DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
Commenter: Airbus A-1		
General Comment: Airbus welcomes the FAAs recognition that the content of 25.981(a)(3) can be improved in light of developments in tank flammability reduction systems and also the shift in focus from preventing ignition sources (sparks) to the wider issue of preventing fuel vapor ignition (explosion), and taking into account all of the contributing factors.	None	No change requested or made.
Commenter: Airbus A-2		
This policy states that its applicability is limited to fuel tank structure. However, there are other parts of the design which may be identical in concept, but which are normally categorized as being systems installations – e.g. fuel or hydraulic pipe bracketry. It seems incongruous that different parts of the same fuel tank design should be considered under different certification requirements. Airbus believes this policy should be extended to cover also such aspects of in-tank systems installations.	Page 7: Eligibility for Consideration Under This Policy "The relief from § 25.981(a)(3) provided by this policy is intended to be limited to areas of fuel tank structure and systems installations for which compliance with § 25.981(a)(3) is shown by the applicant and determined by the FAA to be impractical. […]" Page 9: Special Conditions "[…] In addition, the FAA considers the requirements in § 25.981(a)(3) to be inappropriate for fuel tank structural and systems installations lightning protection features where application of those requirements is shown to be impractical.	In developing the proposed policy, the FAA determined that relief from the requirement of § 25.981(a)(3) was warranted for areas where it was shown to be impractical to meet that regulation, and where it could be shown that an acceptable level of safety would be provided by meeting a different standard. The FAA agrees that, from an electrical bonding standpoint, there is not a clear line between structural elements and systems elements, and many of the same design challenges exist for both structural bonding and the bonding of systems elements. The extension of the proposed relief to systems elements and systems supporting structure was carefully considered. One of the significant factors that led the FAA to arrive at the proposed scope for the

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
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Comment	Requested Change	Disposition
	[…]" Page 9: Special Conditions "3. The applicant must show that the design, manufacturing, and maintenance programs include all practical measures to prevent failures of ~~structural~~ lightning protection design features due to manufacturing variability, aging, wear, corrosion, and likely damage. […]" Page 10: Exemptions for New Type Certificate Programs "1. In responding to § 11.81(c), petitioners seeking an exemption under this policy should refer to this policy memo as acknowledging that compliance with § 25.981(a)(3) is impractical for some areas of ~~structural~~ lightning protection design. The petitioner should identify the specific design features for which an exemption is sought. The petitioner should show that all practical measures have been taken to meet the requirements of § 25.981(a)(3) for the fuel tank ~~structure~~ design." Page 11: Exemptions for New Type Certificate	alternative standard was the expected level of maintenance (disassembly and reassembly) for these design areas. Disassembly and reassembly of electrical bonding elements is considered to present a significant additional risk that a bond will be compromised during the life of an airplane, which generally does not exist for structure that is intended to be permanent. The FAA therefore has not changed the overall intent of this area of the policy, and has not made the changes proposed by the commenter. However, the FAA does agree that clarification of the degree to which "fuel tank structure" includes systems elements or systems supporting elements is needed, and that fuel pump housings that are intended and expected to remain installed for the life of the airplane should be added to that definition. The section of the memo titled "Eligibility for Consideration Under This Policy" has been revised to clarify the scope of the policy memo. In addition, the FAA notes that applicants subject to § 25.981(a)(3) at Amdt. 25-102 have been able to show compliance for systems elements other than supporting structure, thereby demonstrating that compliance is practical for those elements.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
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	Programs "1. In lieu of compliance with the requirements of § 25.981(a)(3), the applicant must show that the design includes at least two independent, effective, and reliable lightning protection features (or sets of features) such that fault tolerance is provided for each area of the ~~structural~~ design area proposed to be exempt from the requirements of that regulation. […]" 2. The applicant must perform an analysis to show that the design, manufacturing processes, and airworthiness limitations section of the instructions for continued airworthiness include all practical measures to prevent, and detect and correct, failures of ~~structural~~ lightning protection design features due to manufacturing variability, aging, wear, corrosion, and likely damage. Page 11, 12: Use of Exceptions Under § 21.101 for Type Design Change Programs on Pre-Amendment 25-102 Airplanes "For type design changes on pre-Amendment 25-102 airplanes that are classified as "significant product level changes" under § 21.101, the FAA will	

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
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Comment	Requested Change	Disposition
	consider allowing applicants to show compliance with an earlier amendment level of § 25.981(a) for lightning protection of fuel tank ~~structure~~ designs, under the provisions of § 21.101. […] Any exception would be limited to aspects of lightning protection of fuel tank ~~structure~~ design where no material benefit from compliance is shown."	
Commenter: Airbus A-3		
It is unclear from the wording of the policy whether the requirements for the prevention of ignition hazard as a result of lightning attachment – e.g. provision of redundant layers of protection - should be applied to those items which are subject to direct lightning strike attachment, or whether they are required to also be applied to fasteners which can experience lightning conducted currents. Some protection means may be practicable for application to only limited areas of the fuel tank surface (e.g. lightning Zone 1 or Zone 2 areas).		The safety requirements of the proposed special conditions and exemptions are intended to be applied to various design areas based on the relevant threat(s) for each design area (direct attachment and/or conducted current). For example, for areas meeting the Zone 3 definition, compliance with the architecture, probability, and manufacturing quality assurance requirements would be shown only for the threats presented by conducted currents. Acceptance of an assumption that direct attachment will not occur for areas and features meeting the Zone 3 definition will be covered in detail in "means of compliance" issue papers for each certification project. Since the policy memo is not intended to cover that level of detail, no change has been made to the memo.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
Commenter: Airbus A-4		
Page 6: Policy "Therefore, for practicality reasons, the FAA has determined that it is acceptable in this case to treat the required analysis as similar to a multiple failure probabilistic analysis performed under § 25.1309(b). Specifically, when complying with the proposed special conditions and exemptions described below, the FAA considers it acceptable to consider the probability of lightning attachment, the distribution of lightning strike energy, and the probability of fuel tank flammability when performing the required safety analysis." The part in bold red should be clarified.	Clarification of the phrase "the distribution of lighting strike energy.	The FAA agrees with the commenter that a potential for confusion exists with the proposed terminology. The FAA intended that wording to mean that a probabilistic distribution of the energy level associated with a given lightning strike could be used as an element of the required numerical probability analysis. The FAA now agrees that wording could be misunderstood to mean the physical distribution of flow of current through the various parts of structure. The proposed phrase has been replaced by the phrase "the statistical distribution of lightning strike amplitude. "
Commenter: Airbus A-5		
Page 7: Examples of FAA Practicality Determinations For aluminum structures, a practical design feature suggested is "strict control of clearance fits & installation practices". For composite structure, equivalent wording is "strict control of bolt/hole fit and quality". The FAA should clarify if there is a specific reason for this difference in the wording.	Clarify intended meaning or provide reason for difference in terminology	The FAA considers the same set of controlled attributes to be applicable to both metallic and composite structure. The wording has been changed to use identical terminology for both types of structure: "strict control of fastener/hole fit, quality, and installation practices.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
Commenter: Airbus A-6		
Page 7: Examples of FAA Practicality Determinations Airbus understands that manufacturing issues may be encountered with interference fit fasteners into composite and may therefore drive the use of clearance fit fasteners for such material. In that case, "strict control of bolt/hole fit and quality" would be considered by Airbus to be an integral part of normal composite structure assembly quality control – Does the FAA consider that "strict control of bolt/hole fit and quality" constitutes a de facto independent layer of protection against ignition hazards?	Clarify intended meaning	The FAA does not consider quality control measures themselves to be an "independent layer of protection." The listed measures to control manufacturing quality are considered practical. Practical measures to address quality control are an explicit requirement separate from the required safety analysis. In addition, the quality control measures serve as part of the justification for assumptions made about build quality escapes and failure rates of structural elements in the safety analysis. A paragraph was added to that section of the memo to clarify this intent.
Commenter: Airbus A-7		
Page 7: Examples of FAA Practicality Determinations The FAA quotes as an example of a failure mode for which it has been determined that it is impractical to provide fault tolerance the "Failures of sealant where the sealant is the primary feature needed to prevent an ignition source in the event of lightning attachment". It is difficult to understand how a design	The FAA should clarify what are the kinds of installations that are covered by the example (what types of installation would be acceptable with sealant as primary lightning protection)	In this section of the policy memo, the FAA listed design features for which it was determined that providing fault tolerance would be impractical. It is recognized that, for those features, a single failure can cause creation of an ignition source in the event of a critical lightning attachment. This would include any design area where sealant is used as a primary lightning protection feature without fault tolerance. Any such features would need to be assessed in the numerical

Comment	Requested Change	Disposition
with sealant used as the primary ignition source prevention feature can meet basic safety requirements (i.e. no single failure to cause fuel vapor ignition, probability of ignition to be Extremely Improbable)? It would appear to be very difficult to demonstrate the reliability of sealant application and that durability in service will be adequate to meet these requirements. This clause appears inconsistent with the rigorous approach called for throughout the rest of the policy. The FAA should clarify what are the kinds of installations that are covered by the example (what types of installation would be acceptable with sealant as primary lightning protection)		probability analysis required by paragraph 1.b. of the proposed special condition and exemption requirements. It is also likely that non-fault-tolerant design features would require periodic inspections under paragraph 3 of the proposed requirement. After review the FAA believes this section is sufficiently clear, but we agree that the particular example cited by the commenter was a poor example of the general intent of this section because it will be very difficult for an applicant to show compliance with the safety analysis requirement for such a feature. That example has been deleted.
Commenter: Airbus A-8		
Page 9: <u>Special Conditions</u> Under the "Special Conditions" section, the alternative requirements in Section 2c state that a safety analysis must show that, "for each failure mode of each particular type of design feature (such as a particular fastener or joint type), the occurrence of an ignition source due to each failure mode of the feature is extremely remote, assuming all instances of that feature (such as the	FAA to clarify	The particular requirement cited by the comment will not exist in the final policy memo because the special condition requirements have been changed to be similar to the exemption requirements (see the response to comment B-7). No specific standard exists in the final policy for the probability of an ignition source. Instead, for all single failures for which providing fault tolerance is shown to be impractical, the applicant must show that a fuel vapor

