the exception of paragraph 2.b, change all references to FMS equipment, flight management system, or equipment in the document body to "RNP equipment."	Editorial	<b>Accepted.</b>
3	TSO-C115d	1	2c	This TSO support operations...	Indicate these are performance-based operations.	Change text to read: "This TSO supports performance-based operations..."	Conceptual	<b>Accepted.</b>
4	TSO-C115d	2	3.a	Functionality paragraph	Add a functionality requirement for applicants to specify which class (A or B) of RNP equipment they are applying for.	Add a new second sentence as follows: "The applicant shall specify whether they are seeking Class A or Class B recognition for their RNP equipment."	Conceptual	<b>Accepted.</b>
5	TSO-C115d	4	5.a	Application Data Requirements	Add additional text requiring applicants to identify the RNP equipment class and update instructions for continued airworthiness.	Add two new items as 5.a(2) and 5.a(3) as follows: "(2) Identify the RNP equipment class; Class A or Class B." and "(3) Instructions for updates to ensure continued airworthiness (e.g., magnetic variation tables)."	Conceptual	<b>Accepted.</b>

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6	TSO-C115d	5	5.b	Application Data Requirements	The boilerplate language in the last sentence about service life is not applicable.	Change the last sentence as follows: "Include recommended inspection intervals and updates for continued airworthiness (e.g. magnetic variation tables), as appropriate."	Conceptual	<b>Accepted.</b>
7	TSO-C115d	8	Appendix 1, paragraph 2.2.1.2.1 Leg Types.	None.	Add a new requirement concerning an IF that is the first waypoint in a departure procedure.	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. <i>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.</i>	Conceptual	<b>Accepted.</b>

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8	TSO-C115d		8 Appendix 1.	Add a new requirement for the MOPS Flight Planning section.	Add a new requirement for RNP equipment to accommodate waypoints with multiple designations for different RNP procedures. This is to address know equipment deficiencies for waypoint that can be multi-use for both a STAR and instrument approach.	Insert a new requirement for 2.2.1.2.2 Flight Planning 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. <i>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).</i>	Conceptual	<b>Accepted.</b> A figure was also included to help understand what the requirement means.
						<i>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</i>		

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<b>Comments Submitted By:</b>		Laura Niles						
<b>Organization:</b>		USAC						
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#	Document Name	Page Number	Paragraph Number	Referenced Text	Comment/Rationale or Question	Proposed Resolution	Comment Type (Conceptual, Editorial, or Format)	Disposition/Response to Comment
1	TSO-C115d	2	2.b(1)(c) Note 2		With a TSO-C145 receiver feeding an FMS, loss of SBAS vertical deviation could occur because of a malfunction in the FMS, which is independent of lateral deviation.	Suggest that loss of vertical deviation should be Minor regardless of the source of the deviation. Hazard category should depend only on the type of operation. AC20-138D Appendix 2 call it Minor for RNP-AR.	Conceptual	<b>Not Accepted.</b> Paragraph 2.d specifically states TSO-C115d is not applicable for RNP AR. For non-RNP AR operations, the reason for a major failure condition when using SBAS is explained in note 2; that is, both lateral and vertical guidance are affected by an SBAS sensor loss of function. This is different when baro-VNAV is used for vertical (as explained) because a baro-VNAV loss of function has no effect on the lateral guidance.

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<b>Comments Submitted By:</b>		Dave Nakamura						
<b>Organization:</b>								
<b>Phone:</b>								
#	Document Name	Page Number	Paragraph Number	Referenced Text	Comment/Rationale or Question	Proposed Resolution	Comment Type (Conceptual, Editorial, or Format)	Disposition/Response to Comment
1	TSO-C115d	Appendix 1			On review of the DO-283 requirements for vertical path performance limits in MOPS para 2.2.2.6.1, the accuracy values shown are the same as the system requirements of the MASPS, yet are defined as those for the RNP equipment, with no substantive guidance to help comply at the equipment level. The current notes are of no help in this. The MOPS accidentally omits additional information and requirements to ensure a clearer equipment requirement with regard to the VNAV equipment error and flight technical error components of the VPPL.	Add new TSO paragraph into Appendix 1. X.X.X VNAV Accuracy requirements. Add the following: "The RNP system VNAV accuracy requirements shall be as specified in DO-283B, 2.2.2.6.1 in addition to the following. a. VNAV equipment error. The VPPL should account for the VNAV equipment error from DO-283, para 2.4.3.16.1. b. Flight Technical Error The VPPL should account for the FTE derived from the vertical deviation limits established in DO-283, para 2.2.2.4.2.1. c. Altimetry System Error The VPPL should account for aircraft altimetry system error."	Conceptual	<b>Not Accepted.</b> Appendix 1 is for specific additions or changes to the MOPS requirements the FAA deems necessary. The MOPS are the equipment-level standards and the TSO is for the equipment design and manufacturing approvals; not the airworthiness approval which is where FTE is taken into account. TSOs never implement aircraft-level requirements such as FTE because the final installation is not known; that is the domain of the airworthiness approval (although the MOPS does provide for "standard" FTE assumptions).
2	TSO-C115d	Appendix 1, Pg 8	2.2.1.2.2		The requirement to use a waypoint in different and multiple procedures seems unnecessary given the basic requirement to use and fly procedures as stored in the database. The basic requirement covers not just one waypoint but the potential of multiple waypoints. However, if there are aspects of the waypoint data for the procedure that are unique to each procedure e.g. different altitude constraint, and it is possible for such differences to be stored in the database for each application, a more explicit statement of what data should be used would be clearer.	The current requirement should be a little more explicit with regard to what needs to be done since as written it appears to be covered by the basic to use and fly the procedure contained in the database.	Conceptual	<b>Not Accepted.</b> This new requirement is to address a known equipment requirements deficiency based on existing instrument procedure design.

