

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
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	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
1.	Nakamura	General	Throughout this systems document, the references to RNP document is DO-283B which is just the equipment requirements for RNP. The system requirements are contained in DO-236C and Change 1. It is not clear why the equipment requirements are being cited as the system requirements. It appears that in many cases the reference should be DO-236 and a few where DO-283 are appropriate. It's also noted that there are a few instances where the European MASPS ED-75 is referenced but DO-236 is not. See Sections 8-3a, 8-3e, 8-3h(10)Note1, 9-3a, 9-3e, 9-3h(10)Note, 9-5.3a, 9-5.3e, 9-5.3h(8) Note, 10-3.1g(10)Note, 10-3.1g(13)(f)Note, 10-3.1g(14)(c)Note, 11-1b, 11-2b, 12-13, A2-2a, A2-2b, A2-2d(2)Note2, A2-3, A2-3b(7), A2-3c(1)Note1, A2-3c(2), A3-1f, A3-2a, A3-2b(2), A3-3a, A3-4a, A3-6.	Suggest reviewing the references and ensuring system requirements are referenced to DO-236 and any necessary equipment requirements are to DO-283. Since the TSO will invoke the RNP equipment requirements, it's expected that only a few select requirements of DO-283 may be referenced.	Accepted. Chapter 7 includes a discussion on the relationship between DO-236C and DO-283B. All references reviewed and corrected consistent with the intent. That is, specific RNP equipment references are only to DO-283B while other references are to both DO-283B and -236C chg 1.
2.	Nakamura	General	It appears that the AC does not fully invoke DO-236 MASPS for RNP systems. The typical practice of invoking a standard with exceptions is not done here, or clearly. There are a	Suggest invoking the MASPS and spelling out the exceptions even if the MASPS requirements are distributed to the various	Not Accepted. The AC now invokes DO-236 where necessary including the advanced RNP appendix. The advanced RNP appendix

Public Review Comment Metric

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---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			number of MASPS requirements that are not fully or partially addressed including ETA, Lateral Control Performance, Speed Control Performance, EPU, Path Definition, permissible legs, magnetic variation, applicable RNP, altitude constraints, speed restrictions, descent path construction, display/entry resolutions, etc, etc.	sections. The most appropriate section to address the MASPS could be that for advanced RNP since many of the other application specific sections only rely on certain elements or requirements in common with the MASPS. Whatever solution is chosen, a fuller and clearer linkage between MASPS and AC appears to be needed.	provides general guidance and it is up to the applicant to meet applicable requirements. It is not necessary to repeat MOPS or MASPS requirements.
3.	Nakamura	S 1-3a, Pg 2	The list of superseded guidance vs what is contained in AC120-29A for RNP would appear to need some clarification on the relationship of the two documents.	Considering adding a note of clarification on the status and role of AC120-29A with regard to RNAV and RNP.	Not Accepted. Not sure what the comment is referring to. AC 120-29A is criteria for approving Category I and II weather minima and is not listed as being superseded by AC 20-138D chg 2.
4.	Nakamura	S1-4d, Pg 4	The response appears to partially respond to the question and additional amplification might be helpful.	Suggest “Paragraph 6-6 addresses loosely-coupled systems and paragraph 6-7 addresses tightly-coupled systems. There is no intent to exclude either loosely-coupled or tightly-coupled INS/GPS from oceanic use <u>through</u>	Not Accepted. The question is specific to oceanic use and LPV. The answer addresses oceanic use and clarifies that no vertical guidance capability (including LPV) is possible for any approach

Public Review Comment Metric

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---------------------------------------	---	---	--------------------------	------------------------

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				<p><u>LNAV approach only.</u> However, un-augmented GPS, even with tightly-coupled INS, is not adequate for vertical aspects of approach approach capability, and hybrid inertial vertical approach capability is not addressed in RTCA/DO-229D, appendix R.</p>	line of minima using un-augmented GPS (i.e., without SBAS or GBAS). Not sure how the suggestion adds further clarity.
5.	Nakamura	S 1-4e(2)(b), Pg 5	The implication of the response is that the operator must implement changes in order to operate aircraft that are not fully compliant. However, the operator should have the choice to determine the extent that they will operate the aircraft equipment as well.	It is up to the operator to determine how to comply <u>or establish appropriate limitations on equipment usage</u> based on their specific operating rules and mission needs.	Not Accepted. Guidance in the AC is intended to be taken as a whole, not parsed into discrete blocks read in isolation. The question concerned an ‘operational’ limitation that was inappropriately in an airworthiness AC. The answer merely states there is a difference between ‘operational’ limitations and certification ‘equipment performance’ limitations. ‘Operational’ regulations and guidance is the appropriate place to look for equipment requirements including any

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

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					limitations associated with meeting those requirements.
6.	Nakamura	S 3-4b(2), Pg 16	This section makes the first mention of advanced RNP. It is in reference to DO-283B with regard to the appropriate functions. However, Appendix 3 establishes the functions required, but is not mention. Suggest reference to Appendix 3 for clarity and completeness.	For example “..for approach capability. <u>See Appendix 3 for the capabilities necessary for advanced RNP recognition and guidance on implementation alternatives.</u> ” Note underline is just to highlight the possible addition.	Partially Accepted. The following sentence was added at the end of the paragraph: <i>See appendix 3 for guidance on advanced RNP capability.</i>
7.	Nakamura	S 4-2, Pg 21	The implementations do not address TSO-C115 equipment. What is the means for this TSO to get into the game?	None.	Not Accepted. It is not necessary to specifically address TSO-C115 equipment because this equipment uses a GPS sensor. The listed GPS sensor TSO’s are used in TSO-C115 equipment for functional operation and the guidance, as stated, applies to the integrated capability.
8.	Nakamura	S 5-3.2(b)	How does this document intend to better harmonize terminology such as RNAV(GPS) vs RNP APCH? It’s clear that terminology is intended to be consistent in a section or as appropriate	None.	Partially Accepted. There is a subtle difference between RNP APCH (nav spec terminology) and RNAV(GPS) a specific

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

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			to past application. However, the various sections allow for some of the same applications but the names are different.		approach type. The idea is to communicate concepts as clearly as possible and use the appropriate terminology for the concept. The document will be reviewed to ensure proper use and communicate clearly.
9.	Nakamura	S 6-2.2, Pg 49	DO-283B contains requirements for a manufacturers data quality requirements document, primarily established by regulators including the FAA. However, there does not appear to be such a requirements here, just that there are data quality requirements whose responsibility is unclear. Additionally, the requirement addresses only assurance level while it was intended that all aspects of the data content would be documented. Please clarify how and what aspects of DQR document requirements will be applied.	See comment.	Not Accepted. ACs do not list requirements. The AC is providing general guidance that manufacturers need to identify an aeronautical data process (not just DQRs) as part of their TSOA application. There is also a reference to AC 20-153 for an acceptable means of qualifying their aeronautical data process.
10.	Nakamura	S 6-7d(h), Pg 51	The statement regarding documentation should consider that there are other implementations where the coasting capability does not reside in the INS/IRU, instead it is in an FMS. If this	See comment	Not Accepted. Paragraph 6-7.a clearly states the guidance in 6-7 is for tightly-coupled architectures. The AC guidance is intended to

Public Review Comment Metric

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---------------------------------------	---	---	--------------------------	------------------------

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			is intended to only address the tightly coupled architectures, it should probably be stated.		be considered as a whole and not parsed into individual paragraphs or sentences.
11.	Nakamura	S 7-1c, Pg 53	Suggest deleting “optional” prior to advanced RNP functions.” The point of what is required and what is optional is clearly spelled out in the appendix. Optional is as unnecessary here as it is for RNP AR, which is also a choice for implementers. The deletion would be more consistent with the rest of the text.	See comment	Accepted.
12.	Nakamura	S 8-2b	The latest revisions to DO-236 is C and Change 1, and for DO-283 it is B.	Update the document revision levels.	Accepted.
13.	Nakamura	S 8-3f, Pg 58	The SIS requirement is stated as though GNSS only equipment is used. Where RNP equipment allows and considers the including of such integrity checks into the RNP performance monitoring and alert, such that a separate integrity alert is not required. As stated, this would lead to implementation where both a SIS integrity alert and RNP integrity alert would be necessary.	Suggest a note that indicates that if the SIS integrity check is an integral part of the RNP integrity alert, a separate SIS integrity alert is not required.	Not Accepted. The SIS is specific to GNSS. All RNP APCH operations require GNSS and SIS integrity checks are part of GNSS sensor requirements. Not sure how this guidance is unclear or some unnecessary burden.
14.	Nakamura	S 8-3g(4), Pg 60	The statement “...alert if the RNP for operations..” is incomplete and can be misinterpreted to mean only the accuracy value. Suggest it should be restated to	See comment	Partially Accepted. Changed the sentence to read: “...alert if the RNP <u>criteria</u> for the operation

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

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			“...alert if the RNP <u>requirements</u> for operations...” so as to ensure that at least the integrity/TSE aspects of performance are included. Note the first statement regarding ANP and RNP accuracy value could also stand a little clarity. However, the tradeoff of adding a substantial amount of text that in the end could also become confusing leads to the simple addition suggested.		cannot be met.”
15.	Nakamura	S 9-3f, Pg 66	The SIS requirement is stated as though GNSS only equipment is used. Where RNP equipment allows and considers the including of such integrity checks into the RNP performance monitoring and alert, such that a separate integrity alert is not required. As stated, this would lead to implementation where both a SIS integrity alert and RNP integrity alert would be necessary.	Suggest a note that indicates that if the SIS integrity check is an integral part of the RNP integrity alert, a separate SIS integrity alert is not required.	Not Accepted. The SIS is specific to GNSS. All IFR-approved GNSS sensors provide SIS integrity checks. However, the RNP alert is at the aircraft level, and encompasses more than just the navigation system.
16.	Nakamura	S 9-3g(3), Pg 67	The statement “...alert if the RNP for operations..” is incomplete and can be misinterpreted to mean only the accuracy value. Suggest it should be restated to “...alert if the RNP <u>requirements</u> for operations...” so as to ensure that at least the integrity/TSE aspects of performance	See comment	Partially Accepted. Changed the sentence to read: “...alert if the RNP <u>criteria</u> for the operation cannot be met.”

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			are included.		
17.	Nakamura	S 9-5.3f, Pg 71	The SIS requirement is stated as though GNSS only equipment is used, which could be the case initially. However, going forward, RNP equipment could be developed and installed. Such RNP equipment could allow the inclusion of such integrity checks into the RNP performance monitoring and alert, such that a separate integrity alert is not required. As stated, this would lead to implementation where both a SIS integrity alert and RNP integrity alert would be necessary.	Suggest a note that indicates that if the SIS integrity check is an integral part of an RNP integrity alert, a separate SIS integrity alert is not required.	Not Accepted. The SIS is specific to GNSS. GNSS, specifically SBAS, is required for the operation and all GNSS sensors provide SIS integrity checks. However, the RNP alert is at the aircraft level, and encompasses more than just the navigation system.
18.	Nakamura	S 10-2.1d, Pg 76	The SIS requirement is stated as though GNSS only equipment is used. However, the lead in text points to INS/IRU as equipment that is also allowed. Both could be used by RNP equipment that is now installed. Such RNP equipment could allow the inclusion of such integrity checks into the RNP performance monitoring and alert, such that a separate integrity alert is not required. As stated, this would lead to implementation where both a SIS	Suggest a note that indicates that if the SIS integrity check is an integral part of an RNP integrity alert, a separate SIS integrity alert is not required.	Not Accepted. The SIS is specific to GNSS. All GNSS sensors provide SIS integrity checks. However, the RNP alert is at the aircraft level, and encompasses more than just the navigation system.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			integrity alert and RNP integrity alert would be necessary.		
19.	Nakamura	S 10-3.1e, Pg 81	The SIS requirement is stated as though GNSS only equipment is used. However, the lead in text points to INS/IRU as equipment that is also allowed. Both could be used by RNP equipment that is now installed. Such RNP equipment could allow the inclusion of such integrity checks into the RNP performance monitoring and alert, such that a separate integrity alert is not required. As stated, this would lead to implementation where both a SIS integrity alert and RNP integrity alert would be necessary.	Suggest a note that indicates that if the SIS integrity check is an integral part of an RNP integrity alert, a separate SIS integrity alert is not required.	Not Accepted. The SIS is specific to GNSS. All GNSS sensors provide SIS integrity checks. However, the RNP alert is at the aircraft level, and encompasses more than just the navigation system.
20.	Nakamura	S 11-2c, Pg 88	The Table 6 flight along vertical profile performance limits were established with an expectation that the constructed path is designed for VNAV operations and not an overlay of a conventional procedure or one where the path construction does not follow the guidance in DO-236 or DO-283.	Suggest a note on the assumption of path construction per TERPS for Baro VNAV.	Partially Accepted. Table 6 is intended for enroute and terminal operations, not approach operations. The existing note and note from the preceding paragraph seem to be misplaced which probably causes confusion. The notes were swapped. However, enroute and

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
					terminal vertical path construction is based on the published altitude restrictions when following a defined procedure. It is a given these altitude restrictions comply with TERPs.
21.	Nakamura	S 11-1b, Pg 86	This references the MOPS for the system, shouldn't it be the MASPS, DO-236? It would be expected that the TSO would reference the MOPS.	Confirm reference.	Not Accepted. When taken as a whole, the guidance is referring to the complete suite of equipment providing temperature compensation and applicable as general guidance information for any project.
22.	Nakamura	S 11-2b, Pg 87	Suggest that the document reference be changed to the MASPS DO-236 for the system performance requirement. The MOPS is for the RNP equipment only. Additionally, post publication review suggests that the values in the MOPS may be inappropriate as they allocate the total system error to the RNP equipment which would leave nothing else for other components of the system, possibly resulting in installed equipment not able to meeting the aircraft system TSE	Suggest changing the reference, and indicating that this is an installed equipment and system performance requirement.	Not Accepted. Taken as a whole, the guidance is referring to the complete suite of equipment providing baro-VNAV capability with explicit details of which error sources apply to which operation. The general guidance is applicable to all projects.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			requirement.		
23.	Nakamura	S 11-2g(7)	This states that an alert is required. Both the MASPS and MOPS require an indication, which allows for visual information or cues.	Suggest changing “a means to alert” to “an indication to”	Partially Accepted. Reading the rest of the paragraph, the second sentence states: “This indicator should be...” For additional clarity, the second sentence changed “indicator” to “indication.”
24.	Nakamura	S 12-12b	The requirement for the navigation system to use the State location for the data used in the database is not a requirement for the system. The navigation system must use what’s in the database for a location, waypoint, fix, etc. It is the navigation database supplier that must ensure that the State data is what is contained in the database.	Suggest orienting the change that either the manufacturer ensures its database and database supplier are compliant with source data usage from a data quality requirement standpoint or that the database supplier provide assurances of meeting this.	Not Accepted. The guidance cannot be parsed into separate paragraphs or sentences and selectively interpreted. The entire section must be read as a whole to understand the intent behind waypoints based on “collocated” VOR/DME. The general guidance is applicable to all manufacturers and projects.
25.	Nakamura	S 19-8	During development of the updates for DO-236 and 283, there was extensive regulatory discussion about the responsibility of manufacturers and	See comment	Not Accepted. This guidance remains valid and has been tweaked over many iterations to be as broadly

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			OEMs to document their data quality requirements for the contents of their navigation database. If this is expected, this point and requirement should be made clearer here.		applicable as possible from any perspective.
26.	Nakamura	A2-5d(1)	Reviews have taken place in the PARC with regard to the need for the 50 second requirement, given that it is also mitigated by the bank angle allowed and the means of continuous guidance. Shouldn't this be removed now or a least relaxed?	See comment.	Not Accepted. PARC reviews and recommendations are not actionable until a coordinated decision is made by the FAA.
27.	AIRBUS	General comment	Almost everywhere in the document, DO-236 has been removed and replaced by DO-283B. Could FAA explain the rationale of the change?		Accepted. Chapter 7 includes a discussion on the relationship between DO-236C and DO-283B. All references reviewed and corrected consistent with the intent. That is, specific RNP equipment references are only to DO-283B while other references are to both DO-283B and -236C chg 1.
28.	AIRBUS	Section 6-4.d Page 42	When the aircraft's navigation system generates a DME/DME position, AC 20-138 requires the navigation system to use available and valid DME facility	The requirement could be completed with: "DME facility reasonableness checks are an acceptable means to protect the robustness of DME selection	Partially Accepted. The paragraph must be read as a whole and not parsed. The paragraph does not limit

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			<p>anywhere within a specified region around the facility. The AC defines this region as greater than or equal to 3 NM from the facility, less than 40 degrees (40°) above the horizon and based on ARINC 424 figure of merit (FOM) when available.</p> <p>The navigation system may use a DME facility when outside the facility's published service volume and outside the region defined in AC 20-138. Specifically, the navigation system may select and use a DME facility when the aircraft is as close as 1 NM (not 3 NM) from the DME facility. Some navigation system may also select and use a DME facility with a ARINC 424 FOM of 3 out to a range of 250 NM from the facility (not 160 NM as defined in the AC). In that case DME facility reasonableness checks must protect the robustness of DME selection outside the published service volume and FOM limitations, while ensuring no misleading information occurs when using DME/DME positioning.</p>	<p>outside the published service volume and FOM limitations, while ensuring no misleading information occurs when using DME/DME positioning.”</p>	<p>which DME’s can be used for RNAV capability by clearly stating any DME facility may be used. The paragraph goes on to describe the <u>minimum</u> capability needed (see the following).</p> <p><i>“The RNAV system may use any receivable DME facility (listed in the A/FD) regardless of its location. When needed to generate a DME/DME position, as a minimum, the RNAV system must use an available and valid low altitude and/or high altitude DME anywhere within the following region around the DME facility:[emphasis added].”</i></p> <p>However, a new note 3 was added after the FOM table with the suggested change.</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
29.	AIRBUS	Section 16-2.1.a. Page 129 <i>Non-numeric cross-track deviation must be continuously displayed in all navigation modes.</i>	The Navigation Display, which is located in the Primary Field of View, can be considered as an alternative means of compliance for this requirement. ND displays deviation of aircraft to the computed path. Its scaling is manually set by the pilot. Different ranges are available for pilot selection (via EFIS Control Panel), from 10 to 640 NM and the Navigation Display is available in all navigation modes and all phases of flight. In addition to Navigation Display, lateral non numerical deviations are also displayed on Primary Flight Display in approach phase, through lateral deviation scale.	The requirement could be completed with: “Using numeric cross-track information next to the aircraft symbol on the navigation display provides equivalent function and FTE monitoring capability.” Or: “... shall present to the crew in the primary field of view mean(s) to display information of error with respect to the flight path.”	Not Accepted. Any unique deviation display implementation must be evaluated as a whole at the aircraft level during the airworthiness approval to determine whether or not equivalent functionality and level of safety is achieved.
30.	AIRBUS	Section 8-3-g.(3).(c) Page 60 <i>The lateral deviation display must have a full-scale deflection suitable for the current phase of flight and must be based on the TSE requirement. Scaling of ± 1 NM for</i>	This section should cover the use of angular deviations as for vertical deviations (Section 11-2-e.(4)).		Not Accepted. This section is for RNP APCH to LNAV minima consistent with the PBN Manual which does not include vertical guidance. Applicants applying baro-VNAV or SBAS vertical guidance need to use the appropriate guidance sections in the AC and