Comment	Requested Change	Disposition
particular fastener type) have failed in that mode." The FAA should confirm whether "occurrence of ignition source" is intended to be based on the assumptions that probability of lightning and flammable vapor are both equal to one (as per terminology in 25.981 (a)(3)), or whether it can include these probabilities, as per the terminology "occurrence of fuel vapor ignition" used elsewhere in this policy.		ignition event is extremely improbable. In that analysis, the policy memo states that it is acceptable to include the probability of a lightning strike, a statistical distribution of lightning amplitude, and the probability of flammability.
Commenter: Airbus A-9		
Page 9: <u>Special Conditions</u> In Section 2.c., the FAA states that the analysis is required to assume that <u>all instances</u> of that feature have failed. As a consequence, in the case of a bolted fastener failure, the analysis would be the following: Probability of ignition source < 10^{-7} per flight hour (Requirement of para 2.c. of the policy) Assuming there are 10^4 fasteners of this type installed in the fuel tanks Assuming an A/C life of 10^5 hours, and that the fastener failure mode	Page 9 "[…] the occurrence of an ignition source due to each failure mode of the feature is extremely remote, ~~assuming all instances of that feature (such as the particular fastener type) have failed in that mode~~."	The particular requirement cited by the comment will not exist in the final policy memo because the special condition requirements have been changed to be similar to the exemption requirements (see the response to comment B-7).

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
could be latent for A/C life, means that the base failure rate for the fastener must be calculated as follows: Average failure rate/FH, $A = 10^{-7}$ (Extremely Remote, as per requirement) Average failure exposure time (latency), $l = 10^5 / 2$ Number of fasteners $n = 10^4$ So, the maximum base failure rate for fasteners that meets the requirement is given by: A x 1/n x 1/l $= 10^{-7}$ x $1/10^4$ x $1/(10^5 / 2)$ $= 2 \times 10^{-16}$ /FH		
Commenter: Airbus A-10		
Even with two independent layers of protection for the fasteners, compliance demonstration is not more practicable to achieve than with the original text of 25.981(a)(3). Even if the policy allows probability of lightning attachment to the A/C and		It appears that the commenter has misunderstood the effect of the requirement. If, for example, the average probability of a critical lightning strike is assumed to be 10E-5, and the average probability of flammable conditions is assumed to be 10E-2, then the contribution from the structural elements would need to

Comment	Requested Change	Disposition
presence of flammable vapor to be taken into account, the base failure rate for the fastener would still be required to be of the order of 10^{-11} per flight hour. If Airbus interpretation of this part of the requirement is correct, it effectively rules out the "Special Condition" approach as a practical option for certification for a new type design. The FAA should confirm if Airbus understanding of this aspect of the policy is corrrect.		be 10E-2 or lower to meet the extremely improbable requirement. Assuming for the sake of simplicity that the fasteners are the only issue, the probability of a fastener with a dual fault would need to be 10E-2 or less when the number of fasteners and the relevant latency periods are considered. However, the special condition requirements have been changed as a result of other comments (see the response to comment B-7). Numerical probability analysis is now required only for any areas of the design that are not fault tolerant.
Commenter: Airbus A-11		
Page 9: Special Conditions On the same topic, Airbus understanding of safety analysis techniques is that in this case, if the probability of lightning must be assumed equal to 1, then it is irrelevant to assume all instances of that feature have failed. Assuming a hazard exists only on the struck fastener (or a small number around it), the correct methodology would be to take the probability of lightning attachment to the individual fastener (or the small group around it) and multiply by the number of fasteners. The FAA should confirm if these two last comments are a correct interpretation of	Page 9 "[…] for each failure mode of each particular type of design feature (such as a particular fastener or joint type), the occurrence of an ignition source due to lightning attachment to that particular fastener or joint type, combined with the occurrence of that ~~each~~ failure mode of the feature is extremely remote, assuming all instances of that feature (such as the particular fastener type) have failed in that mode."	The FAA did not intend that the probability of lightning be assumed to be 1 for this calculation. The FAA intent was to allow the probability of lightning attachments to various parts of the airplane to be considered down to the zone attachment probability level. The FAA does not consider that sufficient data exists to predict the probability of attachment to a specific location. However, the special condition requirements have been changed as a result of other comments (see the response to comment B-7), and the text that led to this comment has been deleted.

Comment	Requested Change	Disposition
the FAA intent.		
Commenter: Airbus A-12		
Page 9: Special Conditions Under the "Special Conditions" Section, the alternative requirements in Section 2 require a safety analysis. The FAA should clarify if the requirements of the Section 2 are: a or (b and c), or a and b and c	Page 9 "Special Conditions […] 2. A safety analysis must show that a. catastrophic fuel tank vapor ignition in the fuel tank system due to lightning is extremely improbable, and b. […]" FAA to confirm	The intent was that a, b, and c all apply. The text format is standard regulatory style for listing a set of requirements. However, the special condition requirements have been changed as a result of other comments, and the text that led to this comment has been deleted(see the response to comment B-7).
Commenter: Airbus A-13		
Page 6: Policy 3rd Paragraph The policy proposes to consider the likelihood of a critical lightning attachment and flammable conditions in the fuel tank in order to determine likelihood of fuel tank vapor ignition. Airbus considers that the term "critical lightning attachment" is potentially confusing. The policy should contain an	Page 6 In order for a vapor ignition event to occur due to a structural failure (or combination of structural failures), that failure must be combined with a ~~critical~~ lightning attachment and with flammable conditions in the fuel tank. Or, include an un-ambiguous definition of the lightning attachment assumptions.	Agreed. The intent is that a critical lightning attachment is an attachment of sufficient magnitude and in a location such that it is a relevant threat for the design feature in question. The text has been revised to make this clear.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
un-ambiguous definition of what is a critical lightning attachment or remove the adjective. The FAA should remove the adjective "critical" or include an un-ambiguous definition of the lightning attachment assumptions to be taken into account in the assessment.		
Commenter: Boeing B-1		
We recognize that the history of the associated rule (14 CFR §25.981) has shown the subject to be of great importance to aviation safety, but one that is extremely complex and challenging. Boeing appreciates the quick efforts of the FAA to develop a policy that will address the impractical aspects of the rule as originally promulgated and subsequently interpreted, and Boeing strongly supports further rulemaking as noted in the proposed policy language.	No change proposed	No change proposed or made
Commenter: Boeing B-2		
Since the promulgation of Amendment 25-102, the Industry has dedicated a tremendous amount of resources to advance the state of our designs to be in compliance. We are concerned, however, about the practice of addressing problematic regulations with a national policy to require petitions for exemption. It has also been our recent experience that	The FAA infers that Boeing is proposing that the FAA not issue the proposed policy memo, and initiate a different industry-agency process review.	The FAA plans to review Amendment 25-102 and likely will propose further rulemaking to address this issue. In the interim, the FAAs administrative options for dealing with designs that do not comply with the existing rule are limited to equivalent safety findings, exemptions, and special conditions. This policy memo is considered necessary to inform the public

Comment	Requested Change	Disposition
other new rules have also produced unexpected or unintended consequences. Therefore, Boeing respectfully recommends that the FAA initiate a joint Industry-agency process review of Amendment 25-102, and other new rules, to develop "lessons-learned" in order to avoid similar recurrences during future rulemaking activities. The objective of this review would be to develop a more robust rulemaking process to help ensure that the outcome of the rulemaking process satisfies the original intent and that unintended consequences are avoided in future rulemaking to the maximum extent possible.		and industry about the way the FAA plans to utilized these options. No change to the memo was made to address this comment.
Commenter: Boeing B-3		
As written, the proposed policy does not clearly delineate the criteria or interfaces that distinguish fuel tank structure and system installations. The definition of fuel tank structure in the proposed policy discusses features like fasteners, coatings, and sealant that are parts of system installations and their structural interfaces, as well as structural elements and joints. For any system elements that are directly attached to structure, their interfaces are similar in lightning protection aspects to structural joints and should be eligible to be covered by this policy. Examples of	Page 2 Definition of Key Terms Lightning protection elements of systems attachments to structure are similar to structural design. The definition of "fuel tank structure" should be clarified to address this. Boeing recommends modifying the definition as follows: *"For the purpose of this policy, 'fuel tank structure' is considered to include structural members, such as airplane skins, joints, ribs, spars, stringers, engine*	This issue was raised by Airbus in comment number A-2, and the general response is given in that section of the table. Most of the specific clarifications proposed by Boeing are consistent with the FAA's intent and corresponding changes have been made. However, since valve housings are expected to be removed and replaced on a significant portion of the airplanes in the fleet at some time in the airplane life, valve housings are more appropriately treated as system elements

Comment	Requested Change	Disposition
these interfaces include pumps, valves, drains, and vents.	*mounts, landing gear and associated fasteners, brackets, coatings and sealant. In addition, attachment hardware associated with components mounted to structure, such as pump and valve housings, drains, and vents, are also considered part of fuel tank structure.'*	rather than structure. As discussed in the response to comment A-2 above, one of the significant factors that led the FAA to arrive at the proposed scope for the alternative standard was the expected level of maintenance (disassembly and reassembly) for these design areas. Disassembly and reassembly of electrical bonding elements is considered to present a significant additional risk that a bond will be compromised during the life of an airplane, which generally does not exist for structure that is intended to be permanent.
Commenter: Boeing B-4		
The SAE lightning environment standards do not define a "Worst Case Lightning Waveform." In fact, there is never one unique waveform. There are usually stroke and intermediate/continuing currents. Which of these, and how much of each, is the "worst case" depends on specific design features. For example, a 5 kA intermediate current of 5 ms duration might cause more hazardous effects than a 200 kA stroke current of 0.5 ms duration. Therefore, what is actually the worst case depends on the structure designs. Because Industry practice does not define a worst-case lightning waveform, we suggest the statement in the proposed policy memo	Page 3 Current Regulations and Advisory Material We consider this an inaccurate statement about Industry practice regarding lightning and it should be corrected. We suggest modifying the text to read as follows: *"In addition, industry and FAA practice has been to assume that a defined ~~worst-case~~ set of severe lightning ~~waveform~~ current components would be associated with every lightning attachment to the aircraft."*	Agreed. The memo has been changed as proposed, except that the term "lightning strike" is used in place of "lightning attachment." Strike is used instead of attachment to avoid confusion over the multiple individual attachments that can occur in a single lightning strike event.