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3	TSO-C115d	Appendix 1, Pg 10	2.4.3.1		<p>The additions create a conflict with the core requirement in 2.2.1.2.1 that specifies the minimum legs to be utilized. Rather than imply through a test requirement that the additional legs should be utilized, it would be better to amend the core 2.2.1.2.1 requirement as well. Additionally, it would be helpful to clarify the context such as "The RNP equipment shall be capable of utilizing the additional ARINC 424 leg types as follows, so as to support the need for their application operationally. These added leg types will be applied where repeatability and predictability of the path and its termination are not essential to that portion of the RNP procedure." Or whatever may be the reason.</p>	<p>Suggest a clarifying addition to 2.2.1.2.1.</p>	Conceptual	<p><b>Not Accepted.</b> There is no conflict because Appendix 1 adds the four additional required leg types to section 2.2.1.2.1 as minimum requirements. These four leg types are being used in RNP procedure designs and RNP equipment must include these leg types to accomplish RNP procedures. The requirement to add these leg types to testing in 2.4.3.1 is based on them being added as minimum requirements to 2.2.1.2.1.</p>
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<b>Comments Submitted By:</b>		Natalie Room						
<b>Organization:</b>		Boeing						
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#	Document Name	Page Number	Paragraph Number	Referenced Text	Comment/Rationale or Question	Proposed Resolution	Comment Type (Conceptual, Editorial, or Format)	Disposition/Response to Comment
1	TSO-C115d	Pg 2	3.c	Section title: Functional Qualification	The section references DO-283B section 2.4 which is titled "equipment test conditions."	Change TSO section title to: "Equipment Test Conditions."	Editorial	<b>Not Accepted.</b> TSO section title formatting is standardized and not subject to change.
2	TSO-C115d	Pg 8-11	Appendix 1	Entire text	DO-283B was just published as a result of a multi-year effort by SC-227 of which the FAA participated. If appendix 1 were needed the FAA should have made the case during SC-227 meetings.	Delete appendix 1	Conceptual	<b>Not Accepted.</b> The FAA did make the case for these changes during SC-227 and the working group was informed they are based on known operational issues that point to deficiencies in the MOPS requirements. The MOPS are implemented by the TSO which is regulatory and the FAA has a responsibility to ensure the standards promulgated by TSO serve the public interest by addressing known operational problems.
3	TSO-C115d	Pg 8	2.2.1.2.1	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).	The use of fly-over waypoints assumes that there is a specific need (such as noise abatement). However, as the ground track is not strictly repeatable and there is no expectation of a leg having RNP requirements following a fly-over waypoint (per the DO-283B MOPS), it is not clear why this requirement was proposed.	Either delete the requirement and note, or add another note as follows: "Note 2: The need for an IF that is a fly-by waypoint, fly-over waypoint, or the initial fix defining an RF leg segment assumes that flight procedures design criteria conform to the expectations of DO-283B MOPS paragraph 1.5.4.3.1. This paragraph of the MOPS includes a comment that, if a fly-over waypoint is used, that "the leg following the fly over fix is assumed to not have the requirement of RNP applied to it as far as the path is not repeatable and airspace protection cannot follow the RNP concept."	Conceptual	<b>Not Accepted.</b> This requirement was added due to existing instrument procedure designs that use IF waypoints as the first waypoint denoting the start of an RF leg during departure procedures. This is not a fly-over turn, it is a fly-over waypoint and the following RF leg is an RNP leg. The RNP equipment must accommodate this type of fly-over waypoint associated with RF legs. Further, the MOPS does specify fly-by turns which also "do not have ground tracks that are repeatable with no expectation of having RNP requirements."

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4	TSO-C115d	Pg 8	2.2.1.2.2	<p>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.</p>	<p>Wording and intent in this paragraph is confusing and unclear. Figure 1, Single Waypoint Serving Multiple RNP Procedures, is not clear. As depicted, the STAR looks like a standard T approach. The diagram could have been made clearer and/or modified so that it cannot be confused with a standard T. In addition, this requirement appears to be unnecessary. (1) Consistent with FAA Order 7100.9E, Appendix B, paragraph 1a, the STAR termination fix must have the same altitude and speed constraints associated with the SIAP, therefore it is not necessary to add an additional requirement restricting how equipment merges onto an RNP approach procedure. (2) Many systems can merge the end of a STAR to the first waypoint of an approach; and (3) this is new functionality not previously discussed during the DO-283B MOPS and DO-236C MASPS development effort.</p>	Delete the requirement.	Conceptual	<p><b>Not Accepted.</b> This requirement is due to an operational issue encountered where RNP equipment does not properly respond to procedure designs that use waypoints for multiple procedures in an effort to: 1) reduce database size by reducing the number of individual procedures; and 2) provide more efficient NAS operations by having more flexibility in the procedure designs. The requirement is necessary because RNP equipment must be able to accommodate existing NextGen procedures that have multiple use waypoints.</p>
5	TSO-C115d	Pg 9	2.2.2.2.6.1 Note	<p><i>Note: 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 <b>not</b> generate a geometric, point-to-point vertical path between two 'AT' constraints on a final approach segment.</i></p>	We believe a second note will add clarification consistent with DO-283B MOPS paragraph 2.2.2.5	We recommend revise the "Note" title to "Note 1" and adding a second note as follows: Note 2: This is not intended to prohibit the optional use of temperature corrected flight path angles, as described in DO-283B Appendix H."	Editorial	<p><b>Partially Accepted.</b> Added a new note 2 as follows: 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.</p>

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<b>Comments Submitted By:</b>		Gary Petty, Mike Webb, John Swigart, Trent Bigler						
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#	Document Name	Page Number	Paragraph Number	Referenced Text	Comment/Rationale or Question	Proposed Resolution	Comment Type (Conceptual, Editorial, or Format)	Disposition/Response to Comment
1	TSO-C115d	Appendix 1			The procedure design orders permit using fly-over turns for instrument procedure designs. Fly-over waypoints and fly-over turns exist in current instrument procedures and both Flight Standards and Air Traffic has the expectation that FMSs (RNP equipment) will have the capability to do fly-over transitions to accomplish these instrument procedure designs.	Insert a requirement in TSO-C115d, appendix 1 for the equipment to perform fly-over transitions.	Conceptual	<b>Accepted.</b> Included change to section 2.2.1.2.9 and added new section 2.2.1.2.9.1.1 to require fly-over transitions.

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<b>Comments Submitted By:</b>		Sylvain Hamel						
<b>Organization:</b>		CMC						
<b>Phone:</b>								
#	Document Name	Page Number	Paragraph Number	Referenced Text	Comment/Rationale or Question	Proposed Resolution	Comment Type (Conceptual, Editorial, or Format)	Disposition/Response to Comment
1	TSO-C115d	Pg 1	2.d		TSO-C115c section 2.d explicitly stated that this TSO does not address positioning requirements to support ADS-B Out capability. Why was text removed?	Possible Omission?	Conceptual	<b>Accepted.</b> Added the following text to the first sentence of section 2.d: ...ground-based augmentation system landing system (GLS) approach operations or the positioning requirements to support ADS-B out capability.
2	TSO-C115d	Pg 2	3.a	This TSO's standards apply to RNP equipment intended to provide a navigation function outputting deviation commands keyed to a desired flight path. The applicant shall specify whether they are seeking Class A or Class B recognition for their RNP equipment. Pilots or autopilots will use the deviations output by the RNP equipment to guide the aircraft.	1st paragraph editorial: 2nd sentence appears to be in the wrong place.	Move 2nd sentence to beginning or end of paragraph, or make it into a separate paragraph.	Editorial	<b>Accepted.</b> Swapped second and third sentences.
3	TSO-C115d	Pg 2	3.b(1)c, Note 1	Note 1: Both baro-VNAV and SBAS are eligible to provide vertical guidance on an RNP approach. This is lateral navigation (LNAV)/VNAV, not LPV	Note 1 is unclear since the note is about vertical guidance but the second sentence refers to lateral navigation.	Note 1: Both baro-VNAV and SBAS are eligible to provide vertical guidance on an RNP approach to LNAV/VNAV minima. Baro-VNAV is not acceptable on LPV minima.	Editorial	<b>Accepted.</b> However, LNAV must have the acronym spelled out at first use.

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4	TSO-C115d	Pg 2	3.d	3.d Environmental Qualifications. 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.	DO-283B refers to DO-160G but TSO-C115d refers to DO-160D.	Change to DO-160G and keep note explaining that earlier version is acceptable under certain conditions	Editorial	<b>Not Accepted.</b> This is the required TSO format language regarding environmental testing and cannot be changed. The intent is to keep TSOs current by defining the minimum acceptable DO-160 version and acknowledging other versions can be acceptable. This way, the TSO does not need to be revised every time a new DO-160 version is published.
5	TSO-C115d	Pg 3	3.e	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.	Consider adding "For legacy systems" in front of last sentence for clarity purposes.	For legacy systems, you may also develop the software according...	Conceptual	<b>Not Accepted.</b> There is no intent to restrict DO-178B to "legacy" systems. It is acceptable to use DO-178B for new designs as well.
6	TSO-C115d	Pg 3	3.f	...RTCA, Inc. Document RTCA/DO-254, Design Assurance Guidance for Airborne Electronic Hardware, to at least ...	Date of DO-254 document is dropped in proposed TSO-C115d. Text "dated April 19, 2000" appeared in earlier TSO-C115c.	Add the date.	Editorial	<b>Accepted.</b>
7	TSO-C115d	Appendix 1, Pg 8	2.2.1.2.1		If the goal is to support existing procedure design should CA leg also be added for RNP1 terminal operation per A90-105 / AC 20-138D?	Consider adding CA leg to the list.	Conceptual	<b>Accepted.</b> CA leg also added to 2.4.3.1 and appendix D for consistency.

