Clearance Record
DOCUMENT COMMENT LOG

Originating Office:	Document Description:	Project Lead:	Reviewing Office:	Date of Review:
AIR-130	**AC 20-138D**	Kevin Bridges		

Comment Number	Page & Paragraph	Comment	Rationale for Comment	Recommendation	Disposition
1.	All	The combination of guidance currently available (this AC, AC 90-101 and AC 90-105) do not make clear the FAA's interpretation as to what systems are and are not "basic RNP" systems for airworthiness purposes. They also do not make clear the FAA's intended use of RNP procedures, including any intent to redesignate existing procedure types as RNP. Paragraphs 1-1.a. and 1-1.c. distinguish between "Global positioning system (GPS) sensors or stand-alone navigation equipment, including those incorporating aircraft-based augmentation system (ABAS), satellite-based augmentation system	Existing guidance is insufficient to the needs of pilots, operators, systems developers and installation approval applicants. Inappropriate designation of procedures as RNP will result in unnecessarily burdensome compliance requirements. Subclassification of RNAV (GPS) procedures based on their content or performance requirements will be excessively complicated for Part 91 operators and will result in operational errors and degraded safety.	1. Define "basic RNP" procedures as those that require no special equipment, aircraft or crew qualification. Such procedures should be RNP 1.0 with regard to operations outside the FAF and RNP 0.3 on final approach. Designate all such procedures "GPS" or "RNAV (GPS)" with no further annotation. 2. Define "advanced RNP" procedures as those that require some special equipment and/or aircraft qualification but no special crew qualifications. Designate all such procedures "RNAV (RNP)" without an "authorization	**Partially Accepted.** This AC is not a policy setting document and is not intended to define how procedures are named, how procedures are defined (i.e., the procedure design criteria), or determine how or where certain procedure types are implemented. Further, RNP is not a "system" definition, it is a "performance" definition. This means that any equipment meeting the RNP performance specifications is acceptable. However, a basic primer on RNAV and RNP was provided in the frequently asked questions section (paragraph 1-4.f) that specifically states GNSS equipment is, by definition,

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		(SBAS), or ground-based augmentation system (GBAS)" and "RNAV intended for required navigation performance (RNP) operations, including advanced functions and RNP authorization required (AR) formerly referred to as special aircraft and aircrew authorization required (SAAAR).". By way of contrast, Paragraph 5-1a states that "GNSS equipment provides accuracy performance monitoring and alerting which, by definition, makes in an RNP capable system." This stops short of saying that it *is* an RNP system for purposes of this AC (which would drive numerous compliance requirements that go well beyond those historically applied to the installation of GPS and GPS/SBAS systems). And Paragraph 8-1 states that "RNP		required" notation. 3. Retain "RNAV (RNP)" with an "authorization required" notation as-is. 4. Identify criteria for all leg types (RF included) that permit their use in each category. 5. Amend guidance to make a clear distinction between "basic RNP" procedures that require no special equipment, aircraft or crew certification,	RNP capable because it includes on-board monitoring and alerting. Paragraph 7-2.a (not changed since revision 'B' was published) states: *GPS is the primary navigation system to support RNP approach procedures.* Paragraph 7-3 has a similar description for RNP 1.0 and RNP 2.0. Paragraph 8-1 clearly defines GPS and RNAV (GPS) approach procedures as RNP procedures. However, paragraph 7-1.c has been added that describes the foundation of RNP and provides clarification on the GNSS TSOs that qualify along with certain conditions where needed. Paragraph 8-2 and 9-2 have been modified consistent with paragraph 7-1.c to add clarity.

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		approach operations… are designated under Part 97 as RNAV (GPS) or GPS", suggesting that this AC has, with a wave of its hand, changed all GPS approaches to RNP approaches. We believe that the correct interpretation is that RNP systems are, or should be, those that are intended to support *designated* RNP procedures in the NAS. We use the term "designated RNP procedures" to distinguish between "ordinary" RNAV procedures that have a traditional expectation of navigational performance (supported by the TERPS) and happen to incidentally benefit from the RNP characteristics of modern equipment from those procedures specifically designed to take advantage of higher levels of navigational performance			

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		through the application of tighter TERPS criteria. At present, it is unclear what procedures the FAA intends to "designate" as RNP procedures under this meaning. If wholesale redesignation of existing GPS and/or RNAV (GPS) procedures as RNP is under consideration, and if that such redesignation triggers significant new compliance requirements under this AC, it is unacceptable based on the level of safety already demonstrated under the traditional system. Moreover, the burden of compliance with AC 90-105 for Part 91 operators, in particular, is unacceptable and possibly unachievable with currently installed equipment. If subclassification of these procedures into RNP and non-RNP procedures is contemplated, the potential			

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		for confusion among pilots, ATC, operations departments, modifiers and others is overwhelming. This is particularly true for relatively inexperienced Part 91 pilots who are tasked with making flight planning and in-flight decisions based in part on the operational capabilities of their airplanes and equipment. If these capabilities are obscured by new complexities in procedure design, it can have significant adverse safety effects.			
2.	N/A	There is no guidance regarding acceptability and means to approve "Final End Point" navigation coding for conventional procedures.	The questions with acceptability of step-downs raises questions regarding the acceptability of Final End Point coding, which provides vertical guidance to the runway when lateral guidance is not provided to the runway. The specific question is addressing acceptability of providing advisory VNAV	Provide explicit guidance regarding approval basis for Final End Point Coding. Refer to ARINC 424 versions in use, such as Supplement 18 and later versions.	**Not Accepted.** Chapter 4 makes it quite clear that there are no standards for how advisory vertical navigation is provided because it is "advisory"; not for any credit. Providing advisory vertical guidance for some lateral path that is not part of the published path for conventional procedures is

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			for a path different than the published lateral path.		no different than providing advisory vertical guidance for enroute or terminal operations. Additionally, ARINC 424 is a communication protocol; not a minimum requirement in any navigation standard.
3.	Not applicable	There are a number of AFM limitations spread throughout the text.	The reader might benefit if all these AFM dispositions are collected in just one chapter/section.	To include a dedicated chapter to address all the AFM limitations.	**Not Accepted.** There have been other comments that the AC already contains too much redundant information. To list all the AFM limitations without the benefit of the explanation contained in the pertinent section would most likely cause more confusion and consternation than it would solve. Additionally, limitations may also depend upon the specific equipment design and may not be broadly applicable. Appendix 5 contains a sample flight manual limitation section with

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					some limitations that are broadly applicable.
4.	All	The AC is very comprehensive with respect to airworthiness issues. While the impulse is appreciated, as is the FAA input on acceptable means of compliance, it often seems to go beyond its scope. In particular, there are many cases where it states requirements that are (or should be) in a TSO or a MOPS (much of Chapter 5, for example), in ACs or other documents pertaining to other interfaced equipment (the material pertaining to the impact of failed outputs on external equipment, for example) or in guidance describing generally accepted alteration methods (the material on wiring and anti-interference filtering, for example) and other general issues (Paragraph 17-4 on software change practices). Many, many paragraphs	Out-of-scope material results in unnecessary compliance burdens on applicants and extra work reviewing the results at the FAA. Inclusion of material that properly belongs in other documents has the effect of hiding it from the users of those other documents.	1. Eliminate material in this AC that already appears in other documents. If necessary, make reference to the other documents rather than repeating the material. 2. Eliminate or clearly identify material that does not constitute part of the means of compliance with airworthiness requirements offered by this AC. 3. Where material appears in this AC that properly belongs elsewhere, identify it for future action.	**No Action at this time.** We completely understand the comment. However, there are competing priorities for this document that are occasionally in opposition to each other. The intent of the document is to provide all positioning and navigation system guidance in one document. There are other comments to include even more information in the AC (such as that requested in comment #2). It is always a struggle to moderate the amount of information in the document given: all the possible combinations/permutations of equipment integrations; the narrower focus of individual commenters on their specific issues; new issues found during

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		offer only information or other material not relevant to compliance with airworthiness requirements. Short term inclusion of this material in this AC greatly complicates the document and its analysis with regard to a particular applicant's needs. Its long term maintenance in this AC will have the effect of hiding it from many of those who are directly affected.			certification applications in the field; desire for reduced referencing of other documents for "one-stop-shopping" to ease the burden of finding information; experienced readers versus inexperienced readers; and having the guidance material intent interpreted correctly.
5.	All	It appears that many compliance items are adequately addressed by TSO compliance. This is not always clear from the AC as written, resulting in a potential for redundant compliance activities or redundant documentation of compliance activities conducted in the course of TSOA. In those cases where the installation approval applicant is not the TSOA holder, specific visibility to compliance	Redundant activities or documentation result in an unnecessary burden on both the applicant and the FAA.	1. For each TSO discussed in Chapter 3, list those sections elsewhere in the AC whose compliance requirements are adequately addressed (in whole or in part) by TSOA; and/or 2. For each section that identifies a compliance requirement that is adequately addressed (in whole or in part) by TSOA, make a clear statement to that effect.	**Partially Accepted.** This is a difficult proposition because a TSOA is a design and production approval, not an airworthiness approval. It is the airworthiness applicant's responsibility to make the argument that the equipment TSOA, after installation, addresses the necessary airworthiness compliance (in whole or in part) as part of their application.

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		activities conducted within the TSOA program may be unavailable.			However, the TSOA holder can greatly assist the airworthiness applicant thru information contained in the installation instructions which is something this AC tries to encourage. But, a new note has been added to paragraph 11-11.b as follows: **Note 3:** The General Aviation Manufacturers Association with FAA collaboration published Publication Number 10 that has recommended guidelines for Part 23 cockpit/flight deck design. Applicants may apply these guidelines for their Part 23 installations. Additional guidance can be found in FAA Human Factors Design Guide. DOT/FAA/CT-96/1.
6.	All	Previous versions of the AC included the concept of a pilot's "primary field of	Loss of the "normal field of view" definition makes the AC less precise and less	Restore the historical definition of the "normal field of view" as well as the	**Partially Accepted.** The current definitions were coordinated with the

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		view" and "normal field of view". "Normal field of view" has now been removed; "primary field of view" evidently has taken its meaning. This has been supplemented by "primary optimum field of view" (grammatically awkward and presumably the same as the former "primary field of view"). We find these terms, as defined, to be less clear than the predecessor terms and contrary to common usage. We suspect that not all references in the AC have been adjusted to the new nomenclature, based on the scarcity of references to the "primary optimum field of view." The questionable utility of the current definitions is further shown by the AC's need to identify items for location "where it is clearly visible to the pilot with the least practicable deviation from the pilot's normal position and line of vision	usable.	associated requirements for data placement.	human factors experts during revision 'B' development to be consistent with the terminology used in other ACs. These definitions have not changed since revision 'B'. If the terms were not used in a specific paragraph it is probably because that paragraph was consolidated from another document or AC 20-138A without change. It is also possible that the language was adjusted due to comments received during previous iterations. However, the comment on paragraph 11-11.b(1) is correct and the text has been changed for clarity as follows: *…pilot's normal position and line of vision when looking forward along the flight path (i.e., within the primary optimum field of view).*

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		when looking forward along the flight path" (Paragraph 11-11b.(1); isn't that the definition of the primary optimum field of view??). We also strongly suspect that the definition of the "primary field of view" is faulty – that "eye rotation only using foveal or central vision" is insufficient to achieve clear vision for many individuals at a horizontal displacement of 35° from center. (Indeed, we understand the "normal field of view" definition to include an expectation of head movement, and would thus have the same expectation with the new maximum "primary field of view".) To the extent that manufacturers have incorporated the term "primary field of view" into their engineering and compliance documentation, this change will cause havoc.			
7.	All	The AC uses "RNP 1",	Inconsistent notation is	Use a single form for RNP	**Accepted.** All references

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		"RNP-1" and "RNP 1.0" interchangeably. A single form should be chosen, hopefully considering what usage is standard among all documents. If necessary, a simple statement somewhere could be made indicating that all three mean the same thing for the benefit of readers coming in from other documents, but all usages in this AC should be the same.	confusing.	1.0 (our preference) throughout the AC.	have been changed to RNP 1.0.
8.	Various	The restrictions on the use of RF legs are excessive. RF legs could be used to advantage in procedure design with identical geometric and protection parameters as DME arcs. In addition, an FAA-commissioned research study has shown that the MITRE test procedures can be successfully hand flown on small airplanes of diverse performance. Demonstration of performance for every airplane	Restrictions are not justified based on available evidence.	Permit limited use of RF legs as part of basic RNAV (GPS) procedures with no special showing.	**Not Accepted.** The NextGen/Greener Skies initiative is creating a new policy limiting the application of RF legs used for non-RNP AR approach procedures. The new policy is predicated upon aircraft having a roll-steering autopilot or flight director. Contact AFS-400 for further information.

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		type/navigator/autopilot combination for certification is unnecessary based on the available evidence.			
9.	Various Places (e.g. 3-4.b.(3), 4-1)	The reference to GPS/SBAS with GPS-provided approved vertical capability is inconsistent in the document.	Use the same term when referring to GPS/SBAS with GPS-provided approved vertical capability, like "SBAS-VNAV"	Define the term SBAS-VNAV as GPS/SBAS with GPS-provided approved vertical capability. Use this term when the document refers to GPS/SBAS with GPS-provided approved vertical capability. For example: 3-4.b.(3) change "both baro-VNAV and GPS/SBAS" to "both baro-VNAV and SBAS-VNAV", and 4-1 change "typically uses GNSS or baro-VNAV" to "typically uses SBAS-VNAV or baro-VNAV".	**Not Accepted.** The comment to use consistent terminology is accepted, but only paragraph 4-1 had the cited instance of inconsistent terminology use. A complete document search turned up no other instances of "GPS/SBAS with GPS-provided approved vertical capability." But the context in paragraph 4-1 makes the use of "GNSS" appropriate. That is because 4-1 refers to "advisory" vertical guidance where <u>any</u> method is acceptable; including non-augmented GPS using simple geometric calculation (hence the term GNSS).
10.	Cover page, 1st	Use of the phrase "radius to fix (RF) turn" is	Consistency with other documents like RTCA DO-	Change to "radius to fix (RF) leg"	**Accepted.** All references throughout the document

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	paragraph	inconsistent with industry standards.	283A, RTCA DO-229D, and ARINC 424.		have been changed to RF leg.
11.	Page 2 Paragraph 1-1.j.	Paragraph 1-1.j. supplies standard language stating that "In lieu of following this method without deviation, the applicant may elect to follow an alternate method,…" Due to the scope and complexity of this AC, it seems highly unlikely that any applicant will follow its methods without deviation. For clarity, it should be noted that partial use of the methods offered is a preferred compliance approach.	Maximum use of identified means of compliance should be encouraged.	Amend Paragraph 1-1.j. to indicate that selective use of the AC's methods is expected and is advantageous to both the applicant and the FAA over completely	**Not Accepted.** The AC attempts to categorize the guidance (equipment performance, installation considerations, and installed performance) as well as segregate according to equipment type (general applicable to all, GNSS, Multi-sensor system, or baro-VNAV) to make it easier to find only the relevant guidance information for the application. But, having a "one-stop-shopping" guidance concept has the disadvantage of being large and including information that one particular applicant might not need even though other applicants will need it. Very few applicants will need to use all the guidance in this AC. For example, any applicant not including baro-VNAV capability will

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					not be concerned with guidance in the baro-VNAV chapters or be expected to follow that guidance. Paragraph 1-1.j uses standard language for any AC. Whether applicants choose to follow any or all of the guidance applicable to their project is strictly their decision. Making the suggested change neither aids in understanding the guidance information contained in this AC nor aids in using the AC.
12.	Page: 4 Para: 1-4. c.	There are references to AC 20-138B in the question and answer section.	Aren't many of those issues cleaned up in the 20-138C version?	Might you consider removing them in this new version, or updating to reflect the current text? Or, add a statement on the pending update as in 10-1.b.	**Accepted.** The questions and responses are still relevant to help applicants understand the guidance material in this revision. However, the text was updated where necessary by either eliminating AC references or changing the revision letter.
13.	Page 4, ¶ 1-4.c.(1)	References "AC 20-138B, section 6-7 c."	It is unclear why this reference is to "AC 20-138B" rather than "AC 20-	Update referenced AC 20-138 version as appropriate.	**Accepted.** Some references to older revisions are necessary for

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			138D".	Check other "20-138" references throughout the document and update as necessary.	clarity based on context, but all other references have been changed to "D."
14.	Page 5, ¶ 1-4.e.(2)(a)	Editorial	Punctuation	Suggest changing: "The acronym 'GNSS' includes satellite constellations such as GPS, GLONASS, Galileo, or Beidou along with augmentation systems such as 'SBAS' and 'GBAS';" To: "The acronym 'GNSS' includes satellite constellations, such as GPS, GLONASS, Galileo, or Beidou, along with augmentation systems, such as 'SBAS' and 'GBAS';" (insert commas after "constellations", "Beidou", and "systems")	**Accepted.**
15.	Page 5, ¶ 1-4.e.(2)(b)	Editorial		Suggest changing: "Please refer"	**Accepted.**

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				To: "Refer"	
16.	Page 5-6, ¶ 1-4.f.(1), ¶ 1-4.f.(1)(a)	Includes only (TSO)-C129(AR) Class A1 in the question (¶ 1-4.f.(1)) and answer (¶ 1-4.f.(1)(a)).	While the question and answer are correct as written, they don't consider that TSO-C129(AR) Class A2 equipment also could be considered RNAV and RNP systems although they are limited to en route and terminal RNAV and RNP capabilities and do not support RNAV (GPS) approaches to LNAV minimum.	Consider including TSO-C129(AR) Class A2 in the question and answer.	**Not Accepted.** The suggested additional information does not add anything to the discussion of RNAV versus RNP. The FAQ is intended as a concept discussion, not a laundry list of qualifying TSOs. Additionally, Class A2 describes a very old, very limited set of installed equipment.
17.	Page 5 Para. 1-4. f. (2)	The answer makes no reference to the appropriate TSO for RNAV/RNP equipment such as TSO-C115c.	Clarify the appropriate TSO for RNAV/RNP capability.	Revise Note (page 6) to say ….when interfaced to an appropriate navigation computer (e.g. TSO-C115c).	**Accepted.**
18.	Page 5 Para. 1-4 f. (2) Figure 2. RNP Depiction	By definition RNP alerting is not based on 95% accuracy but on 2xRNP containment integrity (10^{-5}).	Clarification is requested since Figure 2 could be interpreted as depicting RNP alerting based on accuracy. There is no specific requirement to alert on 1xRNP using a 95% accuracy; this is only an acceptable implementation.	Suggested revision. After "…(see Figure 2 below)" add the following: "In this case the alert is generated when the probability that the TSE exceeds the 2xRNP limit is greater than 10^{-5}."	**Accepted.**

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			Ref: RTCA/DO-283A section 1.9.3	In addition, an associated revision to Figure 2 would be helpful.	
19.	Page 7, Figure 2	The "Alert to Pilot" box in Figure 2 isn't clear as to when the alert will occur.	While the intent may be that the "Alert to Pilot" box is outside the 1 nm 95% line, it isn't clear that it could occur on either side of the aircraft outside the 1 nm 95% line.	Suggest changing the "Alert to Pilot" box in this figure to "Alert to Pilot When RNP 1 Cannot Be Maintained" or adding an "Alert to Pilot" box on the other side of the aircraft as well.	**Accepted.** The figure has been modified to show the alerting at 2xRNP.
20.	Page 6, ¶ 1-4.f.(2)(c)	The paragraph includes the use of the word "approval", "approvals", and "approved" in the context of RNP AR.	AC 90-101A uses the term "authorization" and RNAV(RNP) charts use the term "authorization required".	Suggest using "authorization" and "authorized".	**Not Accepted.** While correct from a strict comparison standpoint, the ACs readers are expected to understand the equivalence between the terms 'approval' and 'authorization' since aircraft certification typically issues design, production, and airworthiness approvals.
21.	Page 6 Para. 1-4.f (2) (c)	RNP AR procedures may be included in the navigation database if the equipment has the capability, by configuration, to filter them	With ARINC 424A the industry is moving toward a unique navigation database for all systems and platforms. Filtering will be performed at the equipment	Replace: "No RNP AR procedures can be included in the navigation databases of equipment that is not approved for RNP AR	**Not Accepted.** Compliance with ARINC 424A is not a specified requirement in any TSO. There has been an issue

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		out.	level based on its installed/configured capabilities. This is already accounted for in para. 11-8b.	operations." by: For equipment that is not approved for RNP AR operations, manufacturers must provide a method to inhibit RNP AR procedures. To meet this need, manufacturers may choose to employ installation-specific configurations (i.e., software, strapping, etc.), or they may offer a tailored navigation database (i.e. a database with RNP AR procedures and a database without RNP AR procedures).	with fielded equipment containing RNP AR approaches in a database that could be selected by the pilot when neither the equipment, aircraft, nor pilot were approved for RNP AR operations. RNP AR is very unique and has unique database control and management requirements as part of the approval. Therefore, RNP AR should not and cannot be part of a "standard" database package.
22.	Page 7 Para. 1-4. g. (2) and (2)	Even though the question is about an Incomplete System TSO, the answer implies that a complete TSOA is not possible with a card.	There are TSOA for circuit card assemblies in existence today. Some such TSOed cards are used in IMA and others within an LRU in federated systems. We agree that the TSOA holder must have design and product control over the	Add item (c) to the answer: (c) It is acceptable to get a complete TSOA at the circuit card level with appropriate limitations and installations instructions. This applies both in the context of an IMA with TSO-C153 certification and	**Not Accepted.** The suggested addition is the subject of an independent TSO and for modular avionics (TSO-C153 and AC 20-170). It is not necessary to re-create the complex requirements and guidance in the FAQ; the reference to 20-170 is

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			article. We see no reason why an end-equipment manufacturer could not take credit from a card TSOA that includes appropriate installation instructions and perform testing per these instructions in order to obtain end-equipment TSOA or an STC.	in the context of a federated system (non IMA) without TSO-C153.	sufficient. The FAA has addressed the GNSS circuit card issue by releasing new TSOs. Refer to TSO-C204, -C205, and –C206.
23.	Page 8, ¶ 1-4.h.(2)	Includes the following: 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 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.	Our equipment has displayed step-down fixes during LPV approaches since their initial airworthiness approval in 2006. Our other TSO-C146 equipment receiving initial airworthiness approval since 2006 also have displayed step-down fixes during LPV approaches. This represents over 40,000 aircraft installations in the US (over 60,000 aircraft worldwide) across all aircraft parts (23, 25, 27 & 29). The majority of these installations are in '"classic" cockpits with limited display capabilities'. We are unaware of any installation issues associated	Either clearly identify the "challenges" associated with display of step-down fix information during LPV approaches or remove ¶ 1-4.h and its subparagraphs. If ¶ 1-4.h is retained, it appears that the reference to ¶ "11-11" in ¶ 1-4.h.(2) should be to ¶ "11-8".	**Not Accepted.** This is a frequently asked question section and not intended as full and complete guidance for the issue. Paragraph 11-8 (the reference has been corrected) has the full and complete guidance information. Additionally, the AC cannot include specific guidance for every possible combination/permutation of equipment and cockpit configuration. Nothing in paragraphs 1-4.h(2) or 11-8 invalidates previous airworthiness approvals if the display of step-down fixes presents information

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		This can be a significant issue in "classic" cockpits with limited display capabilities when the database includes step-down fixes. See paragraph 11-11 for guidance when including step-down fixes in the navigation database.	with its equipment involving LPV capability with step-down fixes and draft AC 20-138D provides no specifics as to situations of "confusing or disparate information presented" which the FAA has identified. Instead, new ¶ 11-11 [sic] specifies "solutions" without clearly identifying the "challenges" that require the "solutions". Specifying "solutions" without identifying the "challenges" will inevitably lead to varying interpretations by ACOs and FSDOs that ultimately cause issues with a dealer's ability to install safety-enhancing TSO-C146 equipment. See the related comments on ¶ 11-8 and its subparagraphs and ¶ 22-3.1.e.		in a clear and unambiguous manner and the MOPS-requirements for distance/bearing to LTP/FTP is readily available.
24.	Page 8 Paragraph 1-4.h(2)	Last sentence contains a reference to Paragraph 11-11. Should be Paragraph 11-8.	Editing error	Correct the text.	**Accepted.**
25.	Pg 8, § 1.4 (h) (2)	In the last line of the answer, referring to the	This is a typographical error that might cause minor	To amend the text, referring paragraph ***11-8*** instead of	**Accepted.**

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		step-down fixes in the navigation databases, where it is written: "*See paragraph **11-11** for guidance …",* it should be read "*See paragraph **11-8** for guidance …".*	annoyances to the reader if not revised.	***11-11***.	
26.	Page 9 Para. 2-2 .a.(2)	Statement "human factors evaluation of the equipment is often subjective"	Under guidance for TSOA, this statement implies that this is acceptable practice. Recent AC 25.1302-1 appears to be good guidance although the intent is for transport category airplanes.	Consider adding a reference to an appropriate human factors evaluation process for TSOA articles.	**Partially Accepted.** The stated reason in the comment, along with the other three reasons stated in the AC paragraph, are valid for why manufacturers are encouraged to involve ACOs early in the process for equipment evaluations. However, the phrase "is often subjective" has been replaced with "can be subjective."
27.	Page 10 Para. 2-3. a.	Statement implies it is possible to get AML-STC for parts 23, 25, 27, and 29	To our knowledge, the only relevant guidance that exists is AC 23-22 which is limited to Part 23 installations only.	Delete references to parts 25, 27 and 29 or provide references to the applicable ACs for these AML-STC.	**Not Accepted.** AML-STC is an FAA-wide policy that is not limited solely to Part 23 airplanes. It is possible to receive an AML-STC for any aircraft make/model. Certainly, the process and requirements to receive an AML-STC will differ

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					among Part 23, 25, 27, and 29; but it is still possible.
28.	Page 14 Paragraph 3-4.a	Stated title of TSO-C115C omits the word "Flight".	Editing error	Correct the text.	**Accepted.**
29.	Page 15 Para. 3-4 b. Note 2	For a system seeking both TSO-C146c and TSO-C115c, which TSO has priority in case of conflicting requirements? Priority is only given between TSO-C115b and TSO-C146c (Page 15, paragraph 3-4 b (1).	TSO-C146c requires an alert when HPL exceeds HAL (1x RNP) in respect to navigation modes (RTCA/DO-229D section 2.2.2.6.2, 2.2.3.6.2 and 2.2.4.6.2 & Table 2-10.) TSO-C115c requires an alert when the probability of signal-in-space errors causing a lateral position error greater than two times the desired RNP (2 x RNP) exceeds 1 x 10-7 per hour. This is the equivalent of alerting when HPL exceeds 2x RNP. For example, for an LNAV/VNAV approach performed with SBAS as the altitude source, the lateral error limit is based on 1x RNP and for the same approach flown with the	Clarify why there are two acceptable alerting limits based on HPL for the same type of operation and which one must be used in the case of equipment seeking both TSO-C146c and TSO-C115c.	**Partially Accepted.** A new note 3 has been added explaining that TSO-C146c Class Gamma equipment has an NSE alerting value that assumes a fixed FTE whereas TSO-C115c does not assume a fixed FTE value. TSO-C146c requirements meet the RNP alerting requirements, and is acceptable for meeting the TSO-C115c requirements if the applicant accepts the fixed FTE assumption. But there is no "priority" since the alerting requirements do not conflict. An applicant that wants a TSO-C146c TSOA must meet the TSO-C146c requirements. An applicant that does not want to meet TSO-C146c requirements

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			same GNSS receiver but with vertical guidance provided by baro-altimetry the alert limit is based on 2x RNP. Note: There are no RTCA/DO-283A requirements that specifically require HPL to meet the containment alerting on TSE, which leaves the door open to various alerting implementation: using HFOM, HPL or a scaling of the previous parameters.		won't get a TSO-C146c TSOA, but can still receive a TSO-C115c TSOA for RNP capability based upon NSE and aircraft FTE. ***Note 3:*** *TSO-C146c Class Gamma has alert limits for navigation system error (NSE) at 1 x RNP value and assumes a fixed, manual flight technical error (FTE). The TSO-C146c Class Gamma FTE assumption and NSE alert meets the 2 x RNP TSE alerting requirement for RNP operations. TSO-C115c does not assume a fixed FTE value which allows applicants to trade off FTE and NSE when meeting the 2 x RNP TSE alerting requirement.*
30.	Page 15 Para. 3-4.b.(2)	RTCA-DO283A Appendix H defines a set of requirements that are not only applicable for approach but also for cruise and descent.	When using a GPS sensor TSO-C115b invoked TSO-C129a which in turn invoked RTCA/DO-208. In RTCA/DO-208, two options for Baro VNAV were available. DO-208, section	Recognize in AC 20-138D that not all Appendix H requirements of RTCA-DO-283A are applicable to system providing Baro-VNAV approach capability for the final approach	**Not Accepted.** The final approach segment is the only "approved" use of baro-VNAV guidance. All other uses are for "advisory" purposes only. AC 20-138D provides

