DISPOSITION OF PUBLIC COMMENTS

AC NO. 25-981-2A, TITLE: FUEL TANK FLAMMABILITY

AC Section	Comment	Requested Change	Disposition
General	**Commenter: C**omments submitted to the proposed rule (NPRM) And not specifically submitted has requested changes to the draft AC.	N/A	In addition to the specific changes requested and listed in this disposition of comments table, the AC was revised to be consistent with the final rule.
General	**Commenter:** Boeing (# 1) The flammability NPRM contains proposed Appendix L defining the process for determining the flammability of fuel tanks (Monte Carlo analysis). The analysis model, typically referred to as the Monte Carlo, is a method of demonstrating compliance with the proposed flammability rule. Accepted industry practice locates compliance methods, design or analysis, in Advisory Circulars. The FAA can manage the method by not approving changes that deviate from the definition, regardless of the location of the method (in the final rule or in the AC). Therefore, the FAA should continue with existing proven processes and continue to place compliance demonstration methods in Advisory Circulars. Should a real improvement to the method be suggested in the future, an applicant will be able to apply that method with FAA approval without a lengthy revision process to the	Boeing requests the FAA relocate the Appendix L analysis model for showing compliance with the proposed rule to the AC.	This comment was addressed in the preamble to the final rule in response to an identical request. As stated in response to this comment in the preamble to the final rule, we have determined that the information in Appendix L should be located in an appendix to Part 25 in the final rule. The final AC therefore reflects the final rule and refers to these as appendices to part 25.

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	rule or to the AC.		
Definitions, page 5, a. Auxiliary Fuel Tank	**Commenter**: Boeing (# 2) Clarify definition of Auxiliary Tank. Delete "pursuant to a supplemental type certificate (STC) or field approval". Auxiliary tanks can be and have been installed as part of the original type certificate on many airplane models.	Reword as follows: a. Auxiliary Fuel Tank. as defined in § 25.1803, is "a normally emptied fuel tank that has been installed to make additional fuel available." These fuel tanks are installed to make additional fuel available for increasing the flight range of that airplane. The term "auxiliary" has previously been used to mean that the tank is secondary to the airplane's main fuel tanks. The reference to "auxiliary tank" in this AC primarily refers to auxiliary body tanks typically located within the pressurized cabin	We partially agree with this Commenter. We have removed the reference to supplemental type certificates and field approvals from the definition. The definition for auxiliary fuel tanks in the final AC has reverted to the definition that was provided in the original issue of AC. 25.981 – 2.
5. Definitions, y. Equivalent Conventional Unheated Aluminum Wing	**Commenter**: Boeing (# 3) The Boeing proposal to the NPRM recommends that the FAA allow any new or existing aluminum fuel tank to be shown by design review to be equivalent in cooling and heating to the fuel tanks determined by ARAC to have a sufficient safety record. Note that though the term includes "Unheated", many of the tanks analyzed by ARAC have minimal heat sources, such as hydraulic heat exchangers and solar heating. The term "unheated" is actually referring to minimal heating.	Reword as follows: y. Conventional Unheated Aluminum Tank is an aluminum structure tank having minimal heat sources and significant cooling, resulting in low flammability exposure and a satisfactory level of safety as established by the Fuel Tank Harmonization Working Group ARAC study. Note that the conventional unheated aluminum tank as analyzed by ARAC typically includes some minimal heating from hydraulic systems.	Although we did not incorporate the request to modify the definition of an equivalent conventional unheated aluminum wing, the guidance in the final AC does recognize minimal heat sources have been located in "conventional unheated aluminum wing tanks." The definition of an equivalent conventional unheated aluminum wing is taken from the final rule text. This definition does not preclude conventional aluminum wing fuel tanks from containing minimal heat sources. A section in this advisory circular provides guidance on when a qualitative assessment may be used for a fuel tank located in a conventional

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	Boeing recommends that an analysis of a non-aluminum fuel tank to an equivalent conventional unheated aluminum wing tank not be allowed. It is unlikely that any manufacturer would go to the trouble of designing and building an equivalent wing in aluminum just to allow for a flammability analysis and the validation of that analysis that would be necessary. There is no precedence that this analysis is reasonable.		unheated aluminum wing. This guidance recognizes that an otherwise conventional unheated aluminum wing tank may include minimal heat sources.
9. b. (4) Fuel Temperature	**Commenter**: Boeing (# 4) Paragraph (4) does not address a design practice, but is a discussion of the analysis assumptions	Paragraphs (2) and (4) should be combined or paragraph (4) should be deleted.	We agree with the Commenter that this paragraph does not address a design practice. We have moved this paragraph to the Monte Carlo method analysis section
10. Determining Fuel Tank Flammability, paragraph a(1) Qualitative Flammability	**Commenter**: Boeing (# 5) Boeing agrees with the concept of the subparagraph proposed, but believes the basis should be as listed as shown in their Requested Change.	The "Conventional Unheated Aluminum Tanks" that the ARAC team determined to be of low risk due to service history actually do have some minimal heat sources typical among them. Some have hydraulic heat exchangers reject heat to the fuel intermittently during operation. All have solar heat loads. Boeing requests that equivalence be shown to a "Conventional Unheated Aluminum Tank." As part of the qualitative description provided by the applicant, any heat sources should be compared with	The Commenter did not propose specific changes to the text of the advisory circular; however we feel the final text of this section addresses the commenters and discussion. This section of the advisory circular provides guidance for when a qualitative analysis of a conventional unheated aluminum wing tank may be acceptable. The text of this section has been made consistent with the preamble discussion in the final rule. This includes the wording that allows "minimal heating from airplane systems or other fuel tanks

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Assessment.		existing in-service wing heat sources. The applicant should demonstrate that all efforts have been made to minimize heat input to the fuel tank. In order to be considered as a "Conventional Unheated Aluminum Tank", no unusual heat sources should be present. Should unusual heat sources be present, that particular tank design should default to the Monte Carlo assessment. The ARAC team determined tanks with sufficient cooling are low risk for flammability exposure and have a satisfactory safety record. Many of those fuel tanks analyzed by ARAC have heat sources such as hydraulic heat exchangers and all have solar heat loads. Requiring the applicant to demonstrate that the design minimizes heat loads into aluminum tanks is good practice. Requiring an applicant proposing unusual heat sources in any tank to conduct a flammability exposure analysis also good practice.	and cooled by ambient airflow during flight."
10. Determining Fuel Tank Flammability, a. Acceptab	**Commenter**: Boeing (# 6) Boeing generally agrees with the FAA proposal and suggests the changes above to allow for "minimally" heated tanks to be shown to be equivalent to a "Conventional Unheated Aluminum Tanks.	Reword as follows: (1) Qualitative Flammability Assessment. (a) Integral aluminum fuel tanks ~~located in the wing~~, fueled with Jet-A type fuel, operated on typical flight profiles, ~~not~~ minimally heated by airplane heat sources and having a large surface area-to-volume ratio to allow cooling, have been shown to	As stated above, the text of this section has been revised to be consistent with the preamble discussion in the final rule. The Commenter requested two changes that still relate to the final advisory circular text. The first would be to remove the words "located in the wing" and the second would be to use the words

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le Means of Determining the Flammability Exposure, (1) Qualitative Flammability Assessment, page 18-19.		minimize the formation of flammable fuel vapors. For these tanks, a qualitative assessment showing equivalency to the Conventional Unheated Aluminum Tank is acceptable. As stated in the Users Manual, any subsonic transport category airplane with fuel tanks only that is designed in accordance with the design guidelines identified in paragraph 9 of this AC, would be considered to meet the intent of the proposed rule and the flammability assessment would consist of a qualitative description of the particular tank design including: 1 a description of the airplane configuration, (including subsonic, wing construction, etc.), 2 a listing of any heat sources in or adjacent to the fuel tank, 3 the type of fuel approved for the airplane, 4 the tank operating pressure relative to ambient static pressure, 5 the tank is uninsulated and made of aluminum, and 6 the tank has a large surface area exposed to outside air to transfer heat from the tank	"conventional unheated aluminum tank", instead of the words "unheated aluminum wing tank." The first proposed change would have the effect of allowing use of the qualitative flammability assessment method for fuel tanks located inside the fuselage and this would be inconsistent with the requirements of the final rule. Therefore, this change was not included in the final AC. We partially agree with the second proposed change. The word "conventional" should have been used in the phrase "unheated aluminum wing tank," but for reasons stated above the word "wing" must be retained. We have revised the advisory circular to consistently use the term "conventional unheated aluminum wing tank."
10.a.(1)(b)	**Commenter**: Boeing (# 7) This is the first suggestion that an	Boeing recommends incorporating paragraph 10.a(1)(b) into paragraph 10.a(1)(a) as one consideration.	We partially agree with the Commenter. We revised paragraph 10.a.(1)(a).6 where we used the term "surface area" to now