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
		<i>the initial, intermediate, and missed approach segments and ±0.3 NM for the final segment is acceptable. It is also acceptable for the scaling to be more conservative than the TSE; for example, ±0.3 NM for the initial, intermediate, and missed approach segments.</i>			requirements documents (i.e, RTCA/DO-283B or RTCA/DO-229D) for that capability.
31.	AIRBUS	Section 11-2.e.(4) Page 90 <i>The deviation scaling supports the FTE monitoring and bounding (75 ft deviation below path).</i>	Excess dev feature (devs flashing at 75ft) shall not be precluded as a means of compliance.		Not Accepted. Nothing in the guidance prescribes a particular solution or prevents a solution for FTE monitoring and bounding.
32.	AIRBUS	Section A2-5.a Page A2-17 <i>No single-point-of-failure can cause the</i>	The RNP architecture fitted with one only FCU may be acceptable provided a probability less than 1E-7 / procedure is demonstrated for the failure conditions leading to the loss of the RNP 0.1		Not Accepted. The guidance provides a “typical” configuration but cannot anticipate every possible

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
		<i>loss of guidance compliant with the RNP value associated with the approach. Typically, the aircraft must have at least the following equipment: dual GNSS sensors, AIRBUS dual FMSs, dual air data systems, dual autopilots, and a single inertial reference unit (IRU).</i>	capability.		combination/permutation that may be implemented. If the applicant can demonstrate meeting the failure condition with an architecture containing one FCU, nothing in the guidance prevents that architecture.
33.	AIRBUS	Section A-3-5.b.(5) Page A3-7 <i>The deviation guidance cues must be scaled to the RNP value.</i>	Some design solutions are based on several studies and are validated by all RNP AR certifications.	There is no added value to a “continuous” display of lateral deviations on PFD, including in the operational context of “advanced RNP / Scalability”, i.e. with RNP between 1 and 0.3NM during initial / intermediate approach.	Not Accepted. The guidance is for non-RNP AR certifications. Aircraft with RNP AR certification may be able to show compliance based upon that certification. Section A3-5 does not contain guidance discussing “continuous display of lateral deviations on the PFD.” Section A3-5.b(5) states the deviation guidance cues must be scaled to the RNP value.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
					This statement is entirely correct for a scalable RNP capability and is consistent with the PBN Manual.
34.	USAF	5-2.3.d, A9-2	SAPT is not defined anywhere in the document. It should be defined in the first instance and in the acronym list.	5-2.3.d The FAA has transitioned to Service Availability Prediction Tool (SAPT) for RAIM ... A9-2 SAPT Service Availability Prediction Tool	Accepted.
35.	USAF	10-3.1.g.13.a Pg 83	There appears to be a discrepancy in the resolution of entry between (TGL-10 Section 1/ Part 3, Table 1 Para 7.2 Page 10-11, PRN Para 5.4 and Para 1.3.3.7.2 and AC 20-138D Change 2 Para 10-3.1.g) and (DO-283B Para 2.2.1.2.7.2 and DO-236C Para 3.7.2.2.4.1). The first group specified increments of 1NM and the second requires increments of 0.1NM	Add clarification to AC	Accepted. Added clarification notes to 10-3.1.g(13) and A3-3.a explaining that RTCA/DO-236C and RTCA/DO-283B require 0.1 nm increments to support both terminal and enroute parallel offsets while the previous revisions only supported enroute/oceanic parallel offset operations. Using 0.1 nm offsets for RNP 4.0 operations is acceptable.
36.	USAF	A9-2	FRT is not listed in the acronym list.	FRT Fixed Radius Transition	Accepted.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
37.	Boeing	Pg 44, Para 6-4.f Note 2	Note 2: When using a minimum of two DME facilities satisfying the criteria above, the 95% position estimation error must be better than or equal to the following equation:	The equation at the top of page 44 is unreadable, we suggest reprinting the equation.	Accepted. This is a Microsoft Word to PDF conversion problem. Re-accomplished the equations in a newer version of Word.
38.	Boeing	Pg 86, Para 11-1.c	The existing language of “not be too burdensome” could be considered vague and open to interpretation. We regard crew workload to be an operational consideration rather than an airworthiness consideration.	We recommend removing a portion of the text as follows: Procedures for manual altitude corrections must be established for systems that do not provide automatic temperature compensation. The pilot workload of manually applying altitude corrections for all segments in the approach procedure (including the missed approach holding waypoint) must not be too burdensome.	Partially Accepted. Pilot workload has always been an airworthiness consideration. However, the last sentence was changed as follows to make this clearer. <i>A pilot workload evaluation must be performed for all segments in the approach, including the missed approach holding waypoint.</i>
39.	Boeing	Pg 97, Para 12-8C	The last sentence contains a grammatical error.	We suggest replacing “does not creating” with “does not create” for grammatical correctness. The airworthiness applicant must ensure the displayed RNAV (GPS) approach is in the primary field of view, in the proper sequence,	Accepted.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				unambiguous, and does not create detrimental clutter.	
40.	Boeing	Pg 108, Para 14-4.b(2)	The existing language of “not be too burdensome” could be considered vague and open to interpretation.	Suggest deleting 14-4.b(2)	<p>Partially Accepted. Pilot workload has always been an airworthiness consideration. However, the sentence was changed as follows to make this clearer.</p> <p>b. If the navigation equipment is not synchronized, then the following issues should be evaluated:</p> <p>(2) The pilot workload associated with manually updating both equipment sets to maintain consistency <i>between the equipment sets.</i></p>
41.	Boeing	Pg A2-3, Para A2-2.c	The equation has a duplicate square root.	We suggest reprinting the equation for clarity.	Accepted. This is a Microsoft Word to PDF conversion problem. Re-accomplished the equation in a newer Word version that seems to convert correctly to

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
					PDF.
42.	Boeing	Pg A2-5, Para A2-3.a(3)	The use of the term “independent” could be misunderstood. The proposed text explicitly states the intent of the requirement. The note also provides a reference to the TAWS TSO section that covers the source selection requirements.	<p>We recommend revising the text as follows:</p> <p>The TAWS must use a primary position solution must be sourced directly from a GNSS or a tightly-coupled GNSS/inertial system. that is independent of the position solution generated by the RNP equipment (e.g., the FMS). A TAWS GNSS position solution is considered independent if it is obtained directly from a GNSS sensor without any reference to or interchange with the RNP equipment’s position output.</p> <p>Note: There is no The intent of this requirement is to allow the TAWS function to continue operation in the event that the RNP equipment is lost or erroneous. It is</p>	<p>Partially accepted. The text was changed as follows:</p> <p><i>The position solution for the TAWS must be sourced directly from a GNSS sensor or a tightly-coupled GNSS/inertial system without any reference to or interchange with the RNP equipment’s (e.g., FMS) position solution output.</i></p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				acceptable for the TAWS to use the RNP equipment position solution as an alternate source in the event that GNSS is lost. Additional information can be found in TSO-151C Appendix 1, Section 5. to exclude a Kalman filtered position solution taken directly from a tightly coupled GNSS/inertial sensor	
43.	Bell Helicopter	<p>Section: 15-7.8 GPS/SBAS Glidepath Low Deviation Alerting Function Page 121</p> <p>Section: 15-9.13 GPS/SBAS Glidepath Low Deviation Alerting Function</p> <p>Section: 18-6. Glidepath Low Deviation Alerting</p>	Bell Helicopter believes that the deviation alerting functions prescribed by the subject paragraphs should be deleted for the following reasons.	The words “highly recommended” and “strongly recommends” in the context of AC material become defacto requirements especially on any new or significantly modified product. This is especially true in the ODA certification environment where deviation from the AC material is not within the ODA purview. It therefore becomes especially important for the FAA to limit itself to the minimum	Not Accepted. LPV and GLS both provide Category I approach capability like an ILS. Therefore, the safety benefit of a low deviation alert for LPV and GLS is identical to the low glideslope alert safety benefit for ILS. This AC is not regulatory and the guidance provides applicants wide latitude to implement the monitor function for LPV and GLS; including thru TAWS/HTAWS/EGPWS if

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
		<p>Function Page 137</p> <p>Appendix A2-1 “RNP AR operations” Item d. “deviation alerting function for excess lateral or vertical deviation”</p>		<p>acceptable means-of-compliance when generating or revising AC material. These “highly recommended” and “strongly recommended” features are prescriptive and editorial, and go beyond what is needed to meet the intent of the rule. They should not be included.</p> <ul style="list-style-type: none"> • Most systems approved today do not provide such automated monitoring and alerting for LPV approaches. The deviations are the primary flight indications used during the approach. The final approach is a short and focused flight task. Flight crew should not require additional alerting for approach indications which are the primary focus of the flight phase. Complacency in monitoring the essential approach status (mostly due to improper overreliance in 	<p>the applicant so desires.</p> <p>An applicant can choose to not follow the guidance in an AC; they simply need to show/document how their application provides regulatory compliance.</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				<p>automation) has led to certain incidents. Providing additional automation to provide additional alerts enables continued complacency and will produce collateral negative effects on what is currently effective alerting .</p> <ul style="list-style-type: none"> • It is believed the addition of these deviation alert features will promote negative learning due to the fact that it cannot be implemented consistently and will have to be enabled/disabled depending on what other equipment is installed so as not to conflict with other alerting. Specifically: <ul style="list-style-type: none"> o The optional mode 5 supported by many (but not all) TAWS/HTAWS/EGPWS systems provides the most apparent conflict with the low deviation alert. <p>TAWS/HTAWS/EGPWS has</p>	

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				<p>the advantage that it provides an independent system to alert, and is therefore superior to an alert based solely on the value of the deviation indication. So this would lead to suppressing the deviation alert in configurations where TAWS/EGPWS mode 5 alerting is provided. But not all helicopter instrument approaches (i.e. EMS private approaches) are supported in the TAWS/EGPWS data base. Therefore the feature will be inconsistent. HTAWS is not required for all rotorcraft and Mode 5 is not a required feature, yet given this change, it will either conflict, or if used in lieu of the alert required by this change, it will become required configuration and operation (affecting MMELs as well).</p> <ul style="list-style-type: none"> o Unlike target baro altitude deviation alerts, navigation deviation alerts 	

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				<p>have to account for momentary, intermittent, or complete loss of navigation signal. Most systems coast through intermittent losses to a degree and then provide flags if they persist. If coupled, the autopilot may decouple after an allowed period and then provide visual and aural indication decoupling occurs. But for an uncoupled approach, typically flags are the only indication presented. Implementing aural and visual the alert for excessive deviation will provide alerting greater than that normally provided for loss of signal. Given the negative training associated with dependency on prominent visual and aural alerts provided with excessive deviation, loss of deviation signal may then go unheeded. Alternately, if loss is included in the new alerting scheme,</p>	

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				<p>momentary losses will likely create nuisance alerts and negative learning. Conflict with autopilot decouple alerts will have to be considered in order to avoid multiple alerts.</p> <ul style="list-style-type: none"> o As noted by the FAA in A2-1(d), these alerts will likely conflict with other aural and visual alerts which exist on the aircraft. The FAA note is that the applicant must sort these out to assure the deviation alerts do “not conflict with existing alerts or cause flight crew human factors issues... supersede and prevent initiation of other mandatory alerting functions.” What is not recognized is the variability of allowed configuration in most general aviation aircraft – especially helicopters – when it comes to the systems that will conflict with these deviation alerts. <p>TAWS/HTAWS/EGPWS are</p> 	

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				<p>kits (often multiple supported models with varying features), radar altimeters are kits (with multiple options for aural alerts) and baro target / MDA alerting . Given the need to provide the new alert required by this proposed change yet resolve any conflict with existing aural alerts, it forces the applicant to address and approve many more configurations, or severely limit the approved configuration. This will lead to a need for separate approvals for each combination with unrelated kits. This becomes excessively burdensome.</p> <ul style="list-style-type: none"> o Assuming a lateral deviation alerting function implemented as a general feature in a flight display, then for missed approach procedures not executed using the FMS, nuisance superfluous alerts are almost 	

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				assured. This will lead to negative learning.	
44.	CMC	Section 2 (Principal changes)	Some (modified) page references are inaccurate.	Page 31 should be mentioned in lieu of page 30. Pages 32, 33, 49, 51, 52, 53, 58, 62, 69, 74, 76, 78, 85, 93, 95, 103, 117, 121, 124, 127, 132, 133, 137, 140, 142, A2-23, A9-2, A10-5 should be mentioned. <i>The above list is not complete...</i>	Accepted. The page change sheet will be updated to accurately reflect which pages have changed.
45.	CMC	Section 3.4b 2) Page 16	Class B includes some Advanced RNP functions (RF legs, Parallel Offsets and Scalable RNP).	It should be clarified that Class B must support RF legs, Parallel Offsets and Scalable RNP, but not the remainder of the Advanced RNP functions.	Partially Accepted. The point of the paragraph is to distinguish between Class A and B equipment. While some advanced RNP functions are required for Class B that does not mean the equipment will have Advanced RNP recognition. The text was changed as follows to clarify: <i>Class B applicants that wish to include baro-VNAV</i>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
					<i>capability or receive advanced RNP recognition must comply with the appropriate RTCA/DO-283B requirements. See RTCA/DO-283B, Table 2-13 for a complete list of the required Class A and Class B functions. The baro-VNAV guidance in this AC must be used when including baro-VNAV for approach capability. See appendix 3 for guidance on advanced RNP recognition.</i>
46.	CMC	8-3.e. Page 58	Reference to DO-283B, para. 2.2.1.2.9.1 (Fly-by Transitions) seems unrelated to the added text about final approach Flight Path Angle, although still related to Path Definition.	We suggest breaking those two different topics into two sub-paragraphs.	Partially Accepted. The comment is overcome by changes related to a previous comment about including references to RTCA/DO-236C for RNP performance at the aircraft level. In making this change, the RTCA/DO-283B paragraph reference was eliminated.
47.	CMC	12-13, P.103	Wrong DO-283B paragraph quoted for Runway Position Monitoring	Replace 2.2.1.4.15 with 2.2.1.4.14	Accepted.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
48.	CMC	A3-1.b(1) Page A3-1	<p>RNP Holding as defined in DO-283B is optional for a Class A and B, therefore a Class A does not support all above A-RNP function.</p> <p>DO-283B defines RNP holds, not RNAV holds. Hence the comment in section A.3-1 (f) is inappropriate. Section A3-4 mentions an alerting function for RNAV holds. This also seems inappropriate.</p> <p>ICAO PBN RNAV holding definition simply equates to ARINC 424 HM legs. There is no mention of alerting and entry procedure similar to DO-283B RNP holds.</p>	Clarify that RNP Holding is also optional for Class A.	<p>Partially Accepted. Paragraph A3-1.b(1) was changed as follows:</p> <p><i>TSO-C115d implements RTCA/DO-283B which provides acceptable methods of implementing advanced RNP functions (except for TOAC) in RNP equipment consistent with the aircraft performance requirements found in RTCA/DO-236C, Chg 1.</i></p> <p>A3-1.f is appropriate since both RTCA/DO-236C and RTCA/DO-283B require implementing HM legs which the comment states are for RNAV holding.</p>
49.	Rockwell Collins	All references to RTCA / DO-283B	Whether "Equipment" or "Aircraft" must comply with either "DO-236C" or "DO-283B" is inconsistent through this AC. See for example 8-3a(1) where aircraft must comply with the MOPS (DO-283B).	Since the airworthiness approval is applicable at aircraft level, we recommend that throughout this AC it always specifies "Aircraft" to comply with the MASP	Accepted. Chapter 7 includes a discussion on the relationship between DO-236C and DO-283B. All references reviewed and corrected consistent with the