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		AC 20-138D should recognize that not all requirements in Appendix H must be met in order to get approval for Baro-VNAV approach capability.	1.3.1, Option a. provides for guidance to a straight-line vertical profile that simulates the function of the ILS/MLS vertical guidance inside the final approach fix was intended for VNAV approach. No such option is provided in RTCA-DO-283A which leaves the equipment manufacturer to interpret which requirements apply to Baro-VNAV approach.	segment. Change text from: "TSO-C115c invokes RTCA/DO-283A appendix H if the applicant wants to include baro-VNAV approach capability. " To: "TSO-C115c invokes RTCA/DO-283A appendix H if the applicant wants to include baro-VNAV capability. Note: RTCA/DO-283A contains a set of requirement for baro-VNAV for all phases of flight. Applicability of the requirements depends on the intended application (VNAV approach only or outside the final approach)."	ample baro-VNAV guidance for approach and advisory operation in chapter 4 and the baro-VNAV chapters (10, 17, and 22).
31.	Page 15 Para. 3-4.b (3)	Does this paragraph imply that an incomplete TSO-C146c Class Gamma must be sought when SBAS-based VNAV is introduced to provide LNAV/VNAV approach capability to a	There are differences between TSO-C115c and TSO-C146c Class Gamma that manufacturers may prefer not to implement for the sole purpose of adding SBAS-based LNAV/VNAV.	Clarify that an incomplete TSO-C146c class Gamma is not optonal when a TSO-C115c system wishes to introduce SBAS-based LNAV/VNAV capability.	**Not Accepted.** When the language says "may be" instead of "must be" the intent is the applicant has discretion on whether or not to follow the guidance (i.e., whether or not to

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		system whose primary TSO is TSO-C115c?	For example, TSO-C115c asks for RNP and scaling of 1.0nm for the missed approach segment. While TSO-C146c class Gamma has the following exception to TSO-C115c: § 2.2.3.7.1.2 states: *"When a missed approach is initiated and the first leg in the missed approach procedure is a TF leg aligned within 3 degrees of the final approach path, the equipment shall automatically switch to terminal mode at the turn initiation point for the first waypoint in the missed approach procedure."* A TSO-C115c system with LPV provided by a federated TSO-C146c Delta-4 does not need to comply with this requirement. However, the same system will have to comply with this requirement for SBAS-based LNAV/VNAV (but not necessarily for LPV since it is a Delta-4 architecture).	Re-phrase the second sentence in Para 3-4.b (3) as follows: "An incomplete system TSO-C146c Class Gamma approval (Gamma-2 or Gamma-3 as appropriate) **may be added to, but is not required,** to the TSO-C115b (or later revision) approval, or replace the TSO-C129(AR) approval if one exists, to provide GPS/SBAS-based VNAV approach capability."	apply for the suggested TSO). We understand there are some requirements for TSO-C146c and TSO-C115c that are, or appear to be, in conflict. In most instances, the appearance of conflict is simply that TSO-C146c requirements are a more stringent or more specific method of meeting the TSO-C115c requirements. For those actual requirements conflict, there is an effort at SC-227 to harmonize requirements among RTCA/DO-229D and RTCA/DO-283B.
32.	Page 16	In a similar fashion to TSO-	LPV is a more hazardous	Insert a new subparagraph	**Not Accepted.** TSO-

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	Para. 3-4.c	C146c class delta-4 in a federated avionics architecture, a certification path should be allowed for TSO-C115c FMS that wish to introduce SBAS-based LNAV/VNAV capability, provided the Delta-4 receiver, and not the FMS, processes the flight path deviations and alerting during the final approach segment. The TSO-C115c RNP/RNAV system provides capability for the initial, intermediate and missed approach segments.	approach condition than LNAV/VNAV with more stringent requirements and a lower line of minima. Therefore, it makes sense that the TSO-C146c class Delta-4 requirements could also be applied to SBAS-based LNAV/VNAV. The system would be required to use the class Gamma LNAV/VNAV path construction requirements when the approach is not collocated with an LPV approach (i.e. no FAS provided). In addition the HAL and VAL from class Gamma LNAV/VNAV requirements would be used.	to 3-4.c. that allows for an installation where the FMS and GNSS are in a federated avionics architecture to utilize TSO-C146c class delta-4 requirements for LNAV/VNAV as well as for LP and LPV. Suggested text: 3-4.c.(5): It is acceptable for the FMS in a federated architecture to use the Class Delta-4 GPS/SBAS equipment to provide a non-precision approach capability (SBAS-based LNAV/VNAV, and SBAS-based LNAV).	C146c Class Delta per the MOPS does not support SBAS-based LNAV/VNAV capability. A manufacturer that wants SBAS-based LNAV/VNAV capability has a path to do so by meeting the TSO-C146c Class Gamma requirements for the FMS as long as an appropriate TSO-C145c Class Beta sensor is providing the SBAS outputs to an FMS.
33.	Page 18, ¶ 4-1 Note 3	Editorial	The term “nonprecision” is hyphenated in the document	Suggest hyphenating, i.e.: “non-precision”. Also, suggest searching document to see whether there are other instances that should be changed.	**Accepted.**
34.	4-2e [Class 3] (pages 19-	The guidance is ambiguous whether advisory vertical guidance is acceptable.	“May not” is used instead of “shall not”. The type vertical guidance (SBAS or	Possible rewording, depending on the intent:	**Partially Accepted.** The guidance information has been changed as shown

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	20)	• The paragraph implies it is not acceptable • Note 1 and Note 2 state it is acceptable Is advisory vertical guidance being discouraged or encouraged?	Baro) is not stated. Although in context, the **bold font** text below strongly implies any advisory VNAV is undesirable but not necessarily unacceptable for both • SBAS-VNAV and • Baro-VNAV when there is an LPV or LNAV/VNAV minimum published. "Class 3 equipment **may not** provide advisory vertical guidance on instrument approach procedures with an LNAV line of minima published with LNAV/VNAV and/or LPV lines of minima**. The reason is due to potential confusion over advisory versus approved vertical guidance and which line of minima applies. This human factors issue is even more critical for GPS/SBAS equipment that has a "fail-down" mode to LNAV minima during the**	"There is no requirement for Class 3 equipment to provide advisory vertical guidance on instrument approach procedures • with an LNAV line of minima published with LNAV/VNAV and/or LPV lines of minima, or • With an LP line of minima. To provide advisory vertical navigation, based on either SBAS-VNAV or baro-VNAV, is acceptable provided the flight deck integration, especially the Primary Flight Display • Prevents confusion regarding advisory versus approved vertical guidance and which line of minima applies, and • Addresses human factors issues, especially for GPS/SBAS equipment that has a "fail-down" mode to LNAV minima during the final segment."	below to permit using advisory vertical guidance on an LNAV line of minima that is collocated with LNAV/VNAV and/or LPV. However, implementing this capability places a large responsibility on the equipment manufacturer and the airworthiness approval holder to coordinate and ensure the design presents clear, unambiguous, easily distinguishable information on when the vertical guidance is "advisory" and when it is "approved." Further, it is only possible to describe general considerations that must be addressed. It is not possible to describe all possible implementations that might be acceptable. e. During RNAV (GPS) instrument approach operations, TSO-

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			final approach segment."		C145/C146(AR) Operational Class 3 equipment may provide advisory vertical guidance when the procedure defines only the LNAV and/or LP line of minima (i.e., procedures without a charted LNAV/VNAV and/or LPV line of minima). **Note:** LP approach procedures will never be published with other lines of minima that contain approved vertical guidance (i.e., LNAV/VNAV or LPV). LNAV and LP lines of minima can be published on the same approach chart; and, it is acceptable to provide advisory vertical guidance, either GPS/SBAS or baro-VNAV, during approach operations using these lines of minima. (1) It is possible for

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					GPS/SBAS Operational Class 3 equipment to also provide advisory vertical guidance for LNAV minima on instrument approach procedures that also contain LNAV/VNAV or LPV lines of minima as published, but with the additional considerations listed below. The reason is due to the wide range of displays, cockpit configurations, and potential confusion over "advisory" versus "approved" vertical guidance and which line of minima applies. (a) LNAV with "advisory" vertical guidance must only be selectable prior to the FAF. (b) The "advisory" vertical guidance indication must be unambiguous and easily distinguishable from the "approved" vertical guidance indication.

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					(c) The installation instructions/manual (or equivalent documents) must define the minimum display capability and cockpit configuration. (d) The equipment must have an installation limitation or method to inhibit the function for non-qualifying installations. (2) It is not acceptable for GPS/SBAS Operational Class 3 equipment to provide "advisory" vertical guidance in a "fail-down" mode from LPV or LNAV/VNAV to LNAV minima during the final approach segment. **Note 1:** GPS/SBAS equipment manufacturers should exercise care when implementing "advisory" vertical guidance for LNAV minima coincident with LNAV/VNAV or

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					LPV minima as published. The cockpit configuration and display capability can influence the ability to provide an unambiguous, easily distinguishable vertical guidance indication during the airworthiness approval. **Note 2:** Both the design approval applicant and airworthiness approval applicant have a responsibility to ensure the implementation is properly configured. Airworthiness approval applicants should contact their ACO early for concurrence on the proposed implementation.
35.	4-2e [Class 3] (pages 19-20)	The same vertical guidance operations should be allowed for Class 3 with SBAS-VNAV as for the equivalent RNP APCH with baro-VNAV. If the intent is to prohibit advisory SBAS-VNAV for approaches with LPV and	Class 3 provisions for unique indications for LNV, versus L/V and LPV approach mode. As such, if LNV APPR is manually selected before FAF and also indicated, the operation should be clear. Class 3 SBAS-VNAV	Suggested rewordings, depending on the intent. Interpretation 1: GPS/SBAS Operational Class 3 equipment ~~may~~ shall not provide advisory vertical guidance on instrument approach procedures with an LNAV	**Partially Accepted.** See above comment resolution. However, an AC cannot use the term “shall” since an AC is not a requirements document.

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		LNAV/VNAV minima, • why is Class 3 restricted more than the equivalent baro-VNAV operations to the same runway? • In addition to the existing Note 2, further clarify in the paragraph that the restriction is specific to SBAS-VNAV.	operation can be viewed as equivalent to RNP APCH baro-VNAV. Baro-VNAV is always available for RNP APPR whether operating to LNAV/VNAV, LNAV, or circling minimum without restrictions (other than temperature, remote altimeter setting, or QFE). Reference AC 90-105 and this AC 20-138(). The only possible difference between Class 3 SBAS-VNAV and RNP APCH baro-VNAV might be with addressing step-downs, for which there is separate guidance.	line of minima published with LNAV/VNAV and/or LPV lines of minima. Interpretation 2: "There is no requirement for Class 3 equipment to provide advisory SBAS vertical guidance on instrument approach procedures • with an LNAV line of minima published with LNAV/VNAV and/or LPV lines of minima, or • With an LP line of minima. To provide advisory vertical navigation, based on either SBAS-VNAV or baro-VNAV, is acceptable provided the flight deck integration, especially the Primary Flight Display • Prevents confusion regarding advisory versus approved vertical guidance and which line of minima applies, and • Addresses human	

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				factors issues, especially for GPS/SBAS equipment that has a "fail-down" mode to LNAV minima during the final segment."	
36.	4-2e [Class 3] Note 1 (pages 19-20)	It is unclear whether Note 1 applies to both SBAS-VNAV and baro-VNAV, or just to SBAS-VNAV. "SBAS-VNAV" refers to vertical guidance based on SBAS, rather than barometric, altimetry (baro-VNAV).	Because Note 2 states that "there is no intent to prevent baro-VNAV...", it raises the question whether Note 1 addresses any VNAV or only SBAS-VNAV.	Possible rewording, depending on the intent: **"Note 1:** LP approach procedures will never be published with other lines of minima that contain approved vertical guidance (i.e., LNAV/VNAV or LPV). LNAV and LP lines of minima can be published on the same approach chart; and, it is acceptable to provide advisory vertical guidance, either SBAS-VNAV or baro-VNAV, during approach operations using these lines of minima."	**OBE.** Resolution of comments above makes this comment moot.
37.	4-2e [Class 3] Note 2: (pages 19-20)	In Note 2, add that baro-VNAV is also acceptable for LP approach.	Note 1 states that advisory vertical guidance is acceptable for both LNAV and LP, but Note 2 only	Suggested rewording **"Note 2:** There is no intent to prevent using baro-VNAV advisory vertical	**OBE.** Resolution of comments above makes this comment moot.

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			addresses LNAV and not also LP. Advisory Baro-VNAV may be beneficial for either LNAV or LP, especially if there are step-downs in the final segment.	guidance for an LNAV or LP approach provided it is selected prior to the final approach fix. See paragraph 17-5 when integrating baro-VNAV with GPS/SBAS vertical guidance."	
38.	4-2e [Class 3] (pages 19-20)	The draft AC only identifies that fail-down is not appropriate for Class 4. However, RTCA DO-229D has the same note for both Class 3 and Class 4. Nonetheless, Fail down from LP to LNAV should not be prohibited for either Class 3 or Class 4. Excerpts from RTCA / DO-229D are under a 2006 Copyright and used with permission by RTCA, Inc., as separately noted. Copies of RTCA / DO-229D may be obtained from RTCA, Inc., at http://www.rtca.org/ or at 1828 L Street, NW Suite 805 Washington, DC	DO-229D contains the same note in both 2.2.5.6.3 for Class Gamma and 2.3.6.2 for Class Delta: "Note Automatic reversion from LP to LNAV is not appropriate **since there is no differentiation in the pilot's primary field of view (LPV to LNAV is clearly indicated by flagging the vertical deviation.)"** The MOPS, a minimum standard, does not address the possibility of advisory vertical navigation for LP. • Observe that, in context, the issue is that Class 3 and 4 indicate the fail-down by flagging the	**Add new notes to Class 3 section, consistent with Class 4 section** **"Note 3:** However, it is not acceptable for Operational Class 4 equipment to ~~provide~~ display advisory vertical guidance when the equipment "fails-down" from LPV or LP to LNAV minima during the final approach segment due to potential confusion over advisory versus approved vertical guidance and which line of minima applies. **Note 4:** RTCA/DO-229D does not address vertical guidance for LP approach. Fail-down from LP to	**Partially Accepted.** The same note from 4-2.f was added to 4-2.e.

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		20036, Telephone 202-833-9339 and Facsimile 202-833-9434.	SBAS-VNAV. • Class 3 or 4 equipment that provided advisory SBAS-VNAV for LP could be designed to flag the advisory SBAS-VNAV in the fail-down to LNAV.	LNAV may be acceptable if the fail-down is adequately indicated, such as by flagging the vertical deviation (consistent with the LPV fail-down operation)".	
39.	4-2f [Class 4] (page 20)	For Class 4 (as was proposed for Class 3) add Note 2 that advisory baro-VNAV is acceptable, applicable to LP approach.	Class 4 equipment may interface with or be integrated with baro-VNAV equipment. As such, advisory baro-VNAV could be provided for LP approach. Operating on an LP with advisory baro-VNAV would be equivalent to operating on a conventional localizer approach with baro-VNAV, which many multi-sensor FMSs already support.	Suggested new Note 2: **"Note 2:** There is no intent to prevent using baro-VNAV advisory vertical guidance for an LP approach provided it is selected prior to the final approach fix. See paragraph 17-5 when integrating baro-VNAV with GPS/SBAS vertical guidance."	**OBE.** The referenced note was deleted as part of the revision in response to comments above. The baro-VNAV guidance in paragraph 4-2.c addresses implementations with baro-VNAV.
40.	4-2f [Class 4] Note (page 20)	Fail-down from LP to LNAV should not be prohibited for Class 4. Excerpts from RTCA / DO-229D are under a 2006 Copyright and used with	The MOPS, a minimum standard, does not address the possibility of advisory vertical navigation for LP. • See **bold font** below that, in context, the RTCA issue is that Class 3 and	**Suggested rewording and new note:** **"**However, it is not acceptable for Operational Class 4 equipment to ~~provide~~ display advisory	**Not Accepted.** Fail-down from LP to LNAV is prohibited by TSO/MOPS. The reason is because LP and LNAV guidance looks exactly the same, thereby providing a human factors

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		permission by RTCA, Inc., as separately noted. Copies of RTCA / DO-229D may be obtained from RTCA, Inc., at http://www.rtca.org/ or at 1828 L Street, NW Suite 805 Washington, DC 20036, Telephone 202-833-9339 and Facsimile 202-833-9434.	Class 4 indicate the fail-down by flagging the SBAS-VNAV. • Class 4 equipment that provided advisory SBAS-VNAV for LP could be designed to flag the advisory SBAS-VNAV in the fail-down to LNAV. DO-229D contains the same note in both 2.2.5.6.3 for Class Gamma and 2.3.6.2 for Class Delta:, (bold face added) "Note Automatic reversion from LP to LNAV is not appropriate **since there is no differentiation in the pilot's primary field of view (LPV to LNAV is clearly indicated by flagging the vertical deviation.)**	vertical guidance when the equipment "fails-down" from LPV or LP to LNAV minima during the final approach segment due to potential confusion over advisory versus approved vertical guidance and which line of minima applies. **Note:** ~~Per~~ RTCA/DO-229D does not address vertical guidance for LP approach. Fail-down from LP to LNAV may be acceptable if the fail-down is adequately indicated, such as by flagging the vertical deviation (consistent with the LPV fail-down operation).~~ it is not appropriate for GPS/SBAS Operational Class 4 equipment to "fail-down" from LP to LNAV.~~	trap on which minimums apply. That is, a pilot who briefed as was flying to LP minima might continue flying to those minima instead of the LNAV minima.
41.	Page 22 Table 1	Contains an asterisk with no associated note.	Editing error	Correct the text.	**Accepted.**
42.	Page 22, ¶ 5-1.a	Editorial	Clarify sentence	Suggest changing:	**Accepted.**

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				"The answer is both because RNP is a subset of RNAV" To: "The answer is GNSS is both an RNAV and RNP system because RNP is a subset of RNAV"	
43.	Page 22, ¶ 5-1.a	Editorial	Punctuation	Suggest changing: "RNP capable" To: "RNP-capable"	**Accepted.**
44.	Page 28, ¶ 5-3.2 d	This paragraph states in sentence 3: LP approaches use the horizontal accuracy and integrity values of LPV but do not provide vertical guidance. Later in the document, ¶ 6-3.b notes: It is acceptable to provide advisory vertical guidance for LP	Clarify what is allowed with regard to vertical guidance on LP approaches.	Suggest changing ¶ 5-3.2 d sentence 3 to: LP approaches use the horizontal accuracy and integrity values of LPV but do not provide approved vertical guidance deviation indications for operational credit.	**Accepted.**

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		approaches using the method described in RTCA/DO-229D for LNAV (see paragraph 4-2.d). This section should clarify what is allowed for LP approaches to reduce confusion.			
45.	Page 28 Para. 5-3.2. e.	Wording of "Manufacturers that choose not to include LP capability in their Class 3 or Class 4 GPS/SBAS equipment" implies this capability is optional in the TSO.	DO-229D requires LP; it is not optional. A deviation is required to omit LP from the equipment.	Suggested wording: e. Manufacturers that choose to deviate from the 'b' or 'c' TSO revision by not including LP capability in their Class 3 or Class 4 GPS/SBAS equipment must …	**Partially Accepted.** The first sentence was changed as follows to make it clear a deviation request is necessary when not including LP: *Manufacturers <u>that request a deviation from the TSO-C145c/C146c requirement to include LP capability</u> in 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.*
46.	Page 28,	The paragraph discusses	An AFM typically identifies	Either:	**Partially Accepted.** There

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	¶ 5-3.2.e	"Manufacturers that choose not to include LP capability" in TSO-C146b/c equipment and ends with the statement that: The limitation must be included in the AFM(S)/RFM(S).	the approach types that <u>are</u> supported but does not specifically identify approach types that <u>are not</u> supported. AC 20-138D Appendix 5 Sample AFM Section 1 General provides several good examples. As another example, FAA AIM 5-4-5.k.1.(d) includes the following: Receivers approved for LP must have a statement in the approved Flight Manual or Supplemental Flight Manual including LP as one of the approved approach types. Given the positive AFM General statement about what approach types are supported, it is unclear what benefit is provided by including an additional statement in the AFM Section 2 Limitations about what approach types are not supported.	• Remove the quoted ¶ 5-3.2.e statement. • 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.	are plenty of examples where limitations are included for functions that equipment does not perform. This is an example of just such a limitation. However, clarification was added that not including LP also requires a TSO deviation. The first sentence was changed as follows: *Manufacturers that request a deviation from the TSO-C145c/C146c requirement* to include LP capability in 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.

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			Additionally, since LP procedures are a minimum requirement of TSO-C146b/c, the equipment manufacturer must request a TSO deviation to not include LP capability. The TSO deviation should be granted only under the conditions that the equipment not allow the selection of LP only procedures and never annunciate LP service for procedures with both LP and LNAV minimums (consistent with RTCA/DO-229D 2.2.1.3 "The equipment shall not permit the flight crew to select a procedure or route that is not supported by the equipment …"). Furthermore, LP approaches were only added to the database by the Type 1 LOA data supplier. Consequently, prior to that time, even though many LP approaches were published, it was not possible for our equipment		

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			that supports LP approaches to include the LP approaches in the database and thus the pilot could not select them. Finally, equipment manufacturers may choose to exclude specific procedures and/or procedure types from the database for a variety of reasons (e.g., the aforementioned DO-229D 2.2.1.3 and new AC 20-138D ¶ 5-6.b "Procedures the GNSS equipment does not support should not be accessible."). The ¶ 5-3.2.e guidance sets an inappropriate expectation that exclusion of database procedures must be documented by an AFM limitation when operator notification of excluded procedures is more appropriately handled under AC 20-153A Type 2 LOA processes.		
47.	Page 28 Para. 5-3.3	This AC describes what data needs to be converted from MSL heights to WGS-	Many conversion models exist with varying degrees of accuracy.	Recommend the use of a specific model (or models), along with a web link if	**Not Accepted.** None of the navigation system MOPS has requirements

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		84 ellipsoid heights. However, there is no mention of any specific conversion model, algorithm or formula. No accuracy requirements for the conversion model are listed either.		possible, provided by a national or international agency. E.g. the EGM96 Worldwide Geoid data provided by the National Geospatial-Intelligence Agency (NGA): http://earth-info.nga.mil/GandG/wgs84/gravitymod/egm96/intpt.html	for data conversion or makes a recommendation on which model to use (including the SBAS MOPS/TSO). The EGM96 model suggested may or may not be applicable or acceptable to a particular State. No particular model can be specifically endorsed because no model has been submitted for evaluation. It is left to the manufacturer to make a substantiation argument for the model they choose.
48.	Page 34, ¶ 5-6.a	Includes the statement: Particular attention should be paid to the specification of the data quality requirements as part of the installation instruction/manual documentation described in AC 20-153 (latest revision) and RTCA/DO-200A, section 2.3.2 and appendix B.	While AC 20-153A ¶ 11 defines operator responsibilities (which allows a manufacturer to infer documentation that an operator may require), we are unaware of any AC 20-153 "specification of … data quality requirements as part of the installation instruction/manual documentation". Similarly, the references to RTCA/DO-200A 2.3.2 and RTCA/DO-200A Appendix B include no	Remove the quoted ¶ 5-6.a statement or clarify how an installer reasonably can be expected to complete an assessment of the data quality requirements given the information a manufacturer is actually required to provide to an installer in accordance with AC 20-153A and RTCA/DO-200A.	**Partially Accepted.** The paragraph has been re-structured and the indicated sentence has been deleted. The subject is sufficiently covered by referencing AC 20-153(latest revision) for detailed guidance.

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			requirements for installation documentation. Consequently, there is no convenient means for an installer to pay particular attention “to the specification of the data quality requirements”. Additionally, it is unreasonable to expect anyone other than an equipment manufacturer to assess the DO-200A 2.3.2 data quality characteristics of accuracy, resolution, traceability, timeliness, completeness, format, and assurance level. Equipment manufacturers make these assessments in the context of the intended function, which is typically associated with a TSO such as TSO-C146 or TSO-C115. Furthermore, the navigation database format and content that equipment will accept is constrained by the manufacturer’s database design. As such, an		

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			installer (and the operator) is limited to using only those database part numbers, defined by the manufacturer and authorized by the FAA, that provide the data quality necessary to perform the intended function. Thus, the pedigree of the database is already established through the FAA authorization at the LRU level in the same fashion that a resistor on a circuit board internal to that same LRU is qualified as suitable for the function in the circuit in which it is placed. Consequently, in addition to the installer's inability to make an assessment of the data quality requirements, there is no need for an installer to make such an assessment by virtue of this pedigree. See also comments on ¶ 11-7.b.		
49.	Page 34, ¶ 5-6.b	Includes the phrase "(see paragraphs 11-7, 11-8 and 14-5)"	Previous comments on these referenced sections suggest removing the database	Suggest removing the quoted ¶ 5-6.b phrase.	**Partially Accepted.** There have been issues with procedures, such as RNP

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			related material.		AR, being available in equipment and aircraft not approved for the function. The point of the guidance is that the flight crew must not be able to access procedures the equipment is not authorized to perform. The paragraph was revised as follows to make this more clear: *For GNSS equipment to perform its intended function the database configuration, as specified by the equipment manufacturer's data quality requirements, must be consistent with the equipment capability. Procedures the GNSS equipment does not support should not be accessible to the flight crew (see paragraphs 12-7, 12-8 and 15-5).*

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50.	Page 34, ¶ 5-6.c	Includes the statements: The GNSS equipment manufacturer is responsible for stating any equipment limitations not supported as part of the data quality requirements for the end-user to identify their database requirements. However, aircraft-level airworthiness limitations can also affect end-user database requirements (see paragraph 11-7.c).	As noted in the previous comment on ¶ 5-6.a, , it is unreasonable to expect anyone other than an equipment manufacturer to assess the DO-200A 2.3.2 data quality characteristics of accuracy, resolution, traceability, timeliness, completeness, format, and assurance level as they pertain to intended function. Consequently, it is unclear what "limitations" there would be in the context of the equipment that would need to be stated. If this statement is alluding to the LP approach example in ¶ 5-3.2.e or the RF leg example in ¶ 11-7.a, see previous comments on the draft guidance in those paragraphs that suggests the draft guidance associated with these examples be removed since AFMs typically identify capabilities that <u>are</u> supported but do not specifically identify capabilities that <u>are not</u>	Remove the quoted ¶ 5-6.c statements or clarify what an equipment manufacturer and/or installer reasonably can be expected to provide in the form of limitations associated with unsupported data quality requirements.	**Partiall Accepted.** The entire paragraph has been deleted. The subject is sufficiently covered by referencing AC 20-153(latest revision) for detailed guidance.

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			supported.		
51.	Pg 34, Para 5-6.c	The proposed text states: *"c. As noted in AC 20-153 (latest revision), the ultimate responsibility to ensure data meets the data quality requirements for the intended application rests with the end- user of the data. …"*	Although paragraph c. has been copied from AC 20-153A and from DO-200A, the citation of AC 20-153A and the term *"end-user"* is an incomplete depiction of the responsibilities as defined in DO-200A. This causes confusion relative to differences in roles and responsibilities between the *"end-user"* and *"user,"* as defined in DO-200A. Per DO-200A, *"users"* (as defined in DO-200A) have a significant role in aeronautical data quality, and must have processes in place to assure the accuracy and integrity of the aeronautical data processes. Further, the responsibility for the quality of aeronautical data rests with each of the users in the aeronautical data chain.	Add the following text to the beginning of paragraph c.: **"c. *As defined in DO-200A, all participants in an Aeronautical Data Chain must ensure that data quality characteristics are correctly established for the data's intended usage, and that these data quality requirements are clearly documented, including users. DO-200A defines users as any group or organisation within an Aeronautical Data Chain that receives data, and also includes responsibilities for each of the users in the aeronautical data chain.* …"**	**Partially Accepted.** The entire paragraph has been deleted. The subject is sufficiently covered by referencing AC 20-153(latest revision) for detailed guidance.
52.	Page 34, ¶ 5-6.2.c	Includes the statement: Data process assurance levels including tool	It is unclear who is expected to verify the data process assurance levels and tool qualification during an	Remove the quoted ¶ 5-6.2.c statement or clarify how an installer reasonably can be expected to complete	**Not Accepted.** All paragraphs need to be taken together for proper context. Paragraph 5-6.2.a states:

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		qualification should be verified during the Letter of Acceptance (LOA) review.	(LOA) review. E.g., is it the ACO processing the TSOA application or the equipment installer? If this guidance is meant for the ACO, then it is inappropriate to include in this AC as its purpose, per ¶ 1-1, is to provide "guidance material for the airworthiness approval of installed positioning and navigation equipment." If this guidance is meant for the installer, then the following are issues: • The sample FAA Type 2 LOA letter (AC 20-153A Appendix 2, Figure 2) includes neither data process assurance levels nor tool qualification information, and Type 2 LOA letters include no such information. • Further, while AC 20-153A ¶ 11 defines operator responsibilities	a LOA review given the information a manufacturer is actually required to provide to an installer in accordance with AC 20-153A.	"The GNSS equipment manufacturer is usually the last link in the aeronautical data processing chain, since the format for the data loaded in the final database is typically proprietary. The applicant for a TSOA/LODA must identify an aeronautical data process accessible to the equipment users. The approval of the process is included as part of the TSOA/LODA for GNSS equipment." The paragraphs following then provide additional information and are not meant to be taken in isolation. It is not practical or normal to cram all thoughts into a long, run-on paragraph.