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	aerodynamic area to volume ratio can be used to judge fuel tank flammability. The requirement for a flammability exposure analysis should be based on the many factors that cause a tank to have high flammability exposure.	(b) Fuel tanks with an aerodynamic surface area to volume ratio greater than 1.0 have been shown to meet these criteria. Fuel tanks with a ratio less than 1 require development of a Monte Carlo Model flammability assessment model.	read "aerodynamic surface area." This introduces the term aerodynamic surface area in paragraph 10.a.(1)(a). We retained the discussion of aerodynamic surface area to volume ratio in paragraph 10.a(1)(b) and added a parenthetical explanation of the ratio as "(surface area / volume)."
10.a.(1)(b)	**Commenter**: Airbus The FAA states: *H(b) Fuel tanks with an aerodynamic surface area to volume ratio greater than 1.0 have been shown to meet these criteria. Fuel tanks with a ratio less than* 1 *require development of a Monte Carlo Mode flammability assessment model. The aerodynamic surface area includes the area of the integral aluminum wing fuel tank that is exposed to outside air. It does not include any portion of a fuel tank that is shielded from free stream airflow, such as the front and rear spar, or an area under a fairing or wing thermal blanket."*	This description requires further clarification as to precisely what the FAA mean by surface area to volume ratio as a ratio should be non dimensional phone.	As stated above, we revised paragraph 10.a.(1)(a).6 where we used the term "surface area" to now read "aerodynamic surface area." This introduces the term aerodynamic surface area in paragraph 10.a.(1)(a). We retained the discussion of aerodynamic surface area to volume ratio in paragraph 10.a(1)(b) and added a parenthetical explanation of the ratio as "(surface area / volume)."
10.a.(1) new	**Commenter**: Boeing (# 8) Boeing requests the above paragraph be added to section 10 above current paragraph (c). Aux tanks that are	Add the following new paragraph: (x) Pressurized Auxiliary fuel tanks located in the cargo area of the airplane have been shown to be low flammability. If an auxiliary tank can be shown to be	We did not incorporate this comment. No data was submitted to demonstrate that a pressurized auxiliary fuel tank located in the cargo area of an airplane is equivalent to a conventional unheated aluminum

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	pressurized will have similar flammability exposures to Conventional Unheated Aluminum Tanks. Given that the aux tank is located within the cargo compartment typically, the aux tank will remain at cabin temperature, all but eliminating flammability during ground operations.	held near cabin pressure throughout the aircraft mission profile, the auxiliary tank can be considered equivalent to a Conventional Unheated Aluminum Tank qualitatively.	wing tank. The Commenter did not include the word "wing" when they used the phrase "conventional unheated aluminum tank" but as stated above the word "wing" must be included.
10.a.(1)(c)	**Commenter**: Boeing (# 9) Boeing proposed in comments to the Flammability NPRM that the FAA should use a fixed 3% benchmark for flammability exposure. Tanks constructed with materials different in properties to aluminum should meet the fixed requirement of 3%, rather than an unknown quantity represented by a hypothetical version of the tank in question designed in aluminum.	Reword as follows: "(c) ~~Wing~~ Tanks that do not meet the criteria in this paragraph for use of the qualitative method must use the Monte Carlo method. ~~For example, if the fuel tank were made of composites, the applicant would need to conduct an assessment of a simulated wing fuel tank meeting the criteria above, on the airplane type for which approval is sought. This would establish the maximum allowable flammability level for the wing fuel tank. By comparing the reference unheated aluminum wing tank to the tank in question, the applicant can demonstrate that adequate provisions have been included in the designed to minimize flammability exposure.~~ " Fuel tanks that are constructed of other materials than aluminum must use the Monte Carlo method.	The changes requested by this comment are not incorporated in the final AC. The qualitative method that is described in the preamble to the final rule and for which guidance is provided in this advisory circular is limited to use for integral fuel tanks located in conventional unheated aluminum wings. Therefore, the word " wing" is maintained in the text of this section of the advisory circular. The final rule requires that "no fuel tank Fleet Average Flammability Exposure on an airplane may exceed three percent of the Flammability Exposure Evaluation Time (FEET) as defined in Appendix N of this part, or that of a fuel tank within the wing of the airplane model being evaluated, whichever is greater. If the wing is not a conventional unheated aluminum wing, the analysis must be based on an assumed Equivalent Conventional Unheated Aluminum Wing

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			Tank." Therefore, the rule allows for either using the 3% flammability limit or using the conventional unheated aluminum wing tank to establish the flammability limit.
10.a.(2)	**Commenter**: Airbus The FAA states: *"When the compliance demonstration requires demonstrating a fuel tank meets a specific fuel tank flammability or the tank does not meet the qualitative assessment criteria previously discussed, the flammability assessment must be conducted in accordance with the method that is incorporated by reference in the regulation as defined in the FAA document, "Fuel Tank Flammability Assessment Method Users Manual," dated March 2005. This document may be obtained from the following web site: (http://wwwjire.tcfaa.gov/systems/fueltanklFTFAMstm"*	The date of the model should be revised with the date of the final rule when all identified improvements and security protection features (proposed by the peer review) are incorporated	The NPRM and draft AC referred to the draft User's Manual. The User's Manual was updated to reflect the requirements of the final rule and issued as the final User's Manual.
10.a.(2) Figure 1)	**Commenter**: Airbus The figure uses color coding for some inputs but there is no explanation of what the intent of the colours is.	An explanation would be useful.	We agree and incorporated the recommended change.

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10.a.(2)(b)	**Commenter**: Boeing (# 10) Boeing recommends deleting "The applicant is allowed to perform a qualitative assessment of each compartment in the tank to determine the most critical compartment with the worst case flammability. The flammability exposure of the most critical compartment of the fuel tank would then be stated as the fuel tank flammability." As the Boeing comments stated in response to the flammability NPRM, all bays must be considered in the analysis. The flammability of the fuel tank is a summation of all the times when any bay in the tank is flammable. To only consider the most flammable of those bays would lower the total flammability by allowing less flammable bays to be ignored. Paragraph (c) of this part is correct and supports this position	Reword as follows: (b) The flammability exposure must be determined independently for each tank or compartment of each tank if partitions exist in the tank that prevent mixing of fuel vapors. Within each tank where barriers or walls prevent mixing of the fuel/air mixtures, separate volumes or compartments should be treated independently to determine the worst case flammability exposure for that tank because of temperature variations within different portions of the tank. If FRM based upon inerting is used, oxygen concentration in those compartments of the tank can differ significantly from other compartments in the tank (such as an airplane model that has a center wing box that extends out into the wing, or a compartment in a fuel tank where vent inlets may create differences in temperature or oxygen concentration (if an FRM based on inerting is used)).	We agree with the Commenter and have revised this paragraph of the advisory circular accordingly.
10.a.(3) DEVELOPING INPUTS TO THE MONTE	**Commenter**: Airbus Typographic error in the third sentence: *"Appendix L of the proposed rule provides standard distributions and values that must be used when determine fuel tank flammability.* "	The word *"determine"* should be replaced by *"determining"*.	We agree and corrected the error.

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CARLO MODEL			
11 b	**Commenter**: Boeing (# 11) Delete horizontal stabilizer. The Horizontal stabilizer on Boeing airplanes is located in the aft unpressurized section of the fuselage. This area is as cold as the wings as there is no insulation and no heat sources.	Reword as follows: b. Cooling/Ventilation of Fuel Tanks. If the fuel tank is located in an area of the airplane where little or no cooling occurs, such as the center wing box~~, horizontal stabilizer,~~ or auxiliary fuel tanks located in the cargo compartment, ventilation or dedicated cooling may also be an effective means of demonstrating compliance	We partially agree with the Commenter. We did not delete the words "horizontal stabilizer." We inserted the word "certain" so it now reads "certain horizontal stabilizers."
11.c	**Commenter**: Boeing (# 12) Boeing proposes to recognize that pressurized auxiliary fuel tanks are equivalent in flammability to Conventional Unheated Aluminum Tanks. The aux tank will be at or near cabin temperature on the ground, all but eliminating ground flammability exposure.	Reword as follows: c. Controlling Fuel Tank Pressure. The flammability of the fuel tank is affected by the pressure in the tank…. Many recently designed auxiliary fuel tanks incorporate structural features that allow utilization of pneumatic pressure to transfer fuel from the fuel tank to the airplane fuel tank system. These tanks typically are designed to operate at a pressure equivalent to roughly 10,000 feet. This results in a significant reduction in fuel tank flammability. Auxiliary Fuel Tanks pressurized in this manner have been shown to be equivalent to a Conventional Unheated Aluminum Tank in flammability exposure. Controlling fuel tank pressure is one means of	We did not incorporate this comment. No data was submitted to demonstrate that a pressurized auxiliary fuel tank located in the cargo area of an airplane is equivalent to a conventional unheated aluminum <u>wing</u> tank. The Commenter did not include the word "wing" when they used the phrase "conventional unheated aluminum tank" but as stated above the word "wing" must be included.