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			See also 8-3e and elsewhere.	(RTCA DO-236C). The only exception would be for items that are indeed equipment (not aircraft) unique functions that are detailed only in the MOPS (DO-283B), not in the MASP (DO-236C).	intent. That is, specific RNP equipment references are only to DO-283B while other references are to both DO-283B and -236C chg 1.
50.	Rockwell Collins	4-2c(1) p 21 (pdf 32) 4-2c(2) Note 2 (pdf 32) 12-8c p. 97 (pdf 108) 12-8d Note 1: p.98 (pdf 109) 12-8d Note 2: p.98 (pdf 109) See also 11-2b p.87 (pdf 98)	4-2c(1) contradicts 4-2c(2)Note 2 and 12-8d Notes 1 and 2 regarding whether baro-LNAV/VNAV and step-downs. LNAV/VNAV is stated to NOT need step-downs, but elsewhere it's stated that Baro-VNAV does not clear step-downs. Which is right? Baro-LNAV/VNAV operation is indeed approved per AC 90-105 and this AC. The explicit contradiction is that 12-8c states, "a final approach segment step-down fix does not apply to the LNAV/VNAV or LPV minima" and that LNAV/VNAV do not need step-downs in final, contrary to these 3 items: <ul style="list-style-type: none"> • 4-2d(2) Note 2 states, "Baro-VNAV is subject to performance limitations 	We recommend that you remove the contradictions in the guidance for LNAV/VNAV for the case that baro-VNAV is approved for operating to the LNAV/VNAV. We offer these alternatives: 1) Either provide separate guidance for step-down on baro-VNAV/VNAV versus SBAS-LNAV/VNAV (that baro-LNAV/VNAV requires step-downs but SBAS-VNAV/VNAV does not), or	Accepted. The last sentence in paragraph 4-2.c(1) was deleted which makes all the guidance consistent.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			<p>that could potentially cause advisory vertical path guidance to fall below the step-down fixes on LNAV approaches."</p> <ul style="list-style-type: none"> • 4-2c(1) states "..due to potential anomalies, the flight crew/pilots must use the primary barometric altimeter to confirm compliance with published altitude restrictions" • 4-2c(2) states, "..the flight crew must use the primary barometric altimeter as the primary reference for compliance with all altitude restrictions associated with the instrument approach procedure; including all associated step-down fixes. 	<p>2) Remove the contradictory statements for Baro-LNAV/VNAV so the guidance is identical for baro-LNAV/VNAV and SBAS-LNAV/VNAV.</p>	
51.	Rockwell Collins	4-2d(1)(b) p. 22 (pdf 33)	<p>Although dating from the earlier revision, the 4-2d(b) recommendation that "'advisory" vertical guidance be unambiguous and easily distinguishable from "approved" vertical guidance is unclear because this AC does not yet unambiguously distinguish between "approved" and "advisory". Is the intent to distinguish baro-VNAV from SBAS-</p>	<p>There is no suggested recommendation since the intent of the requirement is not understood. The approach mode annunciations (RNP APCH, RNP AR APCH, LPV APCH, etc.) already distinguish the different operations without any need</p>	<p>Not Accepted. The one location where inconsistent guidance regarding step-down fixes has been corrected per the comment above and the recommendation to make "advisory" vertical guidance distinguishable from</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			VNAV, or distinguish ILS-look alike from linear vertical deviation, or is something else intended?	for additional requirements. We request that you consider providing clarification.	<p>“approved” vertical guidance (no matter what source provides it) still applies.</p> <p>The comment that RNP APCH, RNP AR APCH, and LPV APCH provide a distinction between advisory and approved vertical guidance is incorrect since RNP APCH and RNP AR APCH are approach types that can have lines of minima with or without approved vertical guidance. LPV APCH is a line of minima with approved vertical guidance but does not address the LP line of minima which does not have approved vertical guidance. Chapter 4 needs to be read as a whole (including the supporting information in section 12-8) and not parsed into discrete pieces.</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
52.	Rockwell Collins	4-2c(1).page 22 (pdf 33) 12-8c.(3) p.97 (pdf 108) 12-8d Note 1: p.98 (pdf 109) 12-8d Note 2: p.98 (pdf 109)	The guidance in 12-8 (that Approved Vertical Guidance should not show step down fixes in the final segment) seems to contradict 4c(1) which states that for baro-LNAV/VNAV the crew should use primary barometric altimeter to confirm compliance with published altitude restrictions. Instead, in the case of baro-LNAV/VNAV, the optimal implementation should be to include step-down fixes in the final segment to aid baro-VNAV path compliance with published altitude restrictions.	We recommend that you add that, “For RNP APCH operations with baro-VNAV to the LNAV/VNAV minimum, the optimum solution is to show named step-down fixes in the final approach segment to better assure the barometric path remains consistent with obstacle clearance surfaces both when operating within charted temperature limits and when applying temperature compensation.” Alternatively, please provide text that clears this apparent contradiction.	Not Accepted. Per the previous comment, the inconsistent sentence in paragraph 4-2.c(1) regarding step-down fixes has been deleted. All the remaining guidance remains consistent and applicable.
53.	Rockwell Collins	8-3.e p. 58 (pdf 69)	The procedure-defined barometric flight path angle does not always clear the barometric procedure altitudes. Despite changes in procedure design, there is still sometimes a small mismatch such that the descent angle must be raised, typically not more than 0.1degrees, to clear the Final Approach Fix. This	Please consider adding the following note: “In the case that the barometric descent angle passes below a barometric procedure altitude, the decent angle may be increased (raised) to be consistent with the barometric	Not Accepted. The comment points out the flaw with baro-VNAV systems and why baro-VNAV systems have limitations for pilots to use the primary barometric altimeter for compliance with ATC

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			sometimes happens even on RNP AR approaches.	procedure altitude."	altitude restrictions; including approach procedure restrictions. This is particularly true for baro-VNAV systems without temperature compensation.
54.	Rockwell Collins	8-3j p. 62 (pdf 73) 9-3i p. 69 (pdf 80) 9-5.3 p. 74 (pdf 85) 19-8 p. 140 (pdf 151) Appendix 2 A2-7d p. A2-23 (pdf 192)	Regarding the new requirement for DO-200B, cancellation policy for DO-200A should be consistent between AC 20-138D and AC 20-153B. Further, as written, this requires updating to DO-200B for any new installation of existing equipment, even if the equipment and associated DQR have not changed. This is contrary to the understanding in SC-217 that DO-200B would not be required for 3-5 more years.	Please consider the following alternatives: Preferred Recommendation: Replace DO-200B and AC 20-153B with DO-200A and AC 20-153A, deferring the update to a future revision to AC 20-138E. Alternative Recommendation: Add a cancellation policy for DO-200A that is consistent with AC 20-153B. Especially since this is a change to AC 20-138D (not a new revision to AC 20-138E), the cancellation policy should include provision that new airworthiness approvals of existing (or minor updates to existing) equipment	Partially Accepted. Some DO-200B citations are simply as reference, such as the one in paragraph 5-3.3.b, while some citations are for implementation. In those cases where the citation is for an implementation, DO-200B will be replaced by AC 20-153(latest revision). Revision 'B' should be published by the time AC 20-138D Chg 2 is published.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				previously approved in conjunction with RTCA DO-200A/AC20-153A should continue to be possible still based on RTCA DO-200A/AC20-153A. A new airworthiness approval of existing equipment should not automatically invoke the new requirements of RTCA DO-200B.	
55.	Rockwell Collins	11-2.b(2) p. 87 (pdf 98)	The note contradicts an earlier statement that says Table 6 is for en route, terminal, and approach IFR operations (see 11-2.b)	<p>Please consider deleting the note:</p> <p>“Note: Table 6 applies to en route and terminal operations specifying vertical performance requirements that rely on baro-VNAV performance.”</p> <p>Alternatively, please add clarifying text that resolves the apparent contradiction.</p>	Accepted. The note was deleted.
56.	Rockwell Collins	12-13 p. 87 (pdf 98)	The reference to the DO-283B section 2.2.1.4.15 for Runway Position Monitoring is incorrect; it should be	Please change reference to the DO-283B section from	Accepted.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			2.2.1.4.14.	"2.2.1.4.15" to "2.2.1.4.14".	
57.	Rockwell Collins	12-2a Table 8 p. 93 (pdf 104)	Update Table 8 to include other operations addressed in this AC, RNP AR and Approved Vertical Navigation. Table 8 does not clearly distinguish between lateral and vertical.	We recommend that In Table 8: 1) Add column for RNP AR 2) Add column for Approved Vertical Guidance 3) Clarify which columns are only lateral or both lateral and vertical.	Not Accepted. RNP AR has its own appendix for compliance. The hazard classifications in table 8 are for lateral and approved vertical guidance, with column 1 for advisory vertical guidance. The note contains a failure condition exception for baro-VNAV.
58.	Rockwell Collins	12-2.a.Table 8 p. 93 (pdf 104)	As we understand, “GNSS Precision Approach (Cat I)” is meant to mean a GBAS-Augmented / GLS Approach.	Please update the heading of the last column of Table 8 to say: “GBAS GNSS Precision Approach (Cat. I)”. <u>Rationale:</u> This will provide better differentiation between the last two columns of Table 8, helping to clarify that one is referring to an LPV approach and the other is referring to a GLS approach.	Accepted. Changed column to “GLS Approach.”

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
59.	Rockwell Collins	<p>All references to “LNAV/VNAV” including:</p> <ul style="list-style-type: none"> • 12-2 Table 8 p. 93 (pdf 104) • Chapter 4 pp 21-25 (pdf 32-36) • 12-8c.(3) p.97 (pdf 108) • 12-8d Note 1: p.98 (pdf 109) • 12-8d Note 2: p.98 (pdf 109) • Appendix 9d p. A9-1 (pdf 249) • All other uses of “LNAV/VNAV” throughout Draft AC 20-138D Change 2 	<p>Throughout this AC and especially in section 12-8, it is not always clear whether “LNAV/VNAV” refers to:</p> <ul style="list-style-type: none"> • Only the LNAV/VNAV Level of Service with SBAS-VNAV in accordance with TSO-C146() • Also or instead refers to baro-VNAV when authorized to operate to the LNAV/VNAV minimum during RNP APCH in accordance with AC 90-105 and this AC. 	<p>We recommend that throughout the AC (not only this section), that you consider replacing “LNAV/VNAV” consistently with</p> <ul style="list-style-type: none"> • “SBAS LNAV/VNAV Level of Service” when only SBAS-VNAV in accordance with TSO-C146() is intended; • “Baro LNAV/NAV” when Baro-VNAV is used to operate to the LNAV/VNAV minimum; • “LNAV/VNAV minimum” when the minimum itself is intended and the means of vertical guidance (baro-versus SBAS) is irrelevant. <p>Also, we recommend a statement up front or in Appendix 9d explaining the nomenclature conventions.</p>	<p>Not Accepted. LNAV/VNAV is a line of minima where the vertical component can be provided by either baro-VNAV or SBAS. Baro-VNAV is the only sensor that has prevalent error sources which can adversely affect the generated path. The AC already distinguishes sensor-specific guidance where needed.</p>
60.	Rockwell Collins	<p>All references to “LNAV/VNAV” including</p>	<p>It is our assumption is that regulatory guidance for SBAS-LNAV/VNAV</p>	<p>If the assumption is valid, no change is recommended.</p>	<p>Assumption is correct, no change is needed.</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
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	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
		<ul style="list-style-type: none"> • 12-2 Table 8 p. 93 (pdf 104) • Chapter 4 pp 21-25 (pdf 32-36) • 12-8c.(3) p.97 (pdf 108) • 12-8d Note 1: p.98 (pdf 109) • 12-8d Note 2: p.98 (pdf 109) • Appendix 9d p. A9-1 (pdf 249) • All other uses of “LNAV/VNAV” throughout Draft AC 20-138D Change 2 	<p>applies equally to both:</p> <ul style="list-style-type: none"> • SBAS LNAV/VNAV Level of service based on FAS Block • SBAS Stand-alone LNAV/VNAV Level of service when there is not a FAS Block, in accordance with RTCA / DO-229D. (See paragraph 2.2.4.5.1 [Database Requirements] content.) 	<p>However, if the assumption is not valid, we recommend that you add any guidance that is unique to SBAS Stand-alone LNAV/VNAV Level of Service.</p>	
61.	Rockwell Collins	12-8c p. 97 (pdf 108)	<p>We question whether the text Is correct that "a final approach segment step-down fix does not apply to the LNAV/VNAV" minimum in the case of barometric VNAV operations. This question is raised because:</p> <ul style="list-style-type: none"> • Baro-VNAV accuracies are different than those with SBAS, both SBAS Stand-alone LNAV/VNAV or FAS-Block LNAV/VNAV.) Especially 	<p>If the text is correct, then we recommend that you replace the existing statement with the following:</p> <p>"However, a final approach segment named step-down fix does not apply to the LPV minimum. Also, a final approach segment step-down fix does not apply to the</p>	<p>Not Accepted. Baro-VNAV systems have a general limitation for pilots to use the primary barometric altimeter for compliance with all altitude restrictions.</p> <p>However, the particular issue raised has been discussed in various forums. The procedure designers state</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
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	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			<p>under non-standard temperature conditions;</p> <ul style="list-style-type: none"> We have noted contradictory draft regulatory guidance for baro-LNAV/VNAV, per separate comments herein to this AC. <p>It seems reasonable that a named step-down fix would need to be temperature compensated to ensure that the entire final segment is consistent with the Vertical Path Angle in the final segment.</p>	<p>LNAV/VNAV minimum, regardless whether the operation is performed using barometric VNAV, using the LNAV/VNAV Level of Service based on a FAS Block, or using the Stand-alone LNAV/VNAV Level of Service (when no FAS Block is available, as defined in RTCA / DO-229D)."</p>	<p>that step-down fixes on final approach segments have adequate margin for baro-VNAV and there is no issue when using SBAS-based VNAV. There was strenuous objection from the aviation community to stating step-down fixes on LNAV/VNAV applied only when using baro-VNAV due to the potential pilot confusion on whether the guidance is provided by baro or SBAS VNAV. There was also an objection to penalizing SBAS-based VNAV with a restriction that only applies to baro-VNAV.</p>
62.	Rockwell Collins	<p>12-8c.(3) p.97 (pdf 108) 12-8d Note 1: p.98 (pdf 109) 12-8d Note 2: p.98 (pdf 109) 4-1 p. 21 (pdf 32) 4-2c(1) p 21 (pdf 32)</p>	<p>As related to 12-8d Note 1 and Note 2 on step-downs, it's unclear exactly which Barometric VNAV operations constitute "Approved Vertical Guidance". Contributing to the confusion are:</p> <ul style="list-style-type: none"> Section 4-1 states, "Only ...LNAV/VNAV and LPV approach procedures are approved for operational 	<p>We recommend to following:</p> <p>1) Update Section 4-1 Advisory Vertical Guidance to state that RNP AR APCH is also approved for operational credit.</p>	<p>Partially Accepted. Revised note 1 to remove the phrase "...including baro-VNAV guidance" from the sentence. Chapter 4 was revised per a previous comment and is consistent with the advisory vertical</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
		Appendix 9d p. A9-1 (pdf 249) Table 8 page 93 (pdf 104)	<p>credit” which seemingly excludes RNP AR APCH to the RNP minimum;</p> <ul style="list-style-type: none"> • Section 4-1 also isn’t clear whether “LNAV/VNAV” is only SBAS-LNAV/VNAV or also Baro-LNAV/VNAV; • Appendix 9-1d "Approved Vertical Guidance" doesn't include RNP AR and isn’t clear whether “LNAV/VNAV” is only SBAS-LNAV/VNAV or also Baro-LNAV/VNAV; • Appendix 9-1a "Advisory Vertical Guidance" merely references chapter 4 and does not explain what is intended. 	<p>2) Since there is a section for “Advisory Vertical Guidance”, add a new section for “Approved Vertical Guidance”, and address step-downs within this new section for Approved Vertical Guidance (instead of in section 12-8).</p> <p>3) Define "Approved Vertical Guidance" to include all the following:</p> <ul style="list-style-type: none"> • LPV Level of Service; • SBAS LNAV/VNAV Level of Service with SBAS-VNAV (based either on FAS Block or else is Stand-alone LNAV/VNAV); • Baro-LNAV/VNAV for RNP APCH in accordance with AC 90-105; • RNP AR APCH to the RNP minimum; • RNP 0.3 for helicopter; • DA in lieu of MDA HBAT 	guidance discussion in chapter 12.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				99-08 and HBGA 99-12.	
63.	Rockwell Collins	12-8c (3) p. 97 (pdf 108) 12-8d Note 1: p.98 (pdf 109)	<p>We question why this AC states in 12-8c(3) "the optimum implementation is ...not showing final approach segment step-down fixes during LNAV/VNAV approach".</p> <p>This statement apparently contradicts 12-8d Note 1 which states, "The limitation must make it clear that it is unacceptable to follow VNAV path guidance below a step-down fix altitude restriction."</p>	We recommend that the suggested optimum baro-LNAV/VNAV implementation should include named step-down fixes and that the barometric path should be consistent with both the final approach step-down altitudes and final vertical path angle (whichever is higher) consistent with the existing baro-VNAV accuracy requirements in 11-2.b.	Not Accepted. The optimal implementation is to show step-down fixes for LNAV and LP line of minima but not LNAV/VNAV and LPV where step-down fixes don't apply. Per the previous comment note 1 was changed to eliminate potential confusion.
64.	Rockwell Collins	12-8c.(3) p.97 (pdf 108) versus 12-8d Note 1: p.98 (pdf 109) And 12-8d Note 2: p.98 (pdf 109) See also 11-2b p.87 (pdf 98)	<p>12-8 is a section on step-downs, but Notes 1 and 2 on page 98 create ambiguities about authorizing baro-VNAV as "approved vertical guidance" in general. For the LNAV/VNAV minimum in particular:</p> <p>1) Since it is for operational credit, do not operations in accordance with AC 90-105 (to the LNAV/VNAV minimum with baro-VNAV) constitute "Approved Vertical Guidance"?</p>	<p>We recommend the following:</p> <p>1) Since there is an "Advisory Vertical Guidance" section, add an "Approved Vertical Guidance" section. We suggest that this text be added to either 12-8c.(3) or to new section where "Approved Vertical</p>	Not Accepted. The potentially confusing guidance in 12-8.d note 1 has been changed.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			<p>2) Note 2 assumes that after 1989 Baro-VNAV was assessed as major, but this is not valid because:</p> <p style="padding-left: 20px;">2a. Often baro-VNAV is assessed as minor because the crew must still use primary altimetry to comply with procedure altitudes.</p> <p style="padding-left: 20px;">2b. AC 90-105 requires only the lateral be major, not the vertical.</p> <p>3) How to address baro-VNAV systems certified “after 1989” isn’t addressed as related to step-downs.</p> <p>4) Note 2 implies “major” for Baro-VNAV would be sufficient. However, would not the newest vertical Total System Error budget be another necessary condition for “approved [baro] VNAV” capability?</p>	<p>Guidance" is addressed:</p> <p>2) Change the suggested optimum implementation is as follows:</p> <ul style="list-style-type: none"> • “For TSO-C146() equipment, the suggested optimum implementation is showing named step-down fixes in the final approach segment for the LNAV and LP Levels of Service but not showing step-downs in the final approach segment for the LNAV/VNAV and LPV Levels of Service with SBAS-VNAV. • For RNP APCH operations with baro-VNAV to the LNAV/VNAV minimum, the optimum solution is to show step-down fixes in the final approach segment to better assure the barometric path remains consistent with obstacle 	