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8	TSO-C115d	Appendix 1, Pg 9	2.2.1.2.1		The title of the revised TSO is about RNP equipment, not RNAV equipment, nor FMS equipment. Hence the addition of the FM, VA, VI, VM legs appears inappropriate since it contradicts the DO-236C MASPS paragraph 3.2.7 (Prohibited Leg Types), which precludes to have an assigned RNP value on such legs.	A note should be added stating that these additional four leg types are not RNP legs but are RNAV legs that are still required for PBN operations in today's airspace.	Conceptual	<b>Partially Accepted.</b> The appendix 1 lead paragraph changed as follows: This appendix describes modifications and additions to the requirements found in RTCA/DO-283B the RNP equipment shall meet for compliance with this TSO. The expectation is that RNP equipment will execute published instrument procedures designed to provide maximum efficiency and flexibility even if not meeting a strict interpretation of RNP. The modifications and additions below are necessary to ensure RNP equipment can properly execute current and future instrument procedure designs.
9	TSO-C115d	Appendix 1, Pg 9			Text refers to DO-283B Section 2.2.1.4.14 Electronic Map Display. DO-283B section 2.2.1.4.14 is actually entitled Runway Position Monitoring.	Typo?	Editorial	

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<b>Comments Submitted By:</b>		Hugues Meunier						
<b>Organization:</b>		Thales						
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#	Document Name	Page Number	Paragraph Number	Referenced Text	Comment/Rationale or Question	Proposed Resolution	Comment Type (Conceptual, Editorial, or Format)	Disposition/Response to Comment
1	TSO-C115d	Pg 1	2.c	This TSO supports performance-based operations using RNP values from RNP 0.3 through RNP 4.0.	It is understood that "Advanced RNP" are supported by this TSO, in accordance with RTCA DO-283B.	In order to clearly indicate that "Advanced RNP" are also covered by this TSO, Section 2.c should be updated as follows : "... Values from RNP 0.3 through RNP 0.4, including Advanced RNP	Editorial	<b>Partially Accepted.</b> Added the phrase: "...and Advanced RNP functions" at the end of the sentence.
2	TSO-C115d	Pg 1	2.d		No mention is made within this TSO for RNAV operations. As this TSO refers to RNP Equipment, it is our understanding that those RNAV operations are not considered by this TSO.	It is suggested to explicitly mention in section 2.d that RNAV operations are not covered by this TSO, in addition to all operations already explicitly mentioned.	Conceptual	<b>Not Accepted.</b> RNP is a subset of RNAV and as such the RNP equipment is expected to support RNAV functionality. Appendix 1 is included to address known issues and existing instrument procedure designs that may not meet a strict interpretation of RNP, but provide more efficient, flexible operations.
3	TSO-C115d	Pg 2	3.a	This TSO'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.	Depending of the aircraft guidance architecture, some RNP equipment does not send deviations to autopilots but rather steering commands. As indicated in RTCA DO-283B §1.2.3, "steering commands" (for the aircraft flight control system) and "path deviations" (for the displays) are more appropriate wordings.	It is suggested to modify the sentence of section 3.a as follows: "This TSO's standards apply to RNP equipment intended to provide a navigation function outputting steering commands or path deviations to a desired flight path. The applicant shall specify whether they are seeking Class A or Class B recognition for their RNP equipment. Pilots or autopilots will use the steering commands or path deviations output by the RNP equipment to guide the aircraft	Editorial	<b>Not Accepted.</b> The suggested change says the same thing, but uses more words to do it which does not provide additional clarity.
4	TSO-C115d	Pg 2	3.b	RNP 0.3 through 4.0	As it is understood that "Advanced RNP" are supported by this TSO, it would be desirable to mention that this Section 3.b is also applicable to Advanced RNP.	It is suggested to explicitly add after "(1) RNP 0.3 through RNP 4.0" "including Advanced RNP"	Editorial	<b>Partially Accepted.</b> Added the phrase: "...including Advanced RNP functions" to the end of the sentence.

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5	TSO-C115d	Pg 2	3.b(1)c, Note 2	...independent (see the latest revision of AC 20-138 paragraph 12-2.a).	It would be desirable to explicitly mention the applicable version of AC20-138.	It is suggested to explicitly indicate AC20-138 version D paragraph 12-2.a" in Note 2 of Section 3.b.(c)	Editorial	<b>Not Accepted.</b> AC 20-138D Chg 2 will be published shortly after this TSO is published. Whenever possible the FAA refers to the "latest revision" of guidance material to keep the references current.
6	TSO-C115d	Pg 3	3.d	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.	DO-283B is referencing DO-160G (at page 71), but not DO-160D	It is suggested to replace "DO-160D, Change 3" by "DO-160G"	Editorial	<b>Not Accepted.</b> This is the required TSO format language regarding environmental testing and cannot be changed. The intent is to keep TSOs current by defining the minimum acceptable DO-160 version and acknowledging other versions can be acceptable. This way, the TSO does not need to be revised every time a new DO-160 version is published.
7	TSO-C115d	Pg 5	5.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).	No distinction is made here on required documents between complex and simple custom airborne electronic hardware, though DO254 §1.6 states that no extensive documentation is needed for simple custom airborne electronic hardware, but on supporting processes of verification and configuration management needs to be documented.	It is suggested that for simple custom airborne electronic hardware, required documentation be limited in accordance with RTCA §1.6 to a verification plan and a configuration plan.	Conceptual	<b>Not Accepted.</b> This is the standard TSO language and states: "or similar document <u>as applicable.</u> "
8	TSO-C115d	Pg 6	6.h	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.	The requirements in this Section 6.h for simple custom airborne electronic hardware goes beyond RTCA DO254 §1.6.	It is suggested that for simple custom airborne electronic hardware, required data be limited in accordance with RTCA §1.6 to test cases or procedures, tests results, test coverage analysis and configuration management records.	Conceptual	<b>Not Accepted.</b> This is the standard TSO language. Additionally, an RTCA document is not regulatory but the TSO is regulatory. The FAA deems it necessary to require the documentation stated.