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		reducing fuel tank flammability. The Monte Carlo Model defined in paragraph 4e(11) of this AC has features that allow analysis of a fuel tank with fixed or variable pressure so that fuel tank flammability under these conditions can be evaluated	
11.f. g, h, I, and j.	**Commenter**: Boeing (# 13) Oxygen Evolution, Overnight Temperature Change, Open Vent Systems and Descent, and Other Considerations Related to Oxygen are components of determining Oxygen Concentration	The proposed paragraphs g, h, I, and j should be subparagraphs to paragraph f.	Although we understand the commenters suggestion, this is not a mistake, and is related to formatting of the advisory circular and we did not incorporate the comment.
Appendix 1, 3.a	**Commenter**: Boeing (# 14) Boeing proposes these changes to ensure the appropriate data is collected, specifically to support an FRM	Reword as follows: a. Temperature Measurement. The location of test instrumentation should consider tank configuration and operational factors to determine which locations in the fuel tank require evaluation. The fuel temperature should include the critical locations in the tank for each of the fuel loading conditions. Ullage temperature should also be measured to understand ullage temperature, and hence density, where an FRM is concerned. The locations of fuel and ullage temperatures should take into consideration any structural barriers or baffles that may divide the tank into regions that may behave different	We agree with the Commenter and we revised the paragraph to incorporate the intent of the comment.

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		thermally.	
Appendix 1, 3.b	**Commenter**: Boeing (# 15) Boeing proposes changes to ensure key parameters to fuel tank flammability are modeled and validated by testing	Reword as follows: b. Test Conditions. The applicant should conduct sufficient ground and/or flight testing as required that simulates the actual operation of the airplane type so that a validated fuel tank thermal model can be developed that will accurately model the fuel tank. Fuel tank temperatures should be measured so that the change in temperature in each affected tank on the ground and in-flight versus time can be determined. The minimum number of test conditions needed to validate the thermal modeling of the fuel tank will depend upon the number of variables that may affect the fuel tank temperature. For example, a minimum of two test flights would be required, one representative of a short mission for the airplane and one representative of a long mission for a typical CWT design so that variability in mission length, gate time and fuel quantities could be addressed. The short mission should include at least 30 minutes of ground operation prior to flight, and the long mission at least 90 minutes of ground operation prior to flight. For the entire mission (i.e., from the start-up of airplane systems to completion of the flight), temperatures	We agree with the Commenter and we revised the paragraph to incorporate the intent of the comment.

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		should be recorded in the test tank(s) at locations to represent the bulk fuel temperature in each separate section of the test tank(s) unless a qualitative assessment shows that fewer locations can be justified. For this discussion, TAT is used to represent ambient temperature on the ground and TAT in flight. The fuel temperature and TAT shall be recorded at no less than 1-minute intervals. The test program should be designed to address the fuel tank thermal response as a function of day type, including testing on warm days to understand the fuel tank thermal response when the tank is most likely to be flammable.	
Appendix 2, 2.	**Commenter**: Boeing (# 16) Boeing recommends adding words to ensure the instrumentation system is designed to minimize the impact on the environment being measured	Add the following to paragraph 2: All instrumentation has an effect on the environment being measured. Regardless of the method used to measure oxygen concentration, care must be taken to ensure the sampling system impact on the fuel tank environment is minimized. Ullage drawn from the fuel tank for measurement should be returned to the tank in locations that minimize the effect on the ullage being measured. The analysis presented for compliance must include the effect of the instrumentation on the results	We agree with the Commenter and revised this paragraph accordingly.

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Appendix 3, 3.	**Commenter**: Boeing (# 17) Boeing referred to their comments to the Flammability NPRM and their additional comments to this AC, comments # 18-20.	Boeing proposes that the FAA harmonize the proposed AC with the NPRM and agreements regarding Ignition Prevention CDCCL.	It was unclear what change was requested by the Commenter. The final AC has been revised to be consistent with the final rule. The requirements in the final rule for fuel tank flammability related CDCCLs are consistent with the requirements of amendment 25 – 102 for fuel tank ignition prevention CDCCLs. We're not aware of any agreements related to showing compliance to amendment 25 – 102 ignition prevention CDCCLs that would not be consistent with the guidance in this AC. If the Commenter is referring to the agreements on implementation of ignition prevention CDCCLs under SFAR number 88, which were implemented by airworthiness directive, those agreements may not apply when showing compliance to either amendment 25 – 102 or the fuel tank flammability reduction final rule.
Appendix 3, 3.a	**Commenter**: Boeing (# 18) It is not practical at an airplane level to control fuel tank flammability exposure by CDCCL. It is neither practical nor possible to control in a maintenance document all the possible changes to a fuel tank that could be made that might increase fuel tank flammability. The certification process should control the	Boeing proposes to delete "For example, certain fuel tanks may rely on natural cooling to meet the flammability exposure levels applicable to the particular fuel tank. Changes to the airplane, such as installing a fuel re-circulation system, hydraulic heat exchanger in the fuel tank, or a heat source adjacent to the fuel tank, may affect fuel tank flammability exposure. A CDCCL would be necessary	We partially agree with Commenter. We deleted the first sentence that the Commenter requested we delete, which read "For example, certain fuel tanks may rely on natural cooling to meet the flammability exposure levels applicable to the particular fuel tank." However we retained the rest of the paragraph to be consistent with the final rule.

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	effect design changes would have on flammability, not CDCCL. If enacted, the certification standards provided herein, along with the Aircraft Certification Office with oversight responsibility, will provide that control. The Monte Carlo model assumes a specific distribution of fuels used worldwide. The FAA should monitor the distribution fuels used, and adjust the AC if necessary. Flammability related CDCCL should be limited only to those features that are added to comply with 25.981 to ensure the feature is installed and functional	in this example to prohibit the addition of heat to the fuel tank." Boeing proposes to delete "Another example of a CDCCL might be limits on operation with certain fuel types such as JP-4." Boeing proposes to delete "All fuel tanks, even those in airplanes that do not have high flammability fuel tanks, will need to have CDCCL defined so that future modifications	
Appendix 3, 3.c	**Commenter**: Boeing (# 19) CDCCL should not be required to maintain fleetwide flammability exposure limits. CDCCL are intended to ensure design features added to an airplane to comply with 25.981 are present and functional. There is no practical way of ensuring that all possible ways of affecting fuel tank flammability can be identified and visibly identified.	Reword as follows: c. The CDCCLs for fuel tank flammability include any information necessary to maintain those design features that have been determined by analysis of the fuel tank system (e.g., fault tree analysis, failure modes and effects analysis) as needed to maintain the safety features or performance of the FRM or IMM within the limits established by the applicable regulations. AC 25.981-1B contains additional guidance on how to perform the analysis. Critical Design Configuration Control Limitations are	The Commenter suggestion that CDCCLs should not be required to maintain fleetwide flammability exposure limits was addressed for similar comments made to the NPRM. For the reasons stated in the preamble to the final rule, it was not accepted. Therefore, these changes were not incorporated in the final AC.