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				clearance surfaces both when operating within charted temperature limits and when applying temperature compensation. <ul style="list-style-type: none"> • For RNP 0.3 (helicopter) the optimum solution is to include step-downs. • For non-precision approach operations with baro-VNAV (with or without GNSS), the optimal implementation is to include named step-downs in the final approach segment. • For RNP AR APCH, “step-down fixes” do not apply.” 	
65.	Rockwell Collins	12-8d Note 2: p.98 (pdf 109)	Section 12-8d Note 2 implies that since 1989 baro-VNAV is major for vertical guidance; this is not correct. It is typically minor because the pilot must always use the primary barometric altimeter. This Note could be misinterpreted to mean that Baro-LNAV/VNAV needs to be major to be	Please delete Note 2. It is not correct and does not add useful guidance or information.	Not Accepted. The note is accurate because before that date baro-VNAV systems could be compliant with only a minor failure condition for misleading information and still be acceptable for approach operations.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			Approved Vertical Guidance in order to be used as allowed under AC 90-105, which is not the case.		
66.	Rockwell Collins	Appendix 2 A2-1.d p. A2-1 and A2-2(pdf 170-171)	For RNP AR, our assumption is that vertical guidance is "approved" after the FAF and "advisory" before the FAF. As such, vertical deviation alerting would be necessary only after the FAF. Also, the 75' (feet) limit is relevant after the FAF, but not before. Nuisance vertical alerts would be likely with the 75' threshold outside the final segment.	<p>We recommend the following:</p> <p>1) Update the definition of “Approved Vertical Navigation” to include RNP AR after the Final Approach Fix.</p> <p>2) Modify the RNP AR recommendation that excessive vertical deviation alert be provided after the FAF (where the vertical guidance is approved) and where the 75' deviation is relevant.</p>	Not Accepted. Paragraph A2-1.d is for low glideslope deviation alerting function similar to LNAV/VNAV, LPV, and GLS. The guidance clearly states it is for RNP AR approach operations which, by definition, are the final approach segment.
67.	Rockwell Collins	A2-6.b.(2) & (3) p. A2-18 (pdf 187)	RNP AR Missed Approach < 1.0 Safety Classification could be harmonized with EASA AMC 20-26 RNP AR guidance.	<p>We recommend the following actions:</p> <p>Change: In order to harmonize with the regulatory guidance provided in EASA AMC20-26, section 7.2.3.(2), please consider updating the</p>	Action noted. Will coordinate with EASA to request their AMC 20-26 guidance is harmonized with the guidance in appendix 2. However, the FAA cannot guarantee any changes to AMC 20-26 will occur.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
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	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				<p>safety requirement for loss on a RNP AR missed approach < 1.0 from hazardous (sever/major) to a Major failure condition. Also consider removing the requirement of hazardous (sever-major) for misleading lateral guidance.</p> <p>Conversely, please work with EASA to suggest they update the AMC 20-26 RNP AR guidance to match the FAA AC 20-138D RNP AR guidance.</p> <p><u>Rationale:</u> The reason for this request is to harmonize the safety classifications between the FAA AC 20-138D guidance and the EASA AMC 20-26 guidance.</p>	
68.	Rockwell Collins	A3-5.b.(1) p. A3-6 (pdf 201)	Regarding Manual RNP: Systems that can read the RNP value from the onboard navigation database should be given credit for meeting the	Please add a note after section A3-5.b.(1) that says: “A system that can read the RNP value from the onboard	Not Accepted. The rationale about harmonizing scalable RNP with the LNAV/VNAV and LPV requirements to

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			intent of Manual RNP Entry.	<p>navigation database meets the intent of the requirement for manual entry of the RNP value.”</p> <p><u>Rationale:</u> 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 an 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.</p> <p>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</p>	<p>prevent manual insertion of data is completely off-base. Scalable RNP is not intended for the final approach segment; it is only for enroute and terminal routes not the final approach segment. There is no conflict with the DO-229D requirements for LNAV/VNAV and LPV approaches.</p> <p>The RTCA/DO-283B MOPS implemented by TSO-C115d requires a capability to manually enter RNP values to have a scalable RNP function. Additionally, the guidance in A3-5.b is consistent with the PBN Manual.</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				provide the flight crew a means of changing the alert limit.”	
69.	Rockwell Collins	A3-5.b.(4) p. A3-7 (pdf 202)	Regarding the requirement to provide an alert prior to the upcoming waypoint: 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>We recommend the following:</p> <p>1) Please add a note after section A3-5.b.(4) that says: “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.</p> <p>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</p>	Not Accepted. Section A3-5.b is consistent with the PBN Manual for scalable RNP and supported by DO-283B implemented by TSO-C115d.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				<p>flight phases.</p> <p>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> <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><u>Rationale:</u> 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</p>	

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				<p>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.</p> <p>The required PRAIM for the approach provides additional protection for approach proceeds selected in the FMS flight plan.</p> <p>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>	
70.	Thales	General	It is understood that this AC is for the Airworthiness Approval of Positioning and Navigation Systems. However it seems to include requirements for other systems (e.g.: TAWS system), and OPS requirements.	It is suggested to update this AC to focus on positioning and navigation system and address other subjects in relevant respective AC. (AC 25-23/23-18 TAWS for §15-7.8, §15-9.13, § 16-6 and AC 90-101 for A-2.3)	Not Accepted. The only operational discussions in the AC are related to the positioning equipment supporting a given operation such as RNP 1. There is no guidance provided on how to obtain an operational approval. Other systems,

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
					<p>such as TAWS, are only discussed in the RNP AR section which is an aircraft-level certification and is part of the certification requirements.</p> <p>Paragraphs 15-7.8 , 15-9.13, and 16-6 are guidance recommendations for including a glidepath low-deviation alert function in the SBAS, GBAS, and baro-VNAV equipment to support LPV, GLS, and LNAV/VNAV operations. The guidance gives applicants wide latitude in developing the function which can be thru TAWS equipment or thru a different guidance deviation monitor.</p>
71.	Thales	Advisory Circular- Page between page control chart and Table of contents	The revision change number 1. It seems to be an error. However the introduction text (AC addresses GPS, RNAV, RNP and baro VNAV) need to be kept.	It is suggested to check if this page has to be labeled as change 2 or merged with first page as introduction.	Not Accepted. This page structure is not an error. The document must follow the required format and cannot be changed.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
72.	Thales	Advisory Circular- Page between page control chart and Table of contents	This page mentions the AC does not addresses new satellite constellation whereas new satellite constellation are addressed in Chapter 1 1-1.e page 1 and in appendix 8.	It is suggested to make consistent this page (1 st bullet and this statement) with Chapter 1 1.1.e and appendix 8	Not Accepted. That page describes what change 1 contained which is background reference. As noted in the purpose section on the first page: “Change 2 adds additional information...”
73.	Thales	TSO-C115(AR) section 3-4 Page 15	Title of TSOC-115d has changed	It is suggested to replace “ <i>Flight Management System (FMS) Using Multi-Sensor Inputs</i> ” by “ Required Navigation Performance (RNP) Equipment Using Multi- Sensor Inputs”	Accepted. Title changed in Appendix 10 also.
74.	Thales	Prediction Program. section 5-2.3 d and j Page 30 and Definitions and Acronyms Appendix 9 –A9-2.	SAPT acronym is missing (Service Availability Prediction Tool)	It is suggested to add the SAPT acronym in the note of section 5-2.3 (where SAPT first appears) and in appendix 9 A-9.2.	Accepted.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
		Page 254			
75.	Thales	Performance and Functional Criteria for RNP Systems section 8-3.e Page 58	Path definition: The text added is in contradiction with DO283-B: according to DO 283B, the definition of the final segment respects the final FPA except when the FPA is conflicting with the altitude constraint (AT) which must be met first before proceeding to FPA.	It is suggested to remove the following text “ Additionally, when constructing the descent path for the final approach segment of an RNP instrument approach procedure, the equipment must always use the procedure-defined flight path angle. Note: RNP instrument approach procedures may have a final approach fix with an ‘AT’ altitude constraint. The intent of the guidance in paragraph 8-3.e is to use the published flight path angle for descent path construction. This is to ensure geometric point-to-point between two ‘AT’ constraints is not used for the final approach segment.”	Not Accepted. TSO-C115d, appendix 1 modifies RTCA/DO-283B and contains an additional requirement for RNP equipment to use always use the published FPA for the final approach segment to prevent equipment from constructing a geometric point-to-point path if the FAF has an ‘AT’ constraint.
76.	Thales	Performance and Functional Criteria for RNP Systems §9-3.h (10)	The restriction to RNP1 for IF leg is too restrictive. It is also applicable to other RNP and Advanced RNP.	It is suggested to remove “(only for RNP1)”	Not Accepted. Section 9-3 only addresses RNP 2.0 and RNP 1.0 and the IF does not apply to RNP 2.0.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
					RNP APCH, Rotorcraft Enroute RNP 0.3 and advanced RNP are addressed in sections 8-3.h(10), 9-5.3.h(8) and appendix 3 respectively.
77.	Thales	RNP Enroute and Terminal Performance and Functional Criteria. section 9-3 h (11), (12) and (15) Page 68 and 69 and Rotorcraft Enroute, Terminal, and Offshore RNP 0.3. Performance and Functional Criteria. section 9-5.3 h (9), (10) and (12) Page 73	These leg types (VA, VI, VM, CA, FM) are not compliant with the RNP concept which is based on predictable and repeatable ground tracks along which the aircraft shall be contained (see table 2.1 of RTCA DO-283B). 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.	It is suggested to add a clarification stating that (11), (12) and (15) are not applicable for RNP performance monitoring.	Not Accepted. RNP is a complementary sub-set of RNAV capability; not an independent function. The guidance states the equipment must perform an RNAV function and <u>may use</u> the various leg types to perform that function. By definition, those leg types do not include RNP performance monitoring. The RNAV capability is needed to support existing and future procedure designs. TSO-C115d, appendix 1 modifies RTCA/DO-283B to require VA, VI, VM, CA, and FM leg types in RNP equipment. So the guidance

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
					is consistent with the PBN Manual and TSO-C115d.
78.	Thales	General Limitations for Operations under IFR (baro-VNAV) §11-1.b (2)	According to DO283-B, temperature compensation when available must be applied from the Initial Approach Fix until the Missed Approach Holding Point. This could be reflected in this document.	It is suggested to complete §b.: “This enables baro-VNAV operations outside of the temperature limits published on approach procedure charts from the Initial Approach Fix until the Missed Approach Holding Point.”	<p>Partially Accepted. 11-1 states temperature compensation must be applied according to RTCA/DO-283B appendix H. The text in b(2) was changed as follows to keep a parallel construction for clarity:</p> <p>Temperature compensation may be provided on segments <i>other than the final approach and missed approach (i.e., the segments prescribed by RTCA/DO-283B, appendix H)</i> if the equipment...</p>
79.	Thales	GPS/SBAS Glidepath Low Deviation Alerting Function. section 15-7.8.a Page 121 And 15-9.13 page 127	The Glidepath Low Deviation Alerting Function is managed by the TAWS equipment (mode 5 Alert for GBAS and SBAS) as required by TSO C151c. This should apply to GBAS, SBAS and Baro-VNAV.	It is suggested to remove these sections from AC 20-138 and put them into the relevant AC for TAWS (AC 25-23 and AC 23-18).	Not Accepted. The TAWS Mode 5 alert and rule is specific to ILS because it was written prior to LPV, GLS, and LNAV/VNAV implementation in the airspace. However, the

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
		And 18-6. page 137			<p>safety case for a LPV, GLS, and LNAV/VNAV low glidepath warning function is the same. While TSO-C151c provides information on LPV and GLS Mode 5 alerting for new TAWS systems, there are aircraft in service with older TAWS systems that won't have that capability when they install SBAS or GBAS. Additionally, the TAWS Mode 5 alerting tests are not adequate for SBAS and GBAS because they are based on ILS and TSO-C151c does not include LNAV/VNAV which has a similar safety case.</p> <p>This AC permits a method other than TAWS for this function which makes it possible to incorporate the low glidepath function when installing SBAS, GBAS, or baro-VNAV capability in aircraft with TAWS Mode 5</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
					that can't be upgraded to accommodate alerting for these functions. The guidance is appropriate for AC 20-138D.
80.	Thales	Integration with GNSS-Provided Vertical Guidance. §18-5 page 135	There is no sub-chapter b in 18-5	It is suggested to remove chapter style a.	Partially Accepted. The paragraph was split at a logical point to include a 'b'.
81.	Thales	Integration with GNSS-Provided Vertical Guidance. §18-5 (6) (a) page 136	As written in DO283B, cold temperature compensation is an optional feature, therefore this sentence is a consideration for baro-VNAV operation (not baro-VNAV guidance).	It is suggested to add precision: "Effects of cold temperature deviations from International Standard Atmosphere must be considered for baro-VNAV <u>operations</u> "	Accepted.
82.	Thales	Human factors §20-4.d page 142	RTCA SC227 is currently updating DO257-A with display and Human Factors consideration. This reference should be mentioned here	It is suggested to add "and RTCA/DO257A update"	Partially Accepted. The AC cannot reference an RTCA document that is not yet published. However, a note has been added to indicate DO-257 is being revised to provide further human factors information. Note: RTCA/DO-257 is currently under revision and may provide additional

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
					human factors information upon publication.
83.	Thales	Follow-on approval. §23-4 page 153	Following comment #10, precise in the note that baro-VNAV performance can be compared to GPS/SBAS LPV or GPS/SBAS LNAV/VNAV	It is suggested to replace “GPS/SBAS LPV and LNAV/VNAV” by “GPS/SBAS LPV and GPS/SBAS LNAV/VNAV”	Accepted.
84.	Thales	RNP AR General Requirements. Appendix 2 A2-3.b (7) Temp compensation	According to DO283-B, temperature compensation must be applied from the Initial Approach Fix until the Missed Approach Holding Point. So the criterion should extend its application from IAF to MAHP	It is suggested to replace “This criterion applies to the final approach segment” by “This criterion applies from the initial approach fix to the missed approach holding point”	Partially Accepted. The second sentence was deleted because it was redundant. The first sentence invokes compliance with RTCA/DO-283B, appendix H which defines the application to both the final approach and missed approach segments.
85.	Thales	RNP AR General Requirements. Appendix 2 A2-3.c (1)	ICAO doc 9905 (RNP-AR) states that only leg types permitted are RF and TF. This should be reminded in this document. The capability to execute leg transitions should actually be between TF RF or legs, and DF, CF or FA legs.	It is suggested to modify the requirements such as: “The aircraft must have the capability to execute leg transitions between TF or RF legs and the following paths: (a), ((b), (c), (d). The aircraft must have the capability to maintain tracks consistent with these legs” And to add a note reminding	Not Accepted. RNP AR procedures are designed according to the design criteria. The guidance simply states the equipment must accommodate the paths defined. RNP AR procedures are designed to broaden their applicability to as many aircraft as possible by using the least restrictive

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				<p>this: "ICAO doc 9905 (RNP-AR Procedure design manual) allows only TF and RF leg type".</p>	<p>paths consistent with the design criteria.</p>
86.	Thales	RNP AR General Requirements. Appendix 2 A2-3.e(15)(b) Page A2-15	This chapter provides OPS requirement and not system requirement.	It is suggested to remove this chapter from AC 20-138, and to add this chapter into AC 90-101.	Not Accepted. This paragraph describes the aircraft certification guidance for legacy aircraft to gain RNP AR recognition if their displays do not show the current navigation system in use. This is not an operational requirement.
87.	Thales	non-U.S. Constellations with GPS-Based GNS Appendix 8 - A8-1.e Page A8-1	Antenna with TSO-C190(AR) does not appear in the list. In order to address non-U.S. constellation capability as a non-TSO function, it is suggested to add TSO-C190(AR) antenna in this paragraph, which would be interesting in order to reduce the number of antennas to be installed on the aircraft.	<u>Suggested Change:</u> "Manufacturers that have antenna with a TSO-C196(AR), TSO-C145(AR), TSO-C146(AR), TSO-C161(AR) or TSO-C190(AR) TSOA may add non-U.S. constellation capability as a non-TSO function. Adding non-U.S. constellation functionality is considered a new and novel major change to the TSOA	Not Accepted. Including the antenna TSO does not add clarity and does nothing to reduce the number of antennas on the aircraft since TSO-C190 has no application to constellations other than GPS. Further, an antenna having TSO-C190 does not ensure compatibility with GPS receiver equipment for GPS signals. It is up to the equipment manufacturer

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				that will require coordination with the ACO and FAA Headquarters.”	including the non-GPS constellations in their equipment to make sure a compatible antenna (whether it is TSO-C190 or not) is available to receive the signals just as it is for GPS. Additionally, according to the DO-229D and DO-316 it is possible for GPS equipment manufacturers to use a manufacturer-specified antenna instead of a TSO-C190 antenna. So antenna compatibility falls squarely on the equipment manufacturers when adding any non-GPS constellations to the equipment just as it does for GPS since an antenna TSO does not ensure compatibility with the receiver equipment.
88.	Garmin	General comment about use of the term “must” within AC 20-138D	Many instances of the term “must” within this draft AC do not seem to be based on a clear regulatory requirement.	In accordance with OMB <i>Good Guidance Practices</i> (GGP) Section II.2.g and Order 1320.46D Chapter 3 paragraph	Not Accepted. This AC provides acceptable means of compliance and states that it