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			(which allows a manufacturer to infer documentation that an operator may require), we are unaware of any AC 20-153A requirement to provide specific documentation to an installer. Consequently, there is no convenient means for an installer to determine this information via a LOA review. See also comments on ¶ 11-7.b.		
53.	Page 36, ¶ 6-2.a	Includes the statement: Particular attention should be paid to the specification of the data quality requirements as part of the installation instruction/manual documentation described in AC 20-153 (latest revision) and RTCA/DO-200A, appendix B.	See comments on ¶ 5-6.a. Additionally, this statement leaves out the reference to RTCA/DO-200A 2.3.2 included in the revision to ¶ 5-6.a.	Remove the quoted ¶ 6-2.a statement or clarify how an installer reasonably can be expected to complete an assessment of the data quality requirements given the information a manufacturer is actually required to provide to an installer in accordance with AC 20-153A and RTCA/DO-200A.	**Partially Accepted.** The paragraph has been re-structured and the indicated sentence has been deleted. The subject is sufficiently covered by referencing AC 20-153(latest revision) for detailed guidance.

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				If the statement is retained, consider including the reference to RTCA/DO-200A 2.3.2.	
54.	Page 36, ¶ 6-2.b	Includes the phrase "(see paragraphs 11-7, 11-8 and 15-5)"	Previous comments on these referenced sections suggest removing the database related material.	Suggest removing the quoted ¶ 6-2.b phrase.	**Partially Accepted.** There have been issues with procedures, such as RNP AR, being available in equipment and aircraft not approved for the function. The point of the guidance is that the flight crew must not be able to access procedures the equipment is not authorized to perform. The paragraph was revised as follows to make this more clear: *For GNSS equipment to perform its intended function the database configuration, as specified by the equipment manufacturer's data quality requirements, must be consistent with the equipment capability. Procedures the GNSS*

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					equipment does not support should not be accessible to the flight crew (see paragraphs 12-7, 12-8 and 15-5).
55.	Page 36, ¶ 6-2.c	Includes the statements: The RNAV multi-sensor equipment manufacturer is responsible for stating any equipment limitations not supported as part of the data quality requirements for the end-user to identify their database requirements. However, aircraft-level airworthiness limitations can also affect database requirements (see paragraph 11-7.c).	See previous comments on ¶ 5-6.c.	Remove the quoted ¶ 6-2.c statements or clarify what an equipment manufacturer and/or installer reasonably can be expected to provide in the form of limitations associated with unsupported data quality requirements.	**Partially Accepted.** The entire paragraph has been deleted. The subject is sufficiently covered by referencing AC 20-153(latest revision) for detailed guidance.
56.	Pg 36, Para 6-2.c	The proposed text states: *"c. As noted in AC 20-153 (latest revision),the ultimate responsibility to ensure data meets the data quality requirements for the intended application rests with the end- user of the data. …"*	Although paragraph c. has been copied from AC 20-153A and from DO-200A, citation of AC 20-153A and the term "end-user" is an incomplete depiction of the responsibilities as defined in DO-200A. This causes confusion relative to differences in roles and	Add the following text to the beginning of paragraph c. "**c. *As defined in DO-200A, all participants in an Aeronautical Data Chain must ensure that data quality characteristics are correctly established for the***	**Partially Accepted.** The entire paragraph has been deleted. The subject is sufficiently covered by referencing AC 20-153(latest revision) for detailed guidance.

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			responsibilities between the *"end-user"* and *"user"* as defined in DO-200A. Per DO-200A, *"users"* (as defined in DO-200A) have a significant role in aeronautical data quality and must have processes in place to assure accuracy and integrity of the aeronautical data processes. Further, the responsibility for the quality of aeronautical data rests with each of the users in the aeronautical data chain.	***data's intended usage, and that these data quality requirements are clearly documented, including users. DO-200A defines users as any group or organisation within an Aeronautical Data Chain that receives data, and also includes responsibilities for each of the users in the aeronautical data chain. …"***	
57.	Page 36, 6-2.2.c	The middle sentence could be stated more clearly.	The middle sentence has too many thoughts combined into one sentence.	Make a clear statement perhaps dividing the sentence to make the points clear.	**Accepted.** The sentence in paragraph 6.2.c (and corresponding sentence in 5-6.c) were modified as follows: The RNAV multi-sensor equipment manufacturer is responsible for stating any equipment limitations *for functions* not supported *(e.g., RF legs, RNP AR, etc.)* as part of the data

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					quality requirements. *This will assist* the end-user *(i.e., the operator) in identifying* their database requirements.
58.	Page 37, ¶ 6-2.2.c	Includes the statement: Data process assurance levels including tool qualification should be verified during the Letter of Acceptance (LOA) review.	See comments on ¶ 5-6.2.c and ¶ 11-7.b.	Remove the quoted ¶ 6-2.2.c statement or clarify how an installer reasonably can be expected to complete a LOA review given the information a manufacturer is actually required to provide to an installer in accordance with AC 20-153A.	**Not Accepted.** All paragraphs need to be taken together for proper context. Paragraph 5-6.2.a states: "The GNSS equipment manufacturer is usually the last link in the aeronautical data processing chain, since the format for the data loaded in the final database is typically proprietary. The applicant for a TSOA/LODA must identify an aeronautical data process accessible to the equipment users. The approval of the process is included as part of the TSOA/LODA for GNSS equipment." The paragraphs following then provide additional information and are not meant to be taken in

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					isolation. It is not practical or normal to cram all thoughts into a long, run-on paragraph.
59.	Page 45 Para. 6-5 Table-5	Airborne Equipment Error for DME (0.2 nm + 1%) does not match other standards.	RTCA/DO-283A Appendix C assumes the following: "Note: The DME range error will be less than 0.2 NM (95%) for systems installed after 1January 1989 (ICAO Annex 10). Before this date, accuracy was addressed in Annex 10 as a recommended 0.25 NM + 1.25% indicated range." AC 20-138D para. 6-4.2 c) provides different DME ground equipment error assumptions.	Change DME Airborne Equipment Error assumption to the values specified in RTCA/DO-283A Appendix C.	**Not Accepted.** Table 5 is not representing a DME TSO absolute accuracy value. Table 5 is provided in support of the values in Table 4 for single site VOR/DME accuracy.
60.	Page 50, ¶ 7-2.b.(2)	Use of the phrase "Radius to Fix Turns" is inconsistent with industry standards.	Consistency with other documents like RTCA DO-283A, RTCA DO-229D, and ARINC 424.	Change to "Radius to Fix Legs"	**Accepted.**
61.	Page 50 Para. 7-2 b.(3) (b) and (c)	Clarify difference between "loss" and "activation" of the "integrity alerting function".	DO-229D provides a caution associated with loss of integrity monitoring; there is no separate concept of activation of the integrity alerting function. 7-2 b. (b)	Clarify the distinction between "loss" and "activation" of the "integrity alerting function". Clarify what occurs after the FAF given that original TSO-	**Partially Accepted.** Paragraphs 7-1 and 7-2 have been modified to offer clearer guidance regarding RNP. The specific paragraphs and language in

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			appears to include (c) as currently worded.	C129 operation allowed continuing an approach even when integrity was lost.	the comment have been deleted.
62.	Page 51 Paragraph 7-3 and subs	To whom is this directed? Pretty much all of it seems way out of scope of this AC.	Scope control.	Remove the material.	**Accepted.**
63.	Pages 52-60 Chapter 8	This Chapter starts by suggesting that all GPS approaches have been redefined to be RNP approaches. Combined with the rest of the AC, this brings in tremendous numbers of non-traditional compliance items for all GPS systems, including compliance with DO-236B, compliance with AC 20-153 and others.	Compliance with myriad new requirements for systems providing traditional functionality is unnecessarily burdensome.	1. Redefine GPS and RNAV (GPS) approaches to be something other than "full RNP" approaches. We would recommend referring to them as "basic RNP" approaches. 2. Adjust the material to restore the compliance items to their traditional level, commensurate with the actual risk associated with these procedures.	**Partially Accepted.** Nowhere does the guidance material state that all requirements in DO-236B or AC 20-153 compliance is mandatory for equipment to perform approaches with the title RNAV(GPS) or GPS. Additionally, there is significant overlap among the latest revisions of DO-236, DO-283, and the various GPS TSOs/MOPS. Also, since GPS can't function without a database, manufacturers already have to comply with a database control process. But, paragraph 8-2, in conjunction with new material in paragraph 7-1.c, clarifies RNP capability of

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					TSO equipment. However, some RNP capabilities result from a combination of TSO and airworthiness approval because the RNP capability is dependent upon the installation and aircraft capabilities. This is not just an RNP issue, so it is generically addressed in paragraph 11-7.
64.	Pages 52-60 Chapter 8	This Chapter includes numerous compliance items that are already included in some or all of the TSO MOPS. For example, Paragraphs 8-3.a(2) and (3) identify the basic accuracy of a GPS/SBAS system, as acknowledged elsewhere in the AC. This Chapter should include statements that identify TSOA as sufficient to meet those and similar requirements.	Duplication of compliance items results in duplication of effort, both for the applicant and for the FAA.	Identify those cases in which TSOA is sufficient to show compliance with the requirements.	**Partially Accepted.** Paragraph 7-1.c in conjunction with paragraph 8-2 should provide clarification. However, some RNP capabilities result from a combination of TSO and airworthiness approval because the RNP capability is dependent upon the installation and aircraft capabilities. This is not just an RNP issue, so it is generically addressed in paragraph 11-7.
65.	Pages 52-60 Paragraphs 8-2 and 8-4	Based on their titles, Paragraphs 8-2 and 8-4 seem to have identical scope	The AC is confusing as currently organized.	Merge the content of Paragraphs 8-2 and 8-4.	**Accepted.** Paragraph 8-4 has been significantly reduced.

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		but different content. This is confusing.			
66.	Page 53 Para. 8-3. a.(2) and (3)	Please clarify the definition of "total flight time" as it applies to the accuracy requirements.	The need for a clarification is suggested because "total flight time" could be interpreted to mean the duration of the entire flight, or interpreted to be equivalent to the "exposure time" concept used in other documents.	Proposed revision. Add the following new note: "Note 3: In the accuracy requirements of 8-3.a.(2) and 8-3.a.(3) above, "total flight time" refers to the flight duration in the individual segment or combination of segments of the procedure, as applicable."	**Not Accepted.** This guidance was taken directly from AC 90-105 and has been satisfactory since 2009. Further, Chapter 8 is titled: "**Equipment Performance - RNP Approach**" and the specific paragraphs refer to either the initial/intermediate/missed approach segments or the final approach segment. So it is unclear how this can be misinterpreted to apply to the entire flight.
67.	Page 54 Para. 8-3 e	GPS signal in space error alerting is required here for RNP approach and in 9-3 f for RNP terminal but not for other RNP procedures.	Missing requirement for some RNP procedures	Suggested revision: Generalize alert to 2xRNP threshold and move it to Chapter 7 RNP (general). Only keep additional information in the approach or terminal chapters. Also add note that this alert can be common with the RNP containment integrity alert.	**Not Accepted.** Paragraph 8-3.f does have the signal in space alerting for GNSS. The performance and alerting paragraph (8-3.d) have always spelled out what the integrity paragraph (8-3.b) says to be absolutely clear what performance is expected for both RNP APCH and RNP 1.0 (now also

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					including RNP 2.0).
68.	Page 54 § 8-3.e	Change from "*lateral position error*" to "*navigation system error*" is not optimal	Wording in PBN manual ("*SIS errors causing a lateral position error*") seems more consistent with the RNP containment area.	Keep initial wording "*lateral position error*"	**Accepted.**
69.	54 & Para 8-3.e	By changing, from "a lateral position error" in AC 20-138C to " a navigation system error" in draft AC 20-138D, is the assumption that the SIS errors will only contribute to the navigation system error (NSE) in the Total System Error?	The use of "lateral position error" in AC 20-138C seems to require an alert if the probability of SIS errors causing a "Total System Error" (TSE) greater than 2 NM exceeds 10^{-7} per hour. Changing to "navigation system error" seems to exclude the other component of TSE such as FTE.	A note on why NSE is chosen might be useful.	**Partially Accepted.** Another comment was previously received on the change to NSE suggesting that it be changed back to "lateral position error" and that comment was accepted. The sentence once again uses the term "lateral position error."
70.	54 & Para 8-3.e	Is 10^{-7} in any approach more appropriate for operations on the final approach segment?	Both AC 20-138C and draft AC 20-138D states that during operations on the final approach segment, an alert must be provided if the probability of SIS errors causing a navigation system error greater than 0.6 NM exceeds 10^{-7} per hour. The final approach segment is a 3-D geometric path in space that an aircraft is supposed to fly on final approach (See RTCA DO-229D). ICAO	None if 10^{-7} per hour is correct for RNP APR.	**No Action Required.** The paragraph is for RNP 0.3 which is equivalent to LNAV on an RNAV(GPS) approach. There is no vertical RNP so the final approach segment is not a 3-D geometric path in space. RNP 0.3/LNAV corresponds to the non-precision approach line on Table 3.7.2.4-1 which

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			Annex 10 Vol. I Table 3.7.2.4-1 seems to use 10^{-7} in any approach for final approach segment operations.		states 10^{-7} per hour. So paragraph 8-3.e is consistent with the ICAO Annex 10 table.
71.	Page 55, ¶ 8-3.f Note	Use of the phrase "Radius to Fix Turns" is inconsistent with industry standards.	Consistency with other documents like RTCA DO-283A, RTCA DO-229D, and ARINC 424.	Change to "Radius to Fix Legs"	**Accepted.**
72.	Page 57, Para. 8-3 h.(6)(a) and (c).	Since the distances of both (a) and (c) are required to be available simultaneously, please clarify the intended differences between them and why they are both required.	Although the list of display requirements of para. 8-3.h. has become effectively a standard list, common to several ACs and other documents, the distinction between the distances of (a) and (c) has never been made clear. Given that AC20-138() is now intended to be the installation approval standard for all positioning and navigation systems, a clarification would help to avoid misinterpretation.	Clarify or expand the definitions of the distances in 8-3.h.(6)(a) and (c).	**Partially Accepted.** Item c was deleted since it was duplicative.
73.	Pages 61-67 Chapter 9	This Chapter includes numerous compliance items that are already included in some or all of the TSO MOPS. This Chapter	Duplication of compliance items results in duplication of effort, both for the applicant and for the FAA.	Identify those cases in which TSOA is sufficient to show compliance with the requirements.	**Partially Accepted.** Paragraph 7-1.c in conjunction with paragraph 9-2 should provide clarification.

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		should include statements that identify TSOA as sufficient to meet those and similar requirements.			However, some RNP capabilities result from a combination of TSO and airworthiness approval because the RNP capability is dependent upon the installation and aircraft capabilities. This is not just an RNP issue, so it is generically addressed in paragraph 11-7.
74.	Pages 61-66 Paragraphs 9-2 and 9-4	Based on their titles, Paragraphs 9-2 and 9-4 seem to have identical scope but different content. This is confusing.	The AC is confusing as currently organized.	Merge the content of Paragraphs 9-2 and 9-4.	**Accepted.** Paragraph 9-4 has been significantly reduced.
75.	Page 62 Paragraph 9-3a.(2)	The first sentence of the "note" does not appear pertinent to the text.	Document is confusing.	Clarify, correct, move or remove the note.	**Accepted.** This same note is in 90-105. However, for clarification, the following change has been added: *…acceptable means of compliance for maintaining TSE*.
76.	63 & Para 9-3.f	Should "lateral position error" be changed to "navigation system error" for the same reason as in Para 8-3.e?	If the assumption in comment 1 is true, then "navigation system error" would apply here as well.	Confirm that both paragraphs should be consistent.	**Accepted.**
77.	Page 68, ¶ 10-1.b	Includes the statement:	The reference to RTCA/DO-236B, appendix H.2 is	Change the reference to "RTCA/DO-283A	**Not Accepted (now chapter 11).** DO-236B

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		Systems providing temperature compensation to the baro-VNAV guidance must comply with RTCA/DO-236B, appendix H.2.	inconsistent with draft AC 20-138D ¶ 3-4.b.(2), which references RTCA/DO-283A Appendix H for TSO-C115c.	Appendix H".	provides more detailed information on temperature compensation requirements. DO-283A has one paragraph that points to DO-236A for more information. It is more appropriate to point directly to the place where the temperature compensation requirements reside. DO-283A is appropriate for baro-VNAV since that is where the baro-VNAV requirements reside.
78.	Page 68, ¶ 10-1.b Note	Includes the statement: RTCA/DO-236B is currently under revision. Revision 'C' is expected to address baro-VNAV temperature compensation in appendix H.2 and H.3.	While true, it would be more consistent with draft AC 20-138D ¶ 3-4.b.(2) to reference RTCA/DO-283A Appendix H. Additionally, the references to "appendix H.2 and H.3" are too specific.	Suggest changing to: RTCA/DO-283A is currently under revision. Revision 'B' is expected to address baro-VNAV temperature compensation in appendix H.	**Partially Accepted (now chapter 11).** The reference was changed to DO-236C appendix H and there is no reference to either DO-283A or -283B.
79.	Pg 68, Para 10-1.b	The proposed text states *"b. Systems providing temperature compensation to the baro-VNAV guidance*	Automatic temperature compensation per DO-236B, Appendix H-2, is one method for accomplishing the operational intent of this	Revise text and delete the Note as follows: *"b. Systems providing* ***automatic*** *temperature*	**Partially Accepted (now chapter 11).** "Automatic" has been added for clarification and the reference changed to DO-

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		must comply with RTCA/DO-236B, appendix H.2. This enables baro-VNAV operations outside of the temperature limits published on approach procedure charts. *Note: RTCA/DO-236B is currently under revision. Revision 'C' is expected to address baro-VNAV temperature compensation in appendix H.2 and H.3."*	requirement. We suggest that the Note be deleted, as it reflects preliminary information.	*compensation to the baro-VNAV guidance must comply with RTCA/DO-236B, appendix H.2. This enables baro-VNAV operations outside of the temperature limits published on approach procedure charts.* *Note: RTCA/DO-236B is currently under revision. Rev is io n 'C ' is ex pec te d to address baro-VNAV temperature compensation in appendix H.2 and H.3."*	236C.
80.	P68 §10-1B	Note about RTCA/DO-236B current revision can not be left: - Either RTCA/DO-236C official release publication is done before AC20-138D official release, then RTCA/DO-236C must replace all RTCA/DO-236B references, - Either note must be suppressed	This advisory circular must refer to last official release of RTCA/DO236		**Accepted (now chapter 11).** Reference changed to DO-236C.
81.	Page 68, ¶ 10-1.b.(2)	Editorial		Suggest changing:	**Accepted (now chapter 11).**

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				"there's" To: "there is"	
82.	P69 §10-2. b.	In the precision "During final approach only", is it not required to include also effect of temperature error to the baro_VNAV TSE?	To confirm that effect of temperature error are not to be considered for baro VNAV TSE for enroute, terminal, and approach IFR operations.		**Not Accepted (now chapter 11).** Temperature errors are not included because the approach charts are marked with temperature limits. Pilots flying aircraft without automatic temperature compensation are prohibited from using baro-VNAV systems on these approach procedures when the temperature is below or above the published limits.
83.	Pg. 69-70 / 10-2.b-c	The first sentence of paragraph 10-2.b. reads: "For enroute, terminal, and approach IFR operations, the airborne baro-VNAV system must have TSE components in the vertical direction that are less than those shown in Table 6 below, 99.7 % of the flying time (reference RTCA/DO-	The criteria of Table 6 should only be applicable where vertical performance standards exist, which is currently limited to final approach segments. For example, AMC 20-27 specifically limits application of baro-VNAV vertical performance requirements to final approach segments.	Better define the scope of Table 6 by more specifically defining the types of vertical guidance and operations to which it is applicable given current airspace requirements,	**Accepted (now chapter 11).** A clarification note has been added as follows: **Note:** Table 6 applies to enroute and terminal operations specifying vertical performance requirements that rely on baro-VNAV performance.

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		236B, paragraph 2.1.2)." The referenced paragraph in DO-236B reads: "Each aircraft operating in airspace where vertical performance is specified shall have total system error components in the vertical direction that are less than the specified performance limits 99.7% of the flying time." Cessna believes that the interpreting the DO-236B criteria for vertical performance criteria as applicable to all IFR baro-VNAV operations is unwarranted since required vertical performance is not currently specified for all IFR operations.	Further, as discussed in Chapter 4, there are no TSO requirements or MOPS standards regarding advisory vertical guidance minimum performance. When not claiming operational or certification credit, advisory vertical guidance provided for oceanic/remote, enroute and terminal operations to help pilots meet barometric altitude restrictions, while appropriate for IFR operations, should not need to be shown to meet the criteria of Table 6.		
84.	Pg. 69-70 / 10-2.c	The baro-VNAV altimetry system error (ASE) limit equation provided is more restrictive than the certification requirements of 14 CFR 23/25.1325 and CS 23/25.1325 at some	EASA baro-VNAV approach guidance in AMC 20-27 defines ASE limits based on the same equation but specifically states that meeting requirements of the applicable airworthiness	Maintain harmonization with AC 20-27 for baro-VNAV approaches by identifying basic static pressure system airworthiness standards as sufficient to satisfy baro-	**Not Accepted (now chapter 11).** Baro-VNAV system performance requirements exceed the stand-alone altimetry requirements required by rule. The baro-VNAV

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		airspeed/altitude combinations.	standards (e.g. CS-25.1325) meets the ASE requirements for baro-VNAV.	VNAV ASE requirements.	requirements are *system* requirements, not simple altimetry requirements.
85.	Page 69, ¶ 10-2.c	Editorial	Punctuation	Suggest changing: "to qualify a baro-VNAV system the 99.7%" To: "to qualify a baro-VNAV system, the 99.7%" (insert comma after "system")	**Accepted (now chapter 11).**
86.	Pg 69, Para 10-2.c	The proposed text states that altimetry error must be less than the output of the given equation across all altitudes.	Complying with the TSE requirement should be sufficient, regardless of the magnitudes of the individual components that comprise the TSE.	We recommend adding a note (or some other statement) to specify that complying with this requirement is optional if the total system error (TSE) requirement given in Table 6 is met.	**Not Accepted (now chapter 11).** The ASE guidance is not optional. Baro-VNAV guidance in the AC is predicated upon using the primary barometric altimeter as the primary altitude reference for all flight operations. The suggestion would have to be part of an issue paper for the TC/STC applicant to justify not following the acceptable method described in the AC.
87.	Pg 70, Para	Proposed Note 2 states that	Our suggested change is	We recommend that either	**Accepted.** The RVSM line

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	10-2.c Note 2	the 200 ft. TSE requirement comes from RVSM. According to AC 91-85 (*Authorization of Aircraft and Operators for Flight in Reduced Vertical Separation Minimum Airspac*e), the 200 ft. requirement is for altimetry system error (ASE) only, not total system error (TSE). This leaves no room for flight technical error (FTE) or path definition error (PDE). We believe the intent of the requirement is that RVSM-capable aircraft comply with the TSE requirement; however, as written in the proposed text, an aircraft can be RVSM-capable, but not meet the TSE requirement in Table 6.	intended to provide consistency between this proposed AC and AC 91-85.	the TSE requirement be increased to allow for FTE, or the requirement should be clarified to state that ASE is the only component that needs to be considered for the 29,000-41,000 ft. region.	in Table 6, middle column added a reference to note 1 and note 1 has been changed as follows: … Aircraft meeting RVSM requirements provide acceptable vertical total system error in level flight for the last row in table 6. No additional demonstration or compliance evaluation is required. However, the altimetry system error cannot be extrapolated to the other altitude blocks.
88.	Pg 71, Para 10-2.e(1)	The proposed text states: *"(1) The system displays should give no operationally misleading information."*	The requirement for <u>no</u> *operationally misleading* information is neither verifiable nor obvious.	We request that this paragraph be clarified by defining "*operationally misleading information,"* and providing specific information that is of	**Accepted (now chapter 11).** Item number 1 has been deleted. The relevant information is captured in Table 8.

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				concern.	
89.	Page 71, ¶ 10-2.e Table 7 Note 2	While Table 7 Note 1 is consistent with DO-236C FRAC final section 3.7.5.1.2.2 Note 3, Table 7 Note 2 is not consistent with DO-236C FRAC "final" section 3.7.5.1.2.1 Note 1.	Consistency in guidance.	Revise Table 7 Note 2 to be consistent with DO-236C FRAC "final" section 3.7.5.1.2.1 Note 1.	**Not Accepted (now chapter 11).** It is not clear how the notes are inconsistent. The changes to the notes and Table 7 reflect the latest FAA guidance information.
90.	Pg. 72, 10-2. e. (4)(a)	It is unclear how to assess the scaling suitably support the FTE monitoring and bounding. Does the bounding have to be within a simple to read/remember limit such as 1/4 dot or can it be something else. Do the DO-229D specified scalings of paragraph 2.2.4.4.4 satisfy this condition? It is unclear why 75 feet above the path in addition to 75 feet below the path is not included in the AC? Clarify the means by which a TSO-C146c unit with angular VDEV scaling can be approved in this regard.	Systems trying to qualify to multiple uses have multiple requirements that may be conflicting. Compliance is somewhat ambiguous as worded. Need clarification.	Make a clear statement of scaling requirement and how to address that with the mandated scalings of other guidance. Add 75 feet above the path in addition to 75 feet below the path and account for the means by which a TSO-C146a unit with angular VDEV scaling can be approved.	**Not Accepted (now chapter 11).** Chapter 10 is for baro-VNAV, not SBAS. SBAS systems meet the DO-229D requirements and baro-VNAV systems meet the guidance in the AC.

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91.	11-7a. (page 77)	The statement is too open ended, "The avionics must have the functions inhibited through configuration settings (e.g., strapping, software, etc.) if the aircraft is not qualified to perform those functions."	Taken literally, it should be an installation configuration option to inhibit conventional procedures in the FMS navigation database, whereas to include non-authorized procedures is valuable for situational awareness while conventional navaids provide primary navigation. However, likely it is not intended to disable FMS selection of conventional approaches. (Reference, for example, AC 90-108.)	Provide more detailed guidance regarding criteria for determining that a function should be configurable to be disabled at installation. Appropriate guidance would have allowed anticipating new requirements, such as for disabling RF Legs and step-downs at installation.	**Not Accepted (now chapter 12).** The paragraph refers to optional TSO functions. The example for RF makes it quite clear that these are optional functions defined by the TSO/MOPS. How that makes a link to "conventional procedures contained in the FMS navigation database" is not clear. Regardless, the airworthiness applicant must address capabilities in the equipment that an aircraft is not capable of supporting. But, it is impossible to provide specifics in this AC on every potential combination or permutation of equipment capabilities.
92.	11-7a. (page 77)	That RF Turns be an option configurable at installation should be a recommendation instead of a requirement.	It is hypothesized the primary safety concern may be to • Inhibit RNP AR rather than RF Turns, or • Provision to future	If the aircraft meets the functional "must" requirements of Appendix 3-2b items (1), (2), and (3) for public (non RNP AR) RF Turns	**Not Accepted (now chapter 12).** The guidance is here to ensure that any capability the aircraft cannot support is addressed at the time of installation.

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		It is lack of accessible public procedures with RF Turns that hinders aircraft approvals. • The equipment should not be penalized due to a lack of published, public procedures on which to demonstrate airworthiness for RF Turns. (The explicit mega-procedures proposed herein are an improvement.) • If public procedures were both available and accessible, RF Turns could be demonstrated in STCs, and there would be no need to add an equipment requirement to inhibit procedures with RF Turns. • Even with "moved airport" for using RNP AR procedures with RF legs, there is sometimes reluctance to extra expend the effort to approve RF legs for	changes to qualification requirements (such as for 30 degree bank authority) AC 20-138C 16-3d only required that "Positioning and navigation equipment **that does not support RF leg** capability must have an AFMS/RFMS limitation stating the equipment cannot be used for RNP procedures containing RF legs." There was no requirement to inhibit based on lack of aircraft qualification.	• (1) FMS Roll steering, • (2) FMS Roll authority up to or exceeding 25 degrees of bank (currently), and • (3) FMS Moving map that depicts RF Turns, Then an AFM limitation against RF Turns should suffice, provided the equipment inhibits RNP AR procedures. Other suggestions: 1) Add equipment requirement specific to inhibiting RNP AR rather than inhibiting all procedures with RF Turns (example below), 2) Make 11-7a consistent with AC 20-138C/D 16-3 state, "**d.** Positioning and navigation **equipment that does not support RF leg** capability must have an AFMS/RFMS limitation stating the equipment cannot be used for RNP procedures containing RF legs."	The RF Turn example is just that; an example used to illustrate the point being made.

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		public procedures.		For example: "The equipment must inhibit RNP AR procedures if the installation is not approved for RNP AR. Regarding RF Turns on public procedures,"… The avionics must have the functions inhibited through configuration settings (e.g., strapping, software, etc.) if the aircraft is not capable of being approved~~qualified~~ to perform those functions. See Appendix 7. Necessary aircraft capabilities for RF Turns include • a roll-steering autopilot, and • Roll authority up to 25 degrees of bank, and • Map displays able to depict RF Turns. … For ~~this~~ installations that lack any of these capabilities, the avionics would need to have the RF Turn capability inhibited."	