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		intended to ensure the presence and functionality of any design feature intended to comply with 25.981. This information is essential to ensure that maintenance, repairs, or alterations do not unintentionally violate the integrity of the original type design of the fuel tank system.	
Appendix 3, 4.c	**Commenter**: Boeing (# 20) It is not practical to identify all features of an airplane fuel system that may affect fuel tank flammability	Reword as follows: c. To identify the parts or components to which the CDCCL are applicable, the DAH must first conduct a configuration assessment of the FRM or IMM design. The purpose is to identify any foreseeable maintenance or inspection actions that could compromise the configuration of a critical feature of the FRM or IMM. In the context of this guidance, foreseeable causes are those that have occurred in service in the past or those that engineering judgment predicts could compromise the critical feature of a part or component of a FRM or IMM. The DAH must develop maintenance and inspection instructions to prevent those foreseeable causes.	The Commenter requested revising this paragraph to limit and CDCCLs to FRM or IMM design features. A similar comment was also made to the NPRM and it was not incorporated in the final rule. Therefore, this was not incorporated in the final AC.
5.n	**Commenter**: Airbus The FAA provides the following definition: "Ignition Energy is the minimum amount	This definition would benefit from the additional statement: The minimum energy required to ignite fuel vapours varies with both pressure and temperature. However for ignition	In reviewing this comment, we determined that defining ignition energy in this AC is not necessary because ignition energy is not used in the AC. Guidance on fuel tank ignition prevention

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	of energy required to ignite fuel vapors."	mitigation the worst case of temperature and pressure is assumed at all times	is contained in AC 25.981-1, including discussion on ignition energy. Therefore, the definition of ignition energy was removed from this final AC.
9.a	**Commenter**: Alankar Gupta FRS based on the concept of fuel tank cooling requires that the ullage temperature be considered during transient conditions as large variations in ullage and fluid temperatures may occur. The fuel-air ratio of the ullage must be determined using bulk average ullage temperature and pressure	9. General Considerations. a. Formation of Flammable Vapors Suggest revise to read Rather, the fuel properties and temperature and pressure in the fuel tank (ullage and fluid) are used to determine when the fuel tank is flammable	We did not include this requested change. The Commenter request adding the parenthetical words "(ullage and fluid)" in the discussion of using fuel properties and temperature and pressure to determine when the tank is flammable. Although the ullage temperature can affect the fuel tank flammability, the Monte Carlo model originally developed by an ARAC and used in prior special conditions and the final rule uses liquid fuel temperature to determine fuel tank flammability. Ullage temperature and fuel tank surface temperature can affect fuel condensation and vaporization. However, changes in fuel vapor concentrations in a fuel tank caused by fuel condensation and vaporization are included in the definition of "Transport Effects" (defined in Section 5), and the final rule excludes consideration of transport affects when determining fuel tank flammability.
9. b(2)	**Commenter**: Alankar Gupta The statement is valid for (1) unpressurized and pressurized tanks, and (2) for all fuels. The statement of the AC	9. b(2) Suggest revise the first sentence to read Temperature of fuel, in equilibrium with ullage, is one of the key factors that determine fuel tank flammability.	We did not include this requested change. As stated previously, the Monte Carlo model originally developed by an ARAC and used in prior special conditions and the final rule uses liquid fuel temperature

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	implies that it is valid only for unpressurized tanks and is limited to fuel tanks containing Jet A type fuels.		to determine fuel tank flammability. Ullage temperature relates to the "Transport Effects" defined in Section 5, and the final rule excludes consideration of transport affects when determining fuel tank flammability.
9.b(3)	**Commenter**: Alankar Gupta The applicant should be allowed to submit a proposal to the Administrator for approval. Please recognize that AC material is not mandatory, and does not constitute a regulation, see paragraph 2.b of the AC	Fuel Types Suggest revise the sentence to add "**and ullage"** so the sentence would read Because of this wing tanks are commonly not flammable as the fuel **and ullage** temperatures are typically below LFL temperature. Reason –	We did not include this requested change. As stated previously, the Monte Carlo model originally developed by an ARAC and used in prior special conditions and the final rule uses liquid fuel temperature to determine fuel tank flammability. Ullage temperature relates to the "Transport Effects" defined in Section 5, and the final rule excludes consideration of transport affects when determining fuel tank flammability
9.b(3)(a)	**Commenter**: Alankar Gupta The applicant should be allowed to submit a proposal to the Administrator for approval. Please recognize that AC material is not mandatory, and does not constitute a regulation, see paragraph 2.b of the AC.	A sentence in this paragraph said "For consistency across applicants, and for simplicity, each applicant is required to apply the distribution defined in Appendix L unless the FAA finds that this distribution is not representative of the fuels that could be expected to be used on the particular airplane being evaluated." Suggest revise the sentence to read: "For consistency across applicants, and for simplicity, each applicant is **advised** to apply the distribution defined in	This requested change was not incorporated. The Commenter is correct that the guidance in an AC is not mandatory; however, this particular sentence describes a requirement in Appendix N (Appendix L in the NPRM) to part 25 in the final rule. Therefore, this is describing a requirement of the regulation.

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		Appendix L unless **use of other data for fuels proposed for use by the applicant is approved by the Administrator.**	
10 (a)2(b) (This was moved from 9.b(4) in the Draft AC.)	**Commenter**: Alankar Gupta Draft AC paragraph read: "The fuel flash point at a given temperature and pressure is used to determine when the ullage in the tank is flammable. When the fuel temperature at a given altitude is in the range between the LFL and the UFL, the ullage is assumed to instantaneously become flammable. When using a Monte Carlo analysis, that transition is considered to occur instantaneously as pressure and temperature changes. The Monte Carlo Model is based on the assumption that any fuel being loaded during refuel is at ambient outside temperature when determining flammability exposure."	Suggest revise to read "In an equilibrium fuel tank the ullage is flammable when the fuel temperature is the range between LFL and UFL. Monte Carlo analysis ***assumes*** instantaneous equilibrium conditions... "Also, the Monte Carlo Model ***assumes*** that fuel being loaded is at outside ambient temperature. These assumptions, not always true, simplify the analysis. ´	This change is primarily editorial and we did not make the specific changes requested. Another Commenter suggested this fuel temperature paragraph should have been located under the Monte Carlo analysis and section ten of the AC. We agreed that this paragraph should have been located in the Monte Carlo analysis section and was moved to paragraph 10 (a)2(b) in the final AC.
9.b(5) <u>Fuel tank Ullage Sweeping</u>	**Commenter**: Alankar Gupta This method would not result in a non-flammable fuel tank if one evaluates the tank based on the Flammable definition of paragraph 5. e of the draft AC that states; For this AC, a fuel tank vapor space is considered flammable when the bulk average fuel temperature within the tank	Ullage sweeping may not reduce the bulk average fuel temperature within the tank	We agree with the Commenter and revised this paragraph in the final AC based on this comment.

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	is within the flammable range for the fuel type being used.		
9.b(6) Controlling Oxygen Concentration.	**Commenter**: Alankar Gupta The sentence "Therefore, the applicant may establish …….fuel tank" needs further clarification/ explanation. Does it imply that an applicant can propose a fuel tank inerting system with sea-level oxygen concentration greater than 12% based on the structural integrity of the fuel tank?	No specific change provided.	No specific change was requested, and we made no change to the AC based on this comment. We should note that the 12% sea-level oxygen concentration is provided in the definition of inert that is located in Appendix N to part 25. It is therefore part of the regulation. As with any regulation, an applicant may choose to request an equivalent level of safety to the regulation.
5.k. *Fuel Air Ratio (FAR)*	**Commenter**: Airbus The intent of the NPRM is not to impose the use of "inerting" systems but to minimize fuel tank flammability for which oxygen depletion can be one means of achieving this. Therefore the FAA should provide standard Fuel Air Ratios valid for incremental reductions in oxygen concentration down to 12%.	The FAA provides the following definition: " *k. Fuel Air Ratio (FAR) is the ratio of the weight of fuel vapor to the weight of air in the ullage. Specific FAR values are only applicable to conditions where the air is nominally 20.9 percent oxygen.* /I	While reviewing this comment, we determined that fuel-air ratio (FAR) is not used in the text of the advisory circular. Therefore, we deleted FAR from the list of definitions in the final AC.
11.i	**Commenter**: Airbus The FAA states: *"i. Open Vent Systems and Descent. Airplanes with open vent systems will draw in air during descent. The FAA recognizes that the air* drawn *into the tank displaces the nitrogen providing the inert atmosphere and also dilutes the fuel vapor as well. For that reason, the FAA has determined that the Monte Carlo analysis need not include any time determined to be flammable by fuel*	The FAA suggests that it is not necessary to consider periods in decent when the tank could be flammable within the overall flammability assessment. Airbus agrees that in many cases fuel tanks will not be flammable during decent due to a mixture of reasons, (e.g. oxygen con-centration, temperature etc). However to specifically exclude periods when the	We agree with the Commenter that the AC should not provide guidance to exclude periods during descent from using the Monte Carlo model to determine fuel tank flammability. Neither the Monte Carlo model described in the User's Manual nor the final rule provide for the exclusion described in this paragraph of the draft AC. Therefore, this