Comment	Requested Change	Disposition
be corrected.		
Commenter: Boeing B-5		
While this policy states applicability only to lightning protection of fuel tank structure, there are similar issues of impracticality in direct compliance with §25.981(a)(3) regarding lightning protection of system installations in the fuel tank. From a practical standpoint, the protection of fuel tank systems is no different from protection of fuel tank structure in methods as well as conditions required for the top level event (i.e., lightning, flammability and an ignition source.) Achieving three independent, reliable, and effective layers of lightning ignition source prevention design is impractical in many cases, as the lightning protection methods rely heavily on similar techniques as for structural lightning protection, such as electrical bonding of joints. Trying to achieve a third layer of protection will often result in the introduction of new failure modes and potentially decrease the overall safety of the airplane. For example, addition of a redundant bond strap that creates a short circuit that draws lightning current could result in a greater safety risk than if the strap weren't installed. The same issues identified for structural lightning	Page 7 Eligibility for Consideration Under this Policy The same factors that contribute to a fuel vapor ignition due to lightning apply whether it is structure or systems. In addition, lightning protection methods for systems and structure are generally similar, so can have similar impracticality challenges. Therefore, this policy should be applicable for systems as well as structural lightning protection. Boeing recommends that all aspects of lightning protection, both fuel tank structure and systems, be included in the application of this policy. We suggest expanding the applicability of the policy as follows: *"The relief from §25.981(a)(3) provided by this policy is intended to be limited to ~~areas of~~ lightning protection of fuel tank structure and integral tank systems for which compliance with § 25.981(a)(3) is shown by the applicant and determined by the*	This comment raises the same issue as comment A-2 above, and the same response applies. The definition of fuel tank structure has been clarified, but has not been changed to include system elements in general. The FAA does not agree with the statement, "Trying to achieve a third layer of protection will often result in the introduction of new failure modes and potentially decrease the overall safety of the airplane." While a poorly designed additional safety feature may induce additional risk, an additional properly designed, compliant feature would provide an increase in the level of safety.

Comment	Requested Change	Disposition
protection regarding impracticality of using numerical analysis methods (documented in our other comments) apply to systems as well.	*FAA to be impractical. ~~General design areas for which the TAD has determined compliance with § 25.981(a)(3) can be impractical include structural members and joints, fasteners, coatings, and sealants~~. Determinations of practicality are somewhat subjective and can be dependent on the proposed design. Practicality determinations that are outside of the examples provided below should be submitted to the TAD for review to ensure standardization."* Additionally, the background material should be revised to be consistent with this approach.	
Commenter: Boeing B-6		
Section 25.981(d), Amdt. 25-125 [and similar wording in §25.981(b), Amdt. 25-102)] state: *"Critical design configuration control limitations (CDCCL), inspections, or other procedures must be established, as necessary, to prevent development of ignition sources within the fuel tank system pursuant to paragraph (a) of*	Page 8 Examples of FAA Practicality Determinations (last bulleted item that mentions CDCCL) Boeing requests that the policy provide guidance relative to §25.981(d) per Amendment 25-125 [and §25.981(b) per Amendment 25-102] to address the impracticality of applying certain	We don't agree with the wording change proposed by Boeing because this policy memo is not intended to provide detailed methods of compliance with § 25.981(b). However, we acknowledge that the intent of the requirement to visibly identify critical features on the airplane may not be required for some structural lightning protection features. The commenter did not accurately quote the regulation, which

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
this section, to prevent increasing the flammability exposure of the tanks above that permitted under paragraph (b) of this section, and to prevent degradation of the performance and reliability of any means provided according to paragraphs (a) or (c) of this section. These CDCCL, inspections, and procedures must be included in the Airworthiness Limitations section of the instructions for continued airworthiness required by Sec. 25.1529. Visible means of identifying critical features of the design must be placed in areas of the airplane where foreseeable critical design configuration control limitations (e.g., color-coding of wire to identify separation limitation). These visible means must also be identified as CDCCL." It is not clear how some of the provisions of §25.981(d) per Amdt. 25-125 [or §25.981(b) per Amdt. 25-102] are to be applied to lightning. Specifically, the requirement to provide a visible means of identifying critical features of the design and include those as CDCCLs is not practical when there are hundreds or thousands of cases where lightning	continued airworthiness approaches to fuel tank structural lightning protection, such as identification of CDCCL and requiring visible means to identify CDCCL. ——————— We recommend adding guidance as follows: *"An example of satisfactory means of including CDCCL for the purpose of fuel tank lighting protection would be to include adequate instructions and documentation in maintenance information to minimize the potential of maintenance actions, repairs, or alterations that may compromise the critical lightning protection features."*	already contains a relieving provision for the marking requirement that would potentially cover some of the design areas that are the subject of this policy memo. The regulation actually states, "*Visible means to identify critical features of the design must be placed in areas of the airplane where maintenance actions, repairs, or alterations may be apt to violate the critical design configuration limitations …*" Since means of compliance with § 25.981(b) is not the subject of this policy memo, the marking requirements will be addressed through the normal methods of compliance discussions on each project. No change was made to the memo.

Comment	Requested Change	Disposition
protection is mostly provided by inherent design features.		
Commenter: Boeing B-7		
We agree with the overall objective to prevent the ignition of vapors in the fuel tank. While we have historically conducted safety assessments that have led to an outstanding safety record for lightning protection of fuel tanks, we also agree that the safety assessment methods and robustness of design can be improved. However, we recommend that the methodology of analysis to assess compliance be simplified for the reasons described below. For the past several years, Boeing has been working with the FAA via the Issue Paper process to develop proposed means of compliance with 14 CFR §25.981, Amendment 25-102, for fuel tank lightning protection. Issue Papers are commonly necessary for FAA/Industry coordination to define specific requirements for new designs and new regulations. At the beginning of this Issue Paper development, the Boeing position proposed was that providing fault tolerant protection via a prescriptive requirement was appropriate for compliance and would be consistent with proven historical means of	Page 9 Special Conditions Items 2. and 3. Boeing requests that the proposed requirement be replaced with an approach that yields an equivalent level of safety. Specifically, replace Item 2 a, b, and c with the following: *2. The applicant must show that the design includes at least two independent, effective, and reliable lightning protection features (or sets of features) such that fault tolerance is provided for each area of the structural design area proposed to be exempt from the requirements of that regulation. Fault tolerance is not required for any specific design feature if:* *a. providing fault tolerance is shown to be impractical for that feature, and* *b. ignition sources due to that feature and all other non-fault-tolerant features are*	The FAA partially agrees with this comment, and has revised the special conditions ignition source prevention requirements in the memo to be the same as the ignition source prevention requirements for exemptions. This change was made for the same reasons cited by the commenter. However, the requirement for a risk assessment for all of the non-fault tolerant features has been retained. That risk assessment requirement is intended to ensure that the potential for failure of non-fault-tolerant features is minimized and that an excessive number of non-fault-tolerant design features does not exist in the design. This will be clarified in the policy memo. Ultimately, the FAA would only consider a design to be acceptable if the manufacturer can reasonably predict that fuel tank explosions will not occur in the life of the fleet of airplanes of the proposed design. Without a standard for the allowable risk due to single failures, there would be no limit on the number of non-fault-tolerant features allowed in a design, and there would be a significant potential for a design to have an unacceptable risk level due to single