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			<p>FAA Order 1320.46D, <i>FAA Advisory Circular System</i>, is applicable to "...anyone who prepares and issues ACs" (ref. Chapter 1 paragraph 2). Order 1320.46D Chapter 3 paragraph 7.f states:</p> <p>"f. Use "must" to convey regulatory requirements. ... "Must" clearly conveys a requirement."</p> <p>The Office of Management and Budget (OMB), <i>Bulletin for Agency Good Guidance Practices</i> (72 FR 3432), Section II.2.g and II.2.h further clarify that (<u>emphasis added; italics in original</u>):</p> <p>"2. <i>Standard Elements</i>: Each significant guidance document shall:</p> <p>...</p> <p>g. Include the citation to the statutory provision or regulation (in Code of Federal Regulations format) which it applies to or interprets; and</p> <p>h. <u>Not include mandatory language such as "shall," "must," "required" or "requirement," unless the agency is using these words to describe a statutory or regulatory requirement, ..."</u></p> <p>(Note: These OMB <i>Bulletin for Agency Good</i></p>	<p>10.a, which states:</p> <p>"a. Place references in the text where they will be most useful"</p> <p>it is suggested to include all regulatory requirement references where the AC is using "must" to convey a regulatory requirement. Such references will enable the reader to connect the appropriate regulatory requirement and to indicate the basis for the AC using the verb "must".</p> <p>In accordance with OMB GGP Section II.2.h, if a clear regulatory requirement cannot be referenced, change "must" to "should".</p>	<p>is not regulatory or mandatory and applicants are not required to follow the AC's guidance.</p> <p>As stated in the AC, instances where 'must' is used means that is the method that has to be used when following the AC guidance. Other terminology such as 'should', 'may' or 'recommended' describe an acceptable compliance method applicants are encouraged to use (see comment 90).</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			<p><i>Guidance Practices</i> principles are acknowledged by FAA Order 8100.16 Chapter 2 paragraphs 2-2 and 2-2.c and FAA Order FS 8000.96 Chapter 2 paragraph 2.4.)</p> <p>While FAA recognized the issue the use of “must” caused in the context of the TAWS Class A Mode 5 alert as applied to LPV and GLS approaches and made appropriate adjustments in draft AC 20-138D Chg 2, there are still many instances of “must” that have not been addressed.</p>		
89.	Garmin	General comment about A/RFM(S) limitations in AC 20-138D	<p>The FAA in general and this AC in particular are promoting a significant expansion to the AFM limitations section for GNSS-related operations.</p> <p>The FAA has sometimes justified specifying A/RFM(S) content via 2x.1301. Garmin struggles with the use of 2x.1301 as the basis for requiring an A/RFM(S). Many systems, both required and non-required, are installed in aircraft that meet 2x.1301 and do not require an A/RFM(S). In many cases A/RFM(S) specified content is really more appropriate for inclusion in a pilot’s guide and there is no reason to burden the installation by including such content in the A/RFM(S).</p>	<p>See specific suggested changes and rationale provided below for ¶ 4-3.a, ¶ 4-3.b, ¶ 5.3-2.f , ¶ 5-6.1, ¶ 6-2.1, ¶ 11-1.b.(2), ¶ 12-7.a, ¶ 12-8.d, ¶ 15-5a, ¶ 15-6.b., ¶ 15-6.c., ¶ 15-6.d., ¶ 15-7.1.a., ¶ 15-7.2.c , ¶ A2-8.c(1)(d), ¶ A5-Section 2, and ¶A8-1.d.</p>	<p>Action noted. The specific recommendations will be considered individually for disposition.</p> <p>It should be noted that pilot operating handbooks formatted according to GAMA publication 1 for Part 23 aircraft (compliant with 23.1581) are acceptable as an AFM according to AC 23-8C. So references to documentation in the AFM(S) are satisfied by updating the Pilot’s</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			<p>The FAA has also justified specifying A/RFM(S) content via 2x.1581(a)(2). However, 2x.1581(a)(2) is included in Subpart G, Operating Limitations and Information, that also includes more specific regulations for airspeed limitations, maneuvering speed, flap extended speed, minimum control speed, weight and center of gravity, minimum flight crew, kinds of operation, and maximum operating altitude. All of these more specific regulations are relative to the aircraft “design, operating, or handling characteristics” and potential limiting effects on aircraft operation, not equipment operation. i.e., in Garmin’s view, 2x.1581(a)(2) was never intended to be used as a catch-all for applicable operating limitations. Including equipment operating limitations in the A/RFM(S) that does not affect the aircraft “design, operating, or handling characteristics” may actually obscure the primary purpose of an A/RFM(S), which is to provide the pilot with basic information required to safely fly the aircraft.</p> <p>In some cases, this AC is requiring generic operating limitations that are based only on compliance with the operating rules of Part 91, Part 135 and Part 121 as supplemented</p>		Operating Handbook in these instances.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			<p>with other operating guidance material. Generic operating limitations are separately subject to change over time and can in some cases be adjusted in separately approved Op Specs that Part 91K, Part 135, and Part 121 operators must have in place.</p> <p>Revising the operating procedures and/or operating limitations in the A/RFM(S) requires approval by the FAA (ref. 2x.1581(b)). This is an added expense in terms of installation shop time and aircraft downtime.</p> <p>Unnecessary A/RFM(S) content creates added expense and time, which are barriers to achieving installations and actually reduce safety by impeding the installation of safety enhancing equipment.</p> <p>The unnecessary A/RFMS(S) content can also come in conflict with changes to operational guidance or interfere with flexibility that Part 91K, Part 135 and Part 121 operators would normally be allowed. Correcting A/RFM(S) content is always treated as an airplane modification which is particularly unfortunate when there is no change to airplane or its equipment that would otherwise be required.</p>		

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
90.	Garmin	Page 2, ¶ 1-1.g	<p>Includes the following:</p> <p>“This AC is not mandatory and is not a regulation. This AC describes an acceptable means, but not the only means, to comply with applicable regulations.”</p> <p>This statement is not consistent with the standard text specified in FAA Order 1320.46D Chapter 3 paragraph 6.a.(2).</p> <p>Furthermore, the FAA does not include definitions for what “must” and “should” mean within the AC.</p>	<p>For consistency with FAA Order 1320.46D, suggest revising to:</p> <p>“This AC is not mandatory and does not constitute a regulation. This AC describes an acceptable means, but not the only means, to install positioning and navigation equipment. However, if you use the means described in the AC, you must follow it in all important respects.”</p> <p>With respect to the definitions of “must” and “should”, Garmin recommends use of the text in the table included as an attachment at the end of the comment log table. Garmin further recommends that the FAA standardize inclusion of these definitions within all ACs via an update to Order 1320.46D.</p>	<p>Partially Accepted. The language in paragraph 1-1.g was changed as suggested. But instead of a table, a new paragraph 1-1.h was inserted describing the difference between must, should, may, and recommend.</p>
91.	Garmin	Page 8, ¶ 1-4.i.(2)	<p>Includes the following:</p> <p>“Having step-down fixes in the navigation database can present challenges for the airworthiness approval when LPV capability is included since step-down fixes are not</p>	<p>¶ 1-4.i should be removed from AC 20-138D.</p> <p>RNAV(GPS) approach design standards should be changed such that an LNAV line of</p>	<p>Not Accepted. The answer is appropriate to the question asked and the guidance material in section 12-8 supports the answer.</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			<p>applicable to LPV and the LPV requirements are designed to mimic an instrument landing system (ILS). The airworthiness applicant must ensure there is no confusing or disparate information presented to flightcrews due to the cockpit arrangement. This can be a significant issue in legacy cockpits with limited display capabilities when the database includes step-down fixes. See paragraph 12-8 for guidance when including step-down fixes in the navigation database.”</p>	<p>minimums would not be allowed if that same procedure also has an LPV line of minimums and the LNAV line of minimums requires step down fixes.</p> <p>Rationale: Garmin TSO-C146 GNS 430W/530W equipment has displayed step-down fixes during LPV approaches since their initial airworthiness approval in 2006. All other Garmin TSO-C146 equipment receiving initial airworthiness approval since 2006 also have displayed step-down fixes during LPV approaches. This represents over 52,000 aircraft installations in the US (over 80,000 aircraft worldwide) across all aircraft parts (23, 25, 27 & 29). The majority of these installations are in legacy cockpits with “limited display capabilities”.</p> <p>Garmin is unaware of any installation issues associated with its equipment involving</p>	<p>There have been issues when installing LPV capability and incorporating step-down fixes in the navigation database, particularly in legacy aircraft with legacy FMSs and legacy displays.</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				<p>LPV capability with step-down fixes and AC 20-138D provides no specifics as to situations of “confusing or disparate information presented” which the FAA has identified. The guidance provided in AC 20-138D will inevitably lead to varying interpretations by ACOs and FSDOs that ultimately cause issues with Garmin dealer’s ability to install safety-enhancing TSO-C146 equipment.</p> <p>Also, equipment design changes are not the best way to get the behavior that FAA AIR-130 now prefers.</p> <p>The best way forward is to make changes to RNAV(GPS) approach design standards such that an LNAV line of minimums would not be allowed if that same procedure also has an LPV line of minimums and the LNAV line of minimums requires step down fixes.</p>	

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				<p>Changing the RNAV(GPS) approach design standard in this way has the additional advantage that the desired behavior would be produced in all fielded LPV-capable equipment.</p> <p>See the related comments on ¶ 12-8 and its subparagraphs.</p>	
92.	Garmin	Page 24-25, ¶ 4-3.a	<p>This paragraph includes:</p> <p>“When implementing advisory vertical guidance, the equipment manufacturer must provide an equipment limitation in the installation/instruction manual for inclusion in the airplane flight manual (supplement)/rotorcraft flight manual (supplement) (AFM(S)/RFM(S)) and may also include the information in the operations manual.”</p> <p>A limitation is appropriate only for equipment/installations that provide only advisory vertical guidance. For equipment/installations that provide approved vertical guidance for LPV and LNAV/VNAV lines of minimums, no such limitation is appropriate.</p> <p>Outside of the final approach segment, all</p>	<p>See also Garmin’s previous general comment about A/RFM(S) limitations.</p> <p>The requirement for limitations in the AFM should be limited to installations where the LPV and LNAV/VNAV capability is not available due to installation limitations.</p> <p>Equipment that cannot provide both LPV and LNAV/VNAV for any installation should be allowed to provide the limitation in the equipment operating manual.</p> <p>Rationale: Most equipment that can provide approved for LPV and</p>	<p>Not Accepted. Per Garmin’s previous comment an AFM(S)/RFM(S) should be used to document information that pilot’s need to safely operate the aircraft. That includes important limitations like the one for advisory vertical guidance where pilot’s need to always use the primary barometric altimeter for compliance with any ATC or charted procedure altitude restriction.</p> <p>The FAA has given manufacturers the flexibility to include advisory vertical guidance for any LP and</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			VNAV capability is advisory.	LNAV/VNAV capability can also provide advisory VNAV capability for the LP and/or LNAV line of minimums. In this case and for all other VNAV operations outside the final approach segment, the requirement to comply with altitude restrictions is a general operational requirement that is not based on any installation or equipment capability (or lack thereof).	LNAV approach operations and elsewhere along with the flexibility to use their discretion on how to implement that capability. But, that flexibility also comes with responsibility to accurately document the aircraft capability after the equipment is installed thru a controlled and approved document. GAMA publication 1 enables a POH to be an AFM.
93.	Garmin	Page 25, ¶ 4-3.b	This paragraph includes the statement: “The AFM(S)/RFM(S) and/or installation manual limitation does not preclude positioning and navigation equipment from outputting advisory vertical guidance deviations to an autopilot...”	See also Garmin’s previous general comment about A/RFM(S) limitations. Change the quoted statement to: “Use of advisory vertical guidance does not preclude positioning and navigation equipment from outputting vertical guidance deviations to an autopilot...” Rationale:	Not Accepted. The AC guidance on advisory vertical limitation is necessary to ensure safe operation of aircraft with advisory vertical guidance capability. The recommended change essentially says the same thing as the current AC language. However, replacing the language as

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				Since AFM(S)/RFM(S) limitations should not always be required (see also Garmin’s previous comments for ¶ 4-3.b, “use of advisory vertical guidance” is better for capturing the intent of paragraph.	recommended may cause other readers to misinterpret the intent due to the previous paragraph stating a limitation is necessary. It is stronger and clearer to confirm the AFM(S)/RFM(S) limitation does not preclude autopilot coupling during advisory vertical guidance. GAMA Publication 1 enables a POH to be an AFM.
94.	Garmin	Page 32, ¶ 5-3.2.f	This paragraph states: “Manufacturers that request a deviation from the LP capability requirement in TSO-C145d/C146d for their Class 3 or Class 4 GPS/SBAS equipment must provide an appropriate limitation for the installation instructions (or equivalent installation documentation) as part of their TSO application package. The limitation must be included in the AFM(S)/RFM(S).”	See also Garmin’s previous general comment about A/RFM(S) limitations. Suggest changing: “The limitation must be included in the AFM(S)/RFM(S).” To: “The limitation must be included in either the equipment operating manual or the AFM(S)/RFM(S).” Rationale:	Not Accepted. LP capability is required by TSO-C145/C146. Requesting a deviation to not include the capability is acceptable, but that is a major change to the expected equipment performance and aircraft performance after the equipment is installed. Per Garmin’s previous comment an AFM(S)/RFM(S) should be used to document

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				Since the quoted limitation is based exclusively on the design of the equipment, equipment manufacturers should be allowed to provide the limitation in the equipment operating manual.	information that pilot’s need to safely operate the aircraft. Understanding whether the aircraft can accomplish a charted procedure or not is critical to safely operating the aircraft and must be documented as part of the aircraft capability. GAMA Publication 1 enables a POH to be an AFM.
95.	Garmin	Page 38, ¶ 5-6.1	<p>The paragraph states:</p> <p>“The TSOA/LODA installation instructions/manual must contain a limitation identifying the requirements for the navigation database. This limitation will also be included in the AFM(S)/RFM(S).”</p> <p>Two problems here:</p> <ol style="list-style-type: none"> 1. As written, the applicable “must” refers only to installation manual content (not the AFM itself). 2. Equipment manufacturers and Airworthiness Approval holders should have the flexibility to provide database requirements and 	<p>See also Garmin’s previous general comment about A/RFM(S) limitations.</p> <p>Suggest revising the quoted statement as follows:</p> <p>“The TSOA/LODA installation instructions/manual should contain a limitation identifying the requirements for the navigation database. This limitation must also be included in either the AFM(S)/RFM(S) or the equipment operating manual.”</p>	<p>Not Accepted. The equipment cannot function without an appropriate database. The database requirements have to go with the aircraft; particularly since databases can be used to inhibit capabilities the equipment can perform, but the aircraft cannot support.</p> <p>Per Garmin’s previous comment this is documenting aircraft capabilities pilots</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			limitations in the equipment operating manual so that AFM(S)/RFM(S) limitations are not always necessary.		need to safely operate the aircraft which are only known at the time of installation. GAMA publication 1 enables a POH to be an AFM.
96.	Garmin	Page 38, ¶ 5-6.2.c	Includes the statement: “Data process assurance levels including tool qualification should be verified during the Letter of Acceptance (LOA) review.” Problem: The purpose of AC 20-138D is to provide guidance to the installer. Verification of data process assurance levels including tool qualification is performed as part of the LOA submittal process.	Add a note as follows: “ Note: A Type 2 LOA may be used as evidence that the data process assurance levels and tool qualification is appropriate for the intended function of the installed equipment listed on the LOA. (see paragraph 16-5.b.)” Rationale: The installer is allowed to use the Type 2 LOA as evidence of compliance.	Not Accepted. The purpose of the AC is not only to provide guidance to installers. Paragraph 5-6.2.c is directed to manufacturers who are TSOA/LODA applicants. A TSOA/LODA does not provide an airworthiness approval. Paragraph 15-5.c and 19-8 provide the guidance to installers this comment seeks for GNSS equipment.
97.	Garmin	Page 40, ¶ 6-2.1	The paragraph states: “The TSOA/LODA installation instructions/manual must contain a limitation identifying the requirements for the navigation database. This limitation will also be included in the AFM(S)/RFM(S).”	See also Garmin’s previous general comment about A/RFM(S) limitations. Suggest revising the quoted statement as follows:	Not Accepted. The purpose of the AC is not to provide guidance only to installers. Paragraph 6-2.1 is directed to manufacturers. A TSOA/LODA does not

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			<p>Two problems here:</p> <ol style="list-style-type: none"> 1. As written, the applicable “must” refers only to installation manual content (not the AFM itself). 2. Equipment manufacturers and Airworthiness Approval holders should have the flexibility to provide database requirements and limitations in the equipment operating manual so that AFM(S)/RFM(S) limitations are not always necessary. 	<p>“The TSOA/LODA installation instructions/manual should contain a limitation identifying the requirements for the navigation database. This limitation must also be included in either the AFM(S)/RFM(S) or the equipment operating manual.”</p>	<p>provide an airworthiness approval.</p> <p>Paragraph 16-5.c and 19-8 provide the guidance to installers this comment seeks for RNAV multi-sensor equipment.</p>
98.	Garmin	Page 40, ¶ 6-2.2.c	<p>Includes the statement:</p> <p>“Data process assurance levels including tool qualification should be verified during the Letter of Acceptance (LOA) review.”</p> <p>Problem: The purpose of AC 20-138D is to provide guidance to the installer. Verification of data process assurance levels including tool qualification is performed as part of the LOA submittal process.</p>	<p>Add a note as follows:</p> <p>“Note: A Type 2 LOA may be used as evidence that the data process assurance levels and tool qualification is appropriate for the intended function of the installed equipment listed on the LOA. (see paragraph 16-5.b.)”</p> <p>Rationale: The installer is allowed to use the Type 2 LOA as evidence of compliance.</p>	<p>Not Accepted. The purpose of the AC is not to provide guidance only to installers. Paragraph 6-2.1 is directed to manufacturers. A TSOA/LODA does not provide an airworthiness approval.</p> <p>Paragraph 16-5.c and 19-8 provide the guidance to installers this comment seeks for RNAV multi-sensor equipment.</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
99.	Garmin	Page 44, ¶ 6-4.f	Editorial	Correct the formatting of the equation for $2\sigma_D$	Accepted. The equation was re-done in a newer version of Word that is more compatible with PDF conversions.
100	Garmin	Page 62, ¶ 8-3.j	This paragraph includes: “The navigation database suppliers must comply with RTCA/DO-200B.” As written, this statement ignores the fact that there are existing Type 2 LOAs granted against RTCA/DO-200A.	Suggest revising this statement to: “The navigation database suppliers must comply with a recognized revision of RTCA/DO-200.”	Partially Accepted. Per a previous comment, all implementation references to DO-200B are changed to AC 20-153(latest revision). AC 20-153B will be published soon which contains industry agreed implementation guidance for DO-200B. Some references to DO-200B will remain in AC 20-138D Chg 2 but these are information only references, not for implementation.
101	Garmin	Page 69, ¶ 9-3.i	This paragraph includes: “The navigation database suppliers must comply with RTCA/DO-200B.” As written, this statement ignores the fact that there are existing Type 2 LOAs granted against RTCA/DO-200A.	Suggest revising this statement to: “The navigation database suppliers must comply with a recognized revision of RTCA/DO-200.”	Partially Accepted. The reference was changed to AC 20-153 (latest revision) (see comment # 100 disposition).

