DISPOSITION OF PUBLIC COMMENTS
AC 25.975-1, Fuel Vent Fire Protection
Prepared by Mike Dostert, ANM-112

	Comment	Requested Change	Disposition
	Commenter: ANAC, Angelo Megumi de Oliveira		
1.	Consider to include 25.981 as related requirement at section 3.1.		Agree. We added the reference to section 3.1.

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	Commenter: Embraer		
1.	1. Purpose. This advisory circular (AC) provides information and guidance concerning compliance with Federal Aviation Administration (FAA) requirements in Title 14, Code of Regulations (14 CFR) 25.975 and related regulations for preventing fuel tank explosions caused by ignition of vapors outside the fuel tank vents. In the section 7.3 of this AC, it is mentioned that installation of flame arrestor will impact vent system performance, but guidance to show compliance with those portion of the rule is not covered by this AC. Thus, in the purpose, it should be restricted to 25.975(a)(7), instead of mention the whole requirement, since 25.975(a)(1) and (a)(3) refers to prevent vent system to be clogged by ice and vent system performance demonstration criteria.	1. Purpose. This advisory circular (AC) provides information and guidance concerning compliance with Federal Aviation Administration (FAA) requirements in Title 14, Code of Regulations (14 CFR) 25.975(a)(7) and related regulations for preventing fuel tank explosions caused by ignition of vapors outside the fuel tank vents.	Accepted. We added "(a)(7)" to § 25.975 references where appropriate.
2.	3 Related Documents.	3 Related Documents.	Agree. We revised the reference as suggested.

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	3.3 Technical Publications. Military Standard, *Environmental Test Methods*, MIL-SPEC-810C, Method 511.1 Procedure II. Philadelphia, PA: U.S. Department of Defense, 1975.	3.3 Technical Publications. Military Standard, *Environmental Engineering Considerations and Laboratory Tests Methods*, MIL- STD-810G w/ Change 1, Method 511.6 Procedure II. Philadelphia, PA: U.S. Department of Defense, 2014. Proposed change is to refer the most recent version of the Explosive Atmosphere test method.	
3.	7 Flame Arrestors. 7.1 The guidance contained in this AC for flame arrestors addresses performance standards for post-crash ground fire and normal operating condition protection of the fuel tank vents. Embraer provided comment in the Docket No FAA-2014-0500 Notice No 14-07, requesting the scope of 25.975(a)(7) to be restricted to post-crash ground fire event, to be in accordance with the most recent generated Issue Papers for certified models. Thus, proposed change maintains coherence with proposed change in the 25.975(a)(7) text.	7 Flame Arrestors. 7.1 The guidance contained in this AC for flame arrestors addresses performance standards for post-crash ground fire ~~and normal operating condition protection~~ of the fuel tank vents.	We do not agree. This commenter provided comments to the NPRM that the rule should only apply to post-crash fire conditions. The NPRM and final rule discuss the intent of the rule to include conditions other than post-crash fire, as quoted here: *Fires outside of the airplane fuel tanks can be caused by ignition of fuel spilled during refueling, fuel and oil spillage from engines that separate from the airplane following an accident, or fuel leaking from damaged airplane fuel tanks. In some cases, external fires have ignited fuel vapors that have exited the fuel tank vents, resulting in flames traveling back through the vent lines into the fuel tank and causing fuel tank explosions. These explosions have caused passenger fatalities and prevented emergency personnel from assisting survivors.*

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4.	7 Flame Arrestors. 7.3 Installation of flame arrestors in the airplane fuel vent system will impact fuel tank vent system performance. Factors such as added pressure loss during refueling system failure conditions, as well as the impact of environmental conditions such as icing and lightning, must also be addressed when requesting approval of the fuel tank installation. Compliance means for these considerations are not addressed in this AC. General fuel system guidance is provided in AC 25-8, *Auxiliary Fuel Systems Installations.* Once this AC mentions that lightning impacts must be addressed and this AC does not provide guidance for showing compliance with § 25.954, Embraer understands that AC 20-53B should be mentioned.	7 Flame Arrestors. 7.3 Installation of flame arrestors in the airplane fuel vent system will impact fuel tank vent system performance. Factors such as added pressure loss during refueling system failure conditions, as well as the impact of environmental conditions such as icing and lightning, must also be addressed when requesting approval of the fuel tank installation. Compliance means for these considerations are not addressed in this AC. General fuel system guidance is provided in AC 25-8, *Auxiliary Fuel Systems Installations* and AC 20-53B, *Protection of Aircraft Fuel Systems Against Fuel Vapor Ignition Caused by Lightning*.	Accepted. We added a reference to AC 20-53B.
5.	7 Flame Arrestors. 7.8 The test conditions defined in this AC are intended to evaluate flame arrestor effectiveness for addressing two conditions. The first condition is one where flammable vapors are present at the vent outlet and are ignited by an external source. Proposed change to make the intent of the text more clear.	7 Flame Arrestors. 7.8 The test conditions defined in this AC are intended to evaluate flame arrestor effectiveness for addressing two conditions. The first condition is one where flammable vapors are present at the vent inlet/outlet and the outlet vapors are ignited by an external source.	Not accepted. “Vent outlet” describes the location as intended.
6.	7 Flame Arrestors.	Exclude.	Do not agree. As stated in comment 3, we

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	7.10 The applicant should run an adequate number of test conditions to cover a range of flow conditions and establish the conditions that result in the highest surface temperatures. Embraer believes this paragraph should be excluded because it does not seem necessary considering only post-crash condition and its inconsistent with 8.3.2 item which prescribes a specific flow range.		disagree with limiting consideration to only post-crash fires. Other fires, such as those that result from refueling spills, are included. However, we modified the sentence (now in paragraph 7.8) to read: The applicant should *analyze the flame arrestor design to determine the critical flow conditions that result in the highest surface temperatures and* run an adequate number of test conditions to *validate the analysis*.
7.	8.3 Flame Arrestor Installation Test. 8.3.1.2.3 Propane may be used for flame arrestor installation testing where AIT is not a critical parameter for the test. For example, testing of a simulated production flame arrestor installation to validate that temperatures of portions of the installation fuel tank remain below the maximum permitted fuel tank surface temperature (typically 390 °F) would be acceptable, provided the flame arrestor element had been previously qualified to meet the flame propagation prevention requirements. According to AC 25.981-1C the temperature shouldn't exceed 400 ºF, thus proposal to change from 390ºF to 400ºF intents to harmonize the criteria, using the same limit proposed in other FAA guidance material with similar intent	8.3 Flame Arrestor Installation Test. 8.3.1.2.3 Propane may be used for flame arrestor installation testing where AIT is not a critical parameter for the test. For example, testing of a simulated production flame arrestor installation to validate that temperatures of portions of the installation fuel tank remain below the maximum permitted fuel tank surface temperature (typically 400 °F) would be acceptable, provided the flame arrestor element had been previously qualified to meet the flame propagation prevention requirements.	Agreed. We revised the typical fuel tank surface temperature from 390 ° to 400 °F in this paragraph, which is 8.3.1.3.3 in the final AC.