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				Other considerations that an AFM limitation suffices could include: • The equipment was previously demonstrated and approved for FMS guidance on DME arcs, • Demonstrated RF leg capability in bench tests in same or similar avionics set.	
93.	Page 77, ¶ 11-7.a	This paragraph states: 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.) if the aircraft is not qualified to perform those functions. The AFM(S)/RFM(S) must contain an appropriate entry for any limitations.	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 normal practice to make these other functions unavailable to the flight crew if the interfaced equipment is not installed. Furthermore, it is normal practice for an AFM to indicate that a capability that might be disabled, and thus could be unavailable, is optional (this is particularly true for AML STCs).	Either: • Remove the statement that "The AFM(S)/RFM(S) must contain an appropriate entry for any limitations." • 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.	**Not Accepted (now chapter 12).** The provided rationale supports the guidance in the document so it is not clear any change is needed. The AFM(S)/RFM(S) guidance says to include an appropriate entry for any limitations. If there are no limitations, then no entry is needed. If there are limitations, then an entry is needed.

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			Additionally, the RF leg example following the quoted text is similar in nature to the draft AC 20-138D ¶ 5-3.2.e guidance about LP approaches and cause for similar concern. As noted in ¶ 5-3.2.e comment, an AFM typically identifies capabilities that <u>are</u> supported but does not specifically identify capabilities that <u>are not</u> supported. Consequently, a manufacturer's installation instructions for RF leg capability should indicate that the positive statement about RF leg capability should be excluded from the AFM if the supporting autopilot and/or map display capability is not installed. Given the lack of a positive AFM statement that RF leg capability is supported, it is unclear what benefit is provided by including an additional AFM limitation statement that RF leg		

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			capability is not supported.		
94.	Page 77, ¶ 11-7.a	Includes multiple instances of the phrase "RF Turns" and "RF Turn" that are inconsistent with industry standards.	Consistency with other documents like RTCA DO-283A, RTCA DO-229D, and ARINC 424.	Change to "RF legs" (2 times) and "RF leg" (2 times)	**Accepted (now chapter 12).**
95.	Page 77, ¶ 11-7.b	Includes the statement: Particular attention should be paid to the specification of the data quality requirements as part of the airworthiness approval documentation described in AC 20-153 (latest revision) and RTCA/DO-200A, section 2.3.2 and appendix B.	It is unclear what "airworthiness approval documentation described in AC 20-153 … and RTCA/DO-200A" is required to be available for an installer to review. Similar to comments on draft AC 20-138D ¶ 5-6.2.c, the following are issues: • The AC 20-153A Appendix 2, Figure 2 sample FAA Type 2 LOA letter includes no specific information about the "data quality requirements" and instead references manufacturer-specific documentation. Type 2 LOA letters include references to its manufacturer-specific documentation but that documentation is not	Remove the quoted ¶ 11-7.b statement or clarify how an installer reasonably can be expected to examine the "specification of the data quality requirements" given the information a manufacturer is actually required to provide to an installer in accordance with AC 20-153A and RTCA/DO-200A.	**Partially Accepted (now chapter 12).** The sentence has been re-structured to state the data quality requirements are described in AC 20-153 and RTCA/DO-153. The intent for the guidance is that those should be part of the installation instructions. The sentence in has been changed as follows: Particular attention should be paid to the specification of the data quality requirements *described in AC 20-153 (latest revision) and RTCA/DO-200A, section 2.3.2 and appendix B as part of the airworthiness approval documentation.* There is no intent to put an

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			intended for nor supplied to installers. • Further, while AC 20-153A ¶ 11 defines operator responsibilities (which allows a manufacturer to infer documentation that an operator may require), we are unaware of any AC 20-153A requirement to provide specific documentation to an installer. Consequently, there is no convenient means for an installer to examine the "specification of the data quality requirements".		additional burden on installers other than confirming the equipment is able to meet its intended function for the installation by reviewing the available information. All three paragraphs (11-7.a, b, and c) have to be taken together in context.
96.	Page 77, ¶ 11-7.c	Includes the statements: Airworthiness approval holders are responsible for stating any aircraft-level limitations not supported as part of the data quality requirements specified in the airworthiness approval documentation. The	Similar to comments on draft AC 20-138D ¶ 5-6.2.c and ¶ 11-7.b, it is unclear how an installer will be able to state "any aircraft-level limitations not supported as part of the data quality requirements specified in the airworthiness approval documentation" given the information a manufacturer is actually	Remove ¶ 11-7.c. or clarify how an installer reasonably can be expected to state "any aircraft-level limitations not supported as part of the data quality requirements specified in the airworthiness approval documentation" given the information a manufacturer is actually required to	**Not Accepted (now chapter 12).** The guidance clearly states the <u>airworthiness approval holder</u> is responsible for stating any aircraft-level limitations not supported; not the installer. The installer merely checks or confirms the installation is in accordance with the

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		reason is for the end-user to properly identify their database requirements.	required to provide to an installer in accordance with AC 20-153A and RTCA/DO-200A. In similar fashion, and though out-of-scope for draft AC 20-138D, it is unclear how an end-user can be expected "to properly identify their database requirements" given the information a manufacturer is required to provide to an operator in accordance with AC 20-153A and RTCA/DO-200A. This is particularly true for part 91 including subpart K and part 135 and may be true for part 121. The only reasonable activities an operator can be expected to ensure are that the manufacturer has a Type 2 LOA, that there are sufficient instructions for updating a database to comply with continuing airworthiness, and to report errors discovered during the course of their operations.	provide to an installer in accordance with AC 20-153A and RTCA/DO-200A.	airworthiness approval. When taken in context, all the data process assurance guidance from chapters 5, 6, and 11 fit together to complete the data process assurance chain from the equipment manufacturer to the end-user.

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97.	Pg. 78, 11-7. c.	The requirement to provide the data quality requirements for the navigation data base appears to be intended to support the end user acquiring the navigation data independent of the equipment manufacturer. Is this the intent and do the data quality requirements need to be provided when the equipment manufacturer provides databases with an approved LOA.	Clarity of the intent of the requirement is necessary to enable evaluating compliance consistently.	Make the possible cases for database acquisition clear so the user can understand their obligation and the data quality requirements provided by the manufacturer can be properly evaluated.	**Not Accepted (now chapter 12).** The point of all the guidance information on navigation databases is to provide guidance for the entire database chain. The sections on navigation database need to be taken in context relative to the chapter. That is, equipment performance for the equipment manufacturer and installation considerations for the airworthiness approval holder. There is no intent to have end-users acting independently from the manufacturer for databases. However, the end-user is ultimately responsible to ensure the database used supports the installed equipment intended function. As the guidance points out equipment manufacturers

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					have significant impact on the intended function by their inclusion or exclusion of optional functions. The airworthiness approval holder also has an impact when integrating equipment at the aircraft level since the aircraft capabilities may or may not support some equipment functions such as RF legs. The end-user relies heavily on equipment manufacturers (and airworthiness approval holders) to provide an acceptable navigation database, but the ultimate responsibility rests with the end-user.
98.	11-8 (pages 78-80)	The section is not clear that the concern is with step-downs in the final segment (after the Final Approach Waypoint) and not with step-downs in the intermediate segment.	In context, it seems only step-downs in the final segment are an issue.	Clarify that the guidance applies to step-downs after the final approach fix, as coded in the navigation database, and not to step-downs prior to the final approach fix. If there are separate	**Accepted (now chapter 12).** The paragraph title was changed to: *Final Approach Segment* Step-Down Fixes in Navigation Databases.

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				concerns with step-downs in the intermediate segment, provide separate guidance for step-downs in the intermediate segment.	
99.	Page 78, ¶ 11-8 and its subparagraphs	Discusses Step-Down Fixes in Navigation Databases	Our TSO-C129 equipment has displayed step-down fixes for LNAV approaches since 2003 and TSO-C146 GNS equipment has displayed step-down fixes for LNAV, LNAV/VNAV and LPV approaches since their initial airworthiness approval in 2006. All other TSO-C146 equipment receiving initial airworthiness approval since 2006 also have displayed step-down fixes for LNAV, LNAV/VNAV and LPV approaches as well as LP approaches for TSO-C146 equipment that supports them. The combination of TSO-C129 and TSO-C146 represents over 70,000 aircraft installations in the US (over 108,000 aircraft worldwide) across all aircraft parts (23, 25, 27 & 29). The	Either clearly identify the "issues" associated with display of step-down fix information during LNAV, LP, LNAV/VNAV and LPV approaches or remove ¶ 11-8 and its subparagraphs.	**Not Accepted (now chapter 12).** Issues with incorporating step-down fixes depend upon the cockpit configuration and are too numerous to compile a complete list. The existing text does describe pertinent items as part of the problem that manufacturers need to be aware of such as: 1) procedures can contain both named and un-named fixes, 2) ARINC 424 is not a TSO-specified standard, 3) including step-down fixes is not required, step-down fixes do not apply to LPV minima, and 4) cockpit design/layout can influence the airworthiness approval when equipment manufacturers include step-down fixes.

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			majority of these installations are in aircraft with "older cockpit design[s]". We are unaware of any installation issues associated with its equipment involving step-down fixes displayed during LNAV, LP, LNAV/VNAV and LPV approaches and draft AC 20-138D provides no specifics as to the situations where "complicating installation issues" have been introduced. Instead, new ¶ 11-8 and its subparagraphs specify "solutions" without clearly identifying the "issues" that require the "solutions". Specifying "solutions" without identifying the "issues" will inevitably lead to varying interpretations by ACOs and FSDOs that ultimately cause issues with dealer's ability to install safety-enhancing TSO-C146 equipment.		Nothing in the guidance revokes any existing airworthiness approvals; it merely provides guidance for future approvals based upon some issues that have arisen during past approvals.

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			See the related comments on ¶ 1-4.h.(2) and ¶ 22-3.1.e.		
100.	Pg. 78, 11-8.	This section amplifies and clarifies a requirement that has been unclear. The definition of an optimum implementation is appreciated. As this is an installation AC, it would be desirable to have some time frame allowed to make design changes to support this optimum without negatively impacting the ability to install systems in the meantime.	This requirement has been evolving in the guidance and the requirements for the aircraft display system to only include step down fixes for non-LPV approaches is now clearer. The required changes to accomplish this involve the various system integrations and will take additional time in some cases. If the requirement was clear in the TSO requirements, there would be no argument for some period to allow for these modifications. However the inclusion of this requirement in an installation AC will impact installations until equipment modifications can be made. As previously certified installations on aircraft in serial production can continue, some allowance for new installations in retrofit installations until the identified changes could be	Allow a period of time for the Effectivity of this requirement in retrofit installations.	**Partially Accepted (now chapter 12).** This guidance does not mandate any particular implementation and does not affect existing installation approvals. The only thing the guidance is pointing out is: 1) step-down fixes are not required by TSO, and 2) the equipment manufacturer needs to understand the potential impact cockpit configurations can have on installed equipment that includes step-down fixes. There is no intent to "force" equipment re-designs to meet an optimum implementation. To make this clear, the first sentence in paragraph 11-8.c(3) has been changed as follows: The *suggested* optimum implementation is showing

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			made would be reasonable.		step-down fixes for LNAV, LNAV/VNAV and LP approaches, but not showing step-down fixes during an LPV approach.
101.	Page 78, ¶ 11-8.a	Includes the statement: In the U.S. when RNAV (GPS) approach procedures are produced or updated, the procedure designer names the step-down fixes applicable to the LNAV and LNAV/VNAV lines of minima.	It is unclear why this statement refers to step-down fixes as being applicable to LNAV/VNAV lines of minima. FAA Order 8260.58 (O8260.58) Volume 6 (V6) provides the procedure design criteria for RNAV (GPS) approaches for all lines of minima. O8260.58 V6, Chapter 2, titled "Non-Vertically Guided Procedures", ¶ 2.5, titled "Final Segment Stepdown Fixes", includes the only discussion of step-down fixes in the entire O8260.58 V6. O8260.58 V6, Chapter 2 ¶ 2.0 indicates "This chapter contains obstacle evaluation criteria for LNAV and LP non-vertically guided approach procedures." Consequently, step-down fixes are applicable to LNAV and LP	Adjust the discussion throughout ¶ 11-8 and its subparagraphs to ensure it appropriately indicates that step-down fixes are applicable to LNAV and LP lines of minima but not LNAV/VNAV lines of minima.	**Not Accepted (now chapter 12).** LNAV/VNAV minima can be performed using baro-VNAV systems that have different vertical error sources than SBAS-based VNAV. Baro-VNAV also has a lower DAL than SBAS-based VNAV and has always contained a limitation for pilots to confirm all altitudes using the barometric altimeter as a mitigation. It is possible to have the aircraft placed on a vertical path that takes it below the step-down fix altitude and provide less than the intended level of safety margin from obstructions. This equipment performance issue is being discussed with the procedure designers.

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			lines of minima but not LNAV/VNAV lines of minima. Note that the quoted statements also can be found in FAA Order 8260.54A (O8260.54A), the predecessor to O8260.58 V6, in Chapter 3, ¶ 3.5 and ¶ 3.0, respectively; O8260.54A is dated December 7, 2007.		
102.	Page 78, ¶ 11-8.a	Includes the statement: But, many previously published RNAV (GPS) approach procedures still contain unnamed step-down fixes, meaning there will be a mix of named and unnamed step-down fixes published with RNAV (GPS) approach procedures until all the procedures receive their periodic update.	As of cycle 1304 (effective 04-Apr-2013), there are only 116 RNAV (GPS) approaches worldwide that have an unnamed step-down fix.	Suggest changing "many" to "some" or "a few" since 116 approaches is only a small percentage of the RNAV (GPS) approaches worldwide.	**Accepted (now chapter 12).** 116 are still "many" from an absolute standpoint, but the document was changed as suggested.
103.	Page 78, ¶ 11-8.a	Includes the statement: Airworthiness approval applicants should contact their ACO early when seeking an approval for	As noted previously, our TSO-C129 equipment has displayed step-down fixes for LNAV approaches since 2003 and TSO-C146 equipment has displayed	Remove the quoted ¶ 11-8.a statement. At the very least give credit for previous installations that have airworthiness approvals for displaying step-down fixes.	**Not Accepted (now chapter 12).** Nothing in the guidance revokes existing approvals. This is simply guidance making equipment manufacturers

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		equipment with step-down fixes in the onboard navigation database.	step-down fixes for LNAV, LNAV/VNAV and LPV approaches since 2006 and for LP approaches since they were first added to the database in cycle. Consequently, it is not possible for either us or our installers 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.		and airworthiness applicants aware that step-down fixes in navigation databases need careful consideration.
104.	Page 78, ¶ 11-8.a Note 1	Includes the statement: 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.	While it is true that "Step-down fixes are not common to all U.S. RNAV (GPS) approach procedures", U.S. RNAV(GPS) procedures with step-down fixes are "common"; 2596 (43%) as of cycle 1304 (effective 04-Apr-2013).	Suggest revising the statements to: While all U.S. RNAV(GPS) approach procedures do not have a step-down fix, there are a significant number of RNAV(GPS) approach procedures with at least one step-down fix.	**Partially Accepted (now chapter 12).** The text has been changed as follows: **Note 1:** 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*.
105.	Page 78, ¶ 11-8.a Note 2	States: Step-down fixes only apply to LNAV and	As noted in previous comment on ¶ 11-8.a, this statement is incorrect as step-down fixes only apply to	Correct the note to indicate step-down fixes only apply to LNAV and LP lines of minima.	**Partially Accepted (now chapter 12).** LNAV/VNAV minima can be performed using baro-

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		LNAV/VNAV lines of minima.	LNAV and LP lines of minima. Additionally, for approaches with LNAV minima that have step-down fixes and also have LNAV/VNAV and/or LPV minima, charted distances are not from the FAF to the MAP but from the FAF to the step-down fix and from the step-down fix to the MAP. Consequently, it is far easier for a pilot to maintain situational awareness with respect to the chart when the equipment displays active waypoint identifier, distance, etc. that includes the step-down fix even for LNAV/VNAV and LPV lines of minima. This situational awareness is similar to the benefit associated with display of outer/middle/inner markers during an ILS approach ("ILS or LOC" approaches also could benefit from display of step-down fixes if ARINC 424 allowed them in the waypoint sequence). For	Additionally, suggest ¶ 11-8.a be revised to clearly specify the situational awareness benefits that display of step-down fix information provides even on LNAV/VNAV and LPV approaches and to emphasize the importance associated with ensuring all cockpit displays (PFD, MFD) are consistent rather than suggesting "solutions" like providing "a method to remove the step-down fixes for installations that cannot properly support them." (¶ 11-8.b)	VNAV systems that have different vertical error sources than SBAS-based VNAV. Baro-VNAV also has a lower DAL than SBAS-based VNAV and has always contained a limitation for pilots to confirm all altitudes using the barometric altimeter as a mitigation. It is possible to have the aircraft placed on a vertical path that takes it below the step-down fix altitude and provide less than the intended level of safety margin from obstructions. This equipment performance issue is being discussed with the procedure designers. However, LP has been added to the list of minima in the note where step-down fixes apply.

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			specific RNAV(GPS) chart examples, consider the KMCI RNAV(GPS) Y RWY 19L and KADG RNAV(GPS) RWY 5 charts, which have LNAV, LNAV/VNAV and LPV lines of minima. Further, TSO-C146 equipment provides the ability to "fail-down" from LNAV/VNAV to LNAV and LPV to LNAV during the final approach segment if vertical guidance is lost (AC 20-138 has acknowledged this capability in ¶ 4-2.d and ¶ 4-2.e since revision "B"). Not including the step-down fixes on approaches with LNAV/VNAV and/or LPV minima that also have LNAV minima would result in inconsistent equipment behavior and potential loss of situational awareness and pilot confusion in the event that such a fail-down occurred.		

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			While ¶ 11-8.a includes the phrase "Showing step-down fixes on a vertical profile display can enhance flightcrew situation awareness," it does not clearly specify these situational awareness benefits.		
106.	Page 78, ¶ 11-8.a Note 3	Includes the statement: Nor is there any TSO requirement to include step-down fixes in navigation databases for LNAV or LNAV/VNAV approach procedures.	By definition, a TSO is a <u>minimum</u> performance specification; consequently, there are no TSO requirements for many features, like step-down fixes, that benefit our customers. Additionally, as noted in previous comment on ¶ 11-8.a, this statement implies that step-down fixes are applicable to LNAV/VNAV when they only apply to LNAV and LP lines of minima. Furthermore, FAA imposed the following requirement on our AC 20-153A Type 2 LOA: We must also advise its	Remove the quoted ¶ 11-8.a Note 3 statement. At the very least give credit for previous installations that have airworthiness approvals for displaying step-down fixes. Additionally, adjust the note to indicate there is no TSO requirement to include step-down fixes for any line of minima.	**Not Accepted (now chapter 12).** The statement is true.

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			customers of any data received from its Type 1 data supplier(s) that is excluded from the … listed navigation databases due to system or software limitations. Consequently, since our systems support step-down fixes, this would mean either no longer getting the step-down fix information from our Type 1 data supplier or informing our customers at every data cycle that the step-down fixes have been removed. In either case, it negates a benefit our customers requested long before 2003 when our Type 1 data supplier began providing step-down fixes and have come to appreciate since that time.		
107.	Page: 78 Para: 11-8.b.	Although the requirement is clear, it still gives the FMS manufacturer the option of including step-down fix functionality in their software.	Step-down fixes have been a point of contention for lots of years, mostly because some FMS manufacturers saw no need to include the function. That position has caused	Consider a requirement on new installations and/or software updates for step-down fix functionality.	**Not Accepted (now chapter 12).** Minimum equipment requirements are invoked by TSO/MOPS, not an AC. There is no requirement for navigation

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			band-aids to crew procedure and procedure design.		computers to incorporate step-down fixes. Incorporating step-down fixes in navigation databases is, and always has been, entirely optional. Pilots have always been expected to determine step-down fix passage thru either distance from the MAP/threshold or from a crossing radial (on conventional approaches). However, DO-283A is under revision which brings an opportunity to include step-down fixes as a minimum requirement for new FMSs. But that also means creating minimum requirements for displays to present the information.
108.	11-8b. (page 78)	That disabling step-downs be an option configurable at installation should be a recommendation for LPV instead of a requirement for all procedures. Reference, "Equipment	If the equipment is only intended for "proper" installations, there is no need to disable step-downs • The safety (situational awareness) benefit in providing step-downs in the FMS would be denied	It is recommended equipment manufacturers providing step-down fixes in their onboard navigation databases for RNAV (GPS) approach procedures ~~must~~ provide a method to remove the step-down fixes for	**Partially Accepted (now chapter 12).** The paragraph has been modified as follows: Equipment manufacturers providing step-down fixes in their onboard navigation

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		manufacturers providing step-down fixes in their onboard navigation databases for RNAV (GPS) approach procedures must provide a method to remove the step-down fixes for installations that cannot properly support them."	all installations until new equipment was available to disable step-downs in the installation, and • to disable step-downs might never be needed.	• installations that cannot properly support them, or • for LPV and LP approaches, for approvals in ICAO States that prohibit step-downs on LPV an LP.	databases for RNAV (GPS) approach procedures must *either* provide a method to remove the step-down fixes *or provide an installation limitation* for aircraft installations that cannot properly support them. *If removing step-down fixes*, manufacturers may choose to employ installation-specific configurations (i.e., software, strapping, etc.), or they may offer a tailored navigation database (i.e. a database with step-down fixes and a database without step-down fixes).
109.	Page 78, ¶ 11-8.b	Includes the statements: Equipment manufacturers providing step-down fixes in their onboard navigation databases for RNAV (GPS) approach procedures must provide a method to remove the step-down fixes for installations that cannot	Draft AC 20-138D ¶ 11-8.b specifies "solutions" for removing step-down fixes but does not clearly identify the "issues" that require the "solutions". As noted in other comments, there are over 100,000 aircraft with our equipment that displays step-down fixes with no known installation issues. Specifying "solutions"	Clearly identify the "issues" associated with display of step-down fix information during LNAV, LP, LNAV/VNAV and LPV approaches that may require the "solutions". Additionally, make clear that the "solutions" are examples and are not meant to be the only possible solutions. For example, the	**Partially Accepted (now chapter 12).** The text was changed to include defining a limitation or minimum requirements in the installation instructions as follows: Equipment manufacturers providing step-down fixes in their onboard navigation databases for RNAV (GPS)

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		properly support them. To meet this need, manufacturers may choose to employ installation-specific configurations (i.e., software, strapping, etc.), or they may offer a tailored navigation database (i.e. a database with step-down fixes and a database without step-down fixes).	without identifying the "issues" will inevitably lead to varying interpretations by ACOs and FSDOs that ultimately cause issues with a dealer's ability to install safety-enhancing equipment. Additionally, both suggested "solutions" are impractical (particularly the tailored database).	best solution may be to change the installation to remove a piece of equipment that might be showing conflicting information but without specific identified "issues" it is not possible to make this determination.	approach procedures must *either provide a method to remove the step-down fixes or provide an installation limitation for cockpit configurations that cannot properly support them (i.e., define the requirements in the installation instructions/manual).*
110.	Page 78-79, ¶ 11-8.c	Includes the statements: However, a final approach segment step-down fix published on an approach procedure chart that has coincident LNAV, LNAV/VNAV and LPV lines of minima does not apply to the LPV minima. An LPV approach mimics an ILS approach in its construction, presentation and execution by the by the flightcrew so that LPV has no unique training	As noted in previous comment on ¶ 11-8.a, this statement is incorrect as step-down fixes only apply to LNAV and LP lines of minima. Additionally, for approaches with LNAV minima that have step-down fixes and also have LNAV/VNAV and/or LPV minima, charted distances are not from the FAF to the MAP but from the FAF to the step-down fix and from the step-down fix to the MAP. Consequently, it is far easier for a pilot to maintain situational awareness with	Correct the quoted ¶ 11-8.c statement to indicate step-down fixes only apply to the LNAV minima on an approach chart that has coincident LNAV, LNAV/VNAV and LPV lines of minima. Additionally, suggest ¶ 11-8.a be revised to clearly specify the situational awareness benefits that display of step-down fix information provides even on LNAV/VNAV and LPV approaches and to emphasize the importance	**Not Accepted (now chapter 12).** As previously noted for the previous comments, LNAV/VNAV minima can be performed using baro-VNAV systems that have different vertical error sources than SBAS-based VNAV. Baro-VNAV also has a lower DAL than SBAS-based VNAV and has always contained a limitation for pilots to confirm all altitudes using the barometric altimeter as a mitigation. It is possible to have the aircraft placed

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		requirements.	respect to the chart when the equipment displays active waypoint identifier, distance, etc. that includes the step-down fix even for LNAV/VNAV and LPV lines of minima. This situational awareness is similar to the benefit associated with display of outer/middle/inner markers during an ILS approach, which RNAV(GPS) approaches do not provide. Further, TSO-C146 equipment provides the ability to "fail-down" from LNAV/VNAV to LNAV and LPV to LNAV during the final approach segment if vertical guidance is lost (AC 20-138 has acknowledged this capability in ¶ 4-2.d and ¶ 4-2.e since revision "B"). Not including the step-down fixes on approaches with LNAV/VNAV and/or LPV minima as well as LNAV minima would result in inconsistent equipment	associated with ensuring all cockpit displays (PFD, MFD) are consistent rather than suggesting "solutions" like providing "a method to remove the step-down fixes for installations that cannot properly support them." (¶ 11-8.b)	on a vertical path that takes it below the step-down fix altitude and provide less than the intended level of safety margin from obstructions. This equipment performance issue is being discussed with the procedure designers.

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			behavior and potential loss of situational awareness and pilot confusion in the event that such a fail-down occurred. While ¶ 11-8.a includes the phrase "Showing step-down fixes on a vertical profile display can enhance flightcrew situation awareness," it does not clearly specify these situational awareness benefits.		
111.	Page 79, ¶ 11-8.c	Includes the statement: Therefore, the airworthiness applicant must ensure the displayed LPV approach is in the primary field of view, in the proper sequence, unambiguous, and without unnecessary data creating clutter.	While this statement may be trying to identify the issues associated with step-down fixes, the phraseology is unclear and ambiguous. Consider the following: • Does the phrase "displayed LPV approach is in the primary field of view" apply to the CDI/VDI, the LPV annunciation, or something else? Recall that the specific information required to be	Remove the quoted ¶ 11-8.c statement or clarify the specific aspects of the issues associated with step-down fixes as they relate to this statement. If the statement remains, also adjust it as necessary to include LNAV/VNAV.	**Partially Accepted (now chapter 12).** The guidance is consistent with what the MOPS require for LPV approach. It is general guidance for those opting to include step-down fixes. Manufacturers could opt to not include step-down fixes if this general guidance seems too burdensome. However, the phrase "unnecessary data creating clutter" has been changed to "creating detrimental

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			displayed in the primary optimum and primary fields of view are defined elsewhere in AC 20-138D including ¶¶ 11-11.b, 14-2, 14-7.6, 15-2.1, etc. • Does the phrase "in the proper sequence" refer to the waypoint sequence? If so, is this supposed to be interpreted to mean that the sequence does not include step-down fixes even though the chart does? Even if the equipment has been previously installed in 60,000 aircraft and approved for installation via multiple STCs and TCs? • What does the phrase "unnecessary data creating clutter" mean with respect to information required to be displayed in the primary optimum and primary fields of view?		clutter" That is, the intent of the original phrase is to consider the human factors aspect of adding step-down fixes to the presentation.
112.	Page 78-79, ¶ 11-8.c	Editorial		Remove the duplicate "by the" from the phrase	**Accepted (now chapter 12).**

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				"presentation and execution by the by the flightcrew".	
113.	Page 79, ¶ 11-8.c Note	Editorial		Remove the extra blank line preceding the Note.	**Accepted (now chapter 12).**
114.	Page 79, ¶ 11-8.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.	It is unclear what purpose this Note serves. As of cycle 1304 (effective 04-Apr-2013), LPV approaches are now available in Canada, France, Germany, Guernsey, Italy, Switzerland, and United Kingdom as well as the United States. None of these States has indicated their intention to prohibit display of step-down fix information on LPV approaches. Furthermore, as noted in previous comment on ¶ 11-8.a, step-down fixes only apply to LNAV and LP lines of minima so it is unclear why ICAO states would not also consider prohibiting display of step-down fixes on LNAV/VNAV approaches, which have far more applicability worldwide.	Remove the quoted ¶ 11-8.c Note statement; if the statement remains, also adjust it as necessary to include LNAV/VNAV. Additionally, as noted in other previous comments, ¶ 11-8.a should be revised to clearly specify the situational awareness benefits that display of step-down fix information provides even on LPV and LNAV/VNAV approaches. The FAA should ensure these benefits are conveyed to other ICAO States through appropriate ICAO channels.	**Not Accepted (now chapter 12).** The note is simply a caution. Not all States may permit step-down fix displays, particularly if their operations are based on distance/bearing to the MAP or LTP/FTP. Some States may base those operational requirements on a strict interpretation of the MOPS equipment requirements to display distance/bearing to the MAP or LTP/FTP when in approach mode.
115.	Page 79,	Includes the statement:	Grammar. A database	Suggest changing to either:	**Accepted (now chapter**

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	¶ 11-8.c Note	For LPV, some ICAO States may prohibit displaying step-down fix information in the onboard navigation database.	cannot "display" a step-down fix.	For LPV, some ICAO States may prohibit displaying step-down fix information from the onboard navigation database. Or: For LPV, some ICAO States may prohibit including step-down fix information in the onboard navigation database.	**12).** "In" has been replaced with "from."
116.	Page 79, ¶ 11-8.c.(1)	Includes the statement: Integrating an RNAV (GPS) approach with LPV capability in an older cockpit design can be challenging when the onboard navigation database includes step down fixes due to limited display capability and little or no labeling flexibility.	While this statement may be trying to identify the issues associated with step-down fixes, the phraseology is unclear and ambiguous. For example, does the phrase "limited display capability and little or no labeling flexibility" apply to: • The CDI/VDI, whose "classic" mechanical display capabilities include only the ability to display lateral and	Clarify the specific aspects of the issues associated with step-down fixes as they relate to this statement. Also adjust the statement as necessary to include LNAV/VNAV.	**Not Accepted (now chapter 12).** Issues with incorporating step-down fixes depend upon the cockpit configuration and are too numerous to compile a complete list. The existing text does describe pertinent items as part of the problem that manufacturers need to be aware of such as: 1) procedures can contain both named and un-named fixes, 2) ARINC 424 is not

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			vertical deviation, to/from, and flag? • A primary field of view distance indication such as a mechanical "DME" distance display? • Something else? Recall that the specific information required to be displayed in the primary optimum and primary fields of view are defined elsewhere in AC 20-138D including ¶¶ 11-11.b, 14-2, 14-7.6, 15-2.1, etc. Recall also that the majority of the over 40,000 US (and 60,000 worldwide) aircraft installations with equipment providing LNAV/VNAV and LPV with step-down fix are in aircraft with "an older cockpit design".		a TSO-specified standard, 3) including step-down fixes is not required, step-down fixes do not apply to LPV minima, and 4) cockpit design/layout can influence the airworthiness approval when equipment manufacturers include step-down fixes.
117.	Page 79, ¶ 11-8.c.(2)	Includes specific bullet items that display integration must address when installing equipment that displays step-down fixes.	The only bullet that seems to have anything specific with respect to step-down fixes is the third bullet. The 1st bullet is already	Limit the bullets to only those aspects of the issues associated with step-down fixes that are beyond what is already required to be displayed in the primary	**Not Accepted (now chapter 12).** The bullets are general considerations and all apply.