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9	TSO-C115d	Appendix 1 Pg 8-11	2.2.1.2.1, 2.4.3.1, and Appendix D		<p>This Appendix introduces additional leg types (FM, VA, VI, VM) with regard to those defined in table 2.1 of RTCA DO-283B, but those additional leg types are not compliant with the RNP concept which is based on predictable and repeatable ground tracks along which the aircraft shall be contained.</p> <p>Typically, On-board Performance Monitoring and Alerting and deviation required for meeting RNP operation objectives cannot be applied to those unpredictable and unrepeatable leg types.</p>	<p>Consequently it is suggested to remove proposed additional requirements and notes envisioned to be added into paragraph §2.2.1.2.1, § 2.4.3.1 and appendix D.</p> <p>Conversely, if those additional leg types (FM, VA, VI, VM) are nevertheless maintained, TSO should provide further requirements on how addressing RNP performance with those additional leg types.</p>	Conceptual	<p><b>Not Accepted.</b> FM, VA, VI, and VM leg types do not have RNP performance, they are RNAV leg types. Therefore, no RNP performance requirements will be associated with these leg types. But, RNP is a subset of RNAV and the two are complementary, not independent of each other. DO-236C/DO-283B has other "non-RNP" requirements as well such as fly-by transitions and VNAV. The FAA expects RNP equipment to perform existing instrument procedure designs which use these RNAV leg types for maximum efficiency, flexibility, and aircraft eligibility and has included these leg types (along with the other requirements in appendix 1) due to known operational issues pointing to deficiencies in DO-236C/DO-283B.</p>
10	TSO-C115d	Appendix 1, Pg 8-9	2.2.1.2.2	<p>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.</p> <p>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).</p>	<p>Most of current FMS are not compliant with this new requirement about STAR and approach stringing. Currently, if the IAF of the selected approach is present in the selected STAR but is not the last STAR fix, the STAR and approach procedure are merged at this common fix. The subsequent STAR legs are removed. This allows reducing the pilot workload with FPL modifications along the arrival.</p> <p>Keeping this requirement in this TSO as it is would imply inconsistencies with most of existing FMS behavior, and would create a discrepancy between FMS compliant with this TSO and those compliant only to AC 20-138D (but not to this TSO).</p>	<p>Consequently such proposed new paragraph §2.2.1.2.2 and note about STAR and approach stringing should be removed.</p>	Conceptual	<p><b>Not Accepted.</b> Stating that most current FMSs are not compliant is not factually correct. However, it is true that some current FMSs have problems performing these types of existing instrument procedure designs. This requirement is included precisely because some FMSs cannot comply with these existing instrument procedure designs due to a MOPS requirement deficiency.</p>

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				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.				
11	TSO-C115d	Appendix 1, Pg 9	2.2.1.4.14		In DO283B, §2.2.1.4.14 as mentioned in its title is just dedicated to "Runway Position Monitoring" and not to "Electronic Map Display" requirements. Electronic Map Display requirements are not explicitly addressed in RTCA DO-283B". The most relevant paragraph to consider would be in RTCA DO-283B the paragraph §2.2.1.4 Displays and System Alerting	It is suggested to insert the proposed note 2 in RTCA DO-283B as a Note 2 into paragraph §2.2.1.4 "Displays and System Alerting"	Editorial	<b>Partially Accepted.</b> The note doesn't make sense without the electronic map requirement that was in the FRAC version of DO-283B. Changed the reference to 2.1.4 and inserted the following as the second sentence in the paragraph followed by note 2: <i>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.</i>
12	TSO-C115d	Appendix 1, Pg 9-10	2.2.2.2.6.1 note	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.	This proposed TSO is not consistent with DO 283B, and would imply, when the FPA is conflicting with the altitude constraint (AT), that the altitude constraint (AT) will not be respected. With regard to previous version DO-283A, DO283B has specifically addressed in paragraph § 2.2.2.2.6.1.2 the case where a FPA vertical path intersects the altitude of a preceding 3D fix before the fix.	In order to respect "altitude constraints" and to give priority over FPA of those "altitude constraints", it is suggested to remove the proposed additional requirement and associated note envisioned to be added into paragraph 2.2.2.2.6.1	Conceptual	<b>Not Accepted.</b> The requirement does not say to ignore the 'AT' altitude constraint. The requirement says to not use geometric point to point when constructing the final approach segment path. The point being to use the procedure-defined and approved flight path angle rather than a geometric point to point-based path. But the 'AT' constraint still has to be respected and procedure designers using an 'AT' constraint have to ensure the 'AT' constraint altitude is consistent with the published flight path angle. This requirement is necessary to address a deficiency in DO-283B requirements to ensure the RNP equipment calculates the proper flight path for the final approach segment.

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<b>Comments Submitted By:</b>		Terrence Leier						
<b>Organization:</b>		Rockwell-Collins						
<b>Phone:</b>								
#	Document Name	Page Number	Paragraph Number	Referenced Text	Comment/Rationale or Question	Proposed Resolution	Comment Type (Conceptual, Editorial, or Format)	Disposition/Response to Comment
1	TSO-C115d	Pg 1	2.d	This TSO 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 TSOs and advisory circulars for information on these operations.	Consistent with this item 2d that LPV/LP is not addressed (because it's addressed by separate TSO), the SBAS-LNAV/VNAV Level of Service is already completely addressed by separate guidance, TSO-C146() and RTCA/DO-229(). Although RTCA/DO-283B or RTCA/DO-236C define baro-VNAV, they do not define an LNAV/VNAV operation or "Level of Service". Rather, separate airworthiness and operational criteria define the LNAV/VNAV operation when using baro-VNAV.	Please consider adding a clarifying statement that, "This TSO does not address SBAS-LNAV/VNAV Level of Service, neither Stand-alone LNAV/VNAV nor with Final Approach Segment Data Block." And/or, add another statement that says, "In the case that the requirements of this TSO conflict with TSO-C146(), then either is an acceptable means of compliance for equipment approved for both TSOs."	Editorial	<b>Not Accepted.</b> There are many other things this TSO does not address such as TAWS, autopilots, synthetic vision systems, ILS, etc. that are also covered by other TSOs. But it is impractical to list everything not covered by TSO-C115d. 2.d was included as a convenience for the reader to prevent the most common misunderstandings and does not need to grow further.
2	TSO-C115d	Pg 2	3.b(1) & (2)	b. Failure Condition Classifications.  (1) RNP 0.3 through 4.0 including Advanced RNP functions. (2) Design the RNP equipment to the appropriate failure condition classifications consistent with the sensor used.	There is existing AC 20-138 guidance for the safety classification for RNP > 0.3, RNP < 0.3, RNP-2 and RNP-4 airspace, so there is no need to repeat the safety classifications again in this equipment level TSO, where credit for aircraft level mitigations cannot be taken	Please consider moving the text regarding RNP 0.30 through RNP-4 failure condition classification to AC20-138D.	Conceptual	<b>Not Accepted.</b> A TSO is regulatory and AC's are not. Failure condition classification is a standard element in all TSOs and cannot be deleted.