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
102	Garmin	Page 74, ¶ 9-5.3.j	<p>This paragraph includes:</p> <p>“The navigation database suppliers must comply with RTCA/DO-200B. The GPS/SBAS TSOA provides sufficient evidence for compliance to RTCA/DO-200B, but GNSS operational approval for IFR use is based upon a database assurance process through a type 2 LOA (see paragraph 19-8).”</p> <p>As written, these statements ignore the fact that there are existing TSOAs and Type 2 LOAs granted against RTCA/DO-200A.</p>	<p>Suggest revising this paragraph to:</p> <p>“The navigation database suppliers must comply with a recognized revision of RTCA/DO-200. The GPS/SBAS TSOA provides sufficient evidence for compliance to RTCA/DO-200(), but GNSS operational approval for IFR use is based upon a database assurance process through a Type 2 LOA (see paragraph 19-8).”</p>	<p>Partially Accepted. The reference was changed to AC 20-153 (latest revision) (see comment # 100 disposition).</p>
103	Garmin	Page 86, ¶ 11-1.b.(2)	<p>This paragraph includes:</p> <p>“Equipment manufacturers providing baro-VNAV temperature compensation outside of the final approach segment must specify language in the installation instructions/manual for an AFM(S)/RFM(S) caution that the flight crew/pilot must coordinate use of temperature compensation with ATC prior to employing this function. The reason for an AFM(S)/RFM(S) caution is to ensure there is no loss of separation between an aircraft employing temperature compensation and an aircraft not employing this function.”</p>	<p>See also Garmin’s previous general comment about A/RFM(S) limitations.</p> <p>Suggest changing: “must specify language in the installation instructions/manual for an AFM(S)/RFM(S) caution”</p> <p>To: “must include a caution in the equipment operating instructions or AFM(S)/RFM(S)”</p> <p>Also change:</p>	<p>Not Accepted. The installation instructions are where the TSOA holder provides information to the airworthiness approval holder about limitations that affect the safe operation of the aircraft after equipment installation.</p> <p>Aircraft capabilities are documented in the AFM(S)/RFM(S) so that pilots, operators, inspectors,</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			<p>Two problems here:</p> <ol style="list-style-type: none"> 1. As written, the applicable “must” refers only to installation manual content (not the AFM itself). 2. Equipment manufacturers should be allowed to include the limitation in equipment operating instructions. 	<p>“The reason for an AFM(S)/RFM(S) caution”</p> <p>To: “The reason for a caution”</p> <p>Rationale: Since the quoted limitation is based exclusively on the design of the equipment, equipment manufacturers should be allowed to provide the limitation in the equipment operating manual.</p>	<p>etc. understand what operations the aircraft is capable of performing.</p> <p>AC 23-8C enables a pilot’s operating handbook to serve as an AFM if formatted to GAMA publication 1.</p>
104	Garmin	Page 95, ¶ 12-7.a	<p>This paragraph states:</p> <p>“Positioning and navigation avionics might have optional TSO functions that are not supported at the aircraft level after installation. The avionics must have the functions inhibited through configuration settings (e.g., strapping, software, etc.) or through database management processes if the aircraft is not qualified to perform those functions. The AFM(S)/RFM(S) must contain an appropriate entry for any limitations.”</p>	<p>See also Garmin’s previous general comment about A/RFM(S) limitations.</p> <p>Remove the statement that “The AFM(S)/RFM(S) must contain an appropriate entry for any limitations.”</p> <p>Rationale: Equipment that performs functions for a particular TSO (e.g., TSO-C146c) may also meet other TSOs for display of moving map, traffic, weather radar, data link weather, communication radios, etc. It is</p>	<p>Not Accepted. The installation instructions are where the TSOA holder provides information to the airworthiness approval holder about limitations that affect the safe operation of the aircraft after equipment installation.</p> <p>Aircraft capabilities are documented in the AFM(S)/RFM(S) so that pilots, operators, inspectors, etc. understand what operations the aircraft is</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				<p>normal practice to make these other functions unavailable to the flight crew if the interfaced equipment is not installed.</p> <p>An AFM typically identifies capabilities that <u>are</u> supported but does not specifically identify capabilities that <u>are not</u> supported. It is unclear what benefit is provided by including an AFM limitation statement that RF leg capability is not supported given the fact that the equipment does not make the RF leg capability available to the crew.</p>	<p>capable of performing.</p> <p>AC 23-8C enables a pilot’s operating handbook to serve as an AFM if formatted to GAMA publication 1.</p>
105	Garmin	Page 96, ¶ 12-8.a	<p>Includes the statement:</p> <p>“Airworthiness approval applicants should contact their ACO early when seeking an approval for equipment with step-down fixes in the onboard navigation database.”</p>	<p>Ideally, ¶ 12-8 should be completely removed from AC 20-138D. If that is not possible, make the guidance applicable only to the equipment initial airworthiness approval so that it is not an issue for every follow-on airworthiness approval.</p> <p>Rationale: As noted previously, Garmin equipment has displayed step-down fixes for LNAV</p>	<p>Not Accepted. The term “follow-on airworthiness approval” is ill-defined in that an STC holder with an AML has approval to install equipment on multiple aircraft while an STC holder without an AML is restricted to a single type of aircraft.</p> <p>In both cases however a “follow-on approval” can</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				<p>approaches since 2003 and LNAV/VNAV and LPV approaches since 2006 and for LP approaches since 2013. Consequently, it is not possible for Garmin to “contact [an] ACO early” nor should it be necessary given the substantial number of approved installations with the capability to display step-down fixes.</p> <p>All new installations of Garmin’s integrated flight deck equipment require another airworthiness approval and installers of Garmin equipment (the airworthiness approval applicants) will assume that this guidance applies to their projects which creates an unnecessary certification obstacle for them to overcome.</p>	<p>mean a completely new airworthiness approval for a new aircraft model not covered by the original airworthiness approval. In that case the “follow-on approval” has to be evaluated as a new approval to ensure the aircraft systems are sufficient to enable displaying step-down fixes.</p> <p>The airworthiness applicant can choose to not contact the ACO early in the project if they assume the risk to the project is minimal. The AC only recommends doing this as a risk mitigation method to smooth the airworthiness application process.</p>
106	Garmin	Page 96, ¶ 12-8.a	<p>Includes the statement:</p> <p>“Including final approach segment step-down fixes in the aircraft’s onboard navigation database is entirely optional. However, the database must include all named waypoints that make up the</p>	<p>Ideally, ¶ 12-8 should be completely removed from AC 20-138D. If that is not possible, remove Note 3.</p> <p>Rationale: The quoted statement from ¶12-</p>	<p>Not Accepted. The entire section needs to be read as a whole. Some procedures have both named and unnamed step-down fixes in the final approach segment. No</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			<p>instrument approach procedure except for final approach segment step-down fixes.”</p> <p>Related Note 3 Includes the statement:</p> <p>“ARINC 424 is not specified by any positioning or navigation TSO. Nor is there any TSO requirement to include final approach segment or unnamed step-down fixes prior to the final approach fix in navigation databases for approach procedures.”</p>	<p>8.a in combination with the quoted statement from the following Note 3 makes a disingenuous suggestion that TSO requirements support the idea that final approach segment step-down fixes are optional.</p> <p>In fact, TSO requirements make no exception for final approach segment fixes. DO-229D (MOPS for TSO-C146d) section 2.2.3.2.1 (Approach Selection) includes only this requirement which is more reasonably interpreted that all fixes are required:</p> <p style="padding-left: 40px;">“After selection and entry of the desired IAWP into the flight plan, the remaining waypoints for the approach and missed approach shall automatically be inserted in the flight plan in the proper sequence.”</p> <p>The statement that ARINC 424 is not specified by any position or navigation TSO is also</p>	<p>reasonable interpretation could conclude that an unnamed step-down fix could be considered a waypoint.</p> <p>Further, The interpretation that DO-229D paragraph 2.2.3.2.1 applies to step-down fixes is also incorrect since 2.2.1.3 describes path definition as being between two waypoints. The waypoints defining the final approach segment are the final approach waypoint (FAWP) and missed approach waypoint (MAWP) per 2.2.3.3.1. Step-down fixes do not apply to LNAV/VNAV or LPV lines of minima, but for LP the final approach segment is defined by the FAWP and LTP/FTP. Nowhere do the DO-229D requirements state that step-down fixes in the final approach segment have to be displayed.</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				<p>disingenuous. While ARINC 424 is not regulatory, it is the aviation industry's standard for exchange of navigation system database information and, as such, represents industry consensus for how ATS procedures (including RNAV approach procedures) should be decomposed into waypoint/leg sequences. This is also acknowledged by AC 20-153() recognizing ARINC 424 as a standard data format for navigation data and DQRs for use in obtaining a Type 2 LOA (see AC 20-153A ¶s 5.d and 20.a and draft AC 20-153B ¶ 12.2).</p>	<p>The DO-229D requirements are set up to be as close to legacy navaid operations as possible for LNAV and LP. On legacy approach procedures a step-down fix was identified by either a crossing radial or a distance from a defined point. In the RNP world crossing radials are not applicable so the normal procedure is to define a step-down fix by distance from a waypoint.</p> <p>As to ARINC 424, no MOPS or TSO, which is the <u>regulatory</u> document implementing the MOPS, nor any other regulation requires manufacturers to use ARINC 424 specifications. That is a manufacturer's choice.</p> <p>As prior comments have pointed out, AC's are guidance, not regulatory. So</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
					the AC 20-153() <u>guidance</u> is not a requirement to use ARINC 424; ARINC 424 is an acceptable method of compliance for database processes. AC 20-153() also references DO-200() for the database requirements. Manufacturers are free to use whatever database specification they wish; even a proprietary one they create for their products.
107	Garmin	Page 96, ¶ 12-8.a Note 1	Includes the statement: “Final approach segment step-down fixes are not common to all U.S. RNAV (GPS) approach procedures. The majority of RNAV (GPS) approach procedures do not have step-down fixes; but a significant minority does.”	Ideally, ¶ 12-8 should be completely removed from AC 20-138D. If that is not possible, change Note 1 so that it reflects the actual demographics of how step-down fixes are used on U.S. RNAV (GPS) approach procedures as follows: “Final approach segment step-down fixes are commonly used on U.S. RNAV (GPS) approach procedures to support an LP or LNAV line of minimums.” Rationale:	Partially Accepted. Note 1 was changed as suggested.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				<p>Note 1 is disingenuous because the actual usage of step-down fixes in U.S. RNAV (GPS) approaches supports the opposite conclusion (that step-down fixes are common).</p> <p>An analysis of CONUS RNAV (GPS) approach procedures in the cycle 1510 of the database, supports these conclusions:</p> <ol style="list-style-type: none"> 1) Of 6122 RNAV (GPS) approaches, only 210 (3%) do not have an LNAV or LP line of minimums. 2) Of 5912 approaches with an LNAV or LP line of minimums, 2994 (51%) have step-down fixes. 3) There are 3587 approaches that have both LPV and LNAV lines of minimums. 1968 (54%) of these have step-down fixes. 	
108	Garmin	Page 96-97, ¶ 12-8.b	Includes the statements: “Equipment manufacturers providing final	Ideally, ¶ 12-8 should be completely removed from AC 20-138D. If that is not possible,	Not Accepted. The suggested paragraph modification is too confusing

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			<p>approach segment step-down fixes in their onboard navigation databases for RNAV (GPS) approach procedures must either provide a method to remove them or provide an installation limitation for cockpit configurations that cannot properly support them (i.e., define the requirements in the installation instructions/manual). If removing final approach segment step-down fixes, manufacturers may choose to employ installation-specific configurations (i.e., software, strapping, etc.), or they may offer a navigation database solution (i.e. a database with final approach segment step-down fixes and a database without final approach segment step-down fixes).”</p>	<p>we suggest the following for the first sentence of ¶ 12-8.b which makes the guidance applicable only to equipment that needs to address the issue:</p> <p>“<u>If equipment manufacturers providing final approach segment step-down fixes in their onboard navigation databases for RNAV (GPS) approach procedures cannot properly support them for all cockpit configurations that are otherwise supported, they must either provide a method to remove them or provide an installation limitation for the unsupported cockpit configurations (i.e., define the requirements in the installation instructions/manual).</u>”</p> <p>Rationale: The design of Garmin’s equipment is such that display of final approach step-down fixes is never a cause for installation limitations (all cockpit configurations that the</p>	<p>and does not provide broadly applicable guidance.</p> <p>Paragraph 12-8.b has to be read in context with the other paragraphs. The intent is to give manufacturers flexibility on how they deal with aircraft configurations that can’t support displaying step-down fixes in the final approach segment. Manufacturers can either limit the installations, or provide a means to inhibit displaying step-down fixes. The suggested change does not communicate that guidance.</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				<p>equipment generally supports also properly supports step-down fixes). The guidance provided in ¶ 12-8.b does not acknowledge that possibility because it provides only two alternatives (remove step down fixes or specify install limitations).</p> <p>As written, this guidance creates an unnecessary certification obstacle for installers of Garmin equipment (the airworthiness approval applicants).</p>	
109	Garmin	Page 97, ¶ 12-8.c	Editorial	<p>Ideally, ¶ 12-8 should be completely removed from AC 20-138D. If that is not possible, suggest changing:</p> <p>“does not creating”</p> <p>To:</p> <p>“does not create”</p>	Partially Accepted. Changed to “does not create.”
110	Garmin	Page 97, ¶ 12-8.c	<p>Includes the statement:</p> <p>“The airworthiness applicant must ensure the displayed RNAV(GPS) approach is in the primary field of view, in the proper sequence, unambiguous, and does not</p>	<p>Ideally, ¶ 12-8 should be completely removed from AC 20-138D. If that is not possible, revise the quoted ¶ 12-8.c statement as follows:</p>	Not Accepted. The entire 12-8.c section has to be read as a whole and not parsed. The following subsections provide the answer the

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			creating detrimental clutter.”	<p>“The airworthiness applicant must ensure that display of step-down fixes in the final approach segment does not create detrimental clutter when using an LNAV/VNAV or LPV line of minima.”</p> <p>Rationale: As written, it is not clear what is intended by “RNAV(GPS) approach is in the primary field of view” In a modern Integrated Flight Deck, there is a lot of information available for an RNAV(GPS) approach but there is no expectation that all of it is provided in the primary field of view.</p> <p>We have understood the original intent of this text was only to ensure that display of step-down fix information (that this AC considers unnecessary) does not create detrimental clutter. The other requirements (primary field of view, proper sequence, unambiguous) are already addressed elsewhere in this AC.</p>	comment seeks in the rationale.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				Regarding the notion that step-down fixes are unnecessary information - note that a downgrade to the LNAV service level is possible at any time (due to loss of SBAS), at which point, step-down fixes are very helpful for enhancing situational awareness.	
111	Garmin	Page 97, ¶ 12-8.c Note	Includes the statement: “For LPV, some ICAO States may prohibit displaying step-down fix information in the onboard navigation database. Navigation system manufacturers should take this into consideration during their navigation system design and airworthiness applicants should consider this during equipment installation.”	Ideally, ¶ 12-8 should be completely removed from AC 20-138D. If that is not possible, remove the quoted ¶ 12-8.c Note. Rationale: This note is speculative and/or misleading. As of cycle 1603 (effective 03-Mar-2016), LPV approaches are now available in Austria, Belgium, Canada, Croatia, Czech Republic, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland, and United Kingdom as well as the United States. Garmin is	Not Accepted. The note is information only and does not cite any guidance document from another country. Manufacturers are free to display step-down fixes during LPV and LNAV/VNAV if they wish to do so. But since step-down fixes do not apply to LPV and LNAV/VNAV it is possible other States’ interpretation of the allowable displayed approach information will be more literal.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				<p>familiar with other ICAO State’s guidance material (e.g. AMC 20-28) and none of these States has indicated their intention to Garmin to prohibit display of step-down fix information on LPV approaches.</p> <p>Furthermore, it is not necessary and probably inappropriate to make reference to other ICAO State’s guidance material in this context.</p>	
112	Garmin	Page 97, ¶ 12-8.c.(1)	<p>Includes the statement:</p> <p>“Integrating an RNAV (GPS) approach with LNAV/VNAV or LPV capability in an older cockpit design can be challenging when the onboard navigation database includes final approach step-down fixes due to limited display capability and little or no labeling flexibility.”</p>	<p>Ideally, ¶ 12-8 should be completely removed from AC 20-138D. If that is not possible, remove the reference to LNAV/VNAV in ¶ 12-8.c.(1).</p> <p>Rationale: The underlying concern about step-down fixes has been based on the similarity of LPV and ILS. Up to this revision of AC 20-138A there has been no similar concern about including step-down fixes in LNAV/VNAV approaches.</p>	Not Accepted. The AC is updated as issues arise and the step-down fix guidance has been in the AC since March of 2014 as a result of problems discovered with some implementations.
113	Garmin	Page 97, ¶ 12-8.c.(2)	The 4th bullet indicates “information to the LTP/FTP” should be displayed “during the	Ideally, ¶ 12-8 should be completely removed from AC	Partially Accepted. Replaced “information” with