AC Section	Comment	Requested Change	Disposition
	temperature analysis during descent as flammable time in the fleet wide flammability exposure results of the Monte Carlo analysis. Once the airplane has landed the analysis should assume the tank is flammable ({the bulk fuel temperature is within the flammable region, and the oxygen concentration in any compartment of the tank is above the inert level.	tank is flammable in decent from the overall flammability assessment is not rational and is not consistent with the safety objective.	paragraph has been deleted from the final AC.
TABLE 2. Summary of flammability limits for the Specific tank types	**Commenter**: Airbus There is an error in column two with respect to the applicable regulations and Fleet Flammability Exposure	➢ Pending Cert Projects: Pre-amendment 25-102 applied before June 6, 2001 are applicable to 25.1817(d)(1) but the Fleet Flammability Exposure should be <7% etc ➢ Pending Cert Projects: Amendment 25-102 applied on or after June 6, 2001 are applicable to 25.1817(d)(2) but the Fleet Flammability Exposure should be <3% etc	The table has been revised in the final AC to be consistent with the final rule.
5.a *Auxiliary Fuel Tank*	**Commenter**: Airbus The FAA provides the case and following definitions for fuel tanks: *"a. Auxiliary Fuel Tank. as defined in § 25.1803, is "a normally emptied fuel tank that has been installed pursuant to a supplemental type certificate (STC) or field approval to make additional fuel available." These fuel tanks are installed to make additional fuel available for increasing the flight range of that airplane.*	These numerous terms cause confusion as to what fuel tanks are concerned. What is apparent from the rule is that the important criteria with respect to Pre amendment 25-102 applied for before 6th June 2001 fuel tanks is the following: "§ 25.1815...(c) (1) ... *(i)Fuel tanks that are designed to be Normally Emptied must meet the flammability exposure criteria of Appendix K of this part if any portion of the tank is located within the fuselage*	We partially agree with the Commenter. The definition of Auxiliary Fuel Tank has been revised to be consistent with final rule and the previous issue of this AC, AC 25.981 – 2. The definition of Main Fuel Tank has also been revised to be consistent with the final rule. In addition, the definition of Normally Emptied from the final rule has been added to the AC.

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	The term "auxiliary" means that the tank is secondary to the airplane's main fuel tanks. The reference to "auxiliary tank" in this AC primarily refers to auxiliary body tanks typically located within the pressurized cabin. *b. Main Fuel Tank means a fuel tank that feeds fuel directly into one or more engines and holds required fuel reserves continually throughout each flight. The functions of the main tanks are immediately available and operate without immediate supervision by the flightcrew in the event of failure or inadvertent depletion of fuel in an auxiliary tank. Generally, main tanks are those dedicated to the feed of the engines during engine feed isolation.* " However in other parts of the AC and NPRM other terms: "§ 25.981...(3) *(iii) Main Fuel Tank means a fuel tank that feeds fuel directly into one or more engines and holds required fuel reserves continually throughout each flight.* "(NPRM page 70949) "§ *25.1803 Definitions.* *(a) Auxiliary Fuel Tank is a Normally Emptied fuel tank that has been installed pursuant to a supplemental type certificate or field approval to make additional fuel available...* *(d) Normally Emptied means a fuel*	*contour* *(ii) For all other fuel tanks, the FRM must meet all of the requirements o/Appendix K of this part, except, instead of complying with paragraph K25.1, the Fleet Average Flammability Exposure level must not exceed 7 percent.* " However, for post amendment 25-102 fuel tanks applied for after 6th June 2001, there is no differentiation. Therefore the important definitions that should be in the AC are: "§ 25.981...(3) *(iii) Main Fuel Tank means a fuel tank that feeds fuel directly into one or more engines and holds required fuel reserves continually throughout each flight.* "(NPRM page 70949) "§ *25.1803 Definitions.* *(d) Normally Emptied means a fuel tank other than a Main Fuel Tank as defined in* 14 *CFR* 25.981 *(b).* "(NPRM page70950) With respect to Auxiliary Fuel Tanks the FAA use of the term is primarily with respect to the notion of whether the fuel tank is part of the original Type Certificate (TC) or a Supplemental Type Certificate (STC) due to differences in the compliance schedules. Therefore the fact that the tank is an auxiliary tank, body tank or	

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	tank other than a Main Fuel Tank as defined in 14 *CFR* 25.981 *(b).* " (NPRM page 70950) Table 2 of the AC (page14) includes the terms *"Wing* & *Tail Tanks"* & *"Fuselage Tanks Normally Emptied"*	even main tank is not the primary concern. (e.g. body tanks can be part of the basic aircraft TC and not an STC). It is the understanding of Airbus that the term auxiliary fuel tank means: "Auxiliary Fuel Tank is a *Normally Emptied* fuel tank that has been installed pursuant to a supplemental type certificate or field approval to make additional fuel available". Further to these definitions that describe either function or certification process the location of the fuel tank and proximity to significant heat sources are the more critical points to consider with respect to fuel tank safety requirements. Therefore Airbus considers that instead of considering the location of the fuel tank in relation to the fuselage the FAA should also consider the proximity to significant heat sources. **Therefore Airbus propose that the three highlighted definitions above for Main Fuel Tanks, Normally Emptied Fuel Tanks and Auxiliary Fuel Tanks are inserted in place of the original definitions and used throughout the AC**	

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		(and NPRM) along with the description of the location and proximity to significant heat sources to avoid any misunderstanding. (E.g. remove terms wing and tail tanks, which could have sections within the fuselage and or be adjacent to significant heat sources, from table two of the AC).	
5.e <u>Flammable</u>	**Commenter**: Gupta e. <u>Flammable</u> ……A non flammable ullage is one where the fuel-air vapor is too lean to burn or is inert as defined below. ***For this AC, a fuel tank vapor is considered flammable when the bulk fuel temperature within the fuel tank is within the flammable range for the fuel type being used.*** For any fuel tank that is subdivided into sections by baffle or compartments, the tank is considered flammable when the bulk average temperature within any section of the tank is within the flammable range for the fuel type being used. <u>Comment</u>: A non-flammable ullage is one where fuel-air vapor is too lean to burn. The fuel air ratio of the ullage depends on the temperature of the ullage and saturation vapor pressure of liquid in contact with the ullage. That is the	I recommend that the definition be revised to read as follows: e. <u>Flammable</u> ……A non flammable ullage is one where the fuel-air vapor is too lean to burn or is inert as defined below. ***For this AC,*** ***(1) During equilibrium conditions the fuel tank vapor is considered flammable when the bulk fuel temperature within the fuel tank is within the flammable range for the fuel type being used.*** ***(2) During non-equilibrium conditions the fuel tank vapor is considered flammable when the ullage temperature is within the flammable range for the fuel type being used, i.e., the fuel-air ratio is within the flammable range for the fuel type being used.*** For any fuel tank that is subdivided into sections by baffle or compartments, the above applies to each compartment.	The definition of flammable in the AC reflects the way Monte Carlo determines flammability. The Monte Carlo model uses the fuel temperature at the calculation interval to determine when a fuel tank is flammable. Therefore the specific requested changes were not incorporated.

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	temperature of the liquid fuel in contact with the ullage. The second statement (***in bold italics***) is correct for steady state (equilibrium) condition but not during transient conditions. To illustrate my point I submit the following. Imagine a flammability reduction system that employs ullage and fuel cooling to reduce fuel tank flammability. The system withdraws ullage mixture from the fuel tank and chills it to a low temperature. Some of the fuel vapors condense out of the ullage mixture during the chilling process. It returns the chilled ullage mixture (of reduced fuel-air ratio) and condensed fuel to the fuel tank. The returned chilled ullage mixture cools the ullage in the fuel-tank which in turn cools liquid fuel in contact with the ullage. A temperature gradient develops within the liquid fuel depth. Liquid fuel in contact with the ullage is at low temperature and the fuel removed from the ullage is at higher temperature. Figure 1 shows graphically the average ullage temperature, temperature of liquid fuel in contact with the cold ullage and the bulk fuel temperature for the system operating at sea-level. The ullage cools faster than the liquid fuel due to its low		

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	heat capacitance. The temperatures of fuel in contact with the ullage and the bulk fuel lag behind the ullage temperatures as the ullage mixture cools the fuel. . According to the bold italic statement the ullage is flammable till the bulk fuel temperature falls below LFL temperature, time t. In reality, the fuel-air ratio of the ullage is lower than the LFL ratio after time t1 and the fuel tank is non-flammable. It remains non-flammable for all conditions when the liquid fuel in contact with the ullage is lower than the LFL temperature. In example above, the fuel remains ***capable*** of generating flammable fuel-air ratio if system operation is terminated before the bulk fuel temperature drops below LFL temperature as then the liquid fuel in contact with the ullage would exceed LFL temperature due to heat flow from the bulk fuel. But, the ullage is non-flammable after time t1, significantly prior to time t.		