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	(prevent fuel ignition inside tanks).		
8.	8.3 Flame Arrestor Installation Test. 8.3.2.2.1 Record the outer tube temperature just downstream of the arrestor and limit it to a temperature of 390 °F to 450 °F depending on the location of the arrestor in the wing. Criteria to establish the temperature limit depending on the location of the arrestor in the wing should be provided. As mentioned in the previous item according to AC 25.981-1C the temperature shouldn't exceed 400 ºF, thus proposal to change from 390ºF to 400ºF intents to harmonize the criteria, using the same limit proposed in other FAA guidance material with similar intent (prevent fuel ignition inside tanks).	8.3 Flame Arrestor Installation Test. 8.3.2.2.1 Record the outer tube temperature just downstream of the arrestor and limit it to a temperature of 400 °F to 450 °F depending on the location of the arrestor in the wing.	We agree with the intent of this comment and added discussion on establishing surface temperature limits in paragraph 8.3.2.2.2.
9.	New paragraph. Embraer believes this paragraph should be removed from item 8.3.4.3, because it is related to the flame front velocity for the flame holding test, thus it is more applicable to be a sub-section of item 8.3.2.2.2.	8.3.2.2.2.1 Flame Front Velocity. The effectiveness of the flame arrestor is dependent on the velocity of the flame front. The vent line length, diameter, and flow losses between the ignition source and arrestor influence the velocity. The flame arrestor installation may have a different vent line length and diameter, with associated flow losses, than what is used for the element test. These installation differences should be accounted for in the compliance demonstration. A separate test may be required to demonstrate that the installed flame arrestor is effective.	We partially agree and moved the Flame Front Velocity paragraph 8.3.4.3 to paragraph 8.3.2.1.2 for the static flow demonstration. The commenter suggested this consideration was applicable to the dynamic (flame holding) demonstration, but the intent was for this to be a consideration in the static flow test.

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10.	New paragraph. FAA mentions only vibration and icing as impact of environmental conditions for installation considerations. Embraer believes lightning impact should be mentioned to say that this AC is not intended to provide guidance for showing compliance with § 25.954.	8.3.4.3 Lightning. The vent system installation should be evaluated from the standpoint of lightning vulnerability. The guidance provided in this AC is not intended to provide guidance for showing compliance with § 25.954 if it is verified that the flame arrestor may be susceptible to the effects of lightning strike. Advisory Circular AC 20-53B, *Protection of Aircraft Fuel Systems against Fuel Vapor due to Lightning* shall be used.	We agree and added discussion in paragraph 7.2 and a new paragraph 8.3.4.4 to address the additional guidance requested in this comment.
11.	8.3.4.3 **Flame Front Velocity.** The effectiveness of the flame arrestor is dependent on the velocity of the flame front. The vent line length, diameter, and flow losses between the ignition source and arrestor influence the velocity. The flame arrestor installation may have a different vent line length and diameter, with associated flow losses, than what is used for the element test. These installation differences should be accounted for in the compliance demonstration. A separate test may be required to demonstrate that the installed flame arrestor is effective.	~~8.3.4.3~~ ~~**Flame Front Velocity.**~~ ~~The effectiveness of the flame arrestor is dependent on the velocity of the flame front. The vent line length, diameter, and flow losses between the ignition source and arrestor influence the velocity. The flame arrestor installation may have a different vent line length and diameter, with associated flow losses, than what is used for the element test. These installation differences should be accounted for in the compliance demonstration. A separate test may be required to demonstrate that the installed flame arrestor is effective.~~ Proposal is to move it as a sub-section of item 8.3.2.2.2 (refer to comment number 8).	Boeing also requested changes regarding this paragraph. We moved the paragraph to 8.3.2.1.2 and revised it to clarify the intent: *The velocity of the flame front as it reaches the flame arrestor can significantly influence the effectiveness of the flame arrestor at preventing flame propagation. The flame front velocity increases as the flame travels down a vent line containing flammable vapors. The velocity of the flame front is installation-dependent and influenced by the vent line length, diameter, and flow losses between the ignition source and arrestor. The test configuration should include consideration of these critical features. If an applicant proposes to use a previously approved flame arrestor element in a new installation with different vent line length and diameter than previously tested, the applicant should account*

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			for these installation differences in the compliance demonstration. The applicant may need to conduct a separate test to demonstrate that the flame arrestor is effective in the installed configuration.
12.	New. Compliance with 25.981 allows use of explosion suppression devices to show compliance with sub-paragraph	To include the section 10 with guidance to demonstrate compliance using explosion suppression devices.	The FAA agrees that fuel tank explosion suppression systems are an allowable means for showing compliance to § 25.981. We added a subparagraph to section 9 regarding the use of explosion suppression technology: *Fuel tank or vent system fire suppression systems typically are activated by a light sensor and discharge a fire suppressant agent that is only effective for a short period of time. Demonstrating compliance using this technology would require showing effectiveness at preventing a fuel tank explosion with a fire present at the fuel tank vent outlet for a minimum of 2 minutes and 30 seconds.*

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	Commenter: Gulfstream Aerospace Corporation		
1.	Section 8.3.1 Test Setup. Paragraph makes reference to figure A-1 of the draft AC, however, more items are being discussed in this paragraph	Gulfstream recommends adding a generic vent system figure with common annotations, or adding more annotations to figure A-1. (Diameter of tube representative of installation,	We added clarification to the note below the figure and modified the figure to include a depiction of the flame front.

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	than are shown in figure A-1.	direction of flame front, tube length representative of installation, orientation of flame arrestor, etc.).	
2.	Section 8.3.1 <u>Test Setup.</u> "For instance, flame arrestor installations <u>that face downward</u> so a ground fire impinges on its face have significantly shorter effectiveness than an arrestor that is mounted <u>vertically</u>."	Gulfstream recommends a wording change to avoid confusion: "For instance, flame arrestor installations that face downward so a ground fire impinges on its face have significantly shorter effectiveness than an arrestor that is mounted <u>horizontally</u>."	We agree and changed the wording accordingly. We made additional changes to this paragraph in response to Boeing's comment 11. The last sentence in paragraph 8.3.1 now reads: *For instance, the flame holding performance of a flame arrestor installation that faces downward, so a ground fire impinges on its face, will have shorter flame holding capability than a flame arrestor that is mounted horizontally.*
3.	Section 8.3.2.1 Flame Propagation Tests Section 8.3.2.2 Flame Propagation Prevention Tests	For clarity, Gulfstream recommends section titles be reworded to: Section 8.3.2.1 Flame Propagation Prevention Tests (Static) Section 8.3.2.2 Flame Propagation Prevention Tests (Dynamic)	We partially agree and made changes to these headings in consideration of this comment and Boeing comment 6: *8.3.2.1 Flame Propagation Tests (Static)* *8.3.2.2 Flame Holding Tests.*
4.	Section 8.3.2.2.1 The sentence, "Record the outer tube temperature just downstream of the arrestor and <u>limit</u> it to a temperature of <u>390°F to 450°F depending on the location of the arrestor in the wing.</u>" is confusing, since the way the sentence is worded may be interpreted as limiting the temperature measurement to a range of 390°F to 450°F. The intent becomes clear after reading the rest of the paragraph and guidance provided in	Gulfstream recommends rewording the sentence as follows: "Record the outer tube temperature just downstream of the arrestor, and limit it to a temperature depending on the location of the arrestor in the wing. AC 25.981-1C provides guidance….."	We agree with this comment and added significant discussion to paragraph 8.3.2.2.1 to clarify how the maximum surface temperatures should be established using guidance in AC 25.981.