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3	TSO-C115d	Pg 2	3b.(1)(a)	<p>Failure of the function defined in paragraph 3.a resulting in misleading lateral or vertical guidance is a major failure condition.</p>	<p>This makes misleading barometric Advisory Vertical Guidance a major failure for all phases of flight (approach, terminal, en route, and oceanic/remote). The issues with this are:</p> <ul style="list-style-type: none"> <li>- Barometric Advisory VNAV, by definition, cannot be major because the crew is required to use the barometric altimeter as the primary altitude reference for all operations, instead of using the Advisory VNAV. We also note that this issue likewise exists in DO-238B 2.1.9.1.</li> <li>- Regardless of the classification, the safety related considerations can only be completely addressed in the airworthiness approval and associated System Safety Assessment for given aircraft installation, not for the individual RNP equipment (FMS).</li> </ul>	<p>Please consider removing the hazard classification for misleading failure from this TSO. Instead, address lateral and vertical misleading failure classification in the airworthiness criteria for the installation, such as AC 20-138D</p> <p>Also, wherever failure classification (TSO or airworthiness) is addressed, state instead for the vertical component, "Failure of function defined in paragraph 3.a resulting in misleading Approved Vertical Guidance is a major failure."</p> <p>Also, clearly define "Approved Vertical Guidance."</p>	Conceptual	<p><b>Not Accepted.</b> The same baro-VNAV system is used for both terminal and approach operations so it must meet the most stringent failure condition; which is major for the approach operation. As stated above, TSOs are regulatory and ACs are not which is why failure condition classification is a standard item in TSOs and can't be removed.</p>
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4	TSO-C115d	Pg 2	3b.(1)(a)	<p>There are issues with using the TSO to address failures resulting in misleading lateral information:</p> <ul style="list-style-type: none"> <li>- Making misleading lateral information major for all operations in effect mandates dual equipage for all FMS operations with GNSS. The delay to equip can delay the benefit to the airspace.</li> <li>- Also, the implication is that an aircraft may have to request vectors or VOR routing if one of the dual FMSs or GPS receivers fails during a domestic en route flight.</li> <li>- Last, this doesn't allow taking advantage of separate aircraft capabilities for RNAV-1, RNAV-2 with DME/DME/IRS RNAV en route in the assessment.</li> </ul> <p>Regardless of the classification, the failure can only be completely addressed in the airworthiness approval and associated System Safety Assessment for given aircraft installation, not for the individual RNP equipment (FMS) without consideration for associated systems and equipment.</p>	<p>Please consider removing the classification for misleading failures from this TSO. Instead, address Misleading failures in airworthiness criteria for the aircraft installation, such as in AC 20-138D.</p>	Conceptual	<p><b>Not Accepted.</b> TSOs are regulatory; ACs are not. TSOs have always had sections on failure condition classification and it can't be removed. Nothing in this section prevents taking credit for multiple sensors, but since the sensors are used for multiple operational functions (enroute, approach, etc) the equipment must meet the failure condition for the most stringent application.</p>
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5	TSO-C115d	Pg 2	3b.(1)(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.	Similarly, there are issues with using the TSO to address failures resulting in loss of function for lateral RNP and (usually advisory) vertical guidance: - Making loss of function major for the GNSS receiver (the required lateral RNP sensor) doesn't allow taking advantage of separate aircraft capabilities for RNAV-1, RNAV-2 with DME/DME/IRS RNAV en route and terminal. - This in effect mandates dual GPS sensor equipage for lateral guidance, regardless of the operation. The delay to equip may delay the benefit to the airspace. - The need for dual should be operational, as is currently done for oceanic/remote and certain European terminal spaces. Regardless of the classification, the failures can only be completely addressed in the airworthiness approval and associated System Safety Assessment, not for the individual RNP equipment (FMS).	Please consider removing the classification for failures resulting in loss of function from the TSO. Instead, address loss of function for the operation in associated airworthiness criteria for the aircraft installation, such as in AC 20-138D.	Conceptual	<b>Not Accepted.</b> See previous comment resolution.
6	TSO-C115d	Pg 2	3b(1)(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.	The lateral portion of Item (c) is redundant with the lateral portion of Item (b).	If the classifications are retained in the TSO, either: Option 1: In item 3.b(1)(c), remove the statement "Loss of function defined in paragraph 3.a is a major failure condition for lateral guidance" because this exact item is already addressed in 3.b(1)(b). Option 2: Make the two items into 3; one for lateral as major, one for baro-VNAV as minor, one for SBAS-VNAV as major.	Editorial	<b>Not Accepted.</b> The current structure is to make it clear what the difference is between baro-VNAV and SBAS-based vertical; both of which can be used for LNAV/VNAV line of minima. The notes explain why the difference exists.

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7	TSO-C115d	Pg 2	3b(1)(c)		<p>Item (c) regarding loss of function for vertical guidance provided by satellite-based augmentation system (SBAS) equipment should be removed. It is inappropriate to include SBAS-LNAV/VNAV Level of Service in TSO-C115d because:</p> <ul style="list-style-type: none"> <li>- TSO-C115d paragraph 2 "Applicability" does not include SBAS LNAV/VNAV Level of Service;</li> <li>- RTCA DO-283B does not include [SBAS] LNAV/VNAV of Service;</li> <li>- The separate TSO-C146() and RTCA/DO-229D already address the SBAS LNAV/VNAV Level of Service;</li> <li>- TSO-C115d paragraph 2 lists RNP 0.3, which although very similar to the LNAV/VNAV Level of Service, is separate criteria. RNP 0.3, for example, does not include the angular criteria allowed for SBAS LNAV/VNAV Level of Service.</li> </ul>	<p>SBAS-LNAV/VNAV Level of Service should be removed from TSO-C116D and instead continue to be addressed in TSO-C146() and AC 20-138D. Specifically, remove the statement, "Loss of the function defined in paragraph 3.a is ... a major failure condition for vertical guidance provided by satellite-based augmentation system (SBAS) equipment."</p>	Editorial	<b>Not Accepted.</b> See previous comment resolution.
8	TSO-C115d	Pg 2	3.b(1).c (Note 1)		<p>It is unclear what is meant by the statement? "This is lateral navigation (LNAV)/VNAV, not LPV." Does it mean on an RNP approach, lateral guidance is to the flight plan, not to the FAS/LPV path? The sentence "This is lateral navigation (LNAV)/VNAV, not LPV" is confusing because:</p> <ul style="list-style-type: none"> <li>• Lateral and vertical are mismatched. The context is the means of vertical navigation (not lateral navigation).</li> <li>• If there is an LPV for the given runway, the TSO-C146() equipment is supposed to use the FAS Block (angular ILS look-alike) rather than RNP 0.3 for the lateral guidance, so this wouldn't relate to RNP 0.3.</li> </ul>	<p>Please consider deleting the line "This is lateral navigation (LNAV)/VNAV, not LPV." Alternatively, provide clarification that would make the statement appropriate for this section.</p>	Editorial	<b>Accepted.</b> The note was changed as follows: 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.

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9	TSO-C115d	Pg 2	3.b(1).c (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).	This note addresses TSO-C146() capability for Stand-alone LNAV/VNAV and SBAS-LNAV/VNAV using a FAS data block as defined in RTCA/DO-229D. As such, the statement is out of scope for a TSO calling out DO-283B.	Please remove Note 2 from TSO-C115D and address this failure classification instead in AC 20-138D.	Editorial	<b>Not Accepted.</b> As previously stated, this note explains why baro-VNAV and SBAS-based vertical have different failure condition classifications in an effort to ensure all readers understand the rationale.
10	TSO-C115d	Pg 2	3.b(2)	Design the RNP equipment to the appropriate failure condition classifications consistent with the sensor used.	This statement seems incomplete and ambiguous: “ (2) Design the RNP equipment to the “appropriate failure condition classifications consistent with the sensor used.”	Please consider deleting this item, since it is covered in 3e and 3f. Alternatively, provide clarification that would make the statement appropriate for this section.	Editorial	<b>Not Accepted.</b> The statement is quite clear when taken in context with section 3.b and is standard TSO language.
11	TSO-C115d	Pg 2-3	3.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.	RTCA DO-160 is now at revision “G” and DO-283B calls out DO-160G, but this document is still referencing DO-160D.	Please change the reference from DO-160D to DO-160G. Or please provide a brief note after section 3.d to explain why you are not referencing the current revision “G” of RTCA DO-160.	Conceptual	<b>Not Accepted.</b> This is the required TSO format language regarding environmental testing and cannot be changed. The intent is to keep TSOs current by defining the minimum acceptable DO-160 version and acknowledging other versions can be acceptable. This way, the TSO does not need to be revised every time a new DO-160 version is published.