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			final approach segment of an LPV approach”.	<p>20-138D. If that is not possible, change the 4th bullet of ¶ 12-8.c.(2) to the following:</p> <p>“Clearly display distance/bearing/track to the Landing Threshold Point/Fictitious Threshold Point (LTP/FTP) or Missed Approach Point (MAP) during the final approach segment of an LPV approach.”</p> <p>Rationale: Other than ¶ 12-8.c.(2), there is no other reference to the term “LTP/FTP” within AC 20-138D. Installers are unlikely to understand this term as the RNAV (GPS) approach waypoint sequence most often includes the runway threshold (RWxx), as the LTP, or other named waypoint, as the FTP, with an indication that the runway threshold/named waypoint is associated with the Missed Approach Point (MAP). Even RTCA/DO-229D sections 2.2.5.4.5 and 2.2.5.4.6 use the</p>	“distance/bearing/track to the Landing Threshold Point/Fictitious Threshold Point (LTP/FTP).” LPV approaches are based on the LTP/FTP from the FAS datablock not a missed approach waypoint.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				<p>term “Missed Approach Waypoint/LTP/FTP” in their titles.</p> <p>Additionally, it is unclear what “information” the 4th bullet expects to be displayed “to the LTP/FTP”. We assume that “distance/bearing/track” is actually intended based on the text of ¶ 12-8.c.(2).</p>	
114	Garmin	Page 97, ¶ 12-8.c.(3)	<p>Includes the statement:</p> <p>“The suggested optimum implementation is showing final approach segment step-down fixes for LNAV and LP approaches, but not showing step-down fixes for LNAV/VNAV or LPV approach.”</p>	<p>¶ 12-8 should be completely removed from AC 20-138D.</p> <p>To get the “optimum” step-down fix implementation that FAA suggests, the FAA should change its own RNAV(GPS) approach design standards such that a LNAV line of minimum would not be allowed if that same procedure also has a LNAV/VNAV or LPV line of minimum and the LNAV line of minimums requires step down fixes.</p> <p>Rationale: There are significant situational awareness benefits for</p>	<p>Not Accepted. Displaying step-down fixes is not required per the DO-229D implemented by TSO. Further, step-down fixes are not applicable to LNAV/VNAV and LPV per the applicable procedure design criteria.</p> <p>The suggested optimum implementation for displaying step-down fixes is just that; a suggestion. Manufacturers are free to use the suggestion or not if they choose to display step-down</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				<p>equipment that displays information consistent with the charted information as well as transition to LNAV after a “fail-down” from LNAV/VNAV or LPV. Consequently, it is clearly questionable as to whether the suggested implementation is indeed “optimum”, especially given the 52,000 US (and 80,000 worldwide) aircraft installations with Garmin equipment that show step-down fixes for LPV and LNAV/VNAV approaches.</p> <p>Rather than suggesting equipment changes, we would point out that FAA can easily address any concern about showing step-down fixes on LPV (or LNAV/VNAV) approaches by revising its own RNAV(GPS) design standards. For example, there are 1968 approaches in the CONUS that have both LPV and LNAV lines of minimums with step-down fixes published to support the LNAV line of minimums. Instead of publishing a single</p>	fixes.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				approach with multiple lines of minimums, the FAA can publish two approaches, a “Z” approach with a LPV line of minimums (no step-down fixes) and a “Y” approach with a LNAV line of minimums (with step-down fixes).	
115	Garmin	Page 98, ¶ 12-8.d and Note 1	Includes the statements: “Therefore, airworthiness applicants must include language for a limitation in the AFM(S)/RFM(S) (or equivalent documentation) requiring the flight crew to use the primary barometric altimeter to comply with a final approach segment step-down fix altitude restriction during an LNAV, LP, or non-ILS conventional approach. Equipment manufacturers should also include a limitation in the equipment operating instructions or flight crew operating manual.”	See also Garmin’s previous general comment about A/RFM(S) limitations. Remove ¶ 12-8.d and the accompanying Note 1 and, if necessary, add information to FAA AIM 5-4-5.m.1.(e) for LNAV minima based on the text quoted below from FAA AIM 5-4-5.m.1.(d) for LP minima. Another area of the FAA AIM that could be considered for additional information is 5-4-5.k, “Vertical Descent Angle (VDA)”. Rationale: AFM Operating Limitations content is prescribed by regulation and generically includes Systems limitations	Not Accepted. Advisory vertical guidance is an option manufacturers can choose to implement for no certification credit. As such, a limitation is necessary in the AFM(S)/RFM(S) to document the aircraft capability and accompanying limitation of that capability for safe operation of the aircraft. AC 23-8C enables a pilot’s operating handbook to serve as an AFM if formatted to GAMA publication 1.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				<p>(e.g., 23.1583(m) “Any limitations on the use of airplane systems and equipment.”). However, it is unclear why it is necessary to include a specific AFM(S) limitation “to use the primary baro altimeter to comply with a step-down fix altitude restriction during” an RNAV approach with LNAV or LP minimums when this is a normal operating procedure. E.g., 14 CFR 91.175(i) includes:</p> <p>“When operating on an unpublished route or while being radar vectored, the pilot, when an approach clearance is received, shall, ... maintain the last altitude assigned to that pilot until the aircraft is established on a segment of a published route or instrument approach procedure unless a different altitude is assigned by ATC. After the aircraft is so established, published altitudes apply to descent within each succeeding route or approach segment unless a different altitude is</p>	

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				<p>assigned by ATC.”</p> <p>FAA AIM 5-4-7.b includes nearly identical language. In both cases, it is understood that the pilot will use the baro altimeter to maintain the charted altitudes. FAA AIM 5-4-5.m.1.(d) discussing “Area Navigation (RNAV) Instrument Approach Charts” LP minima lines also includes the following:</p> <p>“WAAS avionics may provide GNSS-based advisory vertical guidance during an approach to an LP line of minima. Barometric altimeter information remains the primary altitude reference for complying with any altitude restrictions.”</p>	
116	Garmin	Page 98, ¶ 12-8.d Note 2	<p>Note 2 includes the statements:</p> <p>“Baro-VNAV systems certified before 11/20/1989 may have been certified to a lesser standard that is not consistent with a major failure condition. Operators of these aircraft should apply the final approach segment step-down fix to the LNAV/VNAV line of minima and should use the primary</p>	<p>Suggest moving Note 2 to a more appropriate section that addresses the LNAV/VNAV line of minimums. ¶ 11-2.b is suggested as a more appropriate location since that is the paragraph that identifies misleading guidance during LNAV/VNAV approach</p>	<p>Partially Accepted. The note is applicable to section 12-8 since many paragraphs previous to the note state that step-down fixes don’t apply to LNAV/VNAV. The note indicates a corner case where the opposite may apply.</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			barometric altimeter to ensure meeting the step-down fix altitude constraint.”	<p>operations as a major failure condition. Alternatively, ¶ 18-2.b could be a good spot since it addresses limitations provided by the manufacturer of the Baro-VNAV equipment.</p> <p>Rationale: The text of ¶ 12-8.d addresses only advisory vertical guidance. Note 2 is misplaced here because it refers to the use of the LNAV/VNAV line of minimums which is not ordinarily considered advisory. The exact AFM(S)/RFM(S) limitation suggested by the text of ¶ 12-8.d (referring only to LNAV, LP and non-ILS conventional approaches) is not the appropriate operational limitation needed to address the situation described by Note 2.</p>	But the note is also applicable in paragraph 11-2.b and 18-2.b as suggested and has been copied there as well to ensure readers skipping to particular sections have the information.
117	Garmin	Page 117, ¶ 15-5.a	<p>Includes the statements:</p> <p>“It is essential that procedures or optional functions an aircraft is not capable of performing are either removed from the GNSS equipment database, or otherwise inhibited, even if the avionics do support the</p>	<p>See also Garmin’s previous general comment about A/RFM(S) limitations.</p> <p>Either:</p> <ul style="list-style-type: none"> • Remove the statement 	Not Accepted. The paragraph predicates any limitation on: 1) equipment having a particular functional capability, and 2) the aircraft not able to support that

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			function (RNP AR procedures or procedures with RF legs for example). The AFM(S)/RFM(S) must contain an appropriate entry for any limitations (see paragraph 12-7 and 12-8).”	<p>that “The AFM(S)/RFM(S) must contain an appropriate entry for any limitations (see paragraph 12-7 and 12-8).”</p> <ul style="list-style-type: none"> • Or clarify the statement that the AFM must include a limitation only if the AFM otherwise states the equipment includes a capability that is not supported by the installation. <p>Rationale: See Garmin’s comments on ¶ 12-7.a and ¶ 12-8.b.</p>	<p>capability. The paragraph states a limitation is necessary when those two conditions exist. The suggested change does not make the point any more clear.</p> <p>Any limitation must be part of the AFM(S)/RFM(S) to document the aircraft capability for safe operation.</p> <p>AC 23-8C enables a pilot’s operating handbook to serve as an AFM if formatted to GAMA publication 1.</p>
118	Garmin	Page 117, ¶ 15-6.b.	<p>This paragraph states:</p> <p>“When installing GPS equipment that uses RAIM for integrity during instrument meteorological conditions (IMC), there must be a performance limitation in the installation manual (or equivalent installation documentation) for inclusion as a limitation in the AFMS/RFMS. The limitation is to have other navigation equipment available appropriate to the operation.”</p>	<p>See also Garmin’s previous general comment about A/RFM(S) limitations.</p> <p>Suggest changing: “must be a performance limitation in the installation manual (or equivalent installation documentation) for inclusion as a limitation in the AFMS/RFMS”</p>	<p>Not Accepted. Non-SBAS GPS equipment has a performance limitation that affects aircraft capability. That performance limitation is having other navigation equipment available appropriate to the route flown which is important to safe operation of the aircraft.</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			<p>Two problems here:</p> <ol style="list-style-type: none"> 1) As written, the applicable “must” refers only to installation manual content (not the AFM itself). 2) Equipment manufacturers should be allowed to include the limitation in equipment operating instructions. 	<p>To: “must include a limitation in the equipment operating instructions or AFM(S)/RFM(S)”</p> <p>Rationale: Since the quoted limitation is based exclusively on the design of the equipment, equipment manufacturers should be allowed to provide the limitation in the equipment operating manual.</p>	<p>This limitation affecting aircraft capability needs to be in the AFM(S)/RFM(S).</p> <p>AC 23-8C enables a pilot’s operating handbook to serve as an AFM if formatted to GAMA publication 1.</p>
119	Garmin	Page 117-118, ¶ 15-6.c.	<p>This paragraph states:</p> <p>“There must also be a flight planning performance limitation in the installation instructions (or equivalent installation documentation) for inclusion as a limitation in the AFMS/RFMS. This limitation must indicate the equipment has a performance limitation necessitating an alternate airport flight planning operational mitigation (see appendix 5 for an example).”</p> <p>Three problems here:</p> <ol style="list-style-type: none"> 1) As written, the applicable “must” refers only to installation manual content (not the AFM itself). 2) Equipment manufacturers should be 	<p>See also Garmin’s previous general comment about A/RFM(S) limitations.</p> <p>There should be no requirement for an airplane or equipment limitation since this is a general operating rule.</p> <p>If the requirement for a limitation can’t be removed here, we suggest changing:</p> <p>“must be a performance limitation in the installation manual (or equivalent installation documentation) for</p>	<p>Not Accepted. The flight planning operational mitigation is the result of an equipment performance limitation. Any limitation affecting the aircraft capability needs to be documented in the AFM(S)/RFM(S).</p> <p>AC 23-8C enables a pilot’s operating handbook to serve as an AFM if formatted to GAMA publication 1.</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			<p>allowed to include the limitation in equipment operating instructions.</p> <p>3) The actual limitation is only requiring compliance with a general operating rule (described in the AIM) that flight crews are already expected to know.</p>	<p>inclusion as a limitation in the AFMS/RFMS”</p> <p>To:</p> <p>“must include a limitation in the equipment operating instructions or AFM(S)/RFM(S)”</p> <p>Rationale: The actual limitation is only requiring compliance with a general operating rule (described in the AIM) that flight crews are already expected to know.</p>	
120	Garmin	Page 118, ¶ 15-6.d. Note 1	<p>This Note states:</p> <p>“The performance limitation for other navigation equipment appropriate to the operation must be unambiguously stated in the installation documentation and AFMS/RFMS.”</p> <p>Four problems here:</p> <ol style="list-style-type: none"> 1) Using the keyword “must” in a note should be avoided. Notes should only be used to clarify requirements. 2) The note overlaps the requirement expressed in ¶ 15-6.b. 3) Equipment manufacturers should be 	<p>See also Garmin’s previous general comment about A/RFM(S) limitations.</p> <p>Suggest removing this note after ¶ 15-6.d. and possibly modifying the wording of requirement ¶ 15-6.b. See also Garmin’s comments to ¶ 15-6.b. about AFMS limitations.</p>	Accepted. The note is redundant to the guidance in paragraph 15-6.b.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			<p>allowed to include the limitation in equipment operating instructions.</p> <p>4) The actual limitation is only requiring compliance with a general operating rule (described in the AIM) that flight crews are already expected to know.</p>		
121	Garmin	Page 118, ¶ 15-6.d. Note 3	<p>Includes the statement:</p> <p>“The intent is to indicate the equipment has a performance limitation and adequately capture that limitation in the AFMS/RFMS.”</p> <p>Two problems here:</p> <ol style="list-style-type: none"> 1) Equipment manufacturers should be allowed to include the limitation in equipment operating instructions. 2) The actual limitation is only requiring compliance with a general operating rule (described in the AIM) that flight crews are already expected to know. 	<p>See also Garmin’s previous general comment about A/RFM(S) limitations.</p> <p>At minimum, suggest changing: “adequately capture that limitation in the AFMS/RFMS”</p> <p>To: “adequately capture that limitation in the equipment operating instructions or AFMS/RFMS”</p>	<p>Not Accepted. Limitations affecting aircraft capability belong in the AFM(S)/RFM(S).</p> <p>AC 23-8C enables a pilot’s operating handbook to serve as an AFM if formatted to GAMA publication 1.</p>
122	Garmin	Page 118, ¶ 15-7.1.a.	<p>Includes the statements:</p> <p>“When installing equipment that uses GPS/SBAS for integrity during instrument meteorological conditions, there must be a performance limitation in the installation instructions (or equivalent installation documentation) for inclusion as a limitation</p>	<p>See also Garmin’s previous general comment about A/RFM(S) limitations.</p> <p>There should be no requirement for an airplane or equipment limitation since this is a general operating rule.</p>	<p>Not Accepted. The flight planning operational mitigation is the result of an equipment performance limitation. Any limitation affecting the aircraft capability needs to be</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			<p>in the AFMS/RFMS. This limitation must indicate the equipment has a performance limitation necessitating an alternate airport flight planning operational mitigation (see appendix 5 for an example).”</p> <p>Three problems here:</p> <ol style="list-style-type: none"> 1) As written, the applicable “must” refers only to installation manual content (not the AFM itself). 2) Equipment manufacturers should be allowed to include the limitation in equipment operating instructions. 3) The actual limitation is only requiring compliance with a general operating rule (described in the AIM) that flight crews are already expected to know. 	<p>If the requirement for a limitation can’t be removed here, we suggest changing:</p> <p>“must be a performance limitation in the installation manual (or equivalent installation documentation) for inclusion as a limitation in the AFMS/RFMS”</p> <p>To:</p> <p>“must include a limitation in the equipment operating instructions or AFM(S)/RFM(S)”</p> <p>Also change “AFMS/RFMS” in the note that follows this paragraph to “equipment operating instructions or AFM(S)/RFM(S)”</p> <p>Rationale: The actual limitation is only requiring compliance with a general operating rule (described in the AIM) that flight crews are already expected to know.</p>	<p>documented in the AFM(S)/RFM(S).</p> <p>AC 23-8C enables a pilot’s operating handbook to serve as an AFM if formatted to GAMA publication 1.</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
123	Garmin	Page 119, ¶ 15-7.2.c	<p>This paragraph states:</p> <p>“GPS/SBAS installations of Class 3 or Class 4 equipment that complies with TSO revision ‘b’ or later with a deviation to not include LP capability must have an appropriate limitation included in the AFM(S)/RFM(S).”</p>	<p>See also Garmin’s previous general comment about A/RFM(S) limitations.</p> <p>Suggest changing: “limitation included in the AFM(S)/RFM(S).”</p> <p>To: “limitation included in either the equipment operating manual or the AFM(S)/RFM(S).”</p> <p>Rationale: Since the quoted limitation is based exclusively on the design of the equipment, equipment manufacturers should be allowed to provide the limitation in the equipment operating manual.</p>	<p>Not Accepted. LP is a MOPS requirement as implemented by TSO. Having a deviation to not include LP capability in the equipment affects the aircraft capability after installation. A limitation on aircraft capability needs to be documented in the AFM(S)/RFM(S) because it affects the safe operation of the aircraft.</p> <p>AC 23-8C enables a pilot’s operating handbook to serve as an AFM if formatted to GAMA publication 1.</p>
124	Garmin	Page 131, ¶ 16-5.a.	<p>Includes the statement:</p> <p>“It is essential that procedures or optional functions an aircraft is not capable of performing are either removed from the RNAV multi-sensor equipment database, or otherwise inhibited, even if the avionics do support the function.”</p> <p>Problem:</p>	<p>We suggest adding a note after ¶ 16-5.a. as follows:</p> <p>“Note: The intended scope of this guidance is limited to optional procedures and functions described by this Advisory Circular and the applicable TSO/MOPS.”</p>	<p>Not Accepted. Though not captured correctly for the comment, the actual text is exactly the same as is in paragraph 15-5.a relative to SBAS; yet the suggested resolutions are different.</p> <p>The paragraph predicates any</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			We are concerned that the phrase, “procedures or optional functions”, could be interpreted in an expansive way that is well beyond the intended scope that is specifically defined in this AC. Taken literally, it could be seen as a requirement to inhibit (non-authorized) conventional procedures in the navigation database.		limitation on: 1) equipment having a particular functional capability, and 2) the aircraft not able to support that capability. The paragraph states a limitation is necessary when those two conditions exist. The suggested change does not make the point any more clear.
125	Garmin	Page 134, ¶ 18-2.b	Includes the statements: ‘A special concern is using baro-VNAV vertical path guidance on published instrument procedures due to potential anomalies. A baro-VNAV airworthiness approval must have language in the installation instructions for an AFM(S)/RFM(S) limitation on baro-VNAV vertical path guidance. The limitation is that flight crews/pilots must not rely solely on the baro-VNAV vertical path guidance for compliance to published altitude restrictions during SIDs, STARs and LNAV or LP approach procedures. The flight crew/pilots must use the primary barometric altimeter to confirm compliance with all published	Remove ¶ 18-2.b Rationale: ¶ 18-2.b is now redundant with ¶ 4-3.a.	Not Accepted. The comment is correct that 4-3.a and 18-2.b have exactly the same language in the paragraph. However, there is no harm in this because they are exactly the same and those looking only in baro-VNAV sections will see the guidance similar to those who only look at chapter 4 to find advisory vertical guidance information. Repeating the information in