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			addressed by ¶¶ 11-11.b.(1) and 11-11.b.(2). The 2nd bullet is unclear as to what "track" means; i.e., "desired track"? "actual track"? "track angle error"? If so, these are already addressed by ¶ 14-2.b. The 4th bullet indicates "information to the LTP/FTP" should be displayed "during the final approach segment of an LPV approach". Other than new draft AC 20-138D ¶ 11-8.c.(3), there is no other reference to the term "LTP/FTP" within AC 20-138D. Installers are unlikely to understand this term as the ARINC 424 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	optimum and primary fields of view as defined elsewhere in AC 20-138D. Clarify the specific aspects of the issues associated with step-down fixes as they relate to this guidance. If the 4th bullet remains, also adjust it as necessary to include LNAV/VNAV.	

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			(MAP). Even RTCA/DO-229D sections 2.2.5.4.5 and 2.2.5.4.6 use the term "Missed Approach Waypoint/LTP/FTP" (emphasis added) in their titles. Additionally, it is unclear what "information" the 4th bullet expects to be displayed "to the LTP/FTP".		
118.	Page 79, ¶ 11-8.c.(2)	Editorial		Remove extra blank space before the comma in the phrase "database ,". Adjust bullet formatting so that start of text on 2nd and 3rd lines is aligned with start of text on the 1st line.	**Accepted (now chapter 12).**
119.	11-8c(3) (pages 78-79)	The guidance for distance to LTP/FTP is more stringent than DO-229D which often notes that a moving map may be acceptable, without also requiring the numeric information. Excerpts from RTCA / DO-229D are under a 2006 Copyright and used with	Draft AC 20-138D states, "On the LPV final approach segment (i.e., after crossing the final approach fix) it is unacceptable to show distance or bearing numerical information to a step-down fix without also showing the numeric information for the LTP/FTP."	**Suggestion:** "On the LPV final approach segment (i.e., after crossing the final approach fix) it is unacceptable to show distance or bearing numerical information to a step-down fix without also showing either the numeric information for the	**Partially Accepted (now chapter 12).** The paragraph has been changed as follows: The *suggested* optimum implementation is showing step-down fixes for LNAV and LNAV/VNAV approaches, but not showing step-down fixes

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		permission by RTCA, Inc., as separately noted. Copies of RTCA / DO-229D may be obtained from RTCA, Inc., at http://www.rtca.org/ or at 1828 L Street, NW Suite 805 Washington, DC 20036, Telephone 202-833-9339 and Facsimile 202-833-9434.	However, DO-229D states, "A moving map may obviate the need for numerical output." • 2.2.1.4.3 Active Waypoint Distance Display • 2.2.1.4.4 Active Waypoint Bearing Display • 2.2.3.4.4 Missed Approach Waypoint Distance Display • 2.2.3.4.5 Missed Approach Waypoint Bearing Display • 2.2.4.4.5 Missed Approach Waypoint/LTP/FTP Distance Display • 2.2.4.4.6 Missed Approach Waypoint/LTP/FTP Bearing Display • 2.3.4.3 Landing Threshold Point/Fictitious Threshold Point Distance Display	LTP/FTP or else providing a moving map display."	during an LPV approach. When displaying distance/bearing/track to a step-down fix on the LPV final approach segment (i.e., after crossing the final approach fix), *the equipment must also provide a readily available, clear, unambiguous indication of distance/bearing/track to the LTP/FTP. Due consideration should be given to the cockpit configuration and display capabilities during the airworthiness approval process. Additionally,* step-down fixes must not interfere with LPV path construction via the FAS datablock.
120.	11-8c.(3)	The "optimum	The benefits for LP approach	(3) The optimum	**Partially Accepted (now**

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	(page 79)	implementation" does not address that step-downs are beneficial LP and for operating to the LNAV minimum when LPV is not available (LPV fail-down to LNAV during final approach, that is, automatic reversion). What is the optimum implementation for LP?	and for LPV fail-down to LNAV include • Improved situational awareness of the step-down locations and altitudes, • For baro-VNAV systems, advisory vertical guidance for step-downs to aid the crew in ensuring compliance. It would be inconsistent • To provide step-downs for baro-VNAV for LNAV and LNAV/VNAV, and • To not provide step-downs 1. for LPV fail-down to LNAV. 2. For baro-VNAV operations when LPV is predicted to not be available. 3. For LP Also, the crew should have a means to validate on the FMS navigation database	implementation is showing step-down fixes for LNAV, ~~and~~ LNAV/VNAV, LP approaches, and for LPV automatic reversion to LNAV.~~but not showing step-down fixes for LPV~~. On the LPV and LP final approach segment (i.e., after crossing the final approach fix) it is unacceptable to show distance or bearing numerical information to a step-down fix without also showing the either the numeric information for the LTP/FTP or else providing a moving map display~~without also showing the numeric information for the LTP/FTP~~. Additionally, step-down fixes must not interfere with LPV and LP path construction via the FAS data block.	**chapter 12).** LP was added to the list. However, it is sufficient to only state LNAV once since it is irrelevant from a benefit stand-point whether the LNAV was an intentionally selected approach or a fail-down.

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			coding for step-downs to provision for LPV fail-down to LNAV, prior to the real-time occurrence on final approach.		
121.	Page 79, ¶ 11-8.c.(3)	Includes the statement: The optimum implementation is showing step-down fixes for LNAV and LNAV/VNAV approaches, but not showing step-down fixes for LPV.	As noted in previous comment on ¶ 11-8.a, step-down fixes apply to LNAV and LP lines of minima but not LNAV/VNAV minima. Additionally, as noted in previous comments on ¶ 11-8.a Note 2 and ¶ 11-8.c, there are significant situational awareness benefits for 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 40,000 US (and 60,000 worldwide) aircraft installations with equipment that show step-down fixes for LPV and LNAV/VNAV	Remove the quoted ¶ 11-8.c.(3) statement. If the statement remains, adjust it as necessary with respect to LP and LNAV/VNAV minima. Additionally, suggest ¶ 11-8.a be revised to clearly specify the situational awareness benefits that display of step-down fix information provides even on LNAV/VNAV and LPV approaches.	**Not Accepted (now chapter 12).** As previously noted, step-down fixes do apply to LNAV/VNAV. Additionally, extolling the potential benefits of an optional capability only adds to the size of the document and is not necessary.

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			approaches.		
122.	Page 79, ¶ 11-8.c.(3)	Includes the statement: On the LPV final approach segment (i.e., after crossing the final approach fix) it is unacceptable to show distance or bearing numerical information to a step-down fix without also showing the numeric information for the LTP/FTP.	RTCA/DO-229D sections 2.2.5.4.5 (via cross-reference to 2.2.4.4.5) and 2.2.5.4.6 (via cross-reference to 2.2.4.4.6) indicate the distance/bearing "to the LTP/FTP shall be available for display when in terminal and approach modes prior to crossing the LTP/FTP when an approach procedure is selected in the active flight plan"; however: • Neither of these sections requires full-time display of the distance/bearing to the MAP/LTP/FTP but only indicate that these data "shall be available for display". • Both of these sections acknowledge that a moving "map may obviate the need for a numerical output". • AC 20-138D ¶ 15-2.b includes similar text for RNAV multi-sensor equipment but with	If the quoted ¶ 11-8.c.(3) statement represents the "real issue" with display of step-down fixes that has led to all of the added draft AC 20-138D guidance, suggest reducing the new step-down fix guidance to this issue while acknowledging the use of moving map as an acceptable method for allowing display of step-down fixes.	**Accepted (now chapter 12).** The text has been changed as follows: When displaying distance/bearing/track to a step-down fix on the LPV final approach segment (i.e., after crossing the final approach fix), the equipment must also provide a readily available, clear, unambiguous indication of distance/bearing/track to the LTP/FTP. Due consideration should be given to the cockpit configuration and display capabilities during the airworthiness approval process.

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			respect to the “active waypoint”, which would be the step-down fix when the leg to the step-down fix is active and the MAP/LTP/FTP when that waypoint becomes active. These expectations are met in the 40,000 US (and 60,000 worldwide) aircraft installations with our equipment providing LPV (and LNAV/VNAV) with step-down fix by virtue of the integrated moving map, provided the equipment is installed within the field of view guidance specified elsewhere within AC 20-138D (including ‘“classic”, basic “T” instrumentation’). Furthermore, multiple STCs and TCs for Parts 23, 25, 27 and 29 aircraft have been approved for installations that “show distance or bearing numerical information to a step-down fix without also showing the		

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			numeric information for the LTP/FTP" while "[o]n the LPV final approach segment (i.e., after crossing the final approach fix)". Consequently, it is emphatically not true that "it is unacceptable …".		
123.	Page 79, ¶ 11-8.c.(3)	Includes the statement: Additionally, step-down fixes must not interfere with LPV path construction via the FAS datablock.	While this statement is true, it is a TSO-C146() equipment requirement (RTCA/DO-229D sections 2.2.5.3.1), not an installation requirement.	Remove the quoted ¶ 11-8.c.(3) statement as only the equipment manufacturer can ensure this does not occur and TSO-C146() requirements already ensure this.	**Partially Accepted (now chapter 12).** The guidance is attempting to educate both equipment manufacturers and airworthiness approval applicants. However, to be very clear when implementing this non-required function, the text has been changed as follows: Additionally, *equipment manufacturers must ensure step-down fixes do not* interfere with LPV path construction via the FAS datablock.
124.	Page 79 Paragraph 11-8d	The paragraph states that "During an LNAV/VNAV approach, or when using advisory vertical guidance	Document is inconsistent	Correct whichever is wrong.	**Not Accepted (now chapter 12).** This is an area of confusion both inside and outsice of the

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		during a LNAV approach, the flightcrew must ensure compliance with a step-down fix altitude restriction using the barometric altimeter." This is in conflict with Paragraph A9-1d, which states that LNAV/VNAV "approach procedures… contain a TERPS-protected glidepath".			FAA. LNAV/VNAV does have an approved glidepath whereas LNAV does not. It is possible to use baro-VNAV or SBAS for an LNAV/VNAV line of minima. However, baro-VNAV is a 10^{-3} system being used for a 10^{-5} operation. Since 1985 all baro-VNAV systems have had a limitation to use the barometric altimeter to confirm all altitude restrictions. But this has become an issue recently, hence the new guidance in paragraph 11-8.
125.	11.8 d (pages 79-80)	The equipment operation that the vertical deviation may not clear step-downs is not clear in the statement, "During an LNAV/VNAV approach, or when using advisory vertical guidance during a LNAV approach, the flight crew must ensure compliance with a step-down fix altitude restriction	That it could be acceptable for the equipment to display vertical deviation that does not comply with step-downs is contrary certification experiences. In previous certifications, it has been deemed misleading, addressed by either • Requiring the equipment to remove the vertical	Keep the existing statement regarding the crew responsibility for step-downs. Add statement that it is acceptable that equipment to display SBAS-VNAV or baro-VNAV that does not clear the step-downs, and that this may occur due to any of the following	**Partially Accepted (now chapter 12).** LP was added to the first sentence and the next to last sentence.

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		using the barometric altimeter." Step-downs on LP should likewise be addressed.	deviation display, • A limitation against using VNAV, such as in the final approach If it is indeed acceptable, provide clear guidance for consistency in approvals.	• Promulgated angle for procedure, as provided by state source • Database computed angle, as provided by Type 1 source • Lack of step-downs in the navigation database • Step-downs configured to be inhibited in the installation • SBAS-VNAV does not address baro-VNAV altitudes on step-downs Separately, the root cause that the published angle does not clear step-downs should eventually be addressed in the published source.	
126.	Page 79, ¶ 11-8.d	Includes the statements: During an LNAV/VNAV approach, or when using advisory vertical guidance during a LNAV approach, the flightcrew must ensure compliance with a step-down fix	As noted in previous comment on ¶ 11-8.a, step-down fixes apply to LNAV and LP lines of minima but not LNAV/VNAV minima. Additionally, FAA O8260.58 Volume 6, Chapter 2 ¶ 2.5.1.c states "For step-down fixes published in	Remove ¶ 11-8.d and the accompanying Note and, if necessary, add information to the FAA AIM (perhaps 5-4-5.k.1.(e) for LNAV minima and 5-4-5.k.1.(d) for LP minima). If these statements are retained, revise them to be applicable	**Not Accepted (now chapter 12).** As previously noted, step-down fixes do apply to LNAV/VNAV.

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		altitude restriction using the barometric altimeter. The current procedure design criteria attempts to place step-down fixes on or below the VNAV path to provide an opportunity for a continuous descent final approach to the landing runway. However, there is no guarantee the VNAV path guidance will always clear the step-down fix altitude restriction(s).	conjunction with vertically-guided minimums, the published altitude at the fix must be equal to or less than the computed glidepath altitude at the fix." (Note that the quoted statement also can be found in FAA O8260.54A, the predecessor to O8260.58 Volume 6, in Chapter 3, ¶ 3.5.1.c; O8260.54A is dated December 7, 2007.) Consequently, published step-down fixes on an LNAV approach that also has LNAV/VNAV or LPV minima <u>are</u> designed to "guarantee the VNAV path guidance will always clear the step-down fix altitude restriction(s)" meaning at most these statements are applicable only when advisory vertical guidance is displayed. See also comment on ¶ 11-8.d and Note.	only when advisory vertical guidance is provided for: • LNAV approaches without LNAV/VNAV or LPV minima, and • LP approaches with or without LNAV minima	
127.	Page 79, ¶ 11-8.d and	Includes the statements:	As noted in previous comment on ¶ 11-8.a, step-	Remove ¶ 11-8.d and the accompanying Note and, if	**Not Accepted (now chapter 12).** As

Comment Number	Page & Paragraph	Comment	Rationale for Comment	Recommendation	Disposition
	Note	Therefore, airworthiness applicants must include language for an AFM(S)/RFM(S) limitation requiring the flightcrew to use the primary barometric altimeter to comply with step-down fix altitude restriction during an LNAV or LNAV/VNAV approach. Equipment manufacturers should also include a limitation in the equipment operating instructions or flightcrew operating manual.	down fixes apply to LNAV and LP lines of minima but not LNAV/VNAV minima. Also, see other comment on ¶ 11-8.d noting that, at most, such a limitation would be applicable only when advisory vertical guidance is displayed. Additionally, the AFM Operating Limitations content is prescribed by regulation and generically includes Systems limitations (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" a RNAV approach with LNAV or LP minimums when this is a normal operating procedure. E.g., 14 CFR 91.175(i) includes:	necessary, add information to FAA AIM 5-4-5.k.1.(e) for LNAV minima based on the quoted text from FAA AIM 5-4-5.k.1.(d) for LP minima. Another area of the FAA AIM that could be considered for additional information is 5-4-5.i, "Vertical Descent Angle (VDA) on Nonprecision Approaches".	previously noted, step-down fixes do apply to LNAV/VNAV.

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			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 assigned by ATC. 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.k.1.(d) discussing "Area Navigation (RNAV)		

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			Instrument Approach Charts" LP minima lines also includes the following: 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. There are 40,000 US (and 60,000 worldwide) aircraft installations with certified equipment that provides advisory vertical guidance during RNAV (GPS) approaches that do not presently have such an AFM limitation; are they now expected to amend their AFM to include such a limitation? If so: • The certification process required to amend an		

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			AFM makes it prohibitive to make changes to address "general" issues that FAA has the ability to address via the AIM, and • It is not reasonable or practical to expect that previously fielded installations will amend an AFM to include such a limitation. Additionally, if it isn't necessary to amend the existing 60,000 AFMS that are in use, it is unclear why it would be necessary to add a limitation going forward.		
128.	Page 79, ¶ 11-8.d	Editorial		Change the phrase: "comply with step-down fix altitude restriction" To: "comply with a step-down fix altitude restriction" (add "a" prior to "step-down")	**Accepted (now chapter 12).**
129.	Page 79, ¶ 11-8.d Note	Editorial		Change the phrase: "The intent of paragraph is	**Accepted (now chapter 12).**

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				11-8.d is" To: "The intent of paragraph 11-8.d is" (remove "is" preceding "11-8.d")	
130.	Pg 79, Para 11-8.d	The proposed text states: *"d. … Therefore, airworthiness applicants must include language for an AFM(S)/RFM(S) limitation requiring the flightcrew to use the primary barometric altimeter to comply with step- down fix altitude restriction during an LNAV or LNAV/VNAV approach. Equipment manufacturers should also include a limitation in the equipment operating instructions or flightcrew operating manual."*	The original language in AC 20-138C stated: *"The flight crew must use the primary barometric altimeter as the primary reference for compliance with all altitude restrictions associated with the VNAV path; including compliance with all associated step-down fixes."* Alternative types of OEM documents will support the intent of the requirement.	Revise the text as follows: *"d. … Therefore, airworthiness applicants must include language for an AFM(S)/RFM(S) limitation* ***appropriate original equipment manufacturer' s (OEM) documentation*** *requiring the flightcrew to use the primary barometric altimeter to comply with step- down fix altitude restriction during an LNAV or LNAV/VNAV approach. Equipment manufacturers should also include a limitation in the equipment operating instructions or flightcrew operating manual."*	**Partially Accepted (now chapter 12).** The sentence has been changed as follows: Therefore, airworthiness applicants must include language for *a limitation in the* AFM(S)/RFM(S) *(or equivalent documentation)* requiring…
131.	Page 89 Paragraph	The paragraph requires full-time display of autopilot	Content is out of scope of this AC.	Remove.	**Not Accepted (now chapter 14).** This

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	13-6d	modes. It is out of scope of the AC.			guidance is not out of scope, it is very much relevant to positioning and navigation equipment airworthiness integration.
132.	Page 89 Paragraph 13-6i	The paragraph describes interface considerations between nav systems and SVS/EVS systems. It is out of scope of the major section, whose topic is the interface to FGS systems.	Content is out of scope of the section.	Move or remove.	**Not Accepted (now chapter 14).** Applicants are seeking credit for SVS/EVS systems, particularly during LPV operations. So the guidance is very much relevant. Additionally, this paragraph does precisely what is suggested in comment number 2; it references the applicable AC for SVS and EVS systems.
133.	Page 92 Paragraph 13-11d	Discussing use of the outputs of positioning/navigation equipment by other systems, the paragraph states that "Output of navigation position, velocity and time must support the intended function for which it is used under any foreseeable operating condition." This may not be the case	Adequate guidance on SSA exists in other documents. These considerations apply to the receiving equipment, not the positioning/navigation equipment.	Remove.	**Not Accepted (now chapter 14).** Positioning and navigation equipment output uses are proliferating at a rapid rate for both certified and non-certified applications. Paragraph 13-11.d is a general installation consideration for any positioning and navigation system. It has been in the

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		depending on the criticality of the receiving function. The entire paragraph is nothing but a misguided statement of routine considerations in system safety assessment (SSA). It is unnecessary and should be eliminated.			document since revision 'A' and reinforces the need to ensure the criticality of the outputs meets the intended functions. An SSA should address this as a method to comply with the guidance.
134.	Page 95 Paragraph 14-4b	The paragraph states that "The AFM(S)/RFM(S) must describe the effects on any affected system from losing GNSS outputs; the indications that should be expected if GNSS outputs are disrupted; and the flight crew or pilot procedures." This cannot reasonably be the responsibility of the GNSS system manufacturer. The manufacturer of the receiving system is responsible for anticipating the effects of lost inputs and providing appropriate operational guidance to operators. If the GNSS system manufacturer attempted to provide such information, it might well	Requested information is more appropriately provided by manufacturer of receiving equipment.	Remove.	**Not Accepted (now chapter 15).** The paragraph clearly states that the guidance is for TC and STC applicants; not equipment manufacturers (i.e., TSOA holders). The airworthiness approval holder is responsible for all integration aspects of installed equipment. That is the whole point of an airworthiness approval.

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		conflict with the procedures intended by the manufacturer of the receiving system.			
135.	14-5 (pages 95-96)	Regarding the statement, "It is essential that procedures or optional functions an aircraft is not qualified to perform are either removed from the GNSS equipment database, or otherwise inhibited, even if the avionics do support the function." In light of newly proposed requirements for inhibiting step-downs (after final Approach Fix) and RF legs, it is no longer clear how to determine what should be configurable to be disabled at installation.	Taken literally, it should be an installation configuration option to inhibit crew selection for all non-GNSS procedures in the FMS equipment, whereas to allow selecting non-authorized procedures is valuable for situational awareness while the conventional navaids provide primary navigation.	Develop more detailed criteria for determining when • configuration strapping to inhibit a function is required. • To manage capability by database subscription option would be acceptable State so clearly if this is intended to be a new requirement that the GNSS equipment • Should inhibit selection of all conventional procedures not authorized for GNSS or overlay (except as qualified for VOR/DME RNAV capable equipment), • Should only allow the crew to select RNAV (GPS/GNSS), RNAV(RNP), and	**Not Accpeted (now chapter 15).** The procedures or optional functions to inhibit is entirely dependent upon what the equipment is capable of doing and what the aircraft is capable of doing (such as RNP AR). It is impossible to list all possible combinations and permutations that might be available.

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				VOR/DME RNAV and authorized GNSS-overlay procedures, • That the above be configurable at installation	
136.	Page 95-96, ¶ 14-5.a	Includes the statements: It is essential that procedures or optional functions an aircraft is not qualified to perform are either removed from the GNSS equipment database, or otherwise inhibited, even if the avionics do support the function. The AFM(S)/RFM(S) must contain an appropriate entry for any limitations (see paragraph 11-7 and 11-8).	See previous comments on ¶ 5-3.2.e , ¶ 11-7.a and ¶ 11-8.b.	Either: • Remove the statement that "The AFM(S)/RFM(S) must contain an appropriate entry for any limitations (see paragraph 11-7 and 11-8)." • 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.	**Partially Accepted (now chapter 15).** The guidance simply says to include an appropriate entry for any limitation. An appropriate entry is whatever is needed, or not needed, depending upon the particular positioning and navigation equipment in question and the circumstances for the installation. For example, LP approach capability is an expected function for SBAS class 3 equipment, but not class 1, and not providing it would require a limitation. But, including step-down fixes in the navigation database is not an expected function and not including them would not require a limitation.

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					However, the first sentence now includes an example as follows: 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 function *(RNP AR procedures or procedures with RF legs for example).*
137.	Pg. 95, 14-5. a.	This paragraph seems to indicate a new policy that in addition to AFM limitations, any capability not supported in a given installation must be inhibited. This has led to much discussion and the intent of these paragraphs is not completely clear.	In the case of some function that will not work due to an interface in the aircraft, would the function need to be disabled in the equipment or is the fact that it will not work in the installation sufficient. Our examination did not resolve this clearly as written.	Amplifying material with examples of what must be disabled and what may be noted with an AFM limitation would be beneficial.	**Accepted (now chapter 15).** *"(RNP AR procedures or procedures with RF legs for example)*" has been added to the end of the sentence. But these are just two examples. It is possible there are others depending upon the equipment.
138.	Page 96 Paragraph	The paragraph states that adequacy of the database	Requested verification is essentially impossible.	Remove.	**Partiall Accepted (now chapter 15).** The

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	14-5b	process should be verified at system installation time. This goes well beyond the competence level of typical installers and adds no value.			paragraph was re-written to make the confirmation that the data quality requirements are valid at the aircraft level part of the airworthiness approval. That is, there are no additional requirements necessary or limitations as a result of the aircraft level installation. The paragraph now states: *Database process assurance levels are normally addressed <u>at the equipment design level</u> during the LOA review to ensure the data process assurance level, including tool qualification, is appropriate for the intended function of the installed equipment. <u>Documentation that these data quality requirements are valid at the aircraft level must be confirmed during the airworthiness approval.</u>*
139.	Page 96,	Includes the statement:	See previous comments on ¶	Remove the quoted ¶ 14-5.b	**Not Accepted (now**

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	¶ 14-5.b	Database process assurance levels are normally addressed during the LOA review, but should be confirmed at installation to ensure the data process assurance level, including tool qualification, is appropriate for the intended function of the installed equipment.	5-6.a, ¶ 5-6.c, ¶ 5-6.2.c and ¶ 11-7.b.	statement or clarify how an installer reasonably can be expected to complete a LOA review given the information a manufacturer is actually required to provide to an installer in accordance with AC 20-153A.	**chapter 15).** As previously noted, the installer merely checks or confirms the installation is in accordance with the airworthiness approval. When taken in context, all the data process assurance guidance from chapters 5, 6, 11 and 14 fit together to complete the data process assurance chain from the equipment manufacturer to the end-user.
140.	Pg 96, § 14.5 (b) and pg 110, § 15.5 (b)	Paragraphs 14.5 (b) and 15.5 (b) indicate that data process assurance level and tool qualification should be confirmed at installation. The word *"**installation**"* should be clarified.	The reader could benefit if this AC clarified the meaning of the word "***installation***". Although it is broadly used throughout the processes' technical standards (e.g.: DO-178B/C, DO-200A), this nomenclature might induce some readers to misinterpretation, especially in regards to the responsibilities of the OEM and the aircraft operator. The word ***"installation"*** could be replaced by ***"aircraft design and certification"***, or it	The word ***"installation"*** should be replaced by the expression ***"aircraft design and certification".***	**Partially Accepted (now chapter 15).** See previous response that is also in paragraph 15-5.b.