Comment	Requested Change	Disposition
compliance for lightning protection. During this process, some areas were identified where it was impractical to provide fault tolerance, as described in the FAA's proposed policy memo. Additional emphasis on design, manufacturing and, maintenance programs were proposed to address these areas. The FAA position was that a detailed numerical assessment should also be accomplished. Boeing has completed a draft numerical assessment for the Model 787 and provided that to the FAA. The Boeing assessment concludes that the proposed requirements can be met and, while formal submittal and FAA approval has not been reached, we believe the FAA would accept the analysis as meeting the proposed Policy Memo numerical requirements. The assessment required thousands of hours to develop and many detailed discussions with FAA specialists. Boeing found there is limited available source data relevant to lightning attachment and threat interaction with aircraft, and what is available requires numerous simplifying assumptions to be used in a numerical analysis. Examples of required assumptions include:	*shown to be unlikely by design.* Delete the last sentence of Item 3 concerning residual risk, leaving the following: *"3. The applicant must show that the design, manufacturing, and maintenance programs include all practical measures to prevent failures of structural lightning protection features due to manufacturing variability, aging, wear, corrosion, and likely damage."* Revise the background material to be consistent with this approach.	failures. It is not clear to the FAA how the proposed wording "unlikely by design" would be defined or measured. Also, comparison to existing service experience might be valid for some designs, but for other designs, such as composite wing designs, the existing service experience may not be relevant. Finally, as discussed above, such a standard would set no limit on the number of non-fault tolerant features that could exist in a design. We acknowledge the difficulty in estimating with a high degree of accuracy the probability of lightning strikes to particular areas of different aircraft and the statistical distribution of lightning amplitude. The FAA will work with applicants to evaluate proposed assumptions for these factors based on available industry data. Agreements on these assumptions will be documented in means of compliance issue papers. Standardization of these assumptions will be accomplished through involvement of the Transport Airplane Directorate Standards Staff in the coordination of these issue papers.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
• what data sources are appropriate to represent lightning attachment to a specific aircraft, • what parameters and waveforms of lightning are relevant to this problem, and • what criteria constitute sufficient data to make statistical assessments of distributions for the parameters of interest. Such assumptions would vary widely across Industry, resulting in inconsistent analyses between applicants. This problem is the major reason why Industry has defined standard criteria based upon a severe set of lightning waveforms and prescriptive methodologies for implementing and assessing lightning protection designs relative to all past regulatory guidance. The validity of this approach is recognized by FAA through its published advisory material. Further, the Boeing draft analysis failure rates relevant to lightning protection functions of structural elements were not readily available and not easily estimated. Many key elements of lightning protection design are primarily driven by other requirements, such as structural integrity or		

Comment	Requested Change	Disposition
fuel tank integrity against leakage. While it is important and necessary to ensure that the lightning protection function aspects of these kinds of design features are known and controlled, failures associated with these elements may or may not be relevant to lightning protection or degradations that are not typically accounted for, as failures may still be relevant to lightning protection. General failure data of structural elements is not readily and publicly available, which would lead to inconsistent approaches and assumptions among applicants. Having accomplished this task of developing a full numerical assessment, Boeing concludes the assessment led to no differences in design that a more prescriptive approach with a qualitative assessment could not accomplish. Further, this approach would result in a consistent requirement across Industry. It can be understood why a simplified analysis can be used as follows: It is generally accepted by the Industry experts and aviation authorities that high energy strikes to aircraft can be conservatively estimated to be on the order of $10e^{-5}$ per flight hour, when combining probability of		

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
lightning attachment to an airplane coupled with the likelihood of a high amplitude or energy event. Lightning protection is assessed using standardized high energy threats. When coupled with flammability exposure per requirements of 3%, this indicates that the likelihood of high energy lightning attachment during a flammable condition will be extremely remote (on the order of $10e^{-7}$). These probabilities are generic to all transport category aircraft. Therefore, to meet the extremely improbably intent of Item 2.a. in the proposed policy memo, the probability of a failure being present in the ignition source prevention features and sparking due to the specific lighting attachment would need to be on the order of less than 10e-2. By observation, it can be seen that two or more reliable features (typically with individual failure rates of remote or even extremely remote) with independent fault tolerant protection are unlikely to fail as a combination for the life of the aircraft, without a numerical analysis. The detailed draft numerical assessment Boeing has provided to the FAA supports this, as the fault tolerant features are not significant contributors to the top level resulting probabilities.		

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
The types of features identified in the proposed policy memo as single failures that are impractical to eliminate all, are not widespread (i.e., result in limited exposure), and common to existing fleet designs that have demonstrated excellent fleet experience. This fleet experience says the probability of a top event due to these features is already less than extremely remote. Through additional mitigating factors, such as manufacturing inspections, focus on design robustness, CDCCLs, and /or addition of general visual inspection requirements to existing structural zonal inspections, the potential for failures in these limited areas can be further mitigated to make such conditions unlikely by design. This can be accomplished through qualitative assessment without requiring a full numerical analysis. The detailed Boeing analysis also supports this conclusion. We also conclude that a similar rationale applies to equivalency with Items 2.b. and 2.c. of the proposed policy memo. For Item 2.b., where it is assumed an FRM inoperative, the probability of lightning in conjunction with the inherent flammability of the tank is still on the order of extremely remote. The inclusion of unlikely feature		

Comment	Requested Change	Disposition
failure probabilities would meet the $10e^{-8}$ criteria. For Item 2.c,, the standard is extremely remote and the probability of lightning in conjunction with the ignition source prevention criteria defined above again easily meets the extremely remote criteria. The last sentence in Item 3 would also be deleted to be consistent with the logic above. In summary, a large portion of the factors in the numerical type assessment proposed by the policy memo are generic to all aircraft. Given this, we propose a prescriptive approach to incorporate fault tolerance where practical, together with a qualitative assessment that where fault tolerance is impractical, the exposure (quantity) has been limited and mitigating processes have been utilized to make failures unlikely. This would achieve the intent of Item 2 of the proposed policy, provide an equivalent level of safety, and be effective in achieving that level of safety consistently across industry.		
Commenter: Boeing B-8		
We are unclear as to the intent of the wording: *"the occurrence of an ignition source due to each failure mode of the feature is extremely remote, assuming all instances of that feature (such as the*	Page 9 Special Conditions Item 2.c. If Boeing's Comment #5 (above) is not	The issue raised by the commenter no longer exists because the special condition requirements have been changed to be similar to the exemption requirements.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
particular fastener type) have failed in that mode." We believe the intent is that the probability of the feature failure is included in the analysis; and that the intent of the wording *"all instances … have failed"* means to account for the quantity of that feature, where there is a common mode failure that could be driven by a single lightning strike on the airplane. However, it can also be suggested that the wording *"all instances … have failed"* could mean that the failure itself must be assumed to exist with a probability of 1. Given that this analysis is to verify that the failure mode is extremely remote and that the feature failure is the only failure in this analysis, if that probability were assumed to be 1, the remaining probability would only be the probability of the amplitude and strike driving the feature to be an ignition source. This would not be a useful assessment. Please clarify whether this is the intent.	adopted, then we request clarification of the intent of Item 2.c. One way that we suggest is as follows: *"2. A safety analysis must show that ..* *c. for each failure mode of each particular type of design feature (such as a particular fastener or joint type), the occurrence of an ignition source due to each failure mode of the feature is extremely remote~~, assuming all instances of that feature (such as the particular fastener type) have failed in that mode~~. Include a factor for the quantity of that feature on the aircraft, if a common mode failure could affect all of the locations."*	

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
Commenter: Boeing B-9		
We request this change for the same reason/intent described in our Comment #5 (re: page 9, Special Conditions), above, regarding the approach to single failures as applied to exemptions.	Page 11 Exemptions for New Type Certificate Programs Items 1. and 2. Boeing requests that FAA replace the numerical analysis requirement for when fault tolerance is shown to be impractical, with a prescriptive approach that yields an equivalent level of safety. Specifically, modify Item1.b. as follows: *"1. In lieu of compliance with the requirements of §25.981(a)(3), the applicant must show that the design includes at least two independent, effective, and reliable lightning protection features (or sets of features) such that fault tolerance is provided for each area of the structural design area proposed to be exempt from the requirements of that regulation. Fault tolerance is not required for any specific design feature if:* *a. providing fault tolerance is shown to be impractical for that feature, and*	This comment is similar to a portion of comment B-7, and the same response applies. The requirement for a risk assessment for all of the non-fault tolerant features has been retained. That risk assessment requirement is intended to ensure that the potential for failure of non-fault-tolerant features is minimized and that an excessive number of non-fault-tolerant design features does not exist in the design. This will be clarified in the policy memo. Ultimately, the FAA would only consider a design to be acceptable if the manufacturer can reasonably predict that fuel tank explosions will not occur in the life of the fleet of airplanes of the proposed design. Without a standard for the allowable risk due to single failures, there would be no limit on the number of non-fault-tolerant features allowed in a design, and there would be a significant potential for a design to have an unacceptable risk level due to single failures.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
	b. ignition sources due to that feature and all other non-fault-tolerant features are shown to be unlikely by design."	
Commenter: Boeing B10		
While this is well understood for lightning-related regulations, it may not otherwise be consistently applied for analysis related to 14 CFR §25.981.	Page 12 (and elsewhere in the proposed document) Methods of Compliance We request that a sentence be added in the policy memo as follows: *"It has been confirmed that existing practices regarding zoning and testing per SAE or equivalent standards are appropriate for use in demonstrating compliance with special conditions or exemptions approved under the guidelines of this policy memo."*	The FAA agrees with Boeing's understanding that the FAA does not intend to require different practices or assumptions when performing lightning-related analysis. However, since the memo does not address the methods of compliance to that level of detail, no change to the memo has been made. This comment is similar to comment A-3.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
Commenter: Cessna C-1		
The policy appropriately expresses the proposed safety standards in terms of the likelihood of a fuel tank vapor ignition event, and not in terms of the likelihood of an ignition source alone. This approach permits the use of the probability of flammability in the fuel tank during the required safety analysis, and Cessna Engineering agrees with this methodology. In this manner, credit is permitted for recent enhancements in flammability safety standards, and the objective criteria from Amendment 25-125 may be more fully utilized. However, similar benefits are not realized from permitting the use of probabilistic values for lightning. Although clearly a logical extension of previous interpretations, considering lightning probabilities in order to mitigate impractical aspects of § 25.981(a)(3) does not address the root cause of the practicality issue. The application of a probabilistic analysis to a lightning event runs contrary to decades of established, safe, and conservative prescriptive testing	Cessna's comment made the following specific recommendations: 1) "For new type certificate programs, the FAA will consider granting exemptions from 25.981(a)(3) for lightning protection aspects of fuel vapor ignition event prevention ~~of fuel tank structure~~ on airplanes with fuel tank systems that do not comply with that regulation, but which do comply with the applicable fuel tank flammability standards of 25.981(b) at Amendment 25-125." 2) Request removal of references to determination of probabilities for lightning aspects of fuel vapor ignition event safety assessments. In addition, Cessna's comment section made the following additional suggestions: 3) Allow exemptions from all lightning aspects of ignition source prevention in § 25.981(a)(3) and consolidate all aspects of lightning separately in alternative prescriptive requirements. The alternative requirements would serve to augment §	1) This comment about the scope of the relief from § 25.981(a)(3) is similar to comment A-2, and the same response applies. 2) While the FAA acknowledges that precise data on the probability of lightning attachment to various parts of aircraft and on the probability of strikes of a given amplitude are not available, existing data available to industry does allow conservative estimates of those probabilities to be used to more accurately represent the physical factors that contribute to a fuel vapor ignition event. The FAA considers the conservative use of that data to be reasonable and scientifically justified. 3) The proposal to apply prescriptive requirements rather than probabilistic requirements is addressed above in the response to comment B-7. The FAA plans further rulemaking to address the practicality issues associated with § 25.981(a)(3), and the commenter's proposal is one approach under consideration. However, until such rulemaking is proposed, the FAA is