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12	TSO-C115d	Pg 3	3.e	<p>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.</p>	<p>Since the proposal is that failures for the installation be assessed in the airworthiness approval of the installation (instead of in the TSO per 3b), modify Software Qualification to support the intended classification.</p>	<p>Replace "consistent with the failure classification defined paragraph 3b" with "consistent with the following failure classifications:</p> <ul style="list-style-type: none"> <li>- Major for failure of function defined in paragraph 3a resulting in misleading lateral guidance or misleading Approved Vertical Guidance;</li> <li>- Major for failure of function defined in paragraph 3a resulting in loss of function for lateral guidance;</li> <li>- Major for failure of function defined in paragraph 3a resulting in loss of function for vertical guidance based on SBAS;</li> <li>- Minor for failure of function defined in paragraph 3a resulting in loss of function for vertical guidance based on barometric VNAV.</li> </ul>	Editorial	<p><b>Not Accepted.</b> This is the standard TSO format language and it is not necessary to repeat all the failure condition classifications; it is sufficient to refer back to paragraph 3.b.</p>
13	TSO-C115d	Pg 3	3.f	<p>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 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.</p>	<p>Since the proposal is that failures for the installation be assessed in the airworthiness approval of the installation (instead of in the TSO per 3b), modify Hardware Qualification to support the intended classification.</p>	<p>Replace "consistent with the failure classification defined paragraph 3b" with "consistent with the following failure classifications:</p> <ul style="list-style-type: none"> <li>- Major for failure of function defined in paragraph 3a resulting in misleading lateral guidance or misleading Approved Vertical Guidance;</li> <li>- Major for failure of function defined in paragraph 3a resulting in loss of function for lateral guidance;</li> <li>- Major for failure of function defined in paragraph 3a resulting in loss of function for vertical guidance based on SBAS;</li> <li>- Minor for failure of function defined in paragraph 3a resulting in loss of function for vertical guidance based on barometric VNAV.</li> </ul>	Editorial	<p><b>Not Accepted.</b> See previous comment resolution.</p>

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14	TSO-C115d	Pg 6-7	6		It would seem appropriate that there should also be a Manufacturer Data Requirement item "Documentation describing the data distribution process in detail, compliant with RTCA/DO-200B, Standards for Processing Aeronautical Data, dated, ..." as is done for TSO-C146(?)	Please consider adding a DO-200() data item, if appropriate.	Conceptual	<b>Not Accepted.</b> The author is incorrect in stating that TSO-C146d contains a Manufacturer Data Requirement for an RTCA/DO-200B compliant data distribution process. Both TSO-C146d and C115d contain the same list of manufacturer Data Requirements which is standard TSO language.
15	TSO-C115d	Appendix 1	2.2.1.2.1, 2.4.3.1, Appendix D		It is unclear why FM, VA, VI, VM Leg types were added to the definition? They cannot be used to create a repeatable ground track. Will they have RNP values? Some RNP missed approach procedures contain prohibited leg types, specifically CA, but they are not listed here. There are 10 other leg types that an RNAV box implements but they are not listed in the TSO. Why are only these 4 specified? If heading legs are added to the TSO, the MOPS needs to be updated to specify how to apply mag var for those legs. Currently only FC, FA, and HX are addressed.	Please consider not adding FM, VA, VI, VM Leg types. Additionally, Remove Appendix 1 Sections: 2.2.1.2.1, 2.4.3.1, Appendix D.	Conceptual	<b>Not Accepted.</b> FM, VA, VI, and VM leg types do not have RNP performance, they are RNAV leg types. Therefore, no RNP performance requirements will be associated with these leg types. But, RNP is a subset of RNAV and the two are complementary, not independent of each other. DO-236C/DO-283B has other "non-RNP" requirements as well such as fly-by transitions and VNAV. The FAA expects RNP equipment to perform existing instrument procedure designs which use these RNAV leg types for maximum efficiency, flexibility, and aircraft eligibility and has included these leg types (along with the other requirements in appendix 1) due to known operational issues pointing to deficiencies in DO-236C/DO-283B.

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16	TSO-C115d	Appendix 1			<p>Manual RNP. Systems that can read the RNP value from the onboard navigation database should be given credit for meeting the intent of Manual RNP Entry.</p>	<p>Please add an Appendix 1, Exception to the RTCA/DO-238B Requirements that says: "2.2.1.2.12.1, 2.2.1.2.12.2.a, 2.2.1.4 Table 2-3, 2.2.1.4.10, and 4.2: A system that can read the RNP value from the onboard navigation database meets the intent of the requirement for manual entry of the RNP value." Rationale: Reading RNP values from the onboard navigation database can help improve safety and reduce errors that could be introduced by allowing the pilot to enter or change the RNP value. If airspace or obstacle clearance conditions change where a RNP value needs to be changed, the navigation database suppliers can use the processes currently in place to safely update the RNP value in the next navigation database cycle. This also harmonizes TSO-C115d with the LPV and L/V requirements in TSO-C146c, DO-229D, sections 2.2.4.6.1 and 2.2.5.6.1, which say: "The equipment shall not provide the</p>	Conceptual	<p><b>Not Accepted.</b> The MOPS and guidance material allows and encourages manufacturers to include automatically reading leg RNP values from the on-board database. There is no need to include an additional requirement stating that automatically reading RNP values satisfies the manual RNP value requirement. However, the flightcrew needs the capability to insert RNP values consistent with the manual entry requirements for those situations where manual intervention is warranted; particularly for any situation where the database does not provide an RNP value. It is also possible for the manufacturer to ask for a deviation from the manual entry requirements if they believe their automatic implementation satisfies the intent and provides an equivalent (or better) level of safety.</p>
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17	TSO-C115d	Appendix 1			<p>Alert on next leg RNP. Systems that can alert on the current leg RNP, and have a look-ahead alert for the final leg of an approach RNP, in conjunction with the operationally required pre-flight RAIM check, should be given credit for meeting the intent of Alerting on the RNP of the Next Leg.</p>	<p>Please consider adding this Appendix 1 Exception to the RTCA/DO-238B Requirements that says: "2.2.1.4.12.h: For departures (SIDS) in which the RNP values always increase, alerting on the active leg RNP provides an equivalent level of safety for the Next Leg Alert, since the active leg alert inherently also cover the next leg RNP. For airways and arrivals (STARS), the preflight RAIM predictions and the active leg RNP alert provides the equivalent level of safety for the Next Leg Alert. It is equivalent because the next leg alert provides minimal operational benefit in the longer legs used in those flight phases. For approaches, to alert based on the RNP for the final segment provides an equivalent level of safety for the Next Leg Alert because the final segment RNP will always be less than or equal to the next leg RNP.</p>	Conceptual	<p><b>Not Accepted.</b> These 'requirements' appear intended to address a specific implementation for a particular applicant which is not something MOPS typically cover. The existing MOPS requirements are sufficient and it is up to the TSO applicant to show their implementation meets the requirements. An equivalent level of safety finding is more appropriate for an applicant asking for a deviation request because their implementation does not comply with the MOPS requirements, but does provide an equivalent level of safety.</p>
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						<p>A system that alerts on the active leg RNP and also has a look-ahead alert for the final leg of an approach RNP, in conjunction with the operationally required pre-flight RAIM check, meets the intent of the requirement for alerting on the RNP of the Next Leg.”</p> <p>Rationale: Current operational requirements in AC90-105 and AC90-101A require that the flight crew perform a preflight RAIM check for non-SBAS augmented approaches such as RNP and RNP AR. This required RAIM check will alert the crew if the GNSS accuracy on any legs of the flight plan are predicted to be available even before the flight begins. The required PRAIM for the approach provides additional protection for approach proceeds selected in the FMS flight plan. These systems with the addition of the operational pre-flight RAIM check will provide and Equivalent Level Of Safety (ELOS) to alerting on the RNP of the Next Leg.</p>		
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18	TSO-C115d	Appendix 1			Values should be to the waypoint instead of to the lateral bisector.	Please consider adding this Appendix 1, Exception to the RTCA/DO-238B Requirements that says: "2.2.1.2.9.3: Distance-to-go, estimated time of arrival and time-to-go reference parameters may be shown relative to the waypoint, or may be shown relative to the lateral bisector if the geometry allows." Rationale: Showing DTG, ETA, and TTG to the turn bi-sector instead of the waypoint is good in theory, but in practice, certain geometries do not work when implemented in the FMS software. Therefore, the requirement should allow that DTG, ETA, and TTG may be relative to either the lateral bisector or to the waypoint.	Conceptual	<b>Not Accepted.</b> In fly-by and fixed radius transitions, the aircraft never flies over the waypoint, so how can DTG, ETA, TTG calculations be performed to a point that is never reached?
19	TSO-C115d	Appendix 1			Providing lateral path guidance not later than 50 feet without also requiring maximum bank angle limits and V2 speed corrections conflicts with FAA AC120-91, section 14.b.	Please consider adding this Appendix 1, Exception to the RTCA/DO-238B Requirements that says: "2.2.1.3.2.1: When used to conduct a departure procedure off the runway, the RNP equipment shall be capable of providing lateral path guidance not later than 50 feet above the departure runway, and must comply with the maximum bank angle limits and V2 speed corrections given in FAA AC120-91." Rationale: In order to harmonize with FAA AC 120-91, Airport Obstacle Analysis Guidance, certain maximum bank angle limits and V2 speed corrections need to be implemented if lateral guidance on a departure is given below 400 feet.	Conceptual	<b>Not Accepted.</b> The requirement for the RNP equipment stands. RNP procedure design criteria will use the equipment standards; & the criteria in AC 120-91 will not be applied.