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	25.981-1C.		
5.	Section 8.3.3 <u>Pass/Fail Criteria.</u> 8.3.3.1 "The flame arrestor assembly should meet the performance criteria noted above."	Gulfstream recommends that 8.3.3.1 clearly summarize the pass/fail criteria. Furthermore, the pass/fail criteria should be objective and measurable.	We agree and added pass/fail criteria details in the revised paragraph to address this comment: *The flame arrestor installation should meet the performance criteria noted above, including:* • *The static propagation test.* • *The minimum flame holding time of 2 minutes and 30 seconds.* • *Installation-dependent maximum surface temperature limits established for any flame arrestor and vent system components located in fuel tanks or flammable fluid leakage zones that are determined to be a potential source of propagating the external vent flame to the fuel tank.*
6.	Section 8.3.3 <u>Pass/Fail Criteria.</u> 8.3.3.2 "<u>Following passing of the flame arrestor tests noted above</u>, careful examination of the arrestor structural integrity should be conducted…"	It is unclear to Gulfstream if this is truly a pass/fail criterion. If the flame arrestor passed the tests, would the resulting structural integrity matter? Is the intent of this paragraph to have the applicant pay close attention to the structural integrity of the flame arrestor design? Gulfstream recommends moving this paragraph to Section 8.3.4 <u>Related Qualification and Installation Considerations.</u>	Partially agree. We modified the pass/fail criteria text to allow damage to the flame arrestor provided the 2 minute and 30 second flame holding requirement was met and a maintenance requirement is included to replace the flame arrestor if it is exposed to fire: *Flame arrestors have failed the test when the flame passed across the flame arrestor because structural integrity was lost during the test due to weld or brazed joint failures. Damage of flame arrestor assembly components is acceptable if the flame arrestor installation prevents flame*

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			propagation during the test, and the maintenance requirements specify the flame arrestor must be repaired or replaced following an event where the flame arrestor was exposed to flame.
7.	Section 8.3.4 <u>Related Qualification and Installation Considerations.</u> This section only includes considerations for vibration, icing, and flame front velocity.	Gulfstream suggests adding other important qualification considerations that are applicable to the flame arrestor, including operational shock, crash safety, and fluid susceptibility. Furthermore, guidance on similarity is requested.	We agree that the list of considerations in this section is not all-inclusive. We added an introductory paragraph to the section indicating additional design-specific qualification requirements should be established for the design. We also added discussion regarding factors that must be considered when using similarity to a previously approved flame arrestor installation when showing compliance to § 25.975.
8.	Section 8.3.4.3 Flame Front Velocity. “These installation differences should be accounted for in the compliance demonstration.”	Gulfstream requests the FAA provide details for how the installation differences should be accounted for in the compliance demonstration. Perhaps more annotations and notes added to figure A-1.	We added more annotations to the note on figure A-1 as suggested: ***Note:*** *This test schematic is not intended to represent an acceptable test configuration for project-specific compliance testing. The test installation, including the length and diameter of downstream vent line and the orientation of the flame arrestor will have a significant impact on the effectiveness of the flame arrestor. Therefore, the test configuration should represent the actual airplane installation. Additional surface temperature measurements may be needed if the flame arrestor is installed in a location where ignition of flammable vapors could lead to*

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			propagation of the external vent fire into the fuel tank. For example, a vent flame arrestor could be installed adjacent to a fuel surge tank, such that hot surfaces of the flame arrestor or vent system could cause ignition of flammable vapors and propagation of the fire into the fuel tank. Additional surface temperature data would be needed to demonstrate that surface temperature limits are not exceeded.

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	Commenter: Boeing Commercial Airplanes		
1.	Boeing recommends that the FAA address the comments submitted to this AC via the public comment period, and then invite the assistance of SAE Technical Committee AE-5, Aerospace Fuel, Inerting and Lubrication Systems, to do a final technical review before publishing this AC document. There are multiple technical and instructional details of the recommended test practices (independent of the associated regulatory requirements) that could be improved upon for clarity and accuracy. The SAE committee is comprised of experts from OEMs, suppliers, processors, consulting	[The Committee could also assist in dispositioning the comments submitted by industry addressing the technical features of the AC. If required, the FAA could place a copy of the Committee's post-comment period inputs in the public docket (similar to the practice of posting ex parte discussions on rulemaking documents).]	The AC means of compliance is based on methods developed by industry the draft SAE document is similar to the FAA AC. We welcome SAE comments and suggested revisions; however, we do not agree that publication of the AC should be delayed. We can revise the AC if substantive comments are received.

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	firms, government, and others across the aerospace and defense industries, who work with test methods for flame arrestors on a day-to-day basis. Obtaining their additional technical input before final release of this AC could go far in maximizing the usefulness of the AC's testing guidelines and minimizing any future questions or technical difficulties that applicants may have regarding compliance with the testing recommendations.		
2.	Editorial comment. Page: 2, Para: 3.1. Sections 14 CFR. The proposed text lists as references the following sections of 14 CFR: 25.1181, Designated fire zones; regions included. 25.1182, Nacelle areas behind firewalls, and engine pod attaching structures containing flammable fluid lines. 25.1187, Drainage and ventilation fire zones.3.1. Sections of 14 CFR	We recommend that these 3 references be deleted. Fuel vents should not be located in Fire Zones. We consider that references to these regulations will cause confusion.	We agree and deleted the reference.
3.	Editorial comment. Page: 3, Para: 4. Definitions The proposed text states: "**Ignition Source.** A heat source of sufficient	We recommend revising this text to be parallel to the definition that appears in AC 25.981-1C: *"Ignition Source.* ***A source of sufficient energy to ignite combustion of a fuel/air mixture. Surfaces that can exceed the auto-ignition***	We partially agree and changed the definition of "ignition source" to be the same as AC 25.981-1C with the exception of "ignite" in the first sentence. We changed it to "initiate."