Comment	Requested Change	Disposition
practices developed by lightning specialists. As acknowledged by the draft policy memo, no universally accepted data exists to determine the exact probability of a lightning strike or the distribution of strike energy, and the development, standardization, and acceptance of such data would create a significant burden on both the FAA and industry without commensurate safety benefits. It is recommended that the policy surmount this obstacle by allowing exemptions from all lightning aspects of ignition source prevention in § 25.981(a)(3) and consolidating all aspects of lightning separately in alternative prescriptive requirements (including those determined practical by the FAA and this draft policy memo). These alternative lightning requirements would serve to augment § 25.954 and avoid the core incompatibility issue between lightning and probabilistic analysis, facilitating practical means of compliance and restoring § 25.954 to relevancy with improved safety standards for the prevention of fuel tank vapor ignition due to lightning. As emphasized on page 12 of the policy	25.954 and avoid the core incompatibility issue between lightning and probabilistic analysis. 4) Define the term "structure" with regards to lightning protection – system element interfaces that are directly attached to structure will use the same lightning protection strategies.	attempting with this policy to address the immediate practicality issues raised on current certification projects. The FAA has not yet determined whether all aspects of lightning protection should be treated separately from § 25.981(a)(3), and has not made that change to the policy memo. 4) The FAA agrees that further clarification of this definition is needed, and has revised the memo. This was addressed in the response to comment A-2.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
memo, § 25.954 still applies to lightning protection of fuel tanks. However, due to the advent of Amendment 25-102 to Part 25, § 25.954 has been inadvertently superseded. The policy memo correctly identifies areas of improvement which would enhance the value of § 25.954 and retain its utility, including considering practical, prescriptive methods of addressing anticipated design failures, aging, wear, and maintenance errors for airplane structure. The remainder of all ignition source safety assessment items which are not lightning related would then be addressed via the quantitative analysis described in the draft policy memo and relevant guidance material. The draft policy memo correctly identifies structural aspects of lightning protection as an area of potential impracticality in terms of demonstrating compliance with §25.981(a)(3). However, the focus on structure alone results in the need to define the term "structure" with regards to lightning protection. System element interfaces that are directly attached to structure will employ the same lightning protection strategies as structural elements, and clarification would be needed to		

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
ascertain what specific components the policy applies to, but this situation may be avoided if the requested change is accepted. Allowing exemptions for all lightning aspects and applying a prescriptive methodology to them provides the following benefits: 1) Elimination of the need to determine and negotiate standardized probabilities for lightning attachment and strike energy distribution; 2) Avoidance of the need to create an arbitrary delineation between structure and systems; 3) Elimination of the need to demonstrate impracticality, as practical prescriptive requirements will be established. This also prevents the unfortunate consequence of applying probabilistic analysis to lightning: the addition of redundant protection features which themselves introduce additional failure conditions. It is therefore recommended that the policy be expanded to allow exemptions to all lightning aspects of §25.981(a)(3), provided flammability requirements are met along with alternative prescriptive requirements for lightning aspects.		

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
Commenter: Cessna C-2		
In the Examples of FAA Practicality Determinations, the policy does not acknowledge the ability to test fuel tanks to verify that induced energy and voltage levels are insufficient to deliver a spark.	It is requested that this testing be acknowledged as practical in either background material of the policy or in the listing of practical examples as follows: "Examples of design changes or features that have been determined to be practical include: • Lightning threat characterization testing of the fuel tank systems to demonstrate that induced energy and voltage levels are insufficient to deliver a spark;"	The FAA agrees with the commenter's understanding that testing may be used to show that a particular design area will not present an ignition source when subjected to lightning current. However, this is considered to be part of the basic work to define and verify threat levels and to support assumptions about the behavior of the design features. No change to the memo was made.
Commenter: Cessna C-3		
On page 6 of the draft policy memo, it is noted that "the FAA has now determined that there is at least one practical method available to significantly reduce risk due to fuel tank flammability." Clarification is requested to avoid misinterpretation of this statement as an endorsement of one preferred method.	"the FAA has now determined that there are practical methods ~~is at least one practical method~~ available to significantly reduce risk due to fuel tank flammability."	Agreed. The proposed change was made to the memo.
Commenter: Cessna C-4		
On page 7 of the draft policy memo, in the examples of FAA Practicality Determinations, "installation of sealant" is listed as a means of providing fault tolerance. It should be noted that not all sealant applications are equally effective	"Installation of lightning protective sealant or cap seals over fastener heads/ends located inside fuel tanks to provide fault tolerance."	Agreed. The proposed change was made to the memo.

Comment	Requested Change	Disposition
in providing this protection.		
Commenter: Cessna C-5		
The considerations for granting exemptions and special conditions differ in the description of the structured, quantitative assessment of fleet average risk for a fuel tank vapor ignition event. On page 9 of the draft policy memo, the assessment for special conditions specifically includes: "the probability of fuel tank flammability, the probability of lightning, and a distribution of lightning waveforms," but this language is not explicitly repeated in the exemption assessment description on page 11 in paragraph 1b.	As noted in previous comments, it is requested that the probability of lightning and the probability of the distribution of lightning waveforms not be included, but that practical prescriptive means of compliance testing for the lightning environment be specified. This will also serve to address the differences in the assessments.	As noted in the response to comment C-1, the FAA does consider it appropriate to consider probability of lightning and the distribution of lightning amplitude when performing the required safety analysis. No change is made in this respect. The FAA does agree, and had intended, that the use of the probability of flammability, the probability of lightning, and the distribution of lighting amplitude allowed for in the special condition analysis should also be allowed in the risk analysis required under paragraph 1.b. of the proposed exemption conditions. The memo has been changed to make this clear.
Commenter: Cessna C-6		
The requirement to show structural compliance to direct lightning attachment should be limited to Zone 1 and Zone 2, in accordance to ARP 5414A, unless it is a new and novel design. This is critical due to the design considerations that must be applied to areas of critical lightning attachment. The guidance provided in ARP5414A states that direct attachment to Zone 3 areas does not need to be considered for standard aluminum construction aircraft	Clarification and reference to ARP5414A lightning zoning definitions requested.	This comment is similar to comment A-3 and B-10 and the same response applies. The FAA agrees with the intent described in the comment.

Comment	Requested Change	Disposition
and need only be addressed for designs of "new and novel" types where catastrophic failures could occur due to attachment.		
Commenter: Cessna C-7		
"Strict control of bolt/hole fit and quality" and "strict control of clearance fits & installation practices" are considered by aircraft manufacturers to be an integral element of normal assembly quality control. Does the FAA consider this "strict control" to constitute an independent layer of ignition source protection?	Clarification requested.	This comment is similar to comment A-6, and the same response applies. The FAA does not consider manufacturing controls to be an "independent layer" for the purpose of safety analysis.
Commenter: Cessna C-8		
Items listed as determined to be impractical to provide fault tolerance include single failure of a fastener which damages the sealant and single failures of sealant lightning protection. In the draft policy memo's description of alternative requirements for exemptions, once impracticality is established in 1(a), 1(b) is then required. However, 1(b) returns to the probabilistic requirement of extremely improbable when the fuel tank vapor ignition event probabilities are summed. Quantitative failure rates have not historically been applied to structural members, and no universally accepted data exists to determine the	Lightning and its effects are the only cases where fastener and sealant integrity pose an ignition source potential. Addressing lightning in a prescriptive manner rather than a probabilistic one eliminates the intrinsic source of impractical requirements. It is requested that the policy provide for exemptions from all lightning aspects of §25.981(a)(3), with alternative practical prescriptive requirements acceptable to the FAA, provided that the requirements of §25.981(b) to Amendment 25-125 are met.	This comment is similar to comment B-7. The FAA does not agree that it is not possible to use numerical probability analysis to assess risk of a vapor ignition event due to lighting. While many of the contributing failures and environmental factors cannot be characterized with a high degree of accuracy, reasonable estimates can be made to allow numerical probability analysis to be used as an effective tool to estimate the level of risk. Under the exemption conditions, lack of lightning fault tolerance in structural design features is potentially acceptable when impracticality can be shown. However, the