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20	TSO-C115d	Appendix 1			<p>Allow 30 or 45 degree default track change to acquire or depart a parallel offset path.</p>	<p>Please consider adding this Appendix 1, Exception to the RTCA/DO-238B Requirements that says: "2.2.1.2.7.1) The RNP equipment shall: 1) Utilize a standard 30 degree track change from the path being flown (original or offset) to define the transition path (original to offset or offset to original). Note: This does not preclude the manual override of the default intercept angle or the availability of additional crew-selectable intercept angles, or the system from using a different default intercept angle (eg. 45 degrees)." Rationale: The note allows manual override and additional selectable intercept angles, so it would seem a default track change angle of either 30 or 45 degrees would be acceptable.</p>	Editorial	<p><b>Not Accepted.</b> This was debated in the committee; &amp; the committee rejected this concept. Instead, to standardize aircraft performance &amp; behavior, the RNP equipment shall use 30 degrees of track change, as stated in the MOPS.</p>
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<b>Comments Submitted By:</b>		Clayton Vondrasek						
<b>Organization:</b>		Garmin						
<b>Phone:</b>								
#	Document Name	Page Number	Paragraph Number	Referenced Text	Comment/Rationale or Question	Proposed Resolution	Comment Type (Conceptual, Editorial, or Format)	Disposition/Response to Comment
1	TSO-C115d	Pg 2	3.b.(1)(c) Note 1	Note 1: Both baro-VNAV and SBAS are eligible to provide vertical guidance on an RNP approach. This is lateral navigation (LNAV)/VNAV, not LPV.	The "Note 1:" repeated here, especially the 2nd sentence (italicized) reads awkwardly:  Note 1: Both baro-VNAV and SBAS are eligible to provide vertical guidance on an RNP approach. This is lateral navigation (LNAV)/VNAV, not LPV.  Wording should change to more clearly state what is intended by this note.	It seems like this note is trying to say that it is OK to use SBAS for vertical guidance for an LNAV/VNAV line of minimums; e.g., the LNAV/VNAV line of minimums on a RNAV (GPS) approach that also may include a LPV line of minimums. This may seem obvious if one is familiar with TSO-C146() / DO-229() but the TSO-C115d MOPS (i.e., DO-283B) addresses only baro-VNAV and does not mention the use of SBAS. Suggest revising to: Note 1: Both baro-VNAV and SBAS are eligible to provide vertical guidance to lateral navigation (LNAV)/VNAV minimums on a RNP approach. LPV minimums require SBAS for vertical guidance.	Editorial	<b>Partially Accepted.</b> The note was changed per a previous comment as follows: 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.

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2	TSO-C115d	Pg 2	3.b.2	<p>Design the RNP equipment to the appropriate failure condition classifications consistent with the sensor used.</p>	<p>Includes the statement:  Design the RNP equipment to the appropriate failure condition classifications consistent with the sensor used.</p> <p>Wording needs to change to recognize the fact that failure condition classification is ultimately determined by aircraft level analysis.</p>	<p>It is reasonable to clarify the wording to ensure aircraft level analysis is the driver for determining failure classifications. EASA has recognized this using the following wording in ED Decision 2010/010/R 14/12/2010 Annex I Subpart A – General 2.4 Failure condition classification: "Develop the system to, at least, the design assurance level equal to the failure condition classifications provided in the ETSO. Development to a lower Design Assurance Level may be justified for certain cases and accepted during the ETSO process but will lead to installation restrictions."</p> <p>Re-work this section to match the EASA wording. Or work with industry to develop an agreed to wording.</p>	Conceptual	<p><b>Not Accepted.</b> TSOs provide design and production approval, but not airworthiness approval. But, TSO capabilities always include failure condition classifications based on the defined capability as an assumption of the minimum necessary to support installation at the aircraft level. An applicant wishing to support lesser capabilities and consequently support a lesser failure condition classification may do so by providing a mitigating limitation on the equipment applicable to any future airworthiness approval.</p>
3	TSO-C115d	Pg 3	3.d	<p>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.</p>	<p>Paragraph d allows use of another DO-160 standard:  Demonstrate the required performance under the test conditions specified in Section 2.3 of RTCA Inc. Document No. RTCA/DO-283B .....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.</p> <p>RTCA/DO-283B Section 2.3 requires use of DO-160G.</p>	<p>This sentence should be clarified to allow a different standard than RTCA/DO-283B Section 2.3 requires, which was likely the intent.</p> <p>"You may use a different standard environmental condition and test procedure than RTCA/DO-160G , provided the standard is appropriate for the RNP equipment."</p>	Editorial	<p><b>Not Accepted.</b> This is the required TSO format language regarding environmental testing and cannot be changed. The intent is to keep TSOs current by defining the minimum acceptable DO-160 version and acknowledging other versions can be acceptable. This way, the TSO does not need to be revised every time a new DO-160 version is published.</p>

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4	TSO-C115d	Pg 3	3.f	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 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.	Including this specific DO-254 reference is redundant to the rest of the paragraph in this section.  For custom airborne electronic hardware determined to be simple, RTCA/DO-254, paragraph 1.6 applies.  DO-254 makes it clear how to address "simple" custom airborne electronic hardware.	Remove this reference to DO-254 Paragraph 1.6.	Editorial	<b>Not Accepted.</b> This is standard TSO language that cannot be changed to clarify the requirements between complex and simple hardware.
5	TSO-C115d	Pg 3	4.b.(2)	. 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.	Paragraph 4.b.(2) states: Each subassembly of the article that you determined may be interchangeable.  This language is confusing.	The language for this requirement is confusing. This could mean that a stuffed printed circuit board needs the TSO number.  Suggest removing the statement or if removing causes problems, work with industry to establish wording that is better understood.	Editorial	<b>Not Accepted.</b> This is standard TSO language that has been through numerous editorial reviews and cannot be changed.
6	TSO-C115d	Pg 4	5.a.(3)	(3) Instructions for updates to ensure continued airworthiness (e.g., magnetic variation tables).	This item (Instructions for updates to ensure continued airworthiness) is redundant with the last sentence of par 5.b	Delete par 5.a.(3) because it is addressed by par 5.b.	Editorial	<b>Accepted.</b>