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	temperature and energy to initiate combustion of flammable fluid. Surfaces that can exceed the autogenous ignition temperature of the fluid under consideration are considered to be ignition sources. Electrical arcs and friction sparks are also common ignition sources."	***temperature of the flammable vapor under consideration are considered to be ignition sources. Electrical arcs, electrical sparks, and friction sparks are also considered ignition sources if sufficient energy is released to initiate combustion.***" The proposed definition in this AC is different from that in AC 25.981-1C, but not explanation is provided as to why there is this difference. We consider the definition in AC 25.981-1C to be adequate. Having different definitions leads to confusion.	
4.	Substantive comment. Page: 5 Para: 7. Flame Arrestors Subparagraphs 7.4 and 7.5. The proposed text states: *"7.4. To minimize the possibility of propagation of external ground fires through the fuel tank vents, it is beneficial to design a flame arrestor or flame suppression system to be effective for a finite period of time. The FAA previously established a performance standard that, under specified conditions, the airplane must be capable of being evacuated within 90 seconds*	We recommend changing highlighted text to read ***90 seconds*** in lieu of 2 minutes and 30 seconds. (We have made this same request in our comments in the corresponding NPRM relevant to 14 CFR §25.975.) 90 seconds is consistent with existing regulatory evacuation time limits, and has been the minimum industry standard for vent protection means previously certified. As paraphrased from paragraph 7.5 of this draft AC, the means of meeting the time requirements is conservative, and the actual effectiveness of arrestors should [will] exceed the minimum time established by the test means. This conservatism already provides additional evacuation time, without being inconsistent with other time requirements and potentially requiring changes and	We do not agree that 90 seconds is the appropriate standard, and we provided disposition of this proposed change to the regulatory requirement in the preamble of the final rule. • The conditions for the 90-second requirement in § 25.803 assume availability of a minimum number of exits and uninjured passengers who are physically capable of departing the airplane, neither of which is usually the case following an accident. • Additional time is needed for emergency response following an accident. • Most flame arrestors in use today meet the 2 minute and 30 second standard. • The FAA has been applying the 2 minute and 30 seconds standard through project-specific issue papers for several years.

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	(§ 25.803, Emergency evacuation). However, this time period did not consider the effects of a fuel tank explosion on the ability of passengers to leave the crash site or on the safety of emergency crews. In light of these considerations, the FAA proposed that the flame arrestor performance requirements be based on the capability of current technology flame arrestors that have previously been shown to provide acceptable performance on airplanes in the transport airplane fleet. Based on these criteria, the FAA has established a minimum standard of 2 minutes and 30 seconds. This time is consistent with the evacuation time noted above and allows additional time for passengers and crew to exit the crash scene. *7.5. The guidance in this AC as a means of meeting the 2 minute and 30 second time requirement is based on the worst case conditions regarding fuel vapor emissions from the fuel tank vents and is, therefore, conservative. This condition would not likely be present at the fuel tank outlet for long periods of time; therefore, the actual effectiveness of the arrestor should exceed the time that would be required for the external ground fire to breech the fuel tank structural boundary formed by the wing surface. …"*	recertification to previously certified designs.	• Flame holding of 5 minutes is optimal but not practical as flame arrestors would be larger, heavier, and would require modification of fuel system vent lines. Since this was discussed in the NPRM and final rule preambles, we deleted this discussion in the final AC.

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5.	Editorial comment. Page: 6, Para: 7. Flame Arrestors. Subparagraph 7.7. The proposed text states: *"7.7. It is possible for the effectiveness of the flame arrestor assembly, including the line and housing, to be affected by the time required for the flame arrestor assembly surfaces to be heated above the AIT of the flammable mixture on the internal side of the flame arrestor.…"*	The intent of this sentence is unclear. The properties (mass, thermal coefficients, thermal conductivity, etc.) of the flame arrestor and installation (e.g., the line and housing) will affect the time required for the in-tank installation surfaces to be heated above the AIT. Clarification is needed.	We agree. We added a sentence and made the following changes for clarification: *7.5 Flame propagation past the flame arrestor may also occur due to hot surface ignition of flammable vapors. It is possible for the effectiveness of the flame arrestor assembly, including the line and housing, to be affected by the time it takes for the flame arrestor assembly surfaces to be heated above the AIT of the flammable mixture on the internal side of the flame arrestor.*
6.	Editorial comment. Page: 6, Para: 7.8; Page: 7, Para: 8.3; Page: 9, Para: 8.3.2 and later; Page 8, Note (under Paragraph 8.3.1.2.1) "7.8. The test conditions defined in this AC are intended to evaluate flame arrestor effectiveness for addressing two conditions. The first condition is one where flammable vapors are present at the vent outlet and are ignited by an external source. The flame arrestor should be effective at stopping the initial propagation of flame. The second condition is one where a continuous flow of vapor is exiting the fuel vent, and the flame arrestor should hold the flame without passing the flame to the upstream portion of the vent	For the sake of consistency, we recommend revising the nomenclature (see highlights) for the two test conditions addressed in these paragraphs to: ***Flame Propagation*** (what the proposed AC refers to in paragraph 8.3.2.1 as "Flame Propagation") and ***Flame Holding*** (what the proposed AC refers to in paragraph 8.3.2.2 as "Flame Propagation Prevention"). The naming convention used in the proposed AC appears inconsistent and is confusing. The nomenclature for these two tests within Boeing specifications has been: • ***"Flame Propagation"***: - which is a single ignition test done with static flow at the	We agree with the commenter that clarifications are needed. We added and defined "flame holding" to section 4, Definitions. We changed the title of 8.3.2.2 to, "Flame Holding Tests." We also added clarifications to the test descriptions in paragraphs 8.3.2.1 and 8.3.2.2 to differentiate between the test conditions.

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	system. The critical test conditions should be determined following review and analysis of the flame arrestor installation to determine the characteristics of a particular installation." "8.3. Flame Arrestor Installation Test." "8.3.2. Test Conditions. Two tests are run—one for flame propagation prevention in a static vent vapor flow condition, and one for flame propagation in a dynamic vapor flow condition. These conditions provide a conservative demonstration of fuel tank vent fire protection capability with respect to delaying flame front propagation through the fuel vent flame arrestor during ground fire conditions. … 8.3.2.1. Flame Propagation Tests. … 8.3.2.2. Flame Propagation Prevention Tests." "8.3.1.2.1. ... Note: Fuels with higher AITs, such as propane, should not be used for the flame arrestor element test because ignition on the back side of the arrestor would not be adequately evaluated."	arrestor to evaluate the ability of the arrestor to stop a flame front from propagating through the arrestor; and • ***"Flame Holding"*** – which is done with flow through the arrestor for a period of time, to evaluate the ability to hold the flame off the arrestor sufficient that it does not overheat the arrestor for the period of time. While we do not know if this *Boeing* nomenclature is standard throughout the industry, it is consistent with the two conditions described in paragraph 7.8 of the AC. At minimum, a standardized naming convention other than *"Flame Propagation"* for the first test and *"Flame Propagation Prevention"* for the second test is needed. We recommend the terms be established in the "Definitions" section and then used consistently throughout the AC when referring to the two tests.	
7.	Substantive comment. Page: 6, Para: 7. Flame Arrestors, Subparagraph	We recommend removing the reference to the ground refueling condition. While one might expect a ground fire below the	The FAA does not agree with this comment. The commenter suggested we remove the reference to fires caused by ground refueling spills because