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			could be clarified in the Appendix 9 (Definitions and Acronyms).		
141.	Pages 96-106 Paragraphs 14-6 through 14-10	Addition of new Paragraph 14-5 has caused erroneous cross references in the remainder of Chapter 14.	Editing error	Correct cross references.	**Accepted (now chapter 15).**
142.	Page: 96 Para: 14-6.a.	Position is misspelled (positionn)		… of an integrity-assured position solution at the minimum…	**Accepted . (now chapter 15)**
143.	Page 97 Paragraph 14-7.1a	The paragraph requires that the AFMS/RFMS include a limitation on alternate filing. This is not properly an equipment or installation limitation, it is operating guidance based on FAA policy. While the policy may be appropriate, it is not under the control of the equipment manufacturer or installer. It is the subject of standard guidance to pilots (the AIM) and need not be repeated here. Including specific limitations on alternate filing binds a given operator to FAA policy at the time of issuance of the	Standard guidance to pilots that is subject to change outside the control of the manufacturer should not be included as limitations.	Remove.	**Partially Accepted (now chapter 15).** This equipment performance limitation has been around since SBAS equipment was first approved. The note provides further information that the specific language used in 14-7.1a is not required. However, the guidance in 14-7.1a is now more generic, similar to the guidance in 14-6.c as follows: *This performance limitation must indicate the equipment has an alternate airport flight planning*

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		AFMS/RFMS, rendering future policy changes (whether more or less restrictive) ineffective. (By way of example, the aviation press announced on 4/11/13 just such a change, allowing broader use of GPS/SBAS approaches as filed alternates. If the older, more restrictive, policy was imposed as a limitation on operators with existing installations, they would be unable to take advantage of the new policy.)			*limitation (see appendix 5 for an example). The Aeronautical Information Manual provides some operational flexibility regarding the flight planning limitation for operators that also have baro-VNAV capability. Refer to paragraphs 1-1-20 c.7(a) and 5-4-5 k.7(h) in the Aeronautical Information Manual for specific operational guidance.*
144.	Page: 97 Para: 14-7.1.a.	I believe this requirement for not filing RNAV (GPS) to an alternate is being overcome by N 8900.C055, *Alternate Airport IFR Weather Minimums*.	N 8900.C055 paragraph 5.G. specifically allows filing to an alternate using a GPS-based procedure.	Align this text to N 9000.C055.	**Partially Accepted (now chapter 15).** The equipment flight planning performance limitation still exists for both GPS and GPS/SBAS equipment. The AIM provides some operational flight planning flexibility given the limitation and consideration for baro-VNAV equipage. Paragraphs 14-6.c and 14-7.1(b) have been updated to

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					indicate the operational flexibility exists and provides references to the AIM.
145.	Page 97, ¶ 14-7.2.c	Includes the statement: GPS/SBAS installations of Class 3 or Class 4 equipment that complies with the 'b' or 'c' TSO revision, but does not include LP capability, must have an appropriate limitation included in the AFM(S)/RFM(S).	See previous comments on ¶ 5-3.2.e.	Either: • Remove the quoted ¶ 14-7.c statement. • 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.	**Partially Accepted (now chapter 15).** To be consistent with paragraph 5-3.2.e the sentence has been changed as follows: GPS/SBAS installations of Class 3 or Class 4 equipment that complies with the 'b' or 'c' TSO revision *with a deviation to not* include LP capability must have an appropriate limitation included in the AFM(S)/RFM(S).
146.	Page: 104 Para: 14-9.10 NOTE	The 20NM service volume is unrealistic. I have seen and listened to the arguments, but having flight tested and looked at the linear path tracking data for captures at 120NM, this limitation on service volume is somewhat overly conservative.		Reconsider the wording of this note to address extended service volumes based upon performance data.	**Not Accepted (now chapter 15).** The service volume is the region of guaranteed performance that meets required accuracy, integrity, availability and usability. An ILS can be captured far beyond its service volume as well, but that doesn't mean it is necessarily usable although it is

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					possible for flight inspection to extend the service volume. RTCA is actively working on standards for an extended GBAS service volume. The AC note will be revised if and when those standards materialize.
147.	Page 110, ¶ 15-5 and its subparagraphs	Editorial		This entire section appears to be new but there are no change bars. Suggest adding change bars to be consistent with other new/changed information.	**Not Accepted (now chapter 16).** Change bars (and the yellow highlight) are a convenience for the review process only. The change bars get removed for publication.
148.	15-5a (page 110)	Regarding the statement, "It is essential that procedures or optional functions an aircraft is not qualified to perform are either removed from the RNAV multi-sensor equipment database, or otherwise inhibited, even if the avionics do support the function." In light of new requirements for inhibiting step-downs (after final Approach Fix)	Taken literally, it should be an installation configuration option to inhibit selecting conventional procedures in the FMS navigation database, whereas to include non-authorized procedures is valuable for situational awareness while the conventional navaids provide primary navigation.	State the requirement clearly if the intent is to add a new requirement that FMS equipment capable of DME/DME(/IRS) and VOR/DME RNAV should • Should inhibit crew selection of all conventional procedures not authorized for DME/DME(/IRS) or VOR/DME RNAV. • Should only enable and allow selecting RNAV-	**Not Accepted (now chapter 16).** The procedures or optional functions to inhibit is entirely dependent upon what the equipment is capable of doing and what the aircraft is capable of doing (such as RNP AR). It is impossible to list all possible combinations and permutations that might be available.

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		and RF legs, it is no longer clear how to determine what should be configurable to be disabled at installation.		1, RNAV-2, RNP-1, and RNP-2 procedures authorized for DME/DME(/IRS) or VOR/DME RNAV. • That the above be configurable at installation Otherwise, provide more detailed criteria for determining what must be configurable at installation.	
149.	Pg 110 15.5 Installed Performanc e Capability Para a	Current wording: a) Pg A 2-3It is essential that procedures or optional functions an aircraft is not qualified to perform are either removed from the RNAV multi-sensor equipment database, or otherwise inhibited, even if the avionics do support the function	The existing wording suggests that the removal of procedures from the database is the first option to be considered. At the installation level, TC believes that inhibiting the function or option should be the primary requirement if possible, followed by the option of using Limitations to prohibit function use. Removal of procedures from the database is a last resort that should be primarily limited to dealing with TSO functional requirement	The following text is proposed: If functions are not approved in the installations, they should be inhibited. If it is not possible to inhibit a function, an appropriate limitation to prohibit its use is required. Note: Use of database to remove procedures to disable a function may be considered but is not a preferred method of addressing this intent	**Not Accepted (now chapter 16).** The guidance is general in nature and the method chosen to prevent functions an aircraft cannot support is dependent upon the function itself. Sometimes a particular procedure such as an RNAV(RNP) for RNP AR cannot be performed. In this case, the database is where manufacturers would go to remove that type of procedure. In other cases, such as RF legs, it could be either database removal of

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			issues. It should be the last resort in an aircraft installation and is not likely to be supported by an OEM or FMS manufacturer for STCs or limited aircraft installation.		approach procedures or an equipment method to inhibit selection of procedures containing RF legs. The guidance does not imply any order of precedence and is by the nature of the subject discretionary in how it is accomplished depending upon what is being addressed.
150.	Page 110, ¶ 15-5.a	Includes the statements: It is essential that procedures or optional functions an aircraft is not qualified to perform are either removed from the RNAV multi-sensor equipment database, or otherwise inhibited, even if the avionics do support the function. The AFM(S)/RFM(S) must contain an appropriate entry for any limitations (see paragraph 11-7 and 11-8).	See previous comments on ¶ 5-3.2.e , ¶ 11-7.a and ¶ 11-8.b.	Either: • Remove the statement that "The AFM(S)/RFM(S) must contain an appropriate entry for any limitations (see paragraph 11-7 and 11-8)." • 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.	**Not Accepted (now chapter 16).** The guidance simply says to include an appropriate entry for any limitation. An appropriate entry is whatever is needed, or not needed, depending upon the particular positioning and navigation equipment in question and the circumstances for the installation.

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151.	Page 110, ¶ 15-5.b	Includes the statement: Database process assurance levels are normally addressed during the LOA review, but should be confirmed at installation to ensure the data process assurance level, including tool qualification, is appropriate for the intended function of the installed equipment.	See previous comments on ¶ 5-6.a, ¶ 5-6.c, ¶ 5-6.2.c and ¶ 11-7.b.	Remove the quoted ¶ 15-5.b statement or clarify how an installer reasonably can be expected to complete a LOA review given the information a manufacturer is actually required to provide to an installer in accordance with AC 20-153A.	**Not Accepted (now chapter 16).** As previously noted, the installer merely checks or confirms the installation is in accordance with the airworthiness approval. When taken in context, all the data process assurance guidance from chapters 5, 6, 11 and 15 fit together to complete the data process assurance chain from the equipment manufacturer to the end-user.
152.	Page 111, ¶ 16-2	Includes the statements: The FTE values below are also acceptable for curved path segments only with an autopilot and/or FD. Manual flight operation on curved path segments will require a separate FTE evaluation.	A FAA-sponsored data collection project showed that instrument-rated general aviation pilots without training specific to RF legs were able to hand-fly both a minimally-equipped and a technically-advanced Part 23 aircraft while maintaining 95% FTE < 0.25 nm at typical terminal speeds on procedures with RNP 1 RF legs consistent with those in draft AC 20-138D Appendix 7.	Revise these statements to acknowledge autopilot and/or flight director are not required for curved paths with RNP 1 and higher when flown at terminal speeds.	**Not Accepted (now chapter 17).** The NextGen/Greener Skies initiative is creating a new policy limiting the application of RF legs used for non-RNP AR approach procedures. The new policy is predicated upon aircraft having a roll-steering autopilot or flight director. Contact AFS-400 for further information.

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			Consequently, the need for autopilot and/or flight director to maintain the AC 20-138D Table 9 FTE values for RNP 1 curved path segments has been shown to be excessive, particularly when combined with the FAA's expectation that performance should be demonstrated for every airplane type/navigator/autopilot combination for certification.		
153.	Page 111, ¶ 16-3.a	Includes the statement: The map display should be capable of depicting the curved, RF leg segments without discontinuities on both active and inactive leg segments if a moving map display is included with or interfaced to the positioning and navigation equipment.	A FAA-sponsored data collection project showed that instrument-rated general aviation pilots without training specific to RF legs were able to hand-fly both a minimally-equipped and a technically-advanced Part 23 aircraft while maintaining 95% FTE < 0.25 nm at typical terminal speeds on procedures with RNP 1 RF legs consistent with those in draft AC 20-138D Appendix 7. The data collection project also showed that it	Revise ¶ 16-3.a to make clear that the main purpose of the moving map is to enhance situational awareness, and that it is acceptable for the moving map to be located either in the pilot's primary field of view or on a readily accessible display page outside the primary field of view.	**Not Accepted (now chapter 17).** There is no statement in the paragraph that a display must be in the primary field of view. The paragraph references appendix 3 which has specifics on system eligibility. Paragraph A3-2.b(3) contains a note stating that moving maps are for situation awareness benefit. It is not necessary to repeat the information. Further, the cited study is

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			was not necessary for the moving map capable of depicting RF legs to be in the primary optimum field of view or for the moving map to be depicted at all times. ¶ 16-3.a is ambiguous with respect to the purpose of the moving map for RF legs and its acceptable display location. This ambiguity may lead to varying interpretations for acceptable equipment installations supporting RF leg procedures. This ambiguity is a particular concern for existing approved aircraft installations where the equipment that provides the RNAV (GPS) primary guidance and annunciations also incorporates a moving map where the moving map has marginal display placement but other displayed information complies with FAA and manufacturer installation field of view guidance.		particular to Part 23 aircraft while chapter 16 is for all aircraft incorporating RF legs. What applied in the study for Part 23 aircraft isn't necessarily appropriate to aircraft complying with other FAR Parts and cannot be included as general guidance.

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154.	Pg 112, § 16-3 (b) and pg A3-3, § A3-2 (b) (3)	The requirement to display RF legs on moving maps needs to be clarified.	Paragraph 16-3 (b) allows mitigations for moving map displays that are not capable of depicting RF leg segments while in paragraph A3-2 (b) (3) there is no mention to such mitigation.	Clarify the requirement whether the mitigation is allowed or not. If the mitigation is acceptable than a note in paragraph A3-2 (b) (3) should be included with it.	**Accepted (chapter 16 comment now in chapter 17).** Paragraph A3-2.b(3) had been changed for consistency and a note has been added that references 16-3.b. The essence of the changes are to indicate a moving map capable of depicting RF legs <u>should</u> be used for the situation awareness benefit, but alternate methods might be possible if the applicant can demonstrate necessary performance.
155.	Page 112, ¶ 16-3.d	Includes the statement: Positioning and navigation equipment that does not support RF leg capability must have an AFMS/RFMS limitation stating the equipment cannot be used for RNP procedures containing RF legs.	As noted in previous comments on ¶ 5-3.2.e and ¶ 11-7.a, an AFM typically identifies the approach types that <u>are</u> supported but does not specifically identify approach types that <u>are not</u> supported. Given the positive AFM General statement about what approach types are supported, it is unclear what benefit is provided by including an additional statement in the AFM	Either: • Remove ¶ 16-3.d, or • Clarify the statement that the AFM must include a limitation only if the AFM otherwise states the equipment includes RF capability that is not supported by the installation.	**Not Accepted (now chapter 17).** It has happened in the past that procedures containing RF legs were inadvertently accessible in aircraft without the requisite capability to fly them despite the best efforts of equipment manufacturers and airworthiness approval holders to control databases and installed capabilities. Having the pilot know what the aircraft is approved and

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			Section 2 Limitations about what approach types are not supported.		not approved to do is the last line of defense when errors do occur; particularly for these optional PBN capabilities.
156.	Page 113, ¶ 17-2.b	Includes the statements: 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 approach procedures. … The AFM(S)/RFM(S) limitation language must be equivalent to the following: "When using the <insert name> VNAV	See previous comments on "¶ 11-8.d" and "¶ 11-8.d and Note" (see both comments).	Remove ¶ 17-2.b and instead add information to the FAA AIM.	**Not Accepted (now chapter 18).** This language was included in all baro-VNAV approvals since 1985 per AC 20-129. It was an oversight that previous revisions of AC 20-138 did not explicitly make the same reference.

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		system, the barometric altimeter must be used as the primary altitude reference for all operations; including instrument approach procedure step-down fixes."			
157.	Pg 113, Para 17-2.b	The proposed text states: *"b. … The flight crew/pilots must use the primary barometric altimeter to confirm compliance with all published 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 11-8). The AFM(S)/RFM(S) limitation language must be equivalent to the following:* *When using the <insert name> VNAV system, the barometric altimeter must*	Alternative types of OEM documents will support the intent of the requirement.	Revise the text as follows: *"b. … The flight crew/pilots must use the primary barometric altimeter to confirm compliance with all published 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 11-8)* ***per OEM documentation****. The AFM(S)/RFM(S) limitation language must be equivalent to the following:* *When using the <insert*	**Partially Accepted (now chapter 18).** The phrase "(or equivalent documentation)" has been inserted after AFM(S)/RFM(S).

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		be used as the primary altitude reference for all operations; including instrument approach procedure step-down fixes."		*name> VNAV system, the barometric altimeter must be used as the primary altitude reference for all operations; including instrument approach procedure step-down fixes."*	
158.	Pg. 113, 17-2.b	It is unclear if the aircraft is expected to be able to compute temperature compensation for step-down fixes, MDAs and DAs even when not coded in the navigation database.	Need clarification.	A clarifying statement stating if the aircraft is expected to be able to compute temperature compensation for step-down fixes, MDAs and DAs even when not coded in the navigation database.	**Not Accepted (now chapter 18).** Automatic temperature compensation is not a minimum required baro-VNAV system capability. Also, automatic temperature compensation does not eliminate all error sources that could cause baro-VNAV systems to generate misleading vertical path guidance information. The limitation noted has been applied to baro-VNAV systems since AC 20-129 was published in 1985.
159.	Pages 118-119 Paragraphs 18-5	These installation considerations (structural analysis, power supply and environment) are *completely*	Routine considerations covered by other, more general guidance should not be repeated in this AC.	Remove.	**Not Accepted (now chapter 19).** These installation considerations have been in the document

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	through 18-7	routine and should not be listed here.			since revision 'A'. While this information might be completely routine for an experienced applicant, it might not be completely routine for a new, inexperienced applicant. A broad perspective is necessary because the document is intended as "one-stop-shopping" for all positioning and navigation airworthiness guidance.
160.	Page 119 § 18-8	In the sentence "*from the publication of data by the source to its application in the equipment*", "*source*" is lacking precision.	Consistency with wording of AC 20-153.	Replace "*source*" by "*service provider*".	**Partially Accepted (now chapter 19).** To be more precise, the term was changed to "originating source." The reason "service providers" was not used is because there can be "service providers" that are not the source of the data, so that term is not precise enough.
161.	Page 122 Paragraph 20-1.1a	The comment that "Re-evaluation of installed VHF transceiver performance is not necessary if the filter	Considerations isolated to other equipment should not be covered in this AC.	Remove	**Not Accepted (now chapter 21).** VHF transmissions can directly impact GPS installstions,

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		insertion loss is 2 dB or less" is properly within the scope of VHF transceiver guidance, not this AC.			hence the guidance in the GNSS installed performance – test chapter.
162.	Pg 129 Chapter 22 Installed Performanc e- Test Baro (VNAV)	The vertical deviation scaling, particularly for LNAV VNAV, RNP APCH and RNP AR APCH, should be addressed. The standardized scaling desired for the FAS should be reflected in this AC, as it is important guidance. It is recognized that the resolution of this comment may belong in a more generic section of Chapter 17 rather than in Ch 22.	The introduction section should contain the information reflecting the concept recently agreed to within RTCA SC 227, and that will be published in DO 236C. A separate section or subsection may be the most appropriate. As an alternative, this could be located in Chapter 17 as a separate section.	For the final approach segment, the equipment shall provide the capability for a non-numerical vertical deviation display with a full scale deflection of +/- 150 ft. In addition, the implementation shall provide the flight crew an easy way to identify a path deviation of 75 ft using the vertical deviation display alone. Note 1:This is the minimum standard for vertical deviation display scaling and does not preclude using a scale of other than +/- 150 ft. provided that the scaling is suitable to control the aircraft on the intended path and the 75 ft deviation can be easily identified by the flight crew. Applicable certification and operational requirements must be	**Partially Accepted (now chapter 23).** Table 7 and the notes in chapter 11 provides general guidance.

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				satisfactorily met. Systems using angular vertical scaling shall meet the following: The deviation scaling suitably supports the FTE monitoring and bounding (75 ft deviation). The deviation limits are equivalent to the operational limits for glideslope deviations during an ILS approach. Note 2: This may require limiting the length of the approach to exclude operating where the angular deviations no longer support monitoring and bounding of the FTE. A scale change for the final approach shall be done in a manner suitable for transitioning onto the final approach segment.	
163.	Pg 130	There should be additional	When temperature	Either add a statement to (e)	**Accepted (now chapter**

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	Section 22-3.1 e	requirements to ensure that the display of temp compensated altitudes is consistent in the cockpit to preclude crew confusion.	compensation has been activated, the resulting corrected altitudes should be displayed in a consistent manner on all applicable cockpit displays. This should be verified during the functional flight test. Additionally, this should be added as an installation requirement	or add a separate requirement. As follows: When temperature compensation is enabled by the flight crew, ensure that the display of corrected altitude(s) is consistent on all displays in the cockpit.	**23).** A new section (f) was added as follows: *If equipped, when temperature compensation is enabled ensure that the display of corrected altitude(s) is consistent on all displays in the cockpit.*
164.	Page 130, ¶ 22-3.1.e	Includes the statement: In particular, evaluate how distance to go, course, bearing, etc. is displayed on all flight deck presentations during approach procedures when step-down fixes are included in the navigation database (see paragraphs 11-8 and 17-2.b).	This new statement also seems like it would be applicable to section 20-2 under "20. Installed Performance - Test (GNSS)" and section 21-2 under "21. Installed Performance - Test (RNAV Multi-Sensor Equipment)" because these types of equipment can support advisory vertical guidance during LNAV and LP approaches and vertical guidance during LNAV/VNAV approaches using SBAS-based guidance.	Suggest revising this statement to: Evaluate how distance to go, course, bearing, etc. are displayed on all flight deck presentations during approach procedures when step-down fixes are included in the navigation database (see paragraphs 11-8 and 17-2.b). (remove "In particular," and change "is displayed" to "are displayed") Also, consider including the revised statement in section	**Accepted (now chapter 21 and 22).**

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				20-2 and 21-2.	
165.	Pg A2-3, Paragraph A2-2.d(1)	The section title is "RNAV and Baro VNAV." Recommend changing the title of (1) to RNP AR and Baro VNAV	Editorial. Appendix 2 is titled RNP AR Operations, and reference to RNAV is potentially confusing.	Recommend changing the title of (1) to "RNP AR and Baro VNAV"	**Accepted.**
166.	Page A2-4, ¶ A2-3.a.(2)	Includes the statements: The aircraft's TAWS must contain the most current operating software and the most current terrain and obstacle database for eligibility for RNP AR operations. During a formal RNP AR aircraft qualification airworthiness project, the aircraft manufacturer should establish continuing airworthiness procedures requiring the aircraft operator to keep the TAWS operating software current and to update the onboard terrain and obstacle database. … **Note:** The intent	AC 90-101A Appendix 2 includes no guidance regarding the airworthiness of the Class A TAWS; consequently, the draft AC 20-138D ¶ A2-3.a.(2) guidance represents a significant expansion of the original RNP AR airworthiness requirements. AC 90-101A Appendix 4 ¶ 2.b is the closest thing to TAWS airworthiness guidance and states: Class A Terrain Awareness Warning System (TAWS). An operable TAWS is required for all RNP AR procedures. The TAWS should use altitude that is compensated for local pressure and temperature effects (e.g., corrected	Either: • Remove ¶ A2-3.a.(2) and the Note, or • At the very least clearly specify that a software update is required only if the current software is not airworthy for RNP AR operations.	**Partially Accepted.** RNP AR applicants have been receiving approvals with TAWS as a mitigation related to RNP AR requirements. The use of TAWS for this purpose has become so prevalent that it became an "unwritten" acceptable method of compliance. AC 20-138D corrects the "unwritten" part. However, the note has been modified as follows to further clarify the intent behind updating the operating software: **Note:** The intent behind the most current operating software version is to install updates that correct software defects *affecting*

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		behind the most current operating software version is to install updates that correct software defects. There is no intent to force installation of new functions or features.	barometric and Global Navigation Satellite System (GNSS) altitude), and include significant terrain and obstacle data. The quoted ¶ A2-3.a.(2) text seems to place an unnecessary burden on RNP AR operators, obligating them to immediately go through the expense of updating the airworthiness approval to approve the new software even if the changes have nothing to do with the alerting algorithms (e.g., correcting a maintenance feature defect). After a TAWS equipment manufacturer updates software, there is frequently a delay before the software has airworthiness approval due to the time required to update the type certificate or supplemental type certificate. In some cases, the TC or STC is never updated. The real question should be		*airworthiness*. There is no intent to force installation of new functions or features.

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			whether the current software is airworthy. If so, there should be no requirement to update the software just as there is no requirement to update the RNP AR FMS software as long it is airworthy.		
167.	Page A2-4, ¶ A2-3.a.(2)	Includes the statement: When these procedures are not part of the documented RNP AR aircraft qualification, the operator must establish the procedures to meet the TAWS continuing airworthiness requirements and include these procedures in their application to conduct RNP AR ops.	AC 20-138D is installation guidance, not operator guidance. Consequently, this guidance more appropriately belongs in AC 90-101(AR).	Remove the quoted ¶ A2-3.a.(2) text. If the quoted ¶ A2-3.a.(2) text is retained in some form, change the phrase "RNP AR ops" to "RNP AR operations".	**Partially Accepted.** RNP AR is unique because the operator is ultimately the airworthiness applicant even though they rely to a great extent upon the aircraft OEM. The operator has a defined continuing airworthiness responsibility as part of the RNP AR approval. Therefore, the operator is ultimately responsible to establish the TAWS continuing airworthiness procedures if the aircraft OEM or equipment manufacturer made procedures available to the operator. However, "RNP AR ops" was changed to "RNP AR

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					operations."
168.	Pg. A2-4, A2-3. a. (2)	The requirement for the most current terrain and obstacle database also generated much discussion of true intent. We think the requirement should be for clear instructions for continued airworthiness that addresses what terrain or obstacle database updates must be installed to maintain airworthiness. Updates correcting data outside the area of operation or otherwise not applicable should not be required.	The use of only the term most current could lead to requirements that are not sensible.	A clarifying statement regarding the required material and samples of how it should be addressed in instructions for continued airworthiness would be useful.	**Accepted.** The note has been changed as shown to make the intent clear that updates are needed when there are corrections to software defects affecting airworthiness. **Note:** The intent behind the most current operating software version is to install updates that correct software defects *affecting airworthiness*. There is no intent to force installation of new functions or features.
169.	p A2-4 §A2-3. a. (2)	Proposed text requires that TAWS contain the most current operating software. There may be cases where this may prove difficult to achieve (compatibility with interfaced equipments, not required functional upgrades, …). In addition, operator capability to check the latest software release for each RNP AR operation seems	Updating TAWS with most current operating software is a constraint with no guarantee of added value.		**Partially Accepted.** The operator will have an acceptable upgrade process approved during the RNP AR approval process. The clarification note has been changed as follows to make it absolutely clear that the software updates are for airworthiness purposes only:

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		remote. It is therefore recommended that the acceptability of TAWS software known defects be assessed during RNP AR operational approval. Further update should be managed on a case by case basis, triggered by identified operational issues.			**Note:** The intent behind the most current operating software version is to install updates that correct software defects *affecting airworthiness.* There is no intent to force installation of new functions or features.
170.	Page A2-4 § A2-3.a(3)	Does the independence requirement mean that: - the TAWS has to be coupled directly to the navigation sensor, without using the FM generated position (despite possibly the same sensor, e.g. the GNSS)? - or the source itself has to be different (meaning if FM is using GNSS1, the TAWS has to use the GNSS2 and vice versa)?	Clarify whether the objective is to avoid common mode failure between the FM function and TAWS function down to the sensor level.	Requirement to be clarified.	**Not Accepted.** The first interpretation in the comment is correct. The current guidance states: *The TAWS must use a navigation source that is independent of the navigation computer-generated position. A GNSS position source is considered <u>independent if it is sourced directly from a sensor without any reference to or interchange with the navigation computer system's position output</u>*. The guidance cannot be made any clearer

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					and there was no suggestion on how to do so.
171.	pA2-4 §A2-3 a. (3)	What is the recommendation if a unique equipment provides both GNSS position from sensors and computer-generated position?	To precise design constraint to take into account in that case		**Not Accepted.** TAWS requires a GNSS position source. The point of the RNP AR guidance is to ensure the position source is independent and not corrupted by the navigation computer.
172.	Pg A2-4, Para A2-3.a(4)	The current wording is insufficient to ensure that TAWS will protect the aircraft from terrain: "It is recommended that the TAWS use altitude that is compensated for local pressure and temperature effects (e.g., corrected barometric or Global Navigation Satellite System (GNSS) altitude). The altitude compensation should not require flightcrew/pilot action or input and should be independent of flightcrew/pilot primary barometric altimeter setting."	As a recommendation,the current wording, does not assure that alerts will be issued as intended, independent of temperature and baro setting errors	The following text is proposed to address the requirement directly: Terrain Awareness Warning System (TAWS) Altitude Accuracy must meet the alerting criteria of TSO-C151b or later version: (i) without any pilot action or input; (ii) independent of altimeter setting on the altimeter(s); and (iii) independent of temperature and pressure deviations from the International Standard Atmosphere (ISA);	**Not Accepted.** Earlier TAWS versions can be acceptable for RNP AR applications. It is up to the applicant to make the case that the TAWS integration provides suitable mitigation for the desired RNP AR operation.

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173.	Page A2-4 – A2-5, ¶ A2-3.a.(4)	Editorial		Remove the extra blank line after ¶ A2-3.a.(4).	**OBE.** No blank line exists in the latest draft version.
174.	Pg A2-6, Para A2-3.b(4)	This section deals with VOR in the context of an Appendix that addresses RNP AR. It still contains considerations for VOR infrastructure considerations.	The VOR is not eligible to be an RNP nav source because it does not qualify for the required integrity. Given the experience to date with RNP AR , this section should be updated to more directly focus on lessons learned and on the issues with legacy systems.	Suggest the following: The VOR does not meet the integrity requirements to support Public RNP AR procedures and is not eligible to be used as an RNP sensor. For multi sensor systems, or where VOR is blended into the navigation solution, the VOR input should be removed or otherwise excluded. Note: This does not imply a requirement for direct or automated means of inhibiting VOR input. An operational procedure prior to commencing the RNP AR APCH procedure, requiring the flight crew to inhibit VOR-input or requiring the flight crew to execute a missed approach upon annunciation of	**Not Accepted.** The first sentence says that the aircraft's RNAV system may not use VOR-updating when conducting public RNP AR instrument approach procedures. But, that doesn't prevent the RNAV system from using VOR-updating for non-RNP AR functions. The guidance in this paragraph simply instructs the applicant to ensure VOR-updating doesn't affect the RNP AR operations.

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				reversion to VOR-updating may meet this.	
175.	Pg A2-7, Para A2-3.b(7)	This section references RTCA DO 236B. Given that RTCA SC 227 has completed the FRAC for DO 236C which contains the updated Temp Comp Appendix in April 2013, the reference to DO 236C be made directly at this time.	DO 236C is in the final stages for publication and there is little risk in making this change, considering that this AC is still in the comment stages.	Consider changing the reference to DO 236C and deleting the Note.	**Accepted.**
176.	Page A2-7, ¶ A2-3.b.(7)	Includes the statement: Temperature compensation systems with an airworthiness approval providing corrections to the baro-VNAV guidance must comply with RTCA/DO-236B, appendix H.2.	The reference to RTCA/DO-236B, appendix H.2 is inconsistent with draft AC 20-138D ¶ 3-4.b.(2), which references RTCA/DO-283A Appendix H for TSO-C115c.	Change the reference to "RTCA/DO-283A Appendix H"	**Not Accepted.** Temperature compensation is an optional capability. DO-236C provides more detailed information on temperature compensation requirements than DO-283A. DO-283A is under revision though and most likely will contain the same information as DO-236C. However, DO-283B is not scheduled for publication until 2015 which is why the reference is to DO-236C. Paragraph 3-4.b(2) correctly points to DO-283A for baro-VNAV since that is where the

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					minimum baro-VNAV requirements reside and TSO-C115c implements DO-283A.
177.	Page A2-7, ¶ A2-3.b.(7) Note	Includes the statement: RTCA/DO-236B is currently under revision. Revision 'C' is expected to address baro-VNAV temperature compensation in appendix H.2 and H.3.	While true, it would be more consistent with draft AC 20-138D ¶ 3-4.b.(2) to reference RTCA/DO-283A Appendix H. Additionally, the references to "appendix H.2 and H.3" are too specific.	Suggest changing to: RTCA/DO-283A is currently under revision. Revision 'B' is expected to address baro-VNAV temperature compensation in appendix H.	**Partially Accepted.** The reference was changed to DO-236C. Temperature compensation is an optional capability. DO-236C provides more detailed information on temperature compensation requirements than DO-283A. DO-283A is under revision though and most likely will contain the same information as DO-236C. However, DO-283B is not scheduled for publication until 2015 which is why the reference is to DO-236C. Paragraph 3-4.b(2) correctly points to DO-283A for baro-VNAV since that is where the minimum baro-VNAV requirements reside and TSO-C115c implements DO-283A.