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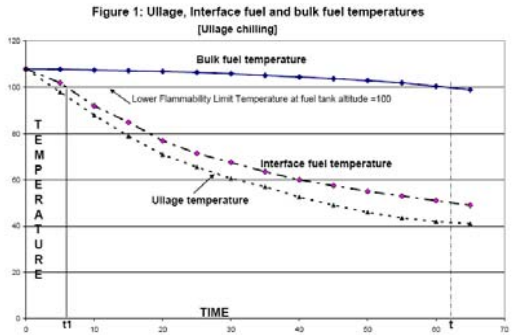
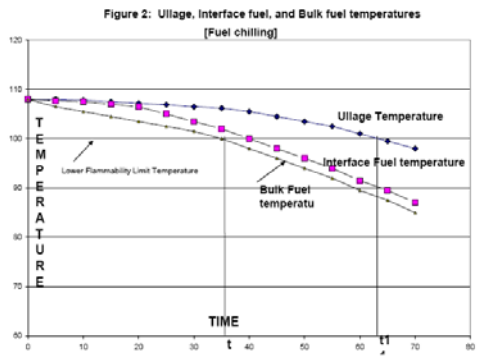
	 Imagine an alternate flammability reduction system that employs fuel and ullage cooling to reduce fuel tank flammability. This system consists of a chiller. In this system liquid fuel is withdrawn from the fuel tank, chilled and returned back to the fuel tank. The cold fuel in turn removes heat from the ullage. The ullage temperature lags fuel temperature as liquid fuel cools the ullage. Figure 2 shows the average ullage temperature, temperature of liquid fuel in contact with the ullage, and the bulk fuel temperature. According to the bold italic statement the ullage is flammable till the bulk fuel temperature falls below LFL temperature, time t. In reality the fuel-air ratio of the ullage remains higher than the LFL ratio until time t1. The fuel tank is flammable even though the fuel is ***not capable*** of generating flammable fuel-air		

AC Section	Comment	Requested Change	Disposition
	ratio after time t.  **TEMPERATURETIME** In summary, the bold italic statement results in erroneous results for a flammability reduction system based on the concept of fuel tank cooling. I presented two cases. The situation is the same if both the ullage and fuel are simultaneously cooled. Reason – Heat capacitance of fuel is significantly greater than that of the ullage. Also, I conclude that with the bold italic statement unnecessarily make the cooling system extremely large. A flammability reduction system, based on the concept of fuel tank cooling, recommended by the working Group (FAA -2005-22997, Section II.D) impractical. Note, LFL temperature decreases at 1 degree Fahrenheit per 808 feet. This would necessitate that the system be designed to		

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	cool fuel during climb (maximum climb rate) when the fuel mass loading is maximum allowable. Anything less than that would cause the fuel tank to be declared flammable.		
5.e Flammable	**Commenter**: Gupta In addition I suggest that the AC must make it clear that liquid fuel is not flammable at or above Lower Flammability Limit temperatures. It is the ullage that is flammable. Fuel at temperatures within the flammable range temperatures has the capability to generate fuel vapors in quantities necessary for flammable fuel-air ratio.	No specific change request.	We agree that it is the fuel vapors mixed with oxygen from air that creates a flammable ullage. We believe this is adequately discussed in section 9 of the AC and the definition of flammable was not revised.
5.g Flammability Exposure Evaluation Time (FEET)	**Commenter**: Gupta It is not evident why the pre-flight time is a function of flight time? And why the post flight time is a constant 30 minutes? Ignition sources result from on board electric power and or heat sources. FEET must start from the time electric power is supplied to the airplane (from on-board or ground source) to the time the power is removed.	No specific change request.	The Commenter didn't provide a specific request to change the AC and the definition of Flammability Exposure Evaluation Time (FEET) in the AC is consistent with the final rule. Therefore no change was made to the definition of FEET in the final AC.
5.h	**Commenter**: Gupta	The flammability envelope for the fuel, **during equilibrium conditions**, for the	The Commenter is correct that Monte Carlo model assumes equilibrium

AC Section	Comment	Requested Change	Disposition
Flammability envelope	The definition is accurate for equilibrium conditions. I suggest this be identified.	fuel is defined by the UFL and LFL as follows:	conditions. However, the definition of the flammability envelope was taken from and is consistent with the final rule. Therefore this change was not incorporated in the final AC.
5.j Flash point	**Commenter**: Gupta The statement is a combination of definition and test method.	Suggest that it be revised as follows for clarity. Flash point of a flammable fluid is the lowest temperature at which the vapor of the fluid, in equilibrium with the fluid temperature, momentarily ignites or flashes when exposed to a flame. Flash point is determined by ASTM D56 method, using a sample of the fluid, slowly heated in a closed system to maintain liquid fuel and ullage in equilibrium with each other and exposing it to a small open flame.	We agree with the Commenter that the definition of flash point in the draft AC included information on flash point test method. We revised that portion of the definition in the final AC to state "The flash point of the fuel is determined using the standard test method (s) permitted by the fuel specification."
5.l Fuel Types	**Commenter**: Gupta I believe ASTM Specification D1655-99 has been withdrawn and replaced. The latest specification is D1655-05.	Replacing the fuel specification number called out in definition with the current fuel specification number.	We agree with the Commenter and revised the reference to fuel specification members to read as follows: "The most widely used fuel types are JET-A or JET-A1, per ASTM International Specification D1655, "Standard Specification for Aviation Turbine Fuels." Older airplanes have been approved for use of JET-B (JP-4)), per ASTM Specification D6615, "Specification for Jet B Wide-Cut Aviation Turbine Fuel."

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5.n Ignition Energy	**Commenter**: Gupta LFL and UFL depend on ignition energy, see DOT/FAA/AR-TN02/79, Limiting Oxygen Concentration Required to Inert Jet Fuel Vapors Existing at Reduced Fuel tank Pressures, Figure 2	Suggest the ignition energy accepted by the FAA as potential hazard be identified.	In reviewing this comment, we determined ignition energy was not used in the AC, except for the definition of the ignition energy. Ignition energy is discussed in AC 25.981 – 1B, "Fuel Tank Ignition Source Prevention Guidelines." Therefore, we deleted the definition of ignition energy from the final AC.
5.o Inert	**Commenter**: Gupta Suggest identifying that the stated oxygen concentrations are independent of the noncombustible gas (nitrogen, carbon dioxide, helium) used to inert the ullage of the fuel tank.	No specific wording change provide.	The Commenter raises an issue that was not addressed in the draft AC. However, data were not provided to substantiate the oxygen concentrations used in the draft AC for inerting with nitrogen are valid for use when other inert gases are used, including carbon dioxide or helium. Therefore, we added a statement to to Section 9 (b) 6, Controlling Oxygen Concentration, of the final AC that designs that control oxygen using other inert gases would need to substantiate the required oxygen concentration (referring to the 12% value for nitrogen).
5.q Lean Fuel Vapor/Air Mixture	**Commenter**: Gupta	Add: During equilibrium conditions this condition occurs when the bulk average fuel temperature is less than LFL temperature for the fuel being used. During non-equilibrium conditions, e.g., active fuel tank cooling (ullage mixture, fuel or ullage and fuel) this condition	Certain research data does indicate ullage temperature can influence the fuel tank flammability, as stated in the commenters recommended change. However, the Monte Carlo method, developed initially by the Aviation Rulemaking Advisory Committee, uses fuel temperature to determine fuel tank flammability

AC Section	Comment	Requested Change	Disposition
		occurs when the bulk average ullage temperature is lower than the LFL temperature. Cold ullage mixture over warm liquid fuel, fuel temperature greater than LFL temperature, can have lean fuel vapor/air mixture. Also, warm ullage, ullage temperature greater than LFL temperature, over cold fuel can be flammable.	exposure. The Monte Carlo model in the proposed rule and the final rule uses fuel temperature to determine fuel tank flammability exposure. The flammability exposure requirements in the proposed rule and the final rule are based on comparisons of the flammability exposure of higher risk fuel tanks to the flammability exposure of conventional unheated aluminum wing tanks. Therefore the requested changes were not incorporated in the final AC.
App. 1	**Commenter**: Airbus Airbus considers that in addition to this appendix the full contents of appendix L of the NPRM (noting the Airbus comments provided in section 3) should also be appended to this AC		The response to similar comments made to the NPRM are discussed in the preamble to the final rule. The proposed Appendix L to Part 25 was created as Appendix N to Part 25 by the final rule. Therefore, this change was not incorporated into the final AC.
App. 1	**Commenter**: Gupta Appendix 1, paragraph 4. <u>Example of a Flight test</u> Using the value of Tau, the tank temperatures can be estimated using the exponential decay equation, Temperature change in time t / Fuel Temp – TAT = $1- e^{(-T/Tau)}$	I believe the AC refers to Fuel temperature change in time t when it refers to Temperature change in time t	We agree with the Commenter and revised the final AC according.