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	7.9. The proposed text states: *"7.9. The conditions under which the flame arrestor should be effective would include those where flammable fluid vapors are exiting the fuel tank at flow rates varying from no flow, typically occurring during normal ground operations, to high flow conditions, typically occurring during refueling or when the fuel tank is heated due to ground fire following an accident."*	wing to start during ground refueling, it cannot be expected to continue for the duration of the time the flame arrestor is required to perform.	the duration of the fire would be less than 2 minutes and 30 seconds. The size and duration of a ground fire resulting from a refueling event cannot be quantified, and large fires have resulted from refueling accidents (e.g., the B777 refueling accident in 2001). Preventing propagation of any fire, including ground refueling fires, is intended in the § 25.975(a)(7) standard.
8.	Substantive comment. Page: 6, Para: 7. Flame Arrestors, Subparagraph 7.10 The proposed text states: *"7.10. …The applicant should run an adequate number of test conditions to cover a range of flow conditions and establish the conditions that result in the highest surface temperatures."*	We recommend deleting this sentence. Paragraph 8.3.2.2.1 states to run the test at a velocity of 0.75 +/- 0.25 ft. per second, based on FAA-sponsored testing documented in reference 3.3. As an AC-defined acceptable means of compliance, use of this range should be sufficient without further investigation. We maintain that the intent of the AC should be to set a standard means of compliance, not a requirement to do research within the certification testing.	We do not concur. The suggested testing is not to do research, it is to demonstrate compliance. The applicant must show the highest surface temperature remains below a value that will result in flame propagation. However, the wording was modified to clarify that the intent of the suggested testing is to validate the surface temperature analysis.
9.	Substantive comment. Page: 7, Para: 8.2. Demonstrating Compliance Using Flame Arrestors The proposed text states: *"8.2. In many cases the flame arrestor is vendor-furnished and, therefore, qualified to meet the flame propagation requirements by the vendor*	We recommend the text be revised as follows: *"8.2. In many cases the flame arrestor is vendor-furnished and, therefore, qualified to meet the flame propagation requirements by the vendor without consideration of the airplane flame arrestor installation. A separate test is then conducted by the airplane manufacturer to show that the flame arrestor installation, including*	The recommended text is identical to the existing text in the draft AC. We made changes to this paragraph, however, to address the comment: *The applicant may propose using flame arrestor elements from a supplier. The supplier may have previously qualified an element to flame propagation requirements without consideration of the design of the airplane into which the flame*

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	without consideration of the airplane flame arrestor installation. A separate test is then conducted by the airplane manufacturer to show that the flame arrestor installation, including considerations such as flame front speeds and duct sidewall temperatures, have been accounted for in meeting the requirement. Fuel types that may be used for each of these tests differ and should be established as discussed below prior to conducting any testing."	*considerations such as flame front speeds and duct sidewall temperatures, have been accounted for in meeting the requirement. Fuel types that may be used for each of these tests differ and should be established as discussed below prior to conducting any testing."* The statement is not accurate. In fact, Boeing requires vendors furnishing fuel systems equipment and components to qualify them in configuration(s) that represent airplane production configuration(s). We assume that other OEMs have similar requirements.	*arrestor will be installed. The applicant should conduct tests to show that they have accounted for any effects of installation, including flame front speeds and duct sidewall temperatures. Fuel types for these tests differ and should be established as discussed in paragraph 8.3.1.3 of this AC prior to conducting any testing.*
10.	Substantive comment. Page: 7, Para: 8. Demonstrating Compliance Using Flame Arrestors, Subparagraph: 8.2. And Page: 10, Para: 8.3.2. Test Conditions, Subparagraph: 8.3.2.2.3, The proposed text states: "8.2. ... Fuel types that may be used for each of these tests differ and should be established as discussed below prior to conducting any testing." And *"8.3.2.2.3. Data from developmental testing show that the temperature of the center of the upstream arrestor face at which failure (propagation of the flame) occurred was*	<u>Regarding subparagraph 8.2.</u>: We recommend deleting the indicated text -- as well as inference(s) elsewhere in AC -- that indicates the use of propane for the flame propagation prevention (flame holding) test is not acceptable. <u>Regarding subparagraph 8.3.2.2.3</u>: We recommend deleting the last sentence of the paragraph (highlighted above). The proposed AC states or infers that propane is an acceptable test fuel for flame propagation testing, but not for the flame arrestor element (flame holding) tests. We presume this is based on the statements in paragraph 8.3.2.2.3, which discuss that the [ASTM D2155 or E659 based] auto-ignition temperature for propane is higher, inferring that it might not result in a test failure when jet fuel vapors would. However, the test	We agree with the commenter to delete the highlighted text and made this change. However, the FAA does not agree with the commenter regarding the use of propane as a test flammable gas. While we agree the text in the AC discussed allowing the center of the flame arrestor to be limited to a maximum of 700 °F, this value is not intended to be the limit for other surfaces. While 700 °F is acceptable for the center of the flame arrestor element, it may not be appropriate for location in the installation where stagnation of the flammable vapor flow is present. Therefore, the flammability characteristics of the test flammable vapor should closely represent that of the critical fuel type for the particular design. We modified the text in paragraph 8.3.1.3.1 to allow use of Hexane as the test gas for kerosene type fuels including Jet A and TS-1. If an applicant

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	typically above 700 °F, which is well above the AIT of JP-4 fuel vapor of 445 °F as established during no flow conditions. The upstream flame arrestor temperature can go well above the AIT without causing upstream ignition because of the high local velocity. For this reason hexane, with an AIT of 433 °F, is used for the flame arrestor element test. FAA Technical Report No. FAA-RD-75-119, Investigation of Aircraft Fuel Tank Explosions and Nitrogen Inerting Requirements During Ground Fires (see section 3.3 of this AC) showed hot surface ignition in the fuel tank to occur at about 520 °F, when it occurred at all.	pass criterion recommended for flame holding is that the center of the arrester upstream face not exceed 700°F, and paragraph 8.3.2.2.3 of the proposed AC states this. Since the energy content (heat of combustion) and flame temperature of propane and hexane are both similar to jet fuels, either fuel type should be acceptable for testing. They will all result in a similar flame arrestor element temperature. Under the dynamic conditions of flow passing though the arrestor, it is unlikely that the upstream flow will ignite before 700°F is reached anyway for any jet fuel type, or hexane or propane. Auto-ignition temperatures measured per ASTM D2155 or E659 are not the same as hot surface ignition temperatures, and their relationship has not been established. To our knowledge, the FAA has previously accepted flame holing testing done with propane, which makes sense because the pass/fail criterion was 700°F, regardless of the static AIT temperature. If propane is not allowed, the FAA should provide hot surface ignition data comparing propane to jet fuel vapors under the dynamic conditions represented by the test to establish why use of propane is not acceptable. Additionally, if the intent was to not allow propane for the flame propagation test, we maintain that it should be allowed. The heat of combustion and flame speed of propane are similar to jet fuels, and the AIT (and hot surface	proposes propane as the test fuel, they may present substantiation to the FAA establishing the properties of propane to be appropriate for their particular design. No changes were made as a result of this comment.