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178.	Pg A2-7, Para A2-3.b(7)	The proposed text in this section includes a new Note that states "(7) Temperature Compensation Systems. … Note: RTCA/DO-236B is currently under revision. Revision 'C' is expected to address baro-VNAV temperature compensation in appendix H.2 and H.3."	The Note should be deleted, as it reflects preliminary information.	We recommend deleting the Note and specifying DO-236() instead.	**OBE.** The reference was changed to DO-236C and the note was deleted.
179.	Page A2-7 – A2-8, ¶ A2-3.c.(1) Note 1	Includes two references to RTCA/DO-236B.	The references to RTCA/DO-236B are inconsistent with draft AC 20-138D ¶ 3-4.b.(2), which references RTCA/DO-283A for TSO-C115c.	Change these references to "RTCA/DO-283A"	**Partially Accepted.** Only revision 'c' of TSO-C115 specifies compliance with DO-283A; previous revisions do not. Almost all in-service FMSs were certified to TSO-C115b or an earlier revision. DO-236B (changed to revision 'C' in the AC) does define and contain performance requirements for the leg types mentioned in A2-3.c(1) and so does DO-283A. For clarity, DO-283A was included in

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					the list of documents in the note.
180.	Page A2-8, ¶ A2-3.c.(2)	Includes a reference to RTCA/DO-236B.	The reference to RTCA/DO-236B is inconsistent with draft AC 20-138D ¶ 3-4.b.(2), which references RTCA/DO-283A for TSO-C115c.	Change the reference to "RTCA/DO-283A"	**Partially Accepted.** A note was added stating that DO-283A contains the same information for fly-by and fly-over theoretical transition area.
181.	Pg A2-11, Para A2-3.c(10)	This section currently deals with a TSO issue that is outside the scope of what an aircraft installation process can address. This section should be revised to address only those integration issues applicable to the installation of an RNP system	Additional installation guidance is appropriate if the aircraft is eligible to support operations in both Mag/TRUE.	Instead of Magnetic Variation, this section should be titled Magnetic/True Heading Reference Source The following guidance is recommended: 1> The aircraft installation must display the aircraft heading source to the flight crew. The display should be clear and unambiguous, correct, and consistent in the cockpit. 2> There should be a means for the flight crew to manually select the desired	**Partially Accepted.** The recommendation is inconsistent. Item 2 says there should be a manual means to override the automatic system selection but item 3 describes descrepancies among the heading reference sources used in the navigation system and displays. Regardless, the paragraph is not intended for aircraft with a magnetic/true switch and is specific to paths defined by CF or FA path terminators. Magnetic variation is applicable to these path terminators and issues have arisen over the magnetic variation methods applied by navigation

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				heading source. This does not preclude a means for the heading reference source to be automatically selected by the system. 3> If a discrepancy between the heading reference sources used by the navigation system and the aircraft displays occurs, an annunciation should be displayed in the Pilot's primary field of view. Where a system relies on pilot manual selection of heading reference source, annunciations should occur in a timely manner to prompt crew action so as to avoid confusion for approach operations. 4> Where a system installation is	computers to generate these paths in northern latitudes with rapid mag/var changes. A note has been added explaining the intent of the guidance is for applying magnetic variation to the paths generated in the navigation computer. Paragraph 13-7 provides general guidance for aircraft with magnetic/true switches.

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				determined to be unable to support consistent operations in True, appropriate limitations must be established and contained in the AFM.	
182.	Page A2-11, ¶ A2-3.c.(10)	Includes the statements: For paths defined by a course (CF and FA path terminators), the navigation system must use the magnetic variation value for the procedure in the navigation database. The navigation database must accurately represent the procedure as promulgated by the procedure designer, including the magnetic variation used in the procedure design.	These statements are not consistent with DO-236C FRAC "final" section 3.2.5.2.	Suggest revising to be consistent with DO-236C FRAC "final" section 3.2.5.2.	**Not Accepted.** RNP AR has more stringent requirements than generic RNP operations described in DO-236C.
183.	Page A2-11 § A2-3.c(10)	The paragraph reads: ***"The navigation database must accurately represent the procedure as***	There is apparently no mechanism to communicate the magnetic variation used during procedure design	Remove the following part of the sentence "including the magnetic variation used in the procdure design"	**Partially Accepted.** There is no intent to have a navigation database code to capture the mag/var used in

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		promulgated by the procedure designer, including the magnetic variation used in the procedure design." This requirement seems impossible to be compliant with. Indeed, how the database content can be aware of the magnetic variation used in the procedure design ?	towards the navigation database. There are multiple mechasnims in place that ensure the navigation database contains up-to-date magnetic variation or identify operational limitations if the magnetic variation database is not up-to-date.		procedure design. The intent is to ensure the magnetic variation compiled or represented in the navigation database is what is intended by the procedure designer. A note has been added as follows: ***Note:*** *The above guidance is for using magnetic variation in the navigation computer for path generation.*
184.	Pg A2-13, Para A2-3.e(5)	Since this is RNP, there is no FROM waypoint. It is always the TO waypoint. Consider correcting this.	The normal area navigation concept is always TO the next waypoint.	Consider deleting this section as TO/TO is covered in Para 8-3g(2)	**Not Accepted.** There is no requirement that RNP (or RNP AR in this case) must be performed with a TO/TO navigation computer. The note directs the reader to section 8-3.g(2) addressing TO/TO navigation computers relative to displaying FROM indications.
185.	Pg A2-14, Para A2-3.e(14) note	Altimeter splits in the cockpit directly affect the flight crew's ability to	The current IFR standard for allowable altimeter split was not developed with the 75 ft	Add guidance to identify/quantify altimeter split. Identify the split	**Not Accepted.** The comment and recommendation are a too

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	1	monitor for the 75 ft below path FTE budget that is part of the vertical path obstacle clearance. This FTE budget is used for the vertical path on LNAV/VNAV,RNP APCH and RNP AR APCH procedures. There is no guidance for the installation to identify this, and how to address large splits that still comply with IFR requirements	vertical error budget as a consideration. Similarly, an altimeter comparator may not be of any use for such VNAV based procedures if its alert threshold is set to 100 ft. Splits of 75 ft or greater, do not support the pilot monitoring task for bounding the FTE. There is a need for installation guidance to identify this issue. The greater the altimeter split, the less FTE is available before an operational go around is required. There are no clear criteria for how to mitigate or deal with this, but at some threshold, the altimeter split must be corrected if an approval is to be operationally usable.	threshold beyond which an approval is not possible without reducing the altimeter split. Coordination with Operational Standards will also be needed for checking altimeter splits before conducting LNAV/VNAV and RNP AR APCH operations.	simplistic characterization of the system(s) for RNP AR VNAV path guidance and barometric altimeter. Different aircraft with different systems react differently with respect to altimeter splits and what is or is not an acceptable split. This is an issue that must be addressed individually during an RNP AR application to determine how the path guidance system and altimetry system operate.
186.	Page A2-16 § A2-4.b and page A3-3 § A3-2.b(2)	Both paragraphs require the ability to command a bank angle up to 25°. However, for helicopters, such an angle cannot be reached without exceeding turn rate 1 (3°/s) due to	Helicopter auto-pilots usually limit bank angle to not exceed turn rate 1 and consequently, the requirement for 25° bank angle capability cannot be fulfilled at approach or missed approach speeds	Objective to be clarified.	**Accepted.** A clarification note was added to explain the bank angle limit is consistent with having one procedure design criteria that can accommodate all aircraft approach speeds (see below).

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		lower approach speed compared to airplanes. What is the rationale for a 25° bank angle requirement?			***Note:*** *The 25 degree bank angle is consistent with a common procedure design criteria that accommodates all aircraft categories; including those with the highest approach speeds. Aircraft with lower approach speeds will typically not achieve these bank angles in normal operations.*
187.	Pg A2-16, Para A2-4.b	Delete this section and reference App 3. It is the same RNP system RF function that supports RNP-1, RNP APCH and RNP AR APCH	Section A2-4 text can be replaced with a reference to App 3 which covers all the RF requirements of this section... App 3 is more comprehensive and better written. That way, all the requirements are consistent in one place.	Delete this section and reference App 3.	**Partially Accepted.** The section remains, but has been reduced to a single paragraph describing the unique possible implementations of RF legs for RNP AR APCH and a reference to appendix 3.
188.	Pg A2-18, § A2-6	It is missing the requirement for misleading vertical and lateral guidance for Approaches with a Missed Approach Less Than RNP 1.	Since in paragraph A2-6 it is mentioned a particular requirement for loss of guidance; the inclusion of requirements for misleading guidance would make the paragraph easier to understand and more	To include the requirements for misleading lateral and vertical guidance.	**Partially Accepted.** The guidance is specific to the missed approach segment which does not have vertical guidance. The vertical guidance information for either RNP 0.3 or RNP less than 0.3

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			complete.		applies to the arrival side of the approach. To try and make it clearer while remaining consistent with 90-101A, the section title and first sentence added the word 'segment'. Sub-paragraphs (1) and (2) were also modified as follows: **A2-6 Requirements for Approaches with a Missed Approach *Segment* Less Than RNP 1.0.** a. The AFM/RFM or aircraft qualification guidance should identify whether or not the aircraft can achieve less than RNP 1.0 when executing a missed approach procedure *segment*. (1) The system design assurance must be consistent with at least a major failure condition for the loss of lateral guidance

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					on an RNP AR approach missed approach segment that requires RNP less than 1.0 to avoid obstacles or terrain. (2) For RNP AR missed approach *segment* operations requiring less than 1.0 to avoid obstacles or terrain, the loss of the lateral guidance display is a hazardous (severe-major) failure condition.
189.	Pg A2-18, § A2.6 (a)	Current wording (for AC 20-138C and also for the draft version of AC 20-138D) of paragraph A2-6 (a) is somewhat awkward and leads to incongruity between items (1) and (2).	Considering the requirement of item (2) where it is stated that *"(…) the loss of the lateral guidance display is hazardous (severe-major) failure condition*.", one of the important parameters related to such requirement is the ability to produce the lateral guidance that is directly associated to the system assurance level, which by item (1) of the same paragraph, can be developed to a design assurance level	Clarify the requirements, such as, for instance: *a) No single point of failure can cause loss of guidance compliant with the RNP value associated with a missed approach procedure. Typically, the aircraft must have at least the following equipment: dual GNSS sensors, dual FMSs, dual air data systems, dual autopilots and a single IRU.* *b) The system design*	**Not Accepted.** While the existing language is awkward, the proposed change does not seem to be any clearer because the proposal could be misinterpreted as applying to the arrival side of the approach rather than the missed approach segment. The change incorporated in response to the comment above for Pg A2-18, § A2-6 should make the existing language clearer that the

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			corresponding to *Major*. Embraer understands that the aim of this paragraph is to assure certain availability of the lateral guidance display and as such it could be rewritten to clarify this intent.	*assurance must be consistent with at least a major failure condition for the loss of lateral guidance.* *c) If a different architecture is proposed which has a single point of failure (as opposed to item a), then it should be demonstrated that the loss of the lateral guidance display is consistent with a hazardous (severe-major) failure condition.*	guidance is specific to the missed approach segment. The existing notes provide clarifications regarding alternate architectures.
190.	Page A2-20 – A2-23, ¶ A2-7 and its subparagraphs	The majority of this section is directed toward operators.	AC 20-138D is installation guidance, not operator guidance. AC 20-138D should address only installation guidance.	Revise A2-7 to address only installation guidance.	**Not Accepted.** RNP AR is unique because the operator is ultimately the airworthiness applicant even though they rely to a great extent upon the aircraft OEM. The operator has a defined continuing airworthiness responsibility as part of the RNP AR approval.
191.	Page A2-21 – A2-22, ¶ A2-7.b.(1)	This paragraph defines a single means by which to perform the accuracy check by comparing "the navigation database with the	One accepted means of compliance is to manually compare the navigation database content as displayed on an FMS with the 8260-10	Modify this paragraph to specify that the equipment manufacturer can perform this accuracy validation check on behalf of the	**Not Accepted.** RNP AR is unique in that the operator has responsibilities as the airworthiness applicant. Nothing in the entire

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		… The FAA Form … 8260-10" content for "A list of the specific procedure data parameters that must be examined during this accuracy check, as well as the allowable differences between source data and that contained in the navigation database for each parameter".	content. However, it is not always possible to compare all of the parameters on the AFS-470 list by this means. A more appropriate means to perform this validation check to the allowable differences would be through the means identified in the Recommendation column.	operator provided: 1) The Type 1 LOA database supplier ensures the accuracy required for the AFS-470 list of parameters between the government source and the ARINC 424 data provided to the equipment manufacturer. 2) The equipment manufacturer with a Type 2 LOA ensures the accuracy required for the AFS-470 list of parameters between the ARINC 424 data provided by the Type 1 LOA supplier and the navigation database provided to the operator. 3) The equipment manufacturer with a Type 2 LOA includes a CRC with sufficient integrity over the entire navigation database provided to the operator and the equipment checks the CRC prior to	section prevents an RNP AR applicant from doing what is suggested. The last sentence in introductory paragraph of A2-7 states: The guidance in this paragraph applies in full to aircraft operators performing RNP AR instrument approach procedures, as well as to any other entity with which an operator may contract to provide navigation database validation services.

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				using the navigation database. If the CRC check fails, the equipment ensures the navigation database content is not available to the pilot.	
192.	Page A2-21 – A2-22, ¶ A2-7.b.(1)	Includes the statement: The FAA Form 8260-series, specifically form 8260-10, and other government source data defining the procedure, are available at the FAA Aviation System Standards website.	AC 90-101A Appendix 3 ¶ 3.a includes a reference not only to form 8260-10 but also to 8260-3. The 8260-3 is a critical form when it comes to documenting approach data although the 8260-10 does include a page where the FAA prints the ARINC 424 coding for the approach. It could be surmised that the intent of removing the 8260-3 reference is that the ARINC 424 page of the 8260-10 should be used exclusively in this check. However, it is even harder for an operator to read the ARINC 424 coding and determine which fields are applicable to the AFS-470 parameter list than by using the 8260-3. Consequently, this makes it	As suggested by other comment on A2-7.b.(1), modify A2-7.b.(1) to specify that the equipment manufacturer can perform this accuracy validation check on behalf of the operator under the suggested conditions.	**Partially Accepted.** 8260-3 was added to the paragraph.

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			even more important to provide specific guidance on how an equipment manufacturer can perform the ¶ A2-7.b.(1) accuracy validation check on the operator's behalf.		
193.	Page A2-22 – A2-23, ¶ A2-7.d	Includes the statement: As a minimum, data suppliers must have an LOA for processing navigation data in accordance with AC 20-153.	As suggested by previous comments on A2-7.b.(1), it is important to recognize a means by which the equipment manufacturer can perform this accuracy validation check on behalf of the operator.	Expand upon the "minimum" for the equipment manufacturer to have a Type 2 LOA and the equipment manufacturer's data supplier to have a Type 1 LOA to expressly indicate that if the data supply chain complies with the method recommended in previous A2-7.b.(1) comment, the equipment manufacturer can perform this accuracy validation check on behalf of the operator.	**Not Accepted.** RNP AR is a specific application for each operator. The operators decide how they will comply with the RNP AR requirements. Nothing in A2-7 prevents an operator from doing what is suggested if it is shown equivalent to the guidance. The last sentence in introductory paragraph of A2-7 states: The guidance in this paragraph applies in full to aircraft operators performing RNP AR instrument approach procedures, <u>as well as to any other entity with which an operator may contract to provide navigation database validation</u>

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					services.
194.	Page A2-25, ¶ A2-8.c.(1)(d) and its subparagraphs	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. Followed by guidance about what types of pre-departure availability predictions are required.	The FAA in general and this AC in particular are promoting a significant expansion to the AFM limitations section for GNSS-related operations. This detracts from important aircraft-specific limitations that pilots need to be directly aware of. In addition, for type-rated airplanes, the additional limitations affect the amount of material a pilot must know when obtaining a type rating as the pilot is responsible for memorizing all airplane limitations prior to the check ride. In all likelihood, a pilot will promptly forget AFM limitations that are operational in nature such as this one and other proposed AFM limitations for LP approaches and RF leg procedures. The proposed AFM limitation is not an airplane limitation and also is not a	• Remove the quoted ¶ A2-8.c.(1)(d) statement • Move the ¶ A2-8.c.(1)(d) subparagraphs to a new section that clarifies the pre-departure RNP prediction capability similar to the ¶ 5-2.3 guidance for FDE prediction program performance.	**Not Accepted.** This section is specific to RNP AR and compliments existing GNSS limitation language relative to availability predictions, but makes them specific to RNP AR APCH. This is not a separate limitation; it clarifies how the existing limitation applies to RNP AR APCH.

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			system limitation that is unique to a specific manufacturer's equipment but instead is an operational limitation as evidenced by the Note after draft AC 20-138D ¶ A2-8.c.(1)(d)(iv) as well as the AC 90-101A 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 reported failures. As another example, although 14 CFR 91.171(a)(2) requires VOR accuracy to have been "checked within the preceding 30 days", there is not an AFM limitation indicating the pilot needs to ensure the VOR accuracy check occurred and passed		

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			within the 30 days prior to using VOR navigation in IFR operations. Similarly, there is no AFM limitation requiring a log of the date of the VOR accuracy check or whether the VOR accuracy check passed. 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 the AIM. See also comments on: • "¶ 11-8.d and Note" with respect to the AFM limitation • Specific ¶ A2-8.c.(1)(d) subparagraphs with respect to the pre-departure RNP prediction capability		
195.	Page A2-25, ¶ A2-8.c.(1)(d)(i)	States: A pre-departure RAIM prediction is sufficient	It is not clear what "is sufficient" means in the context of this statement.	Move the ¶ A2-8.c.(1)(d) subparagraphs to a new section that clarifies the pre-departure RNP prediction	**Partially Accepted.** This section is specific to RNP AR and simply provides guidance on applicability

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		for GPS-based RNP AR operations that are limited to RNP AR 0.3 accuracy.		capability as compared to the ¶ 5-2.3 guidance for FDE prediction program performance. Clarify what "is sufficient" means with respect to the ¶ 5-2.3 FDE prediction program guidance.	of existing equipment prediction requirements to RNP AR APCH airworthiness. The term "sufficient" has been replaced with "acceptable." Other changes have been made as follows: This includes GNSS-based limitations in the AFM(S)/RFM(S) for RNP AR APCH availability predictions at the destination, or checking NOTAMs. *These predictions are consistent with the equipment performance described in chapter 5.* (i) A pre-departure RAIM prediction *(FD or FDE as appropriate)* is *acceptable* for GPS-based RNP AR operations that are limited to RNP AR 0.3 accuracy. (iii) A pre-departure *FDE* RAIM prediction is

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					acceptable for RNP AR operations limited to RNP AR 0.3 accuracy when outside of the GPS/SBAS coverage area or during a GPS/SBAS outage.
196.	Page A2-25, ¶ A2-8.c.(1)(d)(ii)	Includes the statement: An RNP AR operation that is limited to RNP AR 0.3 accuracy based on GPS/SBAS only needs to confirm via NOTAM that there is no GPS/SBAS outage.	Insufficient differentiation between ¶ A2-8.c.(1)(d)(ii) and ¶ A2-8.c.(1)(d)(iii).	Move the ¶ A2-8.c.(1)(d) subparagraphs to a new section that clarifies the pre-departure RNP prediction capability as compared to the ¶ 5-2.3 guidance for FDE prediction program performance. Additionally, suggest changing the quoted ¶ A2-8.c.(1)(d)(ii) statement to: An RNP AR operation that is limited to RNP AR 0.3 accuracy based on GPS/SBAS only needs to confirm via NOTAM that there is no GPS/SBAS outage when within the GPS/SBAS coverage area. (add "when within the GPS/SBAS coverage area"	**Not Accepted.** It is quite clear that the guidance is: 1) for GPS/SBAS, and 2) for RNP AR 0.3. The others apply to: 1) GPS, 2) operating outside of SBAS coverage, and 3) RNP AR less than 0.3.

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				to the end of the sentence)	
197.	Page A2-25, ¶ A2-8.c.(1)(d)(iii)	Includes the statement: A pre-departure RAIM prediction is sufficient for RNP AR operations limited to RNP AR 0.3 accuracy when outside of the GPS/SBAS coverage area or during a GPS/SBAS outage.	See ¶ A2-8.c.(1)(d)(iv) comment regarding how a "pre-departure RAIM prediction" differs from a "pre-departure RNP prediction".	Move the ¶ A2-8.c.(1)(d) subparagraphs to a new section that clarifies the pre-departure RNP prediction capability as compared to the ¶ 5-2.3 guidance for FDE prediction program performance. Clarify what "is sufficient" means with respect to the ¶ 5-2.3 FDE prediction program guidance.	**Partially Accepted.** The word "sufficient" has been changed to "acceptable." Other changes clarified FD or FDE prediction as applicable.
198.	Page A2-25, ¶ A2-8.c.(1)(d)(iv)	Includes the statement: A pre-departure RNP prediction must be conducted prior to dispatch for accuracy values below RNP AR 0.3 (i.e., RNP AR < 0.3).	It is not clear how a "pre-departure RAIM prediction" specified in the preceding paragraphs differs from the "pre-departure RNP prediction" specified by this paragraph, especially since AC 90-101A Appendix 4 ¶ 2.d.(2) states: RNP AR procedures require GNSS updating. Therefore, there is no RNP prediction associated with distance measuring equipment (DME)/DME or very high frequency	Move the ¶ A2-8.c.(1)(d) subparagraphs to a new section that clarifies the pre-departure RNP prediction capability as compared to the ¶ 5-2.3 guidance for FDE prediction program performance.	**Not Accepted.** This guidance is specific to RNP AR less than 0.3 and states it is an RNP prediction, not a RAIM prediction.

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			omni-directional range station (VOR)/DME updating of the aircraft's RNAV system. Based on this AC 90-101A guidance, it would appear that a RAIM prediction is the same thing as a RNP prediction with the possible exception of RNP values smaller than 0.3 and consideration of high terrain that may affect the mask angle (AC 90-101A Appendix 4 ¶ 2.d.(1)).		
199.	A2-25, A2-8.c(1)(d)iv	Does an SBAS equipped airplane need to perform a pre-departure RAIM prediction for RNP AR <0.3 operations within U.S. airspace?	Need clarification.	A clarifying statement regarding whether or not an SBAS equipped airplane needs to perform a pre-departure RAIM prediction for RNP AR <0.3 operations within U.S. airspace.	**Not Accepted.** The guidance states that a pre-departure <u>RNP prediction</u> is required for RNP AR < 0.3; not a RAIM prediction.
200.	Pg A2-26, Para A2-8.e	The current wording is prescriptive and should be revised: *Verify acceptable autopilot response to an RNP fault by pulling the circuit breaker for the RNP equipment.*	Current wording is too prescriptive and assumes that a C/B pull will always simulate a representative RNP system fault. This is not always the case and depends on system	The following revised wording is suggested: **Verify acceptable autopilot response to an RNP fault. The aircraft manufacturer or installer**	**Partially Accepted.** The first sentence has been changed as follows: Verify acceptable autopilot response to an RNP fault by *simulating a*

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			architecture and design of the fault detection characteristics. This same wording appears in a number of sections and should be revised in each for consistency.	**should complete this test in each of the autopilot modes, as applicable. A representative fault may need to be injected into the system, or may be otherwise simulated (by pulling an RNP equipment circuit breaker), as justified by engineering analysis.**	*representative fault consistent with the equipment architecture (e.g., pulling the circuit breaker for the RNP equipment).*
201.	Page A3-1, Appendix 3 title	Uses the phrase "RNP Radius to Fix Turns."	Consistency with other documents like RTCA DO-283A, RTCA DO-229D, and ARINC 424.	Change to "RNP Radius to Fix Legs."	**Accepted.**
202.	Page A3-1, ¶ A3-1	Use of the phrase "RF Turn" is inconsistent with industry standards.	Consistency with other documents like RTCA DO-283A, RTCA DO-229D, and ARINC 424.	Change to "RF leg"	**Accepted.**
203.	Pg A3-1, Para A3-1	Appendix 3 is better written and more comprehensive that the RF section in App 2.	There should not be 2 different places, with slightly different guidance which address the same functionality.	Delete the BOLD text. "**Appendix 3 does not apply to RNP AR; see appendix 2 for all RNP AR guidance"** App 3 reflects all of the requirements of App 2 for RF.	**Accepted.** This sentence has been deleted due to a previously accepted comment to incorporate the RNP AR RF leg material into appendix 3.
204.	Page A3-1, ¶ A3-2.a.(1) and Note 1	Includes two references to RTCA/DO-236B.	The references to RTCA/DO-236B are inconsistent with draft AC	Change the ¶ A3-2.a.(1) reference to "RTCA/DO-283A, Appendix D".	**Partially Accepted.** Previous TSO-C115 revisions did not specify

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			20-138D ¶ 3-4.b.(2), which references RTCA/DO-283A for TSO-C115c.	Change the ¶ A3-2.a.(1) Note 1 reference to "RTCA/DO-283A". Also, for consistency with other similar references consider adding a new Note: RTCA/DO-283A is currently under revision.	DO-283A and the vast majority of FMSs are certified to previous revisions. Note 1 was changed as follows: **Note 1:** The industry standards for paths can be found in *either* RTCA/DO-236C *or RTCA/DO-283A. Both documents contain the same information, but these documents are being revised.*
205.	Pg A3-2, Para A3-2.a(5)	**Failure Modes/Annunciations** The engine failure case should be evaluated under a number of conditions on RF and TF legs to identify the bound of resulting lateral FTE and to establish any special flight crew procedures that may need to be used to safely continue or extract from an RNP RF or TF.	Transport Canada has identified that the engine failure, as a probable failure (greater than 10^{-5}), has the greatest potential adverse effect on FTE on the RF leg. This failure is identified from 25.1309 compliance process and is considered under airworthiness approval in the RNP context. In particular, the transition from RF to straight segment can be challenging for low RNP	The engine failure is an appropriate airworthiness consideration for its impact on the RNP AR qualification of the aircraft. FTE bounding characteristics may be different depending on aircraft configuration (location of engines, approach flap configuration, AP response, FD performance etc….).	**Not Accepted.** RNP AR approvals are not based on abnormal or rare-normal aircraft performance.

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		A section with specific guidance and considerations for the engine failures in the context of RF and for RNP less than .. 3 is recommended. While this failure case is more significant for RNP AR, it is a generic case that should be considered for the RNP APCH approval also.	values. This is less so for aft mounted engine configurations, but can be limiting for the wing mounted engines when a large adverse asymmetric thrust condition exists. (adverse in consideration of the turn direction of the RF leg). On a RNP missed approach procedure, there is little ability to extract, and the missed approach RNP path must be followed until a safe obstruction clearance altitude can be achieved. The Missed Approach scenario is more conservative than an RNP AR APCH procedure where it is possible after some point, to stop the descent, establish a climb and extract the aircraft from obstacles where remaining within 2x RNP of path is no longer critical. However, there is still a period of time on the go around before the aircraft is established in a stable climb, where 2xRNP must be	Regulatory guidance in this AC should be developed, as the engine failure case is likely the largest effect on the ability of the flight crew to follow the RNP path and bound the lateral FTE. TC Flight Test is able to contribute to such advisory material based on certification experience, but a more complete guidance proposal is beyond the time scope of this AC comment process.	

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			maintained. It should be possible to establish airworthiness guidelines by which all aircraft can be consistently assessed for this failure condition and its effect on the RNP bound that may result from resulting FTE excursions		
206.	Pg A3-2, Para A3-2.a(5)	**Failure Modes/Annunciations** The failure modes are covered in a number of sections App 2 and App 3, but are applicable for all RNP approvals. It would be useful to have a single section for Failure Modes considerations for RNP, with subsections for additional guidance for failure on RF legs and for RNP AR considerations.	Consolidate the guidance material in one section, instead of separately in Appendixes. **Chapter 16 Installation Considerations – RNP** is recommended for such a section.	TC offers the following generic wording for consideration in a dedicated section (See also comment 11 on engine failure): The applicant must review any new and existing aircraft failure modes that potentially affect RNP capability. Failures classified per Probable (probability greater than $1x10^{-5}$/fh) and Remote (probability between $1x10^{-5}$/fh and $1x10^{-7}$/fh) need to be reviewed in the context of their impact on the RNP capability to be approved. Where appropriate, mitigating flight crew	**Not Accepted.** The proposed consolidation will be considered as a future change. However, there are several competing considerations right now that prevent making the consolidation including maintaining easy traceability between ACs 90-105 and 20-138() until the next revision of 90-105. Further, Appendix 2 and 3 generally have all the information necessary in one place for applicants that wish to implement RNP AR and RF legs respectively. Not every RF leg applicant will be an RNP AR applicant, so

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				procedures for RNP operations will need to be developed. Failures that need to be reviewed include, but are not limited to: • Failures that significantly disturb the aircraft laterally, • Failures that result in degraded navigation capability, • Failures that affect the performance monitoring and alerting, and • Failures that impact the crew's ability to focus on the navigation task during RNP operations. For RNP significant ***probable*** failures, the aircraft must demonstrate the ability to remain within 1xRNP Total System Error (TSE) using any applicable crew operating procedures.	consolidating information into chapter 16 will not be as straight-forward as indicated. Additionally, the proposed change is focused on abnormal and rare-normal aircraft performance that is not part of RNP or RF leg approvals.