Comment	Requested Change	Disposition
exact probability of a lightning strike or the distribution of strike energy. Even making assumptions on these values, the number of fasteners in a typical wing inflates the summation of probabilities, imposing an impractical reliability number on fastener and sealant integrity.		FAA position is that an assessment should still be required to show that accidents are not anticipated due to non-fault-tolerant design features. The comment proposing application of the policy memo to **all** aspects of lightning protection is similar to comment A-2, and the same response applies. The FAA agrees that numerical probability analysis has not historically been applied to aircraft structure. However, the FAA does consider it possible to estimate failure rates for structural elements, including fastening systems, based on service experience, manufacturing data, and analysis of manufacturing processes. While the FAA acknowledges that precise data on the probability of lightning attachment to various parts of aircraft and on the probability of strikes of a given amplitude are not available, existing data available to industry does allow conservative estimates of those probabilities to be used to more accurately represent the physical factors that contribute to a fuel vapor ignition event. The FAA considers the conservative use of that data to be reasonable and scientifically

Comment	Requested Change	Disposition
		justified. The proposal to apply prescriptive requirements rather than probabilistic requirements is addressed above in the response to comment B-7.
Commenter: GAMA D-1		
GAMA believes that this proposed policy is necessary to resolve the unintended consequences which resulted from an interpretation of §25.981(a)(3) that is contrary to what has been promulgated. As the FAA is reluctant to re-align the current interpretation of §25.981(a)(3) with what was promulgated, there is no direct method of compliance available for aircraft using current technology and therefore all new part 25 aircraft must seek an exemption or special condition. This environment is completely unacceptable and GAMA expects the FAA to work diligently to resolve this condition through rulemaking as quickly as possible. Additionally, GAMA calls for the FAA develop a streamlined process to remove these compulsory exemptions once the regulations have been appropriately updated.	GAMA expects the FAA to work diligently to resolve this condition through rulemaking as quickly as possible. Additionally, GAMA calls for the FAA develop a streamlined process to remove these compulsory exemptions once the regulations have been appropriately updated.	The FAA does plan further rulemaking, as indicated in the policy memo. A process for revising the certification basis for the approvals granted with exemptions is outside the scope of the policy memo.
Commenter: GAMA D-2		
GAMA anticipates the FAA will form an aviation rulemaking committee with a		The process for further rulemaking is outside the scope of the policy memo.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
charter to revise §25.981 and §25.954, *fuel tank lightning protection*, and in so doing will restore a direct path for the certification of these modern airplanes which follow the best design techniques and utilize the safest technology ever put on wing. We would also like to make note that aircraft which will gain exemption or special condition to §25.981(a)(3) through this policy (and those that have done so to date) have met unprecedented design assurance levels with respect to fuel tank ignition sources.		
Commenter: GAMA D-3		
GAMA would like to point out that there is nearly unanimous agreement between the technical experts in the lightning arena with respect to the safest and most appropriate way in which to address lightning in §25.981(a)(3). In the short-term the path for certification outlined in this policy is the only method in which to assure new products which contain the safest features available are put into service while in the long-term there is a need to revise §25.981 and §25.954 to reflect more modern understandings of lightning and to eliminate the need for exemption or special condition on every new part 25 product.		No specific change is proposed or made.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
Commenter: GAMA D-4		
The definition of fuel tank structure in the policy discusses features like fasteners, coatings, and sealant that are parts of system installations and their structural interfaces as well as structural elements and joints. For any system elements that are directly attached to structure, their interfaces are similar in lightning protection aspects to structural joints and should be eligible to be covered by this policy. Examples of these interfaces include pump and valve housings, feed through hardware, drains and vents. Lightning protection elements of systems attachments to structure are similar to structural design.	Specific Comments: Page 2, Definition of Key Terms (Fuel Tank Structure) GAMA requests that the FAA amend the definition of the term "Fuel Tank Structure". The definition of fuel tank structure should be clarified to address this. GAMA recommends the FAA amend the current definition of fuel tank structure to read as follows: *For the purpose of this policy, "fuel tank structure" is considered to include structural members, such as airplane skins, joints, ribs, spars, stringers, engine mounts, landing gear and associated fasteners, brackets, coatings and sealant. In addition, attachment hardware associated with components mounted to structure, such as pump and valve housings, feed through hardware, drains and vents, are also considered part of fuel tank structure.*	This comment is similar to comment A-2, and the same response applies. Changes have been made to the memo to clarify the definition of fuel tank structure.
Commenter: GAMA D-5		
As §25.981(a)(3) addresses ignition sources in the fuel tank it is appropriate to define, in this policy, which areas are included when referring to the "Fuel Tank". Such a definition assures that	Page 2, Definition of Key Terms (New Term – Fuel Tank) GAMA suggests the FAA incorporate the following definition of fuel tank to assure there is a clear understanding of what this	The FAA does not agree with the proposed change. Section 25.981(a) states, "No ignition source may be present at each point in the fuel tank or fuel tank system …" It was not intended that § 25.981 only

Comment	Requested Change	Disposition
evaluations properly address the appropriate areas.	policy addresses: *For the purpose of this policy, "fuel tank" is considered to include those compartments or storage bays intended by design to contain fuel during normal operation of the aircraft.*	apply to the fuel tank compartments themselves, but rather that the entire tank system, including vents, surge tanks, plumbing, etc., is to be considered. Also, external threats that can cause an ignition source within the fuel tank system are to be considered. The intent is to apply the requirements to any portion of the fuel tank system that could potentially cause a catastrophic fuel tank explosion. The scope of applicability of § 25.981(a)(3) is already discussed in AC 25.981-1C.
Commenter: GAMA D-6		
The term "arc/spark-free rivets" is used in the Examples of FAA Practicality Determinations section on page 7 however it is undefined. Typically arc/spark-free rivets are used in composite structure and enable bonding of the fastener to metallic mesh. The reference to use of arc/spark-free rivets in aluminum structure is particularly unclear. Is this in reference to ensuring a well bonded fastener to the surrounding structure, to a specific type of fastener, or to a fastener that has been treated to be non-conductive?	Page 2, Definition of Key Terms (New Term – Arc/Spark-Free Rivets) GAMA requests the FAA provide a definition of what is intended by an Arc/Spark-Free Rivet.	The FAA agrees that the term arc/spark-free rivet should be clarified. The FAA intended it to mean a fastener that is well-bonded to surrounding structure. The wording of the example has been changed to make this more clear.
Commenter: GAMA D-7		
In this section the FAA refers to the term "worst-case lightning waveform". SAE lightning environment standards do not address such a term and in fact there is not	Page 3, Current Regulations and Advisory Material GAMA suggests modifying the existing	This comment is similar to comment B-4, and the same response applies. That comment proposed a slightly different change to address the same concern. The

Comment	Requested Change	Disposition
one unique waveform therefore GAMA suggests the FAA utilize terminology which is consistent throughout industry practice. There are usually stroke and intermediate/continuing currents. Which of these, and how much of each, is "worst case" depends on specific design features. For example: a 5 kA intermediate current of 5 ms duration might cause more hazardous effects than a 200 kA stroke current of 0.5 ms duration. So what is actually worst case depends on the structure designs. Because industry practice does not define a worst-case lightning waveform, we suggest this statement be corrected.	test in that paragraph to result in the following: *In addition, industry and FAA practice has been to assume that a defined set of severe lightning current components, defined within ARP 5412 "Lightning Environment and Test Waveforms, would be associated with every lightning attachment to the aircraft.*	memo has been revised to address that comment.
Commenter: GAMA D-8		
The majority of aircraft which will comply with §25.981(a)(3) in the future will not be of a class that will require compliance with amendment 26-2 which addresses only the largest airliner and cargo type aircraft. Because amendment 26-2 is applicable only to a very small portion of the part 25 airplane fleet the policy should clarify that amendment 26-2 addresses those airplanes with a seating capacity of greater than 30, payloads larger than 7500 lbs, etc. GAMA	Page 4, Amendment 26-2 Material The policy should clarify that amendment 26-2 addresses those airplanes with a seating capacity of greater than 30, payloads larger than 7500 lbs, etc.	The commenter is correct that Amendment 26-2 excludes certain airplane types. However, the section on current regulations and advisory material already reflects this fact by stating, "Amendment 26-2 (also part of the FTFR rule issued in 2008) added regulations requiring compliance with the flammability standards in the new version of § 25.981(b) for certain existing type designs, for certain type design change programs, for

Comment	Requested Change	Disposition
believes this distinction is important as the current wording assumes the minority of the fleet is representative of the whole.		pending new type certificate programs, and for future new production of existing type design airplanes after September 20, 2010." This section was not intended to repeat the detailed applicability requirements of Amendment 26-2. However, the policy memo will be revised to clarify the applicable flammability requirements for pending TCs that would be associated with an exemption in the section on exemptions.
Commenter: GAMA D-9		
GAMA believes the FAA should include discussion regarding zonal analysis of direct lightning attachment to structure. Best practice demonstration of structural compliance to direct lightning attachment is limited to Zone 1 and Zone 2, in accordance to ARP 5414A, unless it is a new and novel design. Compliance to Zone 3 requirements would be limited to conductive current flow, as defined within ARP 5412A and ARP 5414A.This is critical due to the design considerations that must be applied to areas of critical lightning attachment. For example locating fuel tanks in lightning strike Zone 3 is an effective and recommended means of protecting the fuel from the effects of lighting. Energy levels within lighting strike Zones 1 and 2 could be expected to	Page 6, Policy (Additional Clarification) GAMA believes the FAA should include discussion regarding zonal analysis of direct lightning attachment to structure. GAMA suggests the FAA include discussion of the best practices of ARP 5412A and ARP 5414A.	This comment is similar to comments A-3, B-10, and C-6, and the same response applies.