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		ignition) is not the critical factor in preventing flame propagation. A flame arrestor prevents flame propagation by cooling the flame front itself, such that the reaction quenches within the arrestor (does not penetrate to the other side of the arrestor).	
11.	Editorial comment. Page: 7, Para: 8.3. Flame Arrestor Installation Test, Subparagraph 8.3.1. The proposed text states: *"<u>8.3.1 Test Setup</u>* *A schematic of the test setup is shown in figure A-1. The test setup involves mounting the arrestor element in a tube of approximately the same diameter. The speed of the flame front that travels down the fuel vent system tubing is a critical factor in the performance of the flame arrestor. The flame front will accelerate down the tubing so higher velocities will occur as the arrestor is located farther away from the fuel tank vent outlet. Therefore the tubing and length from the fuel tank vent inlet to the flame arrestor should be representative of the production configuration. In addition, the orientation of the flame arrestor in the fixture is a critical parameter for the compliance demonstration. For instance, flame arrestor installations that face downward so a ground fire impinges on its face have significantly shorter effectiveness than*	We recommend revising the text as follows: *"<u>8.3.1 Test Setup</u>* *A schematic of the test setup is shown in figure A-1. The test setup involves mounting the arrestor element in a tube of approximately the same diameter. The speed of the flame front that travels down the fuel vent system tubing is a critical factor in the* ***flame propagation*** *performance of the flame arrestor. The flame front will accelerate down the tubing so higher velocities will occur as the arrestor is located farther away from the fuel tank vent outlet. Therefore the tubing and length from the fuel tank vent inlet to the flame arrestor should be representative of the production configuration,* ***unless the flame arrestor element was tested in another set-up where the flame speed reaching the arrestor would be higher****. In addition, the orientation of the flame arrestor in the fixture is a critical parameter for the compliance demonstration. For instance,* ***the flame holding performance of*** *flame arrestor installations that face downward so a ground fire impinges on its face have ~~significantly~~ shorter effectiveness than*	We agreed and modified the text in paragraph 8.3.1 to include a variation of the recommended text.

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	an arrestor that is mounted vertically. …"	*an arrestor that is mounted vertically. …"* Our recommended changes are meant to clarify the text. The flame speed at the arrestor installation may be a factor in the flame propagation test, but would not be significant in the flame holding test. The installation orientation may affect performance in the flame holding test, but would not be significant in the flame propagation test.	
12.	Substantive comment. Page: 8, Para: 8.3.1.2. Fuel Type, Sub paragraph 8.3.1.2.1. The proposed text states: *"8.3.1.2. Fuel Type.* *8.3.1.2.1. Fuels used in the test should have the same characteristics as the critical fuel approved for use in the airplane. Typically JP-4 is the critical fuel, so JP-4 or hexane has been acceptable provided the correct fuel to air ratio is established for the fuel type being used. Hexane (C6 H14) is readily available and easily manipulated in the gaseous state, and so it is typically a fuel of choice. The AIT of 433 °F closely simulates that of JP-4 vapor, which is 445 °F.* *Note: Fuels with higher AITs, such as propane, should not be used for the flame arrestor element test because ignition on the back side of the*	We request this text be revised by adding information regarding acceptable test methods for aircraft where the critical fuel is Jet A, A1, and/or TS-1 fuel types. The stated intent of the AC is to drive standardization in certification. The AC refers to JP-4 as the typical critical fuel; however, JP-4 is not available in most of the world and often not certified as an allowable fuel type. It is also difficult to obtain even for testing. The FAA has accepted hexane testing as also representative of Jet A, Jet A-1, and TS-1 tests for flame propagation. Also note the AIT of fuel types varies from batch to batch. The AIT of JP-4 should not be stated as a single value (445°F in the draft AC). 400°F is the stated acceptable limit for auto ignition protection in AC 25.981-1C, based on an AIT of approximately 450°F for all kerosene fuel types (Jet A, Jet A1, Jet B, JP4, TS-1, and others).	We added clarification to paragraph 8.3.1.3 to include guidance using hexane as an acceptable fuel to represent Jet A, Jet A-1 and TS-1 fuels. Use of hexane as a test gas to represent the range of kerosene type fuels is acceptable. If an applicant chooses to use another fuel, a separate test proposal can be submitted to the FAA for approval.

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	arrestor would not be adequately evaluated. *8.3.1.2.2. Table A-1 summarizes the properties of hexane and provides an example of the method for calculating the stoichiometric relationship of hexane needed for the test.* *8.3.1.2.3. Propane may be used for flame arrestor installation testing where AIT is not a critical parameter for the test. For example, testing of a simulated production flame arrestor installation to validate that temperatures of portions of the installation fuel tank remain below the maximum permitted fuel tank surface temperature (typically 390 °F) would be acceptable, provided the flame arrestor element had been previously qualified to meet the flame propagation prevention requirements."*		
13.	Editorial comment. Page: 8, Para: 8.3.1.2. Fuel Type, Sub paragraph 8.3.1.2.3. The proposed text states: *"8.3.1.2.3. Propane may be used for flame arrestor installation testing where AIT is not a critical parameter for the test. For example, testing of a simulated production flame arrestor installation to validate that temperatures of portions of the installation fuel tank remain below the maximum permitted fuel tank surface temperature (typically 390 °F) would be*	We recommend revising the text as follows: *"8.3.1.2.3. Propane may be used for flame arrestor installation testing where AIT is not a critical parameter for the test. For example, testing of a simulated production flame arrestor installation to validate that temperatures of portions of the installation* ***within the*** *fuel tank remain below the maximum permitted fuel tank surface temperature (typically 390 °F) would be acceptable, provided the flame arrestor element had been previously qualified to meet the flame propagation prevention requirements."* Clarification. We believe the intent of this	We agree and modified the paragraph 8.3.1.3.3 as suggested.