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				In addition, for RNP AR APCH for RNP significant ***remote*** failures, the aircraft must demonstrate the ability to remain within 2xRNP TSE using any applicable crew operating procedures. The demonstration of failure effects and validation of associated RNP AFM procedures may require an appropriate simulator and/or a representative aircraft. *NOTE: Typical failures that may have RNP significant effects include loss of electrical power, navigation sensor failures, engine failure, and failures of performance monitoring and alerting functionality.*	
207.	Page A3-2, ¶ A3-2.b.(1)	Includes the statements: RNP procedures with RF legs require using an autopilot or FD with at least "roll steering"	A FAA-sponsored data collection project showed that instrument-rated general aviation pilots without training specific to RF legs were able to hand-fly both a	Revise these statements to acknowledge autopilot and/or flight director are not required for curved paths with RNP 1 and higher when flown at terminal	**Not Accepted.** The current concept for RF legs is for a limited implementation predicated upon using a roll steering autopilot or FD. Contact AFS-400 for

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		capability that is driven by the RNP system. The autopilot/FD must operate with suitable accuracy to track the lateral and, as appropriate, vertical paths required by a specific RNP procedure.	minimally-equipped and a technically-advanced Part 23 aircraft while maintaining 95% FTE < 0.25 nm at typical terminal speeds on procedures with RNP 1 RF legs consistent with those in draft AC 20-138D Appendix 7. Consequently, the need for autopilot and/or flight director to maintain the AC 20-138D Table 9 FTE values for RNP 1 curved path segments has been shown to be excessive, particularly when combined with the FAA's expectation that performance should be demonstrated for every airplane type/navigator/autopilot combination for certification.	speeds.	further information.
208.	Pg A3-3, Para A3-2.b(2)	The bank angle requirements should be made consistent to the latest RTCASC-227 requirements (30 deg above 400 ft up to FL 195, and 15 deg above FL 195)	RTCA SC 227 spent considerable time to yield wording that was acceptable to the regulators and Industry to reflect the desired requirements	Update the guidance to reflect the end state desired, consistent with the final draft of DO-236C. Provide sufficient guidance to identify bank angle	**Accepted.** The current wording has been modified to reflect DO-236C and current procedure design information. The note has been changed as follows to explain:

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				limitations less than the requirement and reflect it in the AFM, and any associated flight crew procedures required to mitigate this.	**Note:** The specified bank angles *comply with RTCA/DO-236C and* are consistent with a common procedure design criteria that accommodates all aircraft categories; including those with the highest approach speeds. Aircraft with lower approach speeds will typically not achieve these bank angles in normal operations.
209.	Page A3-3, ¶ A3-2.b.(2)	Includes the statement: The flight management computer, the FD system, and the autopilot must be capable of commanding a bank angle up to 25 degrees above 400 feet AGL.	As noted in ¶ A3-2.b.(1) comment, autopilot and/or flight director are not required to maintain the AC 20-138D Table 9 FTE values for RNP 1 curved path segments.	Revise this statement to indicate the ability to command a 25 degree bank angle is only necessary when autopilot and/or flight director is engaged. Similar changes should be made to ¶ A3-2.a.(3), ¶ A3-2.a.(4), ¶ A3-2.b.(4), ¶ A3-2.c.(1), and ¶ A3-2.c.(2).	**Not Accepted.** An autopilot or FD is necessary for RF legs.
210.	Page A3-3, ¶ A3-2.b.(3)	Includes the statement: The aircraft must have an electronic map display depicting the RNP	A FAA-sponsored data collection project showed that instrument-rated general aviation pilots without training specific to RF legs	Revise ¶ A3-2.b.(3) to make clear that the main purpose of the moving map is to enhance situational awareness, and that it is	**Not Accepted.** The note already states that moving maps are recommended for their situation awareness benefit.

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		computed path of the selected procedure including RF legs.	were able to hand-fly both a minimally-equipped and a technically-advanced Part 23 aircraft while maintaining 95% FTE < 0.25 nm at typical terminal speeds on procedures with RNP 1 RF legs consistent with those in draft AC 20-138D Appendix 7. The data collection project also showed that it was not necessary for the moving map capable of depicting RF legs to be in the primary optimum field of view or for the moving map to be depicted at all times. ¶ A3-2.b.(3) is ambiguous with respect to the purpose of the moving map for RF legs and its acceptable display location. This ambiguity may lead to varying interpretations for acceptable equipment installations supporting RF leg procedures. This ambiguity is a particular concern for existing approved aircraft	acceptable for the moving map to be located either in the pilot's primary field of view or on a readily accessible display page outside the primary field of view.	

Comment Number	Page & Paragraph	Comment	Rationale for Comment	Recommendation	Disposition
			installations where the equipment that provides the RNAV (GPS) primary guidance and annunciations also incorporates a moving map where the moving map has marginal display placement but other displayed information complies with FAA and manufacturer installation field of view guidance.		
211.	Page A3-3, ¶ A3-2.c.(2)	Includes the statement: Use of manual control with CDI only is not allowed on RF legs.	As noted in the comment on ¶ A3-2.b.(1), a FAA-sponsored data collection project showed that instrument-rated general aviation pilots without training specific to RF legs were able to hand-fly both a minimally-equipped and a technically-advanced Part 23 aircraft while maintaining 95% FTE < 0.25 nm at typical terminal speeds on procedures with RNP 1 RF legs consistent with those in draft AC 20-138D Appendix 7. The data collection project was conducted using CDI in conjunction with a	Revise ¶ A3-2.c.(2) to make clear that manual control using CDI and moving map are allowed for RF legs.	**Not Accepted.** The current concept for RF legs is for a limited implementation predicated upon using a roll steering autopilot or FD. Contact AFS-400 for further information.

Comment Number	Page & Paragraph	Comment	Rationale for Comment	Recommendation	Disposition
			moving map. Consequently, the FAA has sufficient data showing that manual control using CDI and moving map are adequate to maintain the AC 20-138D Table 9 FTE values for RNP 1 RF legs.		
212.	App. 4 **GNSS Tests to Support ADS-B**	This appendix should be revised or clarified to show follow- on cert effort. As currently written, there's lots of math in this appendix that may be necessary for a VERY first time installation approval but appears to me to be way over kill for follow on approvals. Other sections of the AC address follow on but not here for GNSS/ADS-B. If I had a guess, I'd say they copied a MOPS test procedure used by a supplier for his first effort and made it the defacto standard for everyone. If the FAA clearly stated it was for		After initial approvals, something very simple like assuring the ADS-B equipment is able to squawk GPS LAT/LON should be enough.	**Partially Accepted.** These test procedures are for GPS equipment manufacturers to generate bench test data to qualify their GPS equipment as suitable for an ADS-B position source. Once the qualification is accomplished, there is no "follow-on approval" and these tests are not an "installation approval." The first sentence in A4-1.a was changed as follows: …describes bench test procedures that *GNSS equipment manufacturers* can use as an acceptable means…

Comment Number	Page & Paragraph	Comment	Rationale for Comment	Recommendation	Disposition
		suppliers/TSO holders, maybe that would help. Ex Page A4-4: Use the simulator velocity truth data ($V_i^{east\_truth}$, $V_i^{north\_truth}$) and the GNSS receiver velocity data (V_i^{east}, V_i^{north}) to determine the horizontal velocity error h_i after the GNSS receiver has entered the desired navigation mode with the specified signal and RFI conditions: $h_i = \sqrt{(V_i^{east\_truth} - V_i^{east})^2 + (V$			
213.	Page A4-1, ¶ A4-2.b	Reference to AC 20-165 (latest revision) appendix 2 paragraph 4k is incorrect.	¶ A4-2.b discusses the position source's velocity accuracy output (NACV) but AC 20-165 appendix 2 paragraph 4k provides requirements for the horizontal velocity output rather than for velocity accuracy. AC 20-165 appendix 2 paragraph 4n provides	Replace the reference to AC 20-165 appendix 2 paragraph 4k with a reference to AC 20-165 appendix 2 paragraph 4n.	**Accepted.**

Comment Number	Page & Paragraph	Comment	Rationale for Comment	Recommendation	Disposition
			requirements for velocity accuracy.		
214.	Page A4-2 Paragraph A4-2.d(4)	Contains stale reference to AC 20-138C.	Editing error	Correct	**Accepted.**
215.	Pages A5-1 through A5-7 Appendix A	Appendix A contains numerous stale references to AC 20-138C.	Editing error	Correct	**Accepted.**
216.	Page A5-6 Section 2, Item 5 of the sample AFMS/RFMS	This item calls for the AIM restriction on alternate filing to be cited as a limitation in the GNSS AFMS/RFMS. The AIM is non-regulatory and making it so by citation in a limitation is inappropriate. It is already commonplace for approaches to be legended as unavailable as filed alternates on the approach plate or accompanying descriptive information. To handle this case differently is clumsy, inflexible and confusing to operators.	This issue can be handled better in existing publications.	Remove. Modify approach plates as necessary to reflect restrictions.	**Partially Accepted.** Appendix 5 is only an example and is not ment to be followed as an absolute requirement. Additionally, the guidance says that AIM references <u>can</u> be used, not <u>must</u> be used (see paragraph 14-6.d and note 3). The existing guidance provides all the flexibility manufacturers need to create their AFMS/RFMS. Paragraph A5-1 states: *The intent of this appendix is to provide general guidance for creating an AFMS/RFMS. <u>The information and structure below are not intended to cover all possible aircraft</u>*

Comment Number	Page & Paragraph	Comment	Rationale for Comment	Recommendation	Disposition
					integrations or equipment capabilities and should not be construed to limit the content included in an AFMS/RFMS. Actual AFMS/RFMS language and structure must be tailored to the actual installation, equipment capabilities, and limitations. AC 25.1581-1 provides flight manual guidance information for transport category airplanes. However, to be absolutely clear, the sentence in the limitations section for item 4 for has been changed to: *Refer to sections 1-1-19, 1-1-20, 1-2-3 and 5-4-5 in the Aeronautical Information Manual for specific operational guidance.*
217.	Appendix 7	These procedures do not distinguish between AR and non-AR procedures. They are inappropriate in scope and content for use with non-AR systems.		Create a subset for non-AR systems.	**Not Accepted.** The procedures were actually created specifically for RNP AR. But, with a few exceptions that are noted in the appendix, RF Turns for RNP AR are no different

Comment Number	Page & Paragraph	Comment	Rationale for Comment	Recommendation	Disposition
					than RF Turns for non-RNP AR.
218.	Appendix 7 RF Turn Demonstration Template (pages A7-1,2,3)	Proposing a standard mega-procedure is welcomed.	Without trial nav database coding it is not clear whether mega-procedure is viable.	Have representative Type 1 database suppliers review the mega-procedure data to confirm that it is sufficient and unambiguous for database coding. The review could include trial coding to be evaluated by the FMS equipment manufacturers, as was performed for "Final End-Point" coding. The ~~survey~~ FMS survey that MITRE performs on behalf of the FAA could be performed in the future with these mega procedures.	**No Action Required.** The database coding for a specific equipment manufacturer's products are their responsibility. This template provides the guidance for manufacturers to create acceptable test procedures. But it is the manufacturer's responsibility to get the test procedures properly coded to run the test. However, the suggested change to "FMS survey" cannot be accepted because the guidance does not apply solely to FMSs. That is, stand-alone Class Gamma SBAS manufacturers can use it as well.
219.	Pages A7-1 – A7-16, Appendix 7 all	Use of the phrases "RF Turn", "RF Turns", "RF turn", "RF turns", etc. are inconsistent with industry standards.	Consistency with other documents like RTCA DO-283A, RTCA DO-229D, and ARINC 424.	Change to "RF Leg", "RF Legs", "RF leg", "RF legs", etc. throughout Appendix 7.	**Accepted.**
220.	Page A-7-1, ¶ A7-1.a	Includes the statement:	Clarify the types of SIDs and STARs that can include RF	Suggest changing the phrase "along with SIDs and	**Not Accepted.** The statement in this appendix

Comment Number	Page & Paragraph	Comment	Rationale for Comment	Recommendation	Disposition
		The templates depict the various RF Turns procedure designers might use when constructing actual initial, intermediate, or missed approach segments for RNAV (GPS) or RNAV (RNP) approaches along with SIDs and STARs.	legs since conventional SIDs and STARs cannot include them.	STARs" to "along with RNAV and RNP SIDs and STARs"	merely indicates that it is possible for SIDs and STARs to have RF legs. There can be "RNP" SIDs and STARs that do not have RF legs. SIDs and STARs with RF legs have a notation on the chart indicating that RF is required.
221.	A7-1, a	It is unclear if this applies to any procedure with an RF turn or only RNP AR	Note 2 implies that this must be done for all types of procedures but other sections only refer to RNP AR	Need to specifically what this section applies too	**Not Accepted.** A7-1.a note 2 and the first sentence in A7-1.c clearly state the templates are designed for use on both RNP AR (e.g., RNAV (RNP)) and non-RNP AR (e.g., RNAV (GPS)) procedures with RF legs
222.	Page: A7-1 Para: A7-1b	"The point is to demonstrate the aircraft is capable of flying the various types of turns including turns of maximum and minimum radius."	The testing does not include types of "maximum radii." We are not aware of a "maximum" allowable radius. Also, I believe in this sentence it should be "radii" not "radius" when referring to max and min.	"The point is to demonstrate the aircraft is capable of flying the various types of turns including turns of minimum radius."	**Accepted.**
223.	Pg A7-1, Para A7-1.b	The proposed text states: *"b. The demonstration*	The requirement for *"all possible"* is neither verifiable nor testable.	Revise the text as follows: *"b. The demonstration*	**Partially Accepted.** The sentence has been changed as follows:

Comment Number	Page & Paragraph	Comment	Rationale for Comment	Recommendation	Disposition
		procedures applicants create need to include all possible RF Turn types that can be used. *…"*		*procedures applicants create need to include all possible RF Turn types that can* ***could*** *be used* ***by the system. The remaining sections of this appendix provide guidance regarding RF turn types that should be considered for inclusion in a demonstration procedure.****"*	The demonstration procedures applicants create need to include the *depicted* RF Turn types *shown in paragraph A7-2.*
224.	pA7-7 §A7-2.3	For approaches 1 & 3 templates, RF turn terminates at the final approach fix, can you confirm that this kind of procedure is authorized.	Usually a 2nm straight segment is sequenced before the FAF.		**Not Accepted.** As stated in paragraph A7-1.c: It should be noted that the templates are designed for use on both RNP AR (e.g., RNAV (RNP)) and non-RNP AR (e.g., RNAV (GPS)) procedures with RF legs. Therefore, the procedures created from the templates will provide "stressing" situations because some license was taken with the procedure design criteria. For example, RF legs on RNAV (GPS) approaches currently terminate at least 2 NM prior to the final

Comment Number	Page & Paragraph	Comment	Rationale for Comment	Recommendation	Disposition
					approach fix, not at the final approach fix (refer to the 'S' turn in Figure 4). Another example is that several RF leg radii were intentionally reduced to approach the 25 degree RNP AR flight guidance system bank angle limits given the design wind criteria and category C/D aircraft speeds.
225.	pA7-7 §A7-2.3	Is this appendix applicable whatever the approach type (LNAV, LNAV/VNAV, LPV)?	To clarify is approach type must be considered for use of RF turn demonstration templates		**Not Accepted.** As stated in paragraph A7-1.a: This appendix provides templates that are an acceptable method to demonstrate an aircraft's capability to perform RF legs. Applicants may use engineering simulations and/or aircraft for the flight test demonstrations. The templates depict the various RF legs procedure designers might use when constructing actual initial, intermediate, or missed approach segments for RNAV (GPS) or RNAV

Comment Number	Page & Paragraph	Comment	Rationale for Comment	Recommendation	Disposition
					(RNP) approaches along with SIDs and STARs.
226.	pA7-8 §A7-2.3 Table 17	Do you confirm final segment status for RF starting at waypoint WP557 and finishing at PFAF7 with associated RNP 0.3?	To confirm that approach procedure with a RF leg as final status is authorized		**Not Accepted.** As previously stated, the templates can be used for both RNP and RNP AR procedures. This means the procedures are "stressing" for non-RNP AR since the RF leg depicted terminates at the PFAF. Howerver, none of the procedures shows an RF leg inside the PFAF which is possible for RNP AR.
227.	Page A-7-7, ¶ A7-2.3.b	Editorial		Change the phrase: "As shown in Figure 8, the Approach 1" To: "As shown in Figure 8, Approach 1" (remove "the")	**Accepted.**
228.	Page: A7-7 Para: A7-2.3b	"Note that there is no straight segment 2 nm prior to"…	Nautical miles should be abbreviated to "NM" to stay consistent		**Accepted.**

Comment Number	Page & Paragraph	Comment	Rationale for Comment	Recommendation	Disposition
229.	pA7-15 §A7-2.3 b)	As noted, configurations proposed for Approach 1 & 3 are more demanding for RNAV (GPS) final segment which may affect capture, more detailed criteria could be provided for the expected behaviour near to the FAF, in particular for LPV minima.	Clarifications of expected system behaviour for the capture are needed		**Not Accepted.** As stated in paragraph A7-1.c: It should be noted that the templates are designed for use on both RNP AR (e.g., RNAV (RNP)) and non-RNP AR (e.g., RNAV (GPS)) procedures with RF legs. Therefore, the procedures created from the templates will provide "stressing" situations because some license was taken with the procedure design criteria. For example, RF legs on RNAV (GPS) approaches currently terminate at least 2 NM prior to the final approach fix, not at the final approach fix (refer to the 'S' turn in Figure 4). Another example is that several RF leg radii were intentionally reduced to approach the 25 degree RNP AR flight guidance system bank angle limits given the design wind criteria and category C/D

Comment Number	Page & Paragraph	Comment	Rationale for Comment	Recommendation	Disposition
					aircraft speeds.
230.	Page A-7-9, ¶ A7-2.3.c	Editorial		Change the phrase: "Similar to Approach 1 in figure 8" To: "Similar to Approach 1 in Figure 8" (capitalize "figure")	**Accepted.**
231.	Page A-7-9, ¶ A7-2.3.c	Editorial		Change the phrase: "The Approach 2, as shown below in Figure 9" To: "Approach 2, as shown in Figure 9" (remove "The" and "below")	**Accepted.**
232.	Page A-7-11, ¶ A7-2.3.d	Editorial		Change the sentence: "Approach 3 is shown below in Figure 10." To:	**Accepted.**

Comment Number	Page & Paragraph	Comment	Rationale for Comment	Recommendation	Disposition
				"Approach 3 is shown in Figure 10." (remove "below")	
233.	Page: A7-3 Para: A7-2.3e	"However, the new airport elevation should be within the range of 1000 - 2000 ft MSL to ensure that the designed turn radii and bank angles do not change significantly."	A closer look at the performance shows that a change of 500 ft could significantly impact the designs. If 500 ft less, the procedures are no longer at the bank angle limitations. If 500 ft more, the bank angle is above the max in most cases.	These procedures will only work as intended at that airport altitude. Any deviation deviation beyond 500 ft elevation may require recalculation of the design.	**OBE.** After a clarification question on the comment, the comment has been withdrawn.
234.	Page: A7-14 Para: A7-3b		See Comment above.		**OBE.** Could not find a lower-case abbreviation for nautical mile anywhere near the referenced paragraph.
235.	Page A-7-14, ¶ A7-3.c	Includes the statement: The information in the following tables list test conditions such as generic aircraft performance parameters, desired atmospheric conditions, and considerations to assist the applicant with creating a detailed test	It is unclear where the "following tables" are. Should this be "paragraphs A7-3.1 and A7-3.2"?	Adjust as appropriate to clarify where the information is located that can be used to "assist the applicant with creating a detailed test plan."	**Accepted.** The text has been changed as follows: The information in the following *paragraphs describes* test conditions…

Comment Number	Page & Paragraph	Comment	Rationale for Comment	Recommendation	Disposition
		plan.			
236.	Page A-7-14, ¶ A7-3.1.c Note	Includes the statement: In addition to the normal performance parameters, the lateral path definition (desired path) and lateral path "cross-track error" (distance from path centerline) should be included in the data set to monitor/review path maintenance performance.	It is unclear what the "normal performance parameters" are.	Suggest changing "normal performance parameters" to "desired data parameters" to be consistent with the terminology used in ¶ A7-3.1.c. Additionally, suggest changing "data set" to "recorded data parameters" to be consistent with ¶ A7-3.1.c.	**Accepted.**
237.	Page: A7-15 Para: A7-3.1 e.	Second sentence references position of data: The wind velocity for the respective altitude should approximate those values shown to the right.	The data is actually below in this paper.	Should read: ….approximate those values shown below.	**Accepted.**
238.	Page A-7-15, ¶ A7-3.1.e	Includes the statement: The wind velocity for the respective altitude should approximate those values shown to the right.	There are no wind velocity values "shown to the right".	Suggest changing "shown to the right" to "shown below".	**Accepted.**
239.	Page A-7-15, ¶ A7-3.1.e	Editorial		Change the phrase: "2000 and 3000 AGL" To:	**Accepted.**

Comment Number	Page & Paragraph	Comment	Rationale for Comment	Recommendation	Disposition
				"2000 and 3000 ft AGL" (insert "ft")	
240.	Page A-7-15, ¶ A7-3.1.e	Editorial		Remove extra blank space before the "(" in the phrase "(airport elevation)".	**Accepted.**
241.	Page A-7-15, ¶ A7-3.1.e	Altitude / wind velocity "table" values are different from those in Appendix 2 Table 11.	It is unclear why the "V_{KTW}" values in the Appendix 7 table are different from those in Appendix 2 Table 11.	Explain why the Appendix 7 "V_{KTW}" values are different from those in Appendix 2 Table 11.	**Not Accepted.** These wind values are taken verbatim from the Mitre test procedures for RF leg demonstrations. Appendix 2 Table 11 is specific to RNP AR qualification.
242.	Page A-7-15, ¶ A7-3.1.e	Editorial		Insert "ft" after each of the altitudes in the altitude / wind velocity "table". Additionally, suggest revising this "table" into one that is similar to Appendix 2 Table 11 and referencing it via its Table number.	**Partially Accepted.** Inserted "ft" after the numbers, but putting a border around it and calling it a table doesn't add to clarity or readability.
243.	Page A-7-15, ¶ A7-3.2 and ¶ A7-3.2.a.(1)	¶ A7-3.2 states: **Airborne Test Conditions.** ¶ A7-3.2.a.(1) states:	It is not entirely clear whether these tests are to be conducted in actual flight conditions (¶ A7-3.2 could be read to imply this) or whether these tests are to be conducted using a simulated	Clarify whether a simulated airborne environment is adequate as a well as addressing the other issues identified in the "Rationale for Comment" column.	**Not Accepted.** Paragraph A7-1.a specifically states: "Applicants may use engineering simulations and/or aircraft for the flight test demonstrations."

Comment Number	Page & Paragraph	Comment	Rationale for Comment	Recommendation	Disposition
		Verify that the simulation is "conformed" with correct avionics hardware and software.	airborne environment. If they are to be conducted using a simulated airborne environment, there are factors that may not allow use of actual hardware. e.g., ¶ A7-3.2.g indicates that autopilot/flight director are to be used but it is not practical to include autopilot servos in a typical lab simulation environment (servos are typically included only in very expensive "iron bird" setups). Additionally, there are other factors than avionics hardware and software that have an effect on the test results. e.g., ¶ A7-3.2.g indicates that autopilot/flight director are to be used, in which case autopilot gains for the particular aircraft being simulated would be necessary to evaluate the ability to maintain lateral path.		It is not necessary to repeat the statement since readers are expected to the entire appendix in context.

Comment Number	Page & Paragraph	Comment	Rationale for Comment	Recommendation	Disposition
			Assuming a simulation environment is adequate, it could be useful to add wording similar to AC 90-101A Appendix 3 ¶ 3.b on the Flyability Check such as: Using either … a flight simulation training device (FSTD) …, or appropriately configured desktop/laptop computer, [fly] the … procedure contained in the [navigation database]…. An FSTD or desktop/laptop computer must utilize software identical to that used by the aircraft (e.g., FMS software) and use an aerodynamic model of the aircraft's flight characteristics.		
244.	Page A-7-15, ¶ A7-3.2.b Note	Editorial		Change the phrase: "(figure 8 and figure 10)" To: "(Figure 8 and Figure 10)"	**Accepted.**

Comment Number	Page & Paragraph	Comment	Rationale for Comment	Recommendation	Disposition
				(capitalize “figure” twice)	
245.	Page A-7-16, ¶ A7-3.2.g and Note	States: Engage autopilot/flight director (as soon as practical after takeoff) and verify the autopilot/flight director is providing guidance to the lateral path. **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.	As noted in previous ¶ A3-2.b.(1) comment, autopilot and/or flight director are not required to maintain the AC 20-138D Table 9 FTE values for RNP 1 curved path segments. The FAA-sponsored data collection project showed that FTE was able to be maintained while hand flying the RF legs with CDI.	Revise these statements to acknowledge autopilot and/or flight director are not required for curved paths with RNP 1 and higher when flown at terminal speeds.	**Not Accepted.** As previously stated, RF legs require autopilot or flight director. Contact AFS-400.
246.	Page A-7-16, ¶ A7-3.2.h	The RNP 1.0 and RNP 0.3 “table” rows include the following statement for the FTE Basis column: Flt Director and/or Autopilot	As noted in previous ¶ A3-2.b.(1) comment, autopilot and/or flight director are not required to maintain the AC 20-138D Table 9 FTE values for RNP 1 curved path segments; however, the FAA-sponsored data collection project used the	Suggest adding a note that indicates the FTE Basis is not meant to preclude manually flying the procedures using CDI.	**Not Accepted.** As previously stated, RF legs require autopilot or flight director. Contact AFS-400.

Comment Number	Page & Paragraph	Comment	Rationale for Comment	Recommendation	Disposition
			autopilot/flight director FTE values as the basis for determining FTE maintenance while hand flying the RF legs.		
247.	Page A-7-16, ¶ A7-3.2.i	Editorial		Change the phrase: "Repeat A7-3.2.b though A7-3.2.h" To: "Repeat A7-3.2.b through A7-3.2.h" (change "though" to "through")	**Accepted.**
248.	Page A8-1, ¶ A8-1.a	Editorial		Remove the extra blank line preceding ¶ A8-1.a.	**Accepted.**
249.	Page A8-1, ¶ A8-1.d	Editorial	Punctuation	Suggest changing: "Future operational credit for GLONASS will be assessed after the GLONASS system and service provider performance capabilities are identified; GLONASS operational support commitments (e.g. international NOTAMS) are	**Accepted.**

Comment Number	Page & Paragraph	Comment	Rationale for Comment	Recommendation	Disposition
				provided; and GPS/GLONASS avionics standards are developed." To: "Future operational credit for GLONASS will be assessed after the GLONASS system and service provider performance capabilities are identified, GLONASS operational support commitments (e.g. international NOTAMS) are provided, and GPS/GLONASS avionics standards are developed." (change semicolon to comma twice)	
250.	Page A8-1, ¶ A8-1.e	Includes the statement: Adding GLONASS is considered a new and novel major change to the TSOA that will require coordination with the ACO. The applicant must present a data	This statement may become outdated and could impose unnecessary burden on applicants desiring to add GLONASS capability.	Remove quoted text or reword so that the ACO has the discretion to treat the addition of GLONASS as something other than a new and novel major change.	**Not Accepted.** The statement will be removed in the future when adding GLONASS capability is no longer considered new and novel.

Comment Number	Page & Paragraph	Comment	Rationale for Comment	Recommendation	Disposition
		package detailing proposed performance, intended function, and limitations. It may be true that adding GLONASS is a new and novel major change to the TSOA at first, but over time this may no longer be the case. Recommend leaving this determination to the ACO.			
251.	Page A10-1, ¶ A10-1.g	Out of date reference		Change "AC 20-165" to "AC 20-165A". Check other references and update to latest revisions (to be consistent with the changes made for AC 23.1309-1E and AC 23.1311-1C in ¶ A10-1.u and ¶ A10-1.v, respectively).	**Accepted.**
252.	Page A10-5, ¶ A10-3.i	Reference doesn't mention "Change 1"	¶ A10-3.h for DO-228 mentions Change 1 while ¶ A10-3.i for DO-229D does not mention Change 1, which was recently published.	Change "RTCA/DO-229D" to "RTCA/DO-229D with Change 1". Check other references and update with current Change as necessary.	**Accepted.**

Comment Number	Page & Paragraph	Comment	Rationale for Comment	Recommendation	Disposition
253.	Pg 98, para 12-9	Last minute change. Original paragraph 12-9.a is no longer correct or pertinent after adding 12-9.c.	Adding paragraph 12-9.c made section 12-9 address both path generation and position determination. The original paragraph 12-9.a contains the following two sentences which are not correct after paragraph 12-9.c was added: *There are two different uses for magnetic variation; one for position determination and one for path generation in the navigation computer. The information in paragraph 12-9 is guidance for magnetic variation used for position determination.* The original paragraph 12-9.a is no longer needed.	Delete paragraph 12-9.a.	**Accepted.** This was a last minute editorial change that does not materially affect the document.