Comment	Requested Change	Disposition
be higher and of more of a direct concern. With the exemptions issued to date, the FAA seems to mirror this concern, as they address only these two lightning zones. The guidance provided in ARP5414A states that direct attachment to Zone 3 areas does not need to be considered for standard aluminum construction aircraft and need only be addressed for designs of "new and novel" types where catastrophic failures could occur due to attachment. GAMA suggests the FAA include discussion of these best practices.		
Commenter: GAMA D-10		
On page 6 of the draft policy memo, it is noted that "the FAA has now determined that there is at least one practical method available to significantly reduce risk due to fuel tank flammability." Clarification is requested to avoid misinterpretation of this statement as an endorsement of one preferred method.	Page 6, Policy GAMA suggests the FAA consider the wording which follows. *the FAA has now determined that there <u>are practical methods</u> ~~is at least one practical method~~ available to significantly reduce risk due to fuel tank flammability.*	Agreed. Comment C-3 is similar, and the proposed change was made.
Commenter: GAMA D-11		
While this policy states applicability only to lightning protection of fuel tank structure, there are similar issues of impracticality in direct compliance to §25.981(a)(3) regarding lightning protection of system installations in the fuel tank. GAMA believes the FAA must	Page 7, Eligibility for Consideration Under This Policy GAMA suggests the FAA include all aspects of lightning protection, both fuel tank structure and systems, in application of this policy. Expand the applicability of	This comment is similar to comments A-2 and C-1, and the same response applies.

Comment	Requested Change	Disposition
include discussion of methods to address the lightning protection of systems in addition to structural considerations. From a practical standpoint, the protection of fuel tank systems from lightning is no different than lightning protection of fuel tank structure in methods as well as conditions required for the top level event (i.e. lightning, flammability and an ignition source.) Achieving three independent, reliable and effective layers of lightning ignition source prevention design is impractical in many cases, as the lightning protection methods rely heavily on similar techniques as for structural lightning protection, such as electrical bonding of joints. Even more importantly trying to achieve a third layer of lightning protection can sometimes force the introduction of new failure modes and potentially decrease the overall safety of the airplane. For example, addition of a redundant bond strap that creates a short circuit which draws lightning current could result in a greater safety risk than leaving it off. The same issues identified for structural lightning protection regarding impracticality of using numerical analysis methods and documented in other comments apply to lightning interaction	the policy as follows: *The relief from § 25.981(a)(3) provided by this policy is intended to be limited <u>to lightning protection of fuel tank structure and integral tank systems</u> for which compliance with § 25.981(a)(3) is shown by the applicant and determined by the FAA to be impractical. ~~General design areas for which the TAD has determined compliance with § 25.981(a)(3) can be impractical include structural members and joints, fasteners, coatings, and sealants.~~ Determinations of practicality are somewhat subjective and can be dependent on the proposed design. Practicality determinations that are outside of the examples provided below should be submitted to the TAD for review to ensure standardization.* Additionally GAMA suggests the FAA revise the background policy material and the policy title to reflect this philosophy.	

Comment	Requested Change	Disposition
with systems in an identical fashion. The same factors that contribute to a fuel vapor ignition due to lightning apply whether it is structure or systems. In addition, lightning protection methods for systems and structure are generally similar so can have similar impracticality challenges. Therefore, this policy should address systems as well as structural lightning protection.		
Commenter: GAMA D-12		
The FAA references "Strict control of bolt/hole fit and quality" and "strict control of clearance fits & installation practices" as practical methods of compliance. Often these practices are considered to be common practices by aircraft manufacturers which provides an integral element of normal assembly quality control. Does the FAA consider this "strict control" to constitute an independent layer of ignition source protection?	Page 7, Examples of FAA Practicality Determinations	This comment is similar to comments A-6 and C-7, and the same response applies.
Commenter: GAMA D-13		
On page 7 of the draft policy memo, in the examples of FAA Practicality Determinations, "installation of sealant" is listed as a means of providing fault tolerance. It should be noted that not all sealant applications are equally effective in providing this protection.	Page 7, Examples of FAA Practicality Determinations GAMA suggests the FAA revise the applicable sentence to read as follows. *Installation of lightning protective sealant*	Agreed. This comment is similar to comment C-4. The proposed change was made.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
	or cap seals over fastener heads/ends located inside fuel tanks to provide fault tolerance.	
Commenter: GAMA D-14		
While sealant may provide an added layer of protection with respect to ignition sources, GAMA believes the FAA should include discussion regarding sound engineering considerations that must be made when choosing to install sealant as a method of compliance. For instance the excessive use of sealant is not sound engineering or manufacturing practice. The installation of fuel tank sealant should be conducted in a prudent manner to ensure additional hazards are not introduced into fuel system. Excessive use of sealant could hide structural failures during routine zonal inspections. The removal of sealant to conduct structural inspections is a difficult task in a confined area introducing potential maintenance faults. For example potential scratching of highly loaded structure or the failure to remove the enough sealant to properly inspect structure.	Page 7, Examples of FAA Practicality Determinations The FAA should include discussion regarding sound engineering considerations that must be made when choosing to install sealant as a method of compliance.	While the FAA agrees with these GAMA comments, the majority discuss a level of detail that the FAA plans to address in means of compliance issue papers or certification plans rather than in the policy memo. Any requirement to add sealant over fasteners in Zone 3 would be driven by the requirement to provide fault tolerance for the applicable Zone 3 threat where practical. If a fastener was shown to be fault tolerant without sealant, no sealant would be required. It was not the intent of the FAA to encourage applicants to use excessive amounts of sealant, and this has not been a problem with applications to date. No change was made to address these comments.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
The scope of what fasteners the FAA found sealant protection to be practical needs to be defined. It is unclear why there would be any benefit – thus why it is practical – to add overcoat to fasteners in Zone 3, where current density levels would be low. GAMA also believes the FAA should consider the impact on other aspects of §25.981 when applying large amounts of sealant. For example, large use of sealant will impact the thermal transfer capability of the wing. As noted in AC25.981-2, fuel tank temperature has a significant impact on flammability. Application of sealant should be minimized to assure the well documented cooling convection within the wing remains optimal as there is more safety benefit to be gained from this effect than from the addition of overcoat sealant.		
Commenter: GAMA D-15		
While the policy is relevant to what the FAA has found to be practical, conspicuously absent is recognition that there are other means to effectively reduce electrical arcing. The use of larger fasteners and / or the reduction of the total number of fasteners for example. Larger fasteners result in low current density and will be less likely to result in electrical	Page 7, Examples of FAA Practicality Determinations	The FAA agrees that use of larger fasteners is one way to reduce current density and reduce or eliminate the potential for arcing. However, the intent of the examples of practicality determinations was to notify applicants and FAA offices that certain design features should not be allowed to be considered impractical. Since the FAA has

Comment	Requested Change	Disposition
arcing. It is self evident that less fasteners will result in less potential for electrical arcing. Because sealant is dependent on the underlying structure, for some failures, it is not always an independent means of protection. And because the excessive use of sealant has the potential to introduce additional hazards into the fuel tank, it is not always the optimal method of compliance. Further it is hard to determine if the FAA has considered the above points and in doing so why the FAA believes the extra cost, weight, and hazards associated with the proposed approach is deemed practical.		not yet dealt with an applicant's proposal that use of larger fasteners is impractical, we do not agree that it is appropriate to add the use of larger fasteners to the list. In addition, the list of examples was not intended to be an exhaustive list. Regarding the use of sealant, the FAA has had applicants choose to apply sealant over large numbers of fasteners as a practical means of providing protection even though it resulted in additional cost and weight. The FAA agrees that, for some failure modes, sealant will not provide an independent means of protection. However, that does not reduce the value of sealant in protecting against other, more common failure modes. No change was made to the memo.
Commenter: GAMA D-16		
In the Examples of FAA Practicality Determinations, the policy does not acknowledge the ability to test fuel tanks to verify that induced energy and voltage levels are insufficient to deliver a spark which is the most optimal method to assure long-term sustainability of design and maintenance free compliance.	Page 7, Examples of FAA Practicality Determinations GAMA suggests the FAA acknowledge testing as practical by listing it as a practical example of compliance as follows: *Examples of design changes or features that have been determined to be practical*	The FAA agrees that testing is an acceptable method to show that, at the applicable threat level, design features or failures of design features will not result in arcing or sparking. However, this is considered to be a method of compliance demonstration rather than a design feature, so it was not included in the list of design features found to be practical. Methods of compliance at this level of detail are