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	acceptable, provided the flame arrestor element had been previously qualified to meet the flame propagation prevention requirements."	section was to refer to installations within the fuel tank. See also our Comment #12 regarding use of propane for both tests.	
14.	Substantive comment. Page: 9, Para: 8.3.2.1. Flame Propagation Tests. Subparagraph: 8.3.2.1.1. The proposed text states: *"8.3.2.1. Flame Propagation Tests.* *8.3.2.1.1. These are tests of the element's flame arresting performance in a static condition with six different fuel/air ratios (lean, between lean and stoichiometric, stoichiometric, 1.15 stoichiometric, between stoichiometric and rich, and rich). FAA sponsored tests done by Atlantic Research, documented in the Lightning Protection Measures for Aircraft Fuel Systems report, show curves of flame arrestor equilibrium temperature for various air-flow ratios as a function of percent stoichiometric fuel/air ratio (Figure A 2). These curves maximize at about 1.1 to 1.15 stoichiometric. The curves indicate higher temperatures occur at lower flow rates."*	We recommend deleting the requirement to run the flame propagation test at six different mixture conditions. We consider that the static flame propagation test should only need to be run at 1.15 +/- 0.05 stoichiometric, which is the range of worst case conditions as stated in the AC. The proposed AC may want to recommend repeating the test 3 or 5 times at this mixture, as is done in explosion proof testing. If the last sentence in subparagraph 8.3.2.1.1 (which we request deleting) is retained, we recommend revising it to state: *"…The curves indicate higher flame temperatures and flame speeds occur 1.10 to 1.20 stoichiometric."* As stated in the last sentence of the paragraph, approximately 1.15 stoichiometric is the worst case (maximum) range. We maintain that each applicant should not have to test a range of points, 5 of which are outside the accepted worst case range. The purpose of this testing is certification, not research validation.	We agree with commenter and have modified paragraph 8.3.2.1 as follows: *This test demonstrates the element's flame arresting performance in a static condition at the critical fuel mixture condition of 1.15 +/- 0.05 stoichiometric. This mixture is based on FAA-sponsored tests done by Atlantic Research, documented in the Lightning Protection Measures for Aircraft Fuel Systems report. The report shows curves of flame arrestor equilibrium temperature for various air-flow ratios as a function of percent stoichiometric fuel/air ratio (see figure A-2 in this AC). These curves maximize at about 1.10 to 1.20 stoichiometric. The curves indicate higher temperatures occur at lower flow rates.*
15.	Editorial comment. Page: 10, Para: 8.3.2.2.: Flame Propagation	We recommend revising the text to read as follows: *"8.3.2.2.1 "...AC 25.981-1C provides guidance*	We agree and corrected the temperature reference.

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	Prevention Tests, Subparagraph 8.3.2.2.1. The proposed text states: *"8.3.2.2.1 "...AC 25.981-1C provides guidance that establishes a maximum allowable surface temperature within the fuel tank (the tank walls, baffles, or any components) that provides a safe margin under all normal or failure conditions that is at least 50 °F (10 °C) below the lowest expected AIT of the approved fuels.…"*	*that establishes a maximum allowable surface temperature within the fuel tank (the tank walls, baffles, or any components) that provides a safe margin under all normal or failure conditions that is at least 50 °F **(10 °C)** **(27°C)** below the lowest expected AIT of the approved fuels. …"* Correction/clarification. A 50°F temperature change (i.e., delta T) is equivalent 27°C, rather than 10°C.	
16.	Substantive comment. Page: 10, Para: 8.3.2.2. Flame Propagation Prevention Tests, Subparagraph: 8.3.2.2.1. The proposed text states: *"8.3.2.2.1. ... As stated in AC 25.981-1C, the AIT accepted by the FAA without further substantiation for kerosene fuels, such as Jet A, under static sea level conditions, is 450°F (232.2°C). This results in a maximum allowable surface temperature of 400°F (204.4°C) for an affected component surface of a fuel tank. The ARAC draft AC 25.863-1, Flammable Fluid Fire Protection, (reference 3.2 of this AC) provides similar guidance that limits surface temperatures in flammable fluid leakage zones to AIT-50°F. The ARAC draft AC also provides guidance for allowing somewhat higher surface temperature limits in certain cases where substantiated."*	We recommend establishing **500°F** as the internal static surface temperature limit for the remote failure conditions that this proposed AC addresses. The AC 25.975 draft notes that AC 25.981-1C allows temperatures of up to 400°F [without further substantiation]. However, AC 25.981-1C, page 14, also states: *"For remote failure conditions of limited duration, it is acceptable to provide substantiation of actual hot-surface ignition temperatures (note that this is different from the auto-ignition temperature of the fuel), and demonstrate a 50°F margin below these temperatures."* The flame holding condition is a remote failure condition, and the 90-second (or 150-second) requirement is a limited duration. On page 28, AC 25.981-1C notes *"a transient excursion up to*	The FAA does not agree with this comment and no changes were made as a result. The regulation required preventing propagation of a flame present at the fuel tank vent into the fuel tank. The probability of the event is not a consideration in the compliance demonstration so the commenter's assertion that the failure condition is remote is not a consideration in demonstrating compliance. This AC allows applicants to propose a higher allowable fuel tank surface temperature for their particular installation. Also, AC 25.981-1C does not allow internal fuel tank temperatures above 400 °F.

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		500°F for a maximum duration of two minutes, has been accepted for certain pneumatic system installations." We, therefore, recommend that the FAA establish 500°F as an allowable surface temperature limit for static surfaces outside the flow path within the tank during this remote condition.	
17.	Substantive comment. Page: 11, Para: 8.3.4. Related Qualification and Installation Considerations. The proposed text states: *"8.3.4.3 Flame Front Velocity* *The effectiveness of the flame arrestor is dependent on the velocity of the flame front. The vent line length, diameter, and flow losses between the ignition source and arrestor influence the velocity. The flame arrestor installation may have a different vent line length and diameter, with associated flow losses, than what is used for the element test. These installation differences should be accounted for in the compliance demonstration. A separate test may be required to demonstrate that the installed flame arrestor is effective."*	We recommend revising the text as follows: *"8.3.4.3 Flame Front Velocity* *The effectiveness of the flame arrestor* ***to prevent flame propagation in a static condition*** *is dependent on the velocity of the flame front. The vent line length, diameter, and flow losses between the ignition source and arrestor influence the velocity. The flame arrestor installation may have a different vent line length and diameter, with associated flow losses, than what is used for the element test. These installation differences should be accounted for in the compliance demonstration* ***for flame propagation in a static condition.*** *A separate test may be required to demonstrate that the installed flame arrestor is effective,* ***unless it can be established that the arrestor has been shown to be effective in a test set-up that would result in higher flame speeds."*** We suggest that the flame front velocity considerations should only be applicable to the	Partially accepted. We did not include a reference to "static condition" since this term did not add clarity to the paragraph. We moved this paragraph to paragraph 8.3.2.1.2 in response to Embraer's comment 9 and modified the text as follows: *The velocity of the flame front as it reaches the flame arrestor can significantly influence the effectiveness of the flame arrestor at preventing flame propagation. The flame front velocity increases as the flame travels down a vent line containing flammable vapors. The velocity of the flame front is installation-dependent and influenced by the vent line length, diameter, and flow losses between the ignition source and flame arrestor. The test configuration should include consideration of these critical features. If an applicant proposes to use a previously approved flame arrestor element in a new installation with different vent line length and diameter than previously tested, the applicant should account for these installation differences in the*

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		flame propagation capability demonstration.	*compliance demonstration. The applicant may need to conduct a separate test to demonstrate that the flame arrestor is effective in the installed configuration.*
18.	Substantive comment. Page: 11, Paragraph: 8.3.3. Pass/Fail Criteria The proposed text states: *“8.3.3 Pass/Fail Criteria.* *8.3.3.1 The flame arrestor assembly should meet the performance criteria noted above.* *8.3.3.2 Following passing of the flame arrestor tests noted above, careful examination of the arrestor structural integrity should be conducted. Flame arrestors have been constructed of one flat and one corrugated stainless steel sheet that is rolled up and placed into a flanged casing. This construction produces a series of small passages. Structural integrity of the coiled sheet metal is maintained by either of the rods that cross at the front and rear face of the coil or by brazing or welding of the coiled sheet metal at various points around the surface. Flame arrestors have failed the test when structural integrity is lost due to weld or brazed joint failures.”*	We recommend deleting subparagraph 8.3.3.2. The intent of the vent flame arrestors is to protect the tank in the case of exposure to an external fire or ignition condition. The testing requires multiple tests be done on the arrestor, when, in fact, few aircraft will see even one threat exposure. The testing should be considered destructive. As long as the arrestor performs its function, its physical condition after the testing should be irrelevant. Aircraft repair after the fire condition protected for would be necessary.	We agree and added a sentence to paragraph 8.3.3.2 to allow the flame arrestor to be damaged during the test, provided the flame arrestor installation meets the minimum performance requirement, and it is replaced after it is exposed to fire. *Damage of flame arrestor assembly components is acceptable if the flame arrestor installation prevents flame propagation during the test, and the maintenance requirements specify the flame arrestor must be repaired or replaced following an event where the flame arrestor was exposed to flame.*
19.	Substantive comment.		