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			<p>altitude restrictions. This includes use of the primary barometric altimeter to ensure compliance with all step-down fixes in the final approach segment of an instrument approach (see paragraph 12-8). The AFM(S)/RFM(S) (or equivalent documentation) limitation language must be equivalent to the following:</p> <p>“When using the <insert name> VNAV system, the barometric altimeter must be used as the primary altitude reference for all operations; including instrument approach procedure step-down fixes.”</p> <p>The problem is this: As revised in change 2 of the AC, this proposed limitation is actually applicable to any use of advisory VNAV (compliance to published altitude restrictions during SIDs, STARs and LNAV or LP approach procedures) regardless of the type or qualification of the sensor (SBAS or Baro-VNAV). Requirements for such limitations on advisory VNAV are already addressed in ¶ 4-3.a.</p>		two sections ensures those who do not read the entire 261 pages will find the pertinent information in the sections of their particular interest.
126	Garmin	Page 140, ¶ 19-8.a and 19-8.b	<p>19-8.a includes:</p> <p>“The TSOA provides sufficient evidence for compliance to RTCA/DO-200B for the</p>	<p>Suggest revising 19-8.a to:</p> <p>“The TSOA provides sufficient evidence for compliance to a</p>	Partially Accepted. RTCA/DO-200B was replaced with AC 20-153(latest revision) per a

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			<p>installation approval, but operational approval for IFR use is based upon a database assurance process through a type 2 LOA.”</p> <p>19-8.b includes:</p> <p>“Verify the navigation database type 2 LOA exists with reference to RTCA/DO-200B as recognized in AC 20-153 (latest revision).”</p> <p>As written, these statements ignore the fact that there are existing TSOAs and Type 2 LOAs granted against RTCA/DO-200A.</p>	<p>recognized revision of RTCA/DO-200() for the installation approval, but operational approval for IFR use is based upon a database assurance process through a type 2 LOA.”</p> <p>Suggest revising 19-8.b to:</p> <p>“Verify the navigation database type 2 LOA exists with reference to a recognized revision of RTCA/DO-200() in accordance with AC 20-153 (any revision).”</p>	<p>previous suggestion. AC 20-153B will contain industry accepted information on applying DO-200().</p>
127	Garmin	Page A2-3, ¶ A2-2.c	Editorial	Correct the formatting of the equation for vertical accuracy,	Accepted. The equation was re-done in a newer Word version that has more compatibility when converting to PDF.
128	Garmin	Page A2-15, ¶ A2-3.e.(15)(b)	<p>General requirement for RNP AR operations states:</p> <p>“(b) In-service aircraft that do not display the current navigation sensor in use may still be eligible for RNP AR approach operations. To be eligible, the aircraft manufacturer must demonstrate continued RNP AR approach performance when GNSS is lost (for</p>	Remove the entire (b) paragraph and all subsections and related notes. At a minimum, move the entire section back to the original location under ¶ A2-5.e.	Not Accepted. First, the paragraph does not “require” inertial navigation. Inertial navigation is provided as an example of how RNP AR performance can be maintained after GNSS is lost.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			<p>example, through inertial navigation) and continue to monitor/annunciate loss of RNP capability (i.e., annunciating “Unable RNP”). Since the loss of GNSS is unlikely: --- etc.”</p> <p>The requirement appears to have been moved from ¶ A2-5.e which dramatically increases the scope of this requirement. Now the requirement implies that all RNP AR systems that do not display the current navigation sensor must have inertial positioning capability. Inertial navigation is only required for RNP less than 0.3 according to A2-5.a.</p> <p>The requirement was also previously only applicable to go-around or missed approach scenarios with RNP less than 1.0 according to A2-6.b. Relocating it to this section expands the scope to general approach operations, and also moves the loss of GNSS discussion from the related missed approach context to a less related navigation sensor display context.</p>		<p>Second, the comment this guidance expands the “requirement” from missed approach only to the entire approach is incorrect. The display of sensor was always necessary for the entire RNP AR approach; it was previously more difficult to tell because the information was in two separate locations.</p> <p>The information was moved to this section because section A2-3.e(15), titled “display of active sensors” is more appropriate to this information than the previous location.</p> <p>A2-3.e(15)(a) already stated the aircraft display had to show the current sensor(s) in use which applies to the entire RNP AR approach. A2-3.e(15)(b) then describes a method for demonstrating</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
					that aircraft not meeting A2-3.e(15)(a) can still qualify for RNP AR approval. (i) is for the final approach segment and (ii) is for the missed approach segment.
129	Garmin	Page A2-22 – A2-23, ¶ A2-7.d	<p>Includes the statement:</p> <p>“As a minimum, data suppliers must have an LOA for processing navigation data in accordance with AC 20-153. An LOA recognizes the data supplier as one whose data quality, integrity, and quality management practices are consistent with the criteria of DO-200B. The aircraft operator’s supplier (e.g., FMS manufacturer) must have a Type 2 LOA. Those entities providing data to the aircraft operator’s supplier likewise must possess either a Type 1 or Type 2 LOA.”</p> <p>Problem: This “minimum” process is considered insufficient for RNP AR which is what drives the need for the additional steps described in ¶ A2-7.b.(1) and ¶ A2-7.d. Additionally, these statements ignore the fact that there are existing Type 2 LOAs granted against RTCA/DO-200A.</p>	<p>Add a note as follows:</p> <p>“It is acceptable for the aircraft operator to delegate compliance with paragraphs A2-7.b.(1) and A2-7.c.(1) to the data supplier as part of its approved data quality process if the supplier can supply evidence of FAA approval for such a process.”</p> <p>Rationale: Garmin already holds an FAA approval to provide these additional validation steps on behalf of its operators. AC 20-138D Chg 2 should provide installers and operators with information that this is an acceptable means of compliance.</p>	<p>Partially Accepted. Per a previous comment the text was changed to eliminate the IAW criteria reference to DO-200B by instead referencing AC 20-153 (latest revision). The text was changed as follows:</p> <p>As a minimum, data suppliers must have an LOA for processing navigation data in accordance with AC 20-153 (<i>latest revision</i>). An LOA recognizes the data supplier as one whose data quality, integrity, and quality management practices are consistent with <i>an acceptable process</i>. The aircraft operator’s supplier (e.g., FMS manufacturer) must have a Type 2 LOA.</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
					Those entities providing data to the aircraft operator’s supplier likewise must possess either a Type 1 or Type 2 LOA.
130	Garmin	Page A2-25, ¶ A2-8.c.(1)(d)	Includes the statement: “This includes GNSS-based limitations in the AFM(S)/RFM(S) for RNP AR APCH availability predictions at the destination, or checking NOTAMs.”	See also Garmin’s general comment above about A/RFM(S) limitations. Remove the quoted ¶ A2-8.c.(1)(d) statement. Rationale: This proposed AFM limitation is not an airplane limitation and also is not a system limitation that is unique to a specific manufacturer’s equipment but instead is a generic operational limitation as evidenced by AC 90-101A Chg 1 Appendix 4 ¶ 2.d guidance that states: “The operator must establish procedures requiring use of [RNP predictive performance] capability as both a preflight dispatch tool and as a flight-following tool in the event of	Not Accepted. The guidance says to check all equipment limitations that can affect RNP AR. This is a completely consistent and logical statement. The AFM(S)/RFM(S) is where limitations and aircraft capability is documented and why the AC guidance is so consistent about documenting aircraft capability in the AFM(S)/RFM(S). AC 23-8C enables a pilot’s operating handbook to serve as an AFM if formatted to GAMA publication 1.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
				<p>reported failures.”</p> <p>In summary, it is unclear why the FAA has chosen a path that promotes cluttering the AFM with GPS operational limitations that are better handled in other documentation like Ops Specs (which all RNP AR approval holders are expected to have).</p>	
131	Garmin	Page A3-2, ¶ A3-1.d.	<p>Includes the statement:</p> <p>‘Equipment manufacturers that choose to include selected advanced RNP functions or “advanced RNP” recognition must provide an advanced RNP statement of capabilities document in the installation instructions/manual.’</p> <p>Problem: Use of the keyword “must” is inappropriate here because it creates an unnecessary certification obstacle for equipment manufacturers that might choose to provide the information in another way (other than installation instructions/manual).</p>	Suggest changing “must” to “should” in the quoted statement.	Accepted.
132	Garmin	Page A3-4, ¶ A3-2.b.(1)	<p>Includes the statements:</p> <p>‘Current Flight Standards policy requires using an autopilot or FD with at least “roll-</p>	Revise these statements to acknowledge autopilot and/or flight director are not required for curved paths with RNP 1 and	Not Accepted. Flight Standards policy over-rides DO-283B requirements. The FAA has authority to add to

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			steering” capability that is driven by the RNP system during RNP procedures with RF legs. The autopilot/FD must operate with suitable accuracy to track the lateral and, as appropriate, vertical paths required by a specific RNP procedure.’	<p>higher when flown at terminal speeds.</p> <p>Rationale: Current “Flight Standards policy” is not consistent with DO-283B (Table 2-7) and ¶ 17-2, Table 9 of this AC.</p> <p>Industry consensus (substantiated with flight test results) is that autopilot and/or flight director are not required for curved paths with RNP 1 or higher.</p>	or amend any MOPS requirements at its discretion.
133	Garmin	Page A3-4, ¶ A3-2.b.(2)	<p>Includes the statement:</p> <p>“The flight management computer, the FD system, and the autopilot must be capable of commanding a bank angle up to 30 degrees above 400 feet AGL.”</p> <p>Problem: Small propeller aircraft and rotorcraft utilize much slower speeds in the terminal area (as compared to turbojets) and thus do not require 30 degrees of bank angle to achieve an appropriate turn radius. In most cases, existing FD and autopilot installations will not permit such a steep bank angle and</p>	<p>Change “must” in the quoted statement to “should”.</p> <p>Rationale: Aircraft and Rotorcraft that utilize lower terminal area speeds do not require 30 degrees bank to achieve an appropriate turn radius.</p>	<p>Partially Accepted. The note contained information about slower aircraft not achieving these bank angles. That was deleted and moved with additional text into the paragraph as follows:</p> <p>The flight management computer, the FD system, and the autopilot must be capable of commanding a bank angle up to 30 degrees above 400 feet AGL.</p>

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
---------------------------------------	---	---	--------------------------	------------------------

	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
			modification of those same installations to allow 30 degrees of bank angle is expensive and unnecessary.		<i>Aircraft with lower speeds will typically not achieve these bank angles in normal operations. For these aircraft it may be acceptable for the flight management computer, the FD system, and the autopilot to command bank angles less than 30 degrees consistent with their maximum airspeed provided the airworthiness applicant can demonstrate RF leg performance (see appendix 7). For RNP AR...</i>
134	Garmin	Page A4-4, ¶ A4-3.g	Editorial	Correct the formatting of the equation for horizontal velocity error.	Accepted. Created the equations in a newer Word version compatible with conversion to PDF.
135	Garmin	Page A4-4, ¶ A4-4.a	Editorial	Correct the formatting of the equation for 95% horizontal velocity error.	Accepted. Created the equations in a newer Word version compatible with conversion to PDF.
136	Garmin	Page A4-5, ¶ A4-5	Editorial	Correct the formatting of the equation for $TS_{h,b}$	Accepted. Created the equations in a newer Word version compatible with conversion to PDF.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
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	Commenter	Section # and Page #	Comment	Suggested Change and Rationale	Disposition
137	Garmin	Page A4-7, ¶ A4-6.g	Editorial	Correct the formatting of the equation for v_i	Accepted. Created the equations in a newer Word version compatible with conversion to PDF.
138	Garmin	Page A4-7, ¶ A4-7.a	Editorial	Correct the formatting of the equation for 95% vertical velocity error.	Accepted. Created the equations in a newer Word version compatible with conversion to PDF.
139	Garmin	Page A4-7, ¶ A4-8	Editorial	Correct the formatting of the equation for $TS_{v,b}$	Accepted. Created the equations in a newer Word version compatible with conversion to PDF.
140	Garmin	Page A4-8, ¶ A4-9.f	Editorial	Correct the formatting of the equation for T_{non_acc} and $HDOP_{non_acc}$ in the text that follows.	Accepted. Created the equations in a newer Word version compatible with conversion to PDF.
141	Garmin	Page A4-8, ¶ A4-9.g	Editorial	Correct the formatting of T_{non_acc}	Accepted. Created the equations in a newer Word version compatible with conversion to PDF.
142	Garmin	Page A5-6, ¶ A5-Section 2, item 7.	Includes the statement: “7. ... Final approach segment step-down fixes do not apply to LNAV/VNAV approach procedure minima.” Problem: This statement is unnecessary since RNAV	See also Garmin’s previous general comment about A/RFM(S) limitations. Remove the quoted statement. Rationale: Including the quoted statement	Accepted.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
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			(GPS) approach charts clearly indicate which fixes are applicable only to the LNAV line of minimums.	in the AFM limitations has more potential to confuse than to clarify.	
143	Garmin	Page A7-18, ¶ A7-3.2.g and Note	<p>States:</p> <p>“Engage autopilot/flight director (as soon as practical after takeoff) and verify the autopilot/flight director is providing guidance to the lateral path.</p> <p>Note: Executing the procedures with autopilot engaged is desired. The test directors should also consider manually flying the procedures with flight director only if the respective test vehicle is capable.”</p>	<p>Revise these statements to acknowledge autopilot and/or flight director is not required for curved paths with RNP 1.</p> <p>See also Garmin’s comments for ¶ A7-3.2.h which suggests using a note to capture the issue of current flight standards policy requiring autopilot/flight director for RF legs.</p> <p>Rationale: These statements are not consistent with ¶ 17-2, Table 9 and DO-283B (Table 2-7) for RNP 1.0 or higher. Current industry consensus (substantiated by flight test evaluation) is that autopilot/flight director is not required for RF legs and RNP 1.0 or higher. Although current flight standards policy requires autopilot/flight director for all RF legs, there is no reason to prevent applicants from</p>	Not Accepted. Flight Standards policy requires autopilot or flight director for RF legs which overrides DO-283B.

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
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				demonstrating RF leg performance without that capability.	
144	Garmin	Page A7-18, ¶ A7-3.2.h	The RNP 1.0 “table” rows does not include Manual Operation in the FTE basis.	<p>Add “Manual Operation” to the FTE basis for RNP 1.0.</p> <p>Address the issue of current flight standards policy by adding a note as follows:</p> <p>“Current Flight Standards policy requires using an autopilot or FD during RNP procedures with RF legs.”</p> <p>Rationale: The RNP 1.0 “table” row is not consistent with ¶ 17-2, Table 9 and DO-283B (Table 2-7). In particular, current industry consensus (substantiated by flight test evaluation) is that autopilot/flight director is not required for RF legs and RNP 1.0.</p>	Not Accepted. For the test procedures in appendix 7 there is no acceptable “manual operation” FTE since Flight Standards requires an autopilot or flight director as specified earlier.
145	Garmin	Page A8-1 – A8-2, ¶ A8-1	Appendix 8 outlines considerations for certification of non-US constellations as non-TSO functions in advance of a multi-constellation receiver TSO. However, it makes no mention of supporting multiple	Provide clarification on FAA position on support of multiple GNSS frequencies as a non-TSO function.	Accepted. Included clarification that using new frequencies is acceptable as a non-TSO function provided

Public Review Comment Metric

Originating Office: AIR-130	Document Description: AC 20-138D Chg. 2	Project Lead/Reviewer Kevin Bridges	Reviewing Office:	Date of Review:
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			<p>GNSS frequencies as a non-TSO function in advance of a multi-frequency GNSS receiver TSO.</p> <p>Would reception of multiple GNSS frequencies be permissible as a non-TSO function? Would it be expressly prohibited?</p>		the signals are declared operational.
146	Garmin	Page A8-1, ¶ A8-1.d.	<p>Includes the statement:</p> <p>“... installation instructions must include appropriate language for an AFM(S)/RFM(S) limitation.”</p> <p>Problem: Use of the keyword “must” is inappropriate here because it creates an unnecessary certification obstacle for equipment manufacturers that might choose to provide the information in another way (other than installation instructions/manual).</p> <p>Also note that, as written, ¶A8-1.d. does not contain any requirement for the Airworthiness approval holder to actually include that limitation in the AFM(S)/RFM(S).</p>	<p>See also Garmin’s previous general comment about A/RFM(S) limitations.</p> <p>Suggest changing “must” to “should” in the quoted statement.</p>	Not Accepted. Adding constellations or frequencies on a non-TSO basis is a limitation since no operational credit is available to adding these functions.