AC Section	Comment	Requested Change	Disposition
	The above relation can be written as Temperature change in time t = [Fuel Temp – TAT] x [1- $e^{(-t/Tau)}$] (1)		
App. 1	**Commenter**: Gupta Gupta, pg 39, Appendix 1, Example-Wing Fuel Tank Flight Test Results **Between time =0 and 10 minutes** Fuel temperature change in 10 minutes = 0.0 Fuel Temp – TAT = 0.0 t = 10.0 Substituting in (1) 0 = 0.0 x [1- $e^{(-10/Tau)}$] In my opinion Tau is indeterminate if my understanding of the relation in the AC is right. **Between time = 70 and 80 minutes** Fuel temperature change in 10 minutes = 2.1 Fuel Temp – TAT = Average of (44.6 and 21.2) = 32.9 t = 10.0 Substituting in (1) 2.1 = 32.9 x [1- $e^{(-10/Tau)}$] 2.1/3.9 = 0.06383 = [1- $e^{(-10/Tau)}$] $e^{(-10/Tau)}$ = 1-0.06383 = 0.93617	I request and suggest that the Advisory Circular provide a sample calculation for both an unheated and heated fuel tank. It should identify the time or temperature drop and other parameters (e.g., mean fuel temp-TA) that must be considered in evaluating Tau. Also, a sample calculation for an “actively” cooled fuel tank (cooling by chilling of ullage gases or by chilling of liquid fuel) would greatly help. Note, the above two cooling processes will result in different fuel temperatures transients for the same heat removal rate.	Appendix 1 provides guidance for developing and validating a thermal model for use in the Monte Carlo model. This guidance should be appropriate for most, if not all, of fuel tank designs. As stated in Section 4 of the Appendix, the sample flight test shown is an illustration of how to demonstrate that the bulk average fuel temperature modeling used in the Monte Carlo Model, based upon use of Time Constant Tau, is acceptable for the particular tank under evaluation. The values used in the table are not intended to represent any actual fuel tank. We reviewed the values in the table and determined the Tau values are calculated correctly. As for the comment that "Tau is indeterminate" we do not see how it could be indeterminate. Tau is used to calculate the delta fuel temp. Tau for each time step is determined completely independently from fuel temperature and is really a function of the user inputs.

AC Section	Comment	Requested Change	Disposition
	Tau -10/Tau Value 100 -0.1 0.904837 120 -0.08333 0.920044 140 -0.07143 0.931063 160 -0.0625 0.939413 180 -0.05556 0.945959 Tau = 150 approximately agrees with the value quoted in AC		
App. 1 Example-Wing Fuel Tank Flight Test Results	**Commenter**: Gupta The draft AC does not identify the fuel in the subject wing tank. If one assumes that tank contains Jet A fuel, Flash point = 100^{0} F, then according to the data the fuel tank is flammable starting at time = 70 minutes and that it remains flammable till time = 145 approximately, see tabulated data below. That is the fuel tank is flammable for 75 minutes of the total 490 mission time (including preflight and post flight) Flammable time/ Total mission time = 75/490 = 15.31% The flammability exposure time would be substantially greater for missions (on an 80^{0} F day) that are shorter than 490	Does this wing tank comply with the proposed Fuel tank flammability requirements? Is this data typical of wing tanks? Please reformat the Table. The last column can neither be viewed nor printed. Time Altitude Tank temperature LFL (temperature) * Comment 0 0 80 90 Non-flammable 60 0 80 90 Non-flammable 70 8750 79.5 79.2 Flammable 80 17500 77.4 68.3 Flammable 90 26250 73.9 57.5	As stated previously, Appendix 1 provides guidance for developing and validating a thermal model for use in the Monte Carlo model. The values used in the table are not intended to represent any actual fuel tank.

AC Section	Comment	Requested Change	Disposition
	minutes. Also, the flammability exposure time would be substantially greater on hot day, e.g., greater than 90^0 F	Flammable 100 35000 69.2 46.7 Flammable 110 35000 63.8 46.7 Flammable 120 35000 58.8 46.7 Flammable 130 35000 53.9 46.7 Flammable 140 35000 49.4 46.7 Flammable 150 35000 45.1 46.7 Non flammable • Assumption Jet A fuel, FP = 100^0 F, Sea-level LFL = 90^0 F • $T_{(LFL)} = T_{(LFL)SL}$ – altitude/808	

AC Section	Comment	Requested Change	Disposition
Appendix 2	**Commenter**: GUPTA Appendix 2 has important information. However, vital information is missing. Is Oxygen concentration measurement in fuel tank(s) required for the certification of a fuel tank inerting system? In particular, in a system that uses on-board inert gas generation using Hollow Fiber Membrane inert gas generator. FAA flight tests on A320 have confirmed that such systems deteriorate in performance rapidly. If the measurement is not required then what would the FAA Administrator accept as a Means of Compliance for 14CFR 25.1301(d) that states: Function properly when installed	No specific change requested.	Section 10.b.(2) of the AC states that when inerting is used "the applicant should present a description of the system including its control logic, and data to substantiate its performance at lowering the ullage oxygen content to below the inert level defined in appendix N to this part to comply with the applicable average flammability level." Oxygen concentration measurement in fuel tank(s) would be required <u>during</u> the certification of a fuel tank inerting system. However, this does <u>not</u> imply that a design should include oxygen concentration measurement in any fuel tank during in-service operation, as no such technology exists at this time.
App. 4	**Commenter**: Airbus SECTION 1.C. COMPLIANCE TIMES As stated in the comments to the NPRM, the specific compliance dates for Airbus aircraft cannot be achieved as, contrary to the FAA assumption, Airbus is not already engaged in developing FRS for any of its models. Further to the above the FAA has not allocated any time for FAA deliberation of compliance plans. Specific slots that take into consideration time of FAA	Airbus requires the same timescales as other OEM in the same position and as identified within section one of this Appendix..	We partially agree with this commenter. The final rule does not include model specific compliance times. The AC has been revised to be consistent with the final rule. Discussion of the disposition of the comments to the NPRM is located in the preamble to the final rule.

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	deliberation must be included within the Compliance Planning Time Lines		
App. 4	**Commenter**: Airbus SECTION 1.F. COMPLIANCE PLANNING Reiterating the statement above the FAA has not allocated any time for FAA deliberation of compliance plans	Specific slots for FAA deliberation must be included within the Compliance Planning Time Lines	The AC has been revised to be consistent with the final rule. Discussion of the disposition of the comments to the NPRM is located in the preamble to the final rule.
App. 4	**Commenter**: Airbus SECTION 2. A.(2) APPLICANTS FOR STC OR TC AMENDMENTS This paragraph states: *"(b) Changes that increase capacity may include activation of dry sections of the airplane that were not originally certificated to contain fuel. For example, the center wing box structure on some versions of certain airplane models did not originally carry fuel but later models of the airplane included fuel in these areas. In addition to the differences in airplane configuration discussed in* § 25. *1815(b), examples of other changes that may increase fuel tank flammability exposure include installation of hydraulic or electronics system heat exchangers in a fuel tank, installation of heater blankets on the wing, modification of the fuel management that results in changes in*	This proposal, to apply § 25.981 as defined in this NPRM on new fuel tanks, (e.g. utilizing a previously dry centre wing box or horizontal tail plane as has been done for existing TCs) could be considered a reasonable and justifiable approach (notwithstanding the Airbus comments on appendix K). However, it is not reasonable to require that minor modifications that could increase the useable fuel volumes of existing fuel tanks. It would be reasonable to require a demonstration that the flammability of the fuel tank is not adversely affected by such an increase, (e.g. it adds no significant heat sources (e.g. hydraulic heat exchanger) or significantly reduces any cooling). But to potentially require the application of full flammability reduction measures (down to 3%) as a result of a simple computer software change or relocation of a level sensor, that results in small increase in capacity, is not justified.	The AC has been revised to be consistent with the final rule. Discussion of the disposition of the comments to the NPRM is located in the preamble to the final rule.