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7	TSO-C115d	Pg 5	5.f.(1)	(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.	This paragraph requires reporting the "failure condition classification" which can be misleading and is inconsistent with the process of determining failure condition classification at the aircraft level.	<p>Failure condition classification is determined by system safety assessment at the aircraft level and can vary based on installation. By providing a failure condition classification at the appliance level this creates an impression that the safety analysis for these functions is complete.</p> <p>Additionally, TSO paragraphs 5.a.(6)(a) and 5.a.(6)(b) already require the Manual(s) to contain the software and AEH design assurance levels that an installer needs to determine whether the equipment can support the aircraft level failure condition classification.</p> <p>Remove the requirement to list "failure condition classification".</p>	Conceptual	<p><b>Not Accepted.</b> This paragraph is requiring a <u>description of non-TSO functions</u> [emphasis added] with <u>examples</u> of what constitutes a description of the non-TSO function. This is the standard TSO language for used for non-TSO functions. As previously stated, all TSO'd avionics have an assumed failure condition consistent with the operational functions to support installation at the aircraft level for those operations.</p>
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8	TSO-C115d	Pg 5	5.f	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:	TSO paragraph 5.f and its subparagraphs include definition of non-TSO functions and the data to be submitted to the ACO for non-TSO functions. This guidance is inconsistent with Order 8110.4C CHG 4.	TSO paragraph 5.f states "Identify functionality or performance contained in the article not evaluated under paragraph 3 of this TSO (that is, non-TSO functions)." Use of the term "performance" in the definition of a non-TSO function is inconsistent with the Order 8110.4C CHG 4 paragraph 6-9.b.(1) and 6-9.b.(3)(a) guidance regarding how to define a non-TSO function. The issue is non-TSO should not be defined as "performance". It will create difficulty if these criteria are used. For example, if a TSO requires a minimum 10 watt transmitter and a company makes equipment that is robust at 11 watts, the performance exceeding the TSO is not called out under the TSO; consequently, by the paragraph 5.f "performance" definition, the 11 watt transmitter has a non-TSO 1 watt capability. The distinction of a "function that can be accomplished outside the	Conceptual	<b>Not Accepted.</b> 8110.4C Chg 5 paragraph 6-9.b(3)(b) clearly states: "[Data submitted to the ACO...should include, as a minimum, the following:] The manufacturer's <u>declared performance requirements</u> [emphasis added]. Where possible, the manufacturer is encouraged to adopt existing industry-accepted standards, e.g., RTCA, EUROCAE, SAE or ARINC. Paragraph 5.f is consistent with the latest 8110.4C change.
						TSO box" as is specified in Order 8110.4C CHG 4 paragraph 6-9 is critical to making non-TSO function work long term. A  Adjust the wording in the TSO (and template) to be consistent with the 8110.4C CHG 4 intent.		

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9	TSO-C115d	Pg 7	7.b	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).	TSO paragraph 7.b contains wording that is inconsistent with Order 8110.4C CHG 4.	<p>TSO paragraph 7.b includes additional guidance about what furnished data should be provided to an operator or repair station when the equipment includes a non-TSO function. The problematic guidance states "include one copy of the data in paragraphs 5.f.(1) through 5.f.(4)." This guidance is inconsistent with Order 8110.4C CHG 4. Order 8110.4C CHG 4 paragraph 6-9.b.(6) defines the FAA-industry agreed data that must be provided to an installer when equipment includes a non-TSO function.</p> <p>Adjust the wording in the TSO (and template) to be consistent with the 8110.4C CHG 4 intent.</p>	Conceptual	<b>Not Accepted.</b> 8110.4C Chg 5 paragraph 6-9.b(6)(a-c) contains the same items as paragraph 7.b (which references 5.f(1-4) although the TSO does not repeat the exact same wording. The difference is, for clarity, the TSO standard language breaks the items into four lines instead of the three lines in the Order. The standard language in the TSO is entirely consistent with Order 8110.4C Chg 5.
10	TSO-C115d	Appendix 1, Pg 8			DO-283B does not include a definition for terms like "shall", "should", "must", and "may". Consequently, it is ambiguous as to whether statements within DO-283B Sections 2.1 and 2.2 that use the term "shall" are considered requirements that if not complied with would need a TSO deviation.	<p>Suggest adding a new Section 1.7.5 Uses of Key Words for Requirements and Recommendations to TSO-C115d Appendix 1 that includes definitions for at least "shall" and "should".</p> <p>Examples that could be used as the basis for such definitions can be found in the following RTCA documents:</p> <ul style="list-style-type: none"> <li>• DO-229D Section 1.1 Introduction</li> <li>• DO-361 Section 1.7.2 Uses of Key Words for Requirements and Recommendations</li> <li>• DO-358 Section 1.8 Definition of Terms</li> <li>• DO-317B Section 1.7 Definition of Terms</li> </ul>	Editorial	<b>Not Accepted.</b> It is commonly understood that "shall" is used in RTCA documents to indicate hard requirements when implemented by TSO. Any other terms such as should or may are used to indicate acceptable methods of satisfying the hard requirements or optional items, but should and may do not indicate hard requirements. This comment should be directed to RTCA for their consideration as a MOPS format standard rather than imposing it via TSO.

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11	TSO-C115d	Appendix 1, Pg 8	2.2.1.2.1	<p>2.2.1.2.1 Leg Types.</p> <p>Add the following required leg types to Table 2-1:</p> <p>FM Fix to Manual Termination</p> <p>VA Heading to Altitude Leg</p> <p>VI Heading to Intercept</p> <p>VM Heading to Manual Termination</p>	<p>Although no explanation is given, we assume that the requirement for additional leg types is based on an understanding of what is needed to support existing RNAV procedures. If this assumption is correct, then CA (Course to Altitude) should also be required.</p>	<p>Add CA (Course to Altitude) to the list of required leg types. CA legs are frequently used on RNAV approaches as the first leg of the missed approach procedure.</p>	Conceptual	<p><b>Accepted.</b> Added CA legs as suggested (also in a previous comment). Additionally, the introduction paragraph is expanded to explain the reason for the requirements additions and modifications as follows:  <i>"This appendix describes modifications and additions to the requirements found in RTCA/DO-283B the RNP equipment shall meet for compliance with this TSO. The FAA 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."</i></p>
12	TSO-C115d	Appendix 1, Pg 10	2.4.3.1	<p>2.4.3.1 Test Scenario(s).</p> <p>Add the following leg types to the list in paragraph (a):</p> <p>FM, VA, VI, VM,</p>	<p>CA legs are also needed to support RNAV procedures.</p>	<p>Add CA to the list of leg types. CA legs are frequently used on RNAV approaches as the first leg of the missed approach procedure.</p>	Conceptual	<p><b>Accepted.</b></p>
13	TSO-C115d	Appendix 1, Pg 10	D10	<p>Appendix D.</p> <p>Add the following leg type definitions to Appendix D:</p>	<p>CA legs are also needed to support RNAV procedures,</p>	<p>Insert a paragraph here with the description of Course to Altitude (CA) See ARINC 424-20, Attachment 5, section 1.4 for the description.</p>	Conceptual	<p><b>Accepted.</b></p>