DISPOSITION OF PUBLIC COMMENTS
AC 25.975-1, Fuel Vent Fire Protection
Prepared by Mike Dostert, ANM-112

<table>
<tr><th>No.</th><th>Comment</th><th>Requested Change</th><th>Disposition</th></tr>
<tr><td></td><td>Commenter: Boeing Commercial Airplanes</td><td></td><td></td></tr>
<tr><td></td><td>Page: A-1, Appendix A - Example of Calculation for Fuel-to-Air Ratio

Note under Table A-1 and Table A-2

“Note: … A 1.15 fraction of stoichiometric mixture of air and hexane has a fuel-to-air weight ratio of …”

And

Table A 2. Fuel/Air Mixtures for Flame Arrestors Tests (see column to the right)</td><td colspan="2"><table>
<tr><th>Condition</th><th>JP-4 Percent by Volume</th><th>JP-4 Fuel/Air Mass Ratio</th><th>Hexane Percent by Volume</th><th>Hexane Fuel/Air Mass Ratio</th></tr>
<tr><td>…</td><td></td><td></td><td></td><td></td></tr>
<tr><td>1.15 Stoichiometric</td><td>1.82</td><td>0.074</td><td>~~2.3~~
2.5</td><td>0.07567</td></tr>
<tr><td>…</td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td></td><td>Comment 19 continued:

We recommend revising the text as follows:

“Note: … A 1.15 fraction of stoichiometric mixture of air and hexane has a ~~fuel-to-air~~ an air-to-fuel weight ratio of …”

And</td><td></td><td>FAA Disposition: The equation provided in the note under Table A-1 actually calculates an air-to-fuel weight ratio, not a fuel-to-air weight ratio. We agree with the commenter and changed the text in the note to say “air-to-fuel weight ratio.”</td></tr>
<tr><td></td><td>Regarding Table A-2: There is no need for testing at the six mixtures listed in the Table when the “1.15 Stoichiometric” case is considered to be the worst case condition. Further, even if multiple mixtures are desired, the Hexane Fuel/Air Mass Ratio of 0.26 is outside the flammability limits; thus, it would not be ignitable. Lastly, note that the Hexane Percent By Volume column is not in agreement with the</td><td colspan="2"><table>
<tr><th>Condition</th><th>JP-4 Percent by Volume</th><th>JP-4 Fuel/Air Mass Ratio</th><th>Hexane Percent by Volume</th><th>Hexane Fuel/Air Mass Ratio</th></tr>
<tr><td>Lean limit</td><td>0.90</td><td>0.035</td><td>~~1.0~~ ***1.3***</td><td>0.04</td></tr>
<tr><td>Between lean limit and stoichiometric</td><td>1.10</td><td>0.045</td><td>~~1.5~~ ***1.7***</td><td>0.05</td></tr>
<tr><td>Stoichiometric</td><td>1.58</td><td>0.065</td><td>~~2.0~~ ***2.2***</td><td>0.0658</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>No.</th><th>Comment</th><th>Requested Change</th><th>Disposition</th></tr>
<tr><td></td><td>Commenter: Boeing Commercial Airplanes</td><td></td><td></td></tr>
<tr><td></td><td>Hexane Fuel/Air Mass Ratio column. The correct Hexane Percent By Volume column would be as indicated below:</td><td colspan="2">
<table>
<tr><td>1.15 Stoichiometric</td><td>1.82</td><td>0.074</td><td>~~2.3~~ 2.5</td><td>0.07567</td></tr>
<tr><td>Between stoichiometric and rich limit</td><td>3.0</td><td>0.15</td><td>~~5.0~~ 6.3</td><td>0.2</td></tr>
<tr><td>Rich limit</td><td>6.16</td><td>0.23</td><td>~~7.0~~ 8.0</td><td>0.26</td></tr>
</table>
</td></tr>
<tr><td></td><td></td><td></td><td>FAA Disposition: We agree and made the changes to the table as noted by the commenter.</td></tr>
</table>

No.	Comment	Requested Change	Disposition
	Commenter: Textron Aviation		
1.	Section 8.3.2.2.1 Current text: … Monitor the temperature at the upstream center of the arrestor; it is required to stay below 700 °F for 2 minutes and 30 seconds. Record the outer tube temperature just downstream of the arrestor and limit it to a temperature of 390 °F to 450 °F depending on the location of the arrestor in the wing. AC 25.981-1C provides guidance… Current wording implies some action may be taken to hold temperature of the component within the specified range. Proposed words clarify that the surface temperature staying	Proposed text: … Monitor the temperature at the upstream center of the arrestor; it is required to stay below 700 °F for 2 minutes and 30 seconds. Record the outer tube temperature just downstream of the arrestor. ~~and limit it to a temperature of~~ The surface temperature is required to remain below 390 °F to 450 °F depending on the location of the arrestor in the wing. AC 25.981-1C provides guidance…	Agree with intent of this comment. Paragraphs 8.3.2.2.1 and 8.3.2.2.2 now include expanded discussion of maximum surface temperatures for both the flame arrestor element and flame arrestor installation maximum surface temperatures that includes the intent of this comment.

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	within the prescribed range is a pass/fail criteria for the test.		
2.	Section 8.3.2.2.1 Current text: AC 25.981-1C provides guidance that establishes a maximum allowable surface temperature within the fuel tank (the tank walls, baffles, or any components) that provides a safe margin under all normal or failure conditions that is at least 50 °F (10 °C) below the lowest expected AIT of the approved fuels.	Correction to reflect the difference between a temperature of 50°F (which is 10°C) and a temperature difference of 50 Fahrenheit degrees, which is 28 Celsius degrees. Proposed text: AC 25.981-1C provides guidance that establishes a maximum allowable surface temperature within the fuel tank (the tank walls, baffles, or any components) that provides a safe margin under all normal or failure conditions that is at least 50 °F (~~10°C~~28°C) below the lowest expected AIT of the approved fuels.	We agree and modified the temperature to 27.7 °C because 50 °F is 27.7777 °C.