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	fuel tank flammability, installation of a fuel re-circulation system that transfers heat from the engine to the fuel tank, or changes to the flight manual to use lower flash point fuels such as JP-4 or Russian or Chinese fuels. " In the NPRM the FAA state: *"...Any design change to a TC subject to the requirements proposed in today's document that adds an auxiliary fuel tank, increases fuel tank capacity, or increases the flammability exposure of the existing fuel tank would have to meet the requirements of§* 25.981 *proposed today. This requirement is intended to apply primarily to future design changes, but it may also apply to design change projects that are pending when this rule* is *issued..."*	Airbus propose that the FAA should restrict the application of any proposed change to section § 25.981 to new Type Certificates and significant design changes, i.e. new fuel tanks. Minor design changes should be required only to show no degradation in the flammability under the criteria proposed by 25.1815.	
App. 5	**Commenter**: Airbus The FAA identify Airbus Industries, this the old name of the company now known as Airbus.	The word Industries has been dropped from the name and the appendix should be amended accord ingly.	We agree with the Commenter and incorporated the requested change.
App. 5	**Commenter**: Airbus Airbus has requested exemption from the proposed rule for certain aircraft models	If granted the relevant aircraft should be removed from the table	This appendix to the AC is consistent with the final rule. Exemptions to the final rule can be requested (and granted by the FAA), per part 11, if it can be shown that doing so is in the public

AC Section	Comment	Requested Change	Disposition
			interest.
For the App.6 Requirements for Airplane Operators	**Commenter**:		Appendix 6 of the draft AC has been deleted from the final AC. Guidance for Airplane Operators is now contained in AC 120.YY, Fuel Tank Flammability.
10.a.(4)	**Commenter**: Airbus There is an error with the paragraph numbering and titles of paragraphs in this section		We reviewed the section and corrected the error.
10.a.(4)(b)	**Commenter**: Airbus Airbus supports the FAA objective of having a common tool that would accurately establish the flammability characteristics of a given fuel tank and allow a direct comparison with other fuel tanks. However; the present FAA methodology for assessing flammability has limitations that mean that results could be arbitrary. Airbus has identified that the database for the distribution of flight ranges mandated in the 'Assessment Method Users Manual' is biased strongly towards shorter flights. A study of the OAG database, (an Industry tool used by airlines and based on actual aircraft movements), contrary to the FAA database, shows that different	Airbus proposes that specific flight range distributions for each aircraft type be used and that these distributions be based on actual aircraft usage. Airbus consider that the OAG or similar database be used as an industry standard. Obviously such a database cannot be used for new TC applications and therefore an appropriate distribution needs to be agreed by the FAA during the Certification Definition Process.	In response to a related comment to the NPRM, a new paragraph M25.3(c)(7), “Airplane Utilization,” was added to Appendix M to part 25. We believe this new paragraph in the appendix addresses this comment. We added a new paragraph 10.a.(4)(b)(7) to the final AC titled “Airplane Utilization.” to include the new paragraph from the rule in the AC.

AC Section	Comment	Requested Change	Disposition
	aircraft types have significantly different flight range distribution patterns. Without representative flight range distribution patterns it is not possible to perform a valid assessment of the fuel tank flammability and any results derived from generic data would be arbitrary (and could under estimate exposure).		
10.a.(4)(a).5 Airplane Climb & Descent Profiles	**Commenter**: Airbus The applicant must use the climb and descent profiles defined in the Users Manual or calculated values as defined in the Users Manual), Airlines will fly their aircraft in accordance with the capabilities of the aircraft. In some instances we have established that the profiles defined by the FAA are outside of the operational envelope of our aircraft and performance data could not be obtained to determine fuel consumption. Airlines normally operate the aircraft as high and as fast as soon as possible for economic reasons. The resulting flight profiles therefore do not match with those mandated in the 'Assessment Method Users Manual'. Without representative flight climb and descent profiles it is not possible to perform a valid assessment of the fuel tank flammability and any results derived	Airbus proposes that manufacturers be permitted to use profiles that are specific to their aircraft types as defined in the Aircraft Flight Manual (AFM).	The final rule requires that Airplane Climb and Descent Profiles used in the Monte Carlo analysis be those defined in the User's Manual. Therefore, this change was not incorporated in the final AC.

AC Section	Comment	Requested Change	Disposition
	from generic data would be arbitrary, (and could under estimate exposure).		
10.a.(4)(a).6 Fuel Tank Thermal Character istics	**Commenter**: Airbus Airbus analysis shows that in order to have comparable results for fuel tanks that are adjacent to Environmental Conditioning Systems (ECS), (that transfer significant heat energy in to the fuel tank), e.g. HCWT it is necessary for the FAA to define the operating conditions of the ECS (e.g. mean, most severe). Without clear guidance, different assumptions could be taken for different aircraft and thus comparative results will not be obtained.	Define the operating conditions of the ECS (e.g. mean, most severe).	We agree with the Commenter and added the following sentences at the end of paragraph 10.a.(4)(a).6, Fuel Tank Thermal Characteristics: "The thermal input data should reflect the most severe airplane operating conditions or configuration. For example, for fuel tanks located near heat sources such as the airplane environmental conditioning system (ECS), also called air conditioning packs (packs), the maximum allowable number of packs should be running during test and modeling conditions."
10.b. Fuel Tank FRM Model -	**Commenter**: Gupta I fail to understand how one can use the Monte Carlo method to demonstrate flammability reduction when it is based on two assumptions that are invalid or technically wrong. 1. A fuel tank vapor space is considered flammable when the bulk average fuel temperature within the tank is within the flammable range for the fuel type being used. 2. Monte Carlo analysis assumes instantaneous equilibrium conditions.	I suggest the AC include some guidance on using Monte Carlo Method on those types of systems	As stated in the response to previous comments, certain research data does indicate ullage temperature can influence the fuel tank flammability, as stated in the commenters recommended change. However the Monte Carlo method, developed initially by the Aviation Rulemaking Advisory Committee, uses fuel temperature to determine fuel tank flammability exposure. The Monte Carlo model in the proposed rule and the final rule uses fuel temperature to determine fuel tank flammability exposure. The flammability exposure requirements in the

AC Section	Comment	Requested Change	Disposition
	With above technically wrong assumptions (a) Fuel tank ullage sweeping system will not be able to reduce the flammability of the fuel tank unless the fuel is simultaneously cooled such that fuel temperature is maintained below LFL during all operating conditions. (b) Fuel tank cooling by chilling ullage and maintaining it chilled below LFL temperature to reduce its fuel air ratio is significantly below the flammable fuel-air ratio will not be able to demonstrate flammability reduction. (c) Fuel tank cooling by chilling fuel and maintaining fuel below LFL temperatures will only be able to demonstrate flammability reduction if the system is designed to cool the fuel (high fuel mass loading) at the rate of 10F per 808 ft climb at airplane maximum climb rate.		proposed rule and the final rule are based on comparisons of the flammability exposure of higher risk fuel tanks to the flammability exposure of conventional unheated aluminum wing tanks. Therefore the requested changes were not incorporated in the final AC.
Table 2	**Commenter**: Transport Canada The requirements for pending certification projects, pre and post amendment 25 – 102 appear to have been inverted	For applications made after June, 2001 (i.e. post amendment 102), the new 25.981 rule is supposed to apply.	We agree with the Commenter and corrected the error in the final AC.
11.m.3	**Commenter**: Transport Canada With respect to the consideration of	No more specific text changes recommended.	Section 25.1309 does not always require an alert when a sensor is reliable and

AC Section	Comment	Requested Change	Disposition
	dormant failures, consistent with the AC 25.1309, if there exists reliable and practical technology regarding oxygen sensor units should be installed. Cockpit indications such as oxygen concentration levels in the fuel tanks would be recommended as an appropriate means to verify the FRM is performing its function		practical. An alert is required if the failure results in a "unsafe" operating condition. The determination if section 25.1309 would require such an indication would be based on the criticality of the FRM installation on a particular airplane. The fuel tank flammability reduction final rule created new flammability reduction requirements that, combined with the existing ignition-prevention requirements, creates a balanced approach to fuel tank safety. A design that meets both the flammability reduction requirements and ignition-prevention requirements would not result in an unsafe operating condition when an FRM failure or malfunction resulted in a flammable fuel tank. Therefore, we did not revise the final AC. in response to this comment.
Appendix 3, 2.b	**Commenter**: Transport Canada The definition provided for ALI (airworthiness limitation) is specific to SFAR 88 (rather than generally applicable to fuel tank safety, or flammability).	Revise definition.	We agree with the Commenter and we revised the definition of ALI in the final AC.
General	**Commenter**: Transport Canada To promote the enterprise approach is for MMEL (Master Minimum Equipment List) for the FRM you would be appropriate for this document to discuss	For example, it may be appropriate to impose limitations/restrictions on aircraft normally operating in warm environmental conditions.	FAA policy is for the Flight Operations Evaluation Board (FOEB) to establish the required limitations or restrictions with regards to operating with equipment inoperative when allowed by the MMEL.

AC Section	Comment	Requested Change	Disposition
	operating limitations/restrictions with regards to the MMEL.		Therefore this comment was not incorporated in the final AC.
General	**Commenter**: Air Line Pilots Association, International ALPA supports the intent for and language of the draft advisory circular.	None.	None.