Comment	Requested Change	Disposition
	include: Lightning threat characterization testing of representative articles of the fuel tank systems to demonstrate that induced energy and voltage levels are insufficient to deliver a spark;	expected to be covered in issue papers and certification plans. No change to the memo was made.
Commenter: GAMA D-17		
GAMA is supportive of §25.981(a)(3) as promulgated and we believe this proposed policy will result in an environment where the highest possible levels of design assurance are achieved while providing a path for new airplane designs which contain these enhanced safety features can be certified. Historically safety assessments have been conducted that have led to an outstanding safety record for lightning protection of fuel tanks. We also agree that over the past several years the field of lightning research has matured and it is appropriate to review existing regulations to assure they take advantage of this modern understanding. GAMA suggests the FAA assemble a group of subject matter experts to revise §25.981 and §25.954 in order to incorporate these best methods of fuel tank lightning protection into the regulations. GAMA does not agree that the methodology of using numerical analysis to assess compliance for lightning adds to safety nor is it appropriate for several reasons	Page 9, Special Conditions in Lieu of §25.981(a)(3) GAMA recommends that a numerical analysis requirement be replaced with a prescriptive approach. Specifically, paragraph 2. a, b, c and 3. on page 9 should be replaced to read as follows: *2. The applicant must show that the design includes at least two independent, effective, and reliable lightning protection features (or sets of features) such that fault tolerance is provided for each area of the structural design area proposed to be exempt from the requirements of that regulation. Fault tolerance is not required for any specific design feature if:* *a. providing fault tolerance is shown to be impractical for that feature, and* *b. ignition sources due to that feature and all other non-fault-tolerant features are shown to be unlikely by design.*	The first part of this comment is similar to comment D-1. The FAA does agree that further rulemaking is needed. The process for conducting that rulemaking is outside the scope of this policy memo. The proposed change to the special conditions is the same as that proposed in comment B-7. The same response applies.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
described below. First, there is little available source data relevant to lightning attachment and threat interaction with aircraft and what is available requires numerous simplifying assumptions to even be useable in a numerical analysis. Examples of required assumptions would include what data sources are appropriate to represent lightning attachment to aircraft, what parameters and waveforms of lightning are relevant to this problem, and what criteria constitutes sufficient data to make statistical assessments of distributions for the parameters of interest. Such assumptions would vary widely across industry resulting in inconsistent application between applicants. This problem is the major reason why industry has defined standard criteria based upon a severe set of lightning waveforms and prescriptive methodologies for implementing and assessing lightning protection designs relative to all past regulatory guidance. The validity of this approach is recognized by FAA through its published advisory material. Second, failure rates relevant to lightning protection functions of structural elements	*3. The applicant must show that the design, manufacturing, and maintenance programs include all practical measures to prevent failures of structural lightning protection features due to manufacturing variability, aging, wear, corrosion, and likely damage. (Delete the last sentence of 3 concerning residual risk)* The FAA should also revise the background material contained in this draft policy document to be consistent with this approach.	

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
are unavailable and not easily estimated. Many key elements of lightning protection design are primarily driven by other requirements, such as structural integrity or fuel tank integrity against leakage. While it is important and necessary to ensure that the lightning protection function aspects of these kinds of design features are known and controlled, failures associated with these elements may or may not be relevant to lightning protection or degradations that are not typically accounted for as failures may still be relevant to lightning protection. Also, general failure data of structural elements is not readily and publicly available leading to inconsistent approaches and assumptions amongst applicants. So while there are no specific probability distributions widely accepted and publicly available for lightning attachment and waveform definitions (such as current amplitude distribution), it is generally accepted by the aviation authorities to be conservatively estimated to be on the order of 10-5 per flight hour when combining probability of lightning attachment to an airplane coupled with the likelihood of a high amplitude or energy event. When coupled with flammability exposure per		

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
requirements of 3%, this indicates the likelihood of lightning attachment during a flammable condition will be improbable, per the definitions of AC 25.1309-1A. To meet the intent of the rule and draft policy the ignition source prevention features would therefore also need to be unlikely to meet the top level objective of 2a. We believe this can be adequately met by providing fault tolerant ignition source protection for lightning without requiring a numerical analysis. Where it can be shown to be impractical to eliminate all single failures to achieve fault tolerance and such failures are not widespread (i.e. result in limited exposure), mitigating factors such as inspections or increased design robustness can also be applied to make such conditions unlikely. This can also be accomplished through qualitative assessment without requiring a numerical analysis. We believe similar rationale applies to equivalency with paragraphs 2 b and c. For 2 b, assuming an FRM inoperative the probability of lightning in conjunction with the inherent flammability of the tank is still on the order of being improbable, so meeting the ignition source prevention feature criteria identified above would meet or exceed the 10-8 criteria. For 2c, the standard is extremely remote and		

Comment	Requested Change	Disposition
the probability of lightning in conjunction with the ignition source prevention criteria defined above easily meets the extremely remote criteria. The last sentence in 3 would also be deleted to be consistent with the logic above. Therefore, we believe that a prescriptive approach can be defined to meet the intent of paragraph 2 of the special conditions which will provide an equivalent level of safety and be more effective in achieving that level of safety consistently across industry. The recommended approach will yield a more consistent and standardized methodology to provide lightning protection for fuel tanks with an equivalent level of safety relative to 25.981a3. The uncertainties noted in our comments related to probability analysis recommended in the draft policy as well as the application of that safety analysis will result in inconsistent design integrity amongst applicants and incorrect conclusions regarding safety, in part due to the necessity of including unsubstantiated numerical factors. This inconsistency in approach has already been demonstrated in the certification of recent airplanes.		
Commenter: GAMA D-18		
The policy does not clearly define how to	Page 10, Exemptions for New Type	The commenter points out that there may

Comment	Requested Change	Disposition
address applicants for a new TC that have a certification basis of post amendment 25-102 and pre-amendment 25-125. In particular it states the "The FAA does not expect to be able to make the finding required for an exemption from 25.981(a)(3) for a new aircraft type that does not meet the requirements of 25.981(b) at Amendment 25-125." However, the two exemptions issued to date did not demonstrate compliance to 25.981(b) at Amendment 25-125 and on the following page there is discussion of exemption methods for pre amendment 25-125 airplane designs. GAMA believes this approach should still be acceptable for aircraft that are not complying with amendment 25-125.	Certificate Programs We request that the FAA clarify this policy to indicate how new TC applicants should address 25.981 whose certification basis does not include Amendment 25-125. Exemptions 8761 and 9148 should provide an acceptable basis for exemptions for pre-amendment 25-125 airplanes. Additionally it should be noted that the majority of these airplanes are not required to comply with amendment 26-2.	be pending new TC projects for which the flammability requirements of Amendment 25-102 apply. The commenter is correct that this is the case for pending new TC applications for aircraft that do not meet the applicability requirements of § 26.37 (30 passengers or more or payload capacity of 7500 pounds or more). All other pending new TC projects are required by § 26.37 to meet the requirements of Amendment 25-125. However, the intent of the flammability requirements of Amendments 25-102 and 25-125 is similar for wing tanks; flammability is expected to be equivalent to that which exists on an airplane with a conventional aluminum wing. The policy memo will be revised to clarify the applicable flammability requirements for pending TCs that would be associated with an exemption.
Commenter: GAMA D-19		
The policy appropriately expresses the proposed safety standards in terms of the likelihood of a fuel tank vapor ignition event, and not in terms of the likelihood of an ignition source alone. This approach permits the use of the probability of flammability in the fuel tank during the required safety analysis, and we agree with this methodology. In this manner, credit is permitted for recent enhancements in	Page 10, Exemptions for New Type Certificate Programs GAMA requests the FAA revise the text to read as follows. *For new type certificate programs, the FAA will consider granting exemptions from 25.981(a)(3) for lightning protection aspects of ignition source prevention of*	This comment is identical to comment C-1, and the same response to that comment applies.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
flammability safety standards, and the objective criteria from Amendment 25-125 may be more fully utilized. However, similar benefits are not realized from permitting the use of probabilistic values for lightning. Although clearly a logical extension of previous interpretations, considering lightning probabilities in order to mitigate impractical aspects of § 25.981(a)(3) does not address the root cause of the practicality issue. The application of a probabilistic analysis to a lightning event runs contrary to decades of established, safe, and conservative prescriptive testing practices developed by lightning specialists. As acknowledged by the draft policy memo, no universally accepted data exists to determine the exact probability of a lightning strike or the distribution of strike energy, and the development, standardization, and acceptance of such data would create a significant burden on both the FAA and industry without commensurate safety benefits. It is recommended that the policy surmount this obstacle by allowing exemptions from all lightning aspects of ignition source prevention in §	*fuel tank structure on airplanes with fuel tank systems that do not comply with that regulation, but which do comply with the applicable fuel tank flammability standards of 25.981(b) at Amendment 25-125.*	

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
25.981(a)(3) and consolidating all aspects of lightning separately in alternative prescriptive requirements (including those determined practical by the FAA and this draft policy memo). These alternative lightning requirements would serve to augment § 25.954 and avoid the core incompatibility issue between lightning and probabilistic analysis, facilitating practical means of compliance and restoring § 25.954 to relevancy with improved safety standards for the prevention of fuel tank vapor ignition due to lightning. As emphasized on page 12 of the policy memo, § 25.954 still applies to lightning protection of fuel tanks. However, due to the advent of Amendment 25-102 to Part 25, § 25.954 has been inadvertently superseded. The policy memo correctly identifies areas of improvement which would enhance the value of § 25.954 and retain its utility, including considering practical, prescriptive methods of addressing anticipated design failures, aging, wear, and maintenance errors for airplane structure. The remainder of all ignition source safety assessment items which are not lightning related would then be addressed via the quantitative analysis described in the draft policy memo and		

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
relevant guidance material. Additionally the draft policy memo does not provide clear guidance on the delineation of structure versus systems in the instances where components or mounting hardware are directly attached to structure. System element interfaces that are directly attached to structure will employ the same lightning protection strategies as structural elements, and should be considered in this policy. The draft policy memo correctly identifies structural aspects of lightning protection as an area of potential impracticality in terms of demonstrating compliance with §25.981(a)(3). However, the focus on structure alone results in the need to define the term “structure” with regards to lightning protection, which crosses the subjective boundary between systems and structure. Clarification would be needed to ascertain what specific components the policy applies to, but this situation may be avoided if the recommendation from Comment 1 is accepted. Allowing exemptions for all lightning aspects and applying a prescriptive methodology to them provides the following benefits: 1) Elimination of the need to determine and		

Comment	Requested Change	Disposition
negotiate standardized probabilities for lightning attachment and strike energy distribution; 2) Avoidance of the need to create an arbitrary delineation between structure and systems; 3) Elimination of the need to demonstrate impracticality, as practical prescriptive requirements will be established. This also prevents the unfortunate consequence of applying probabilistic analysis to lightning: the addition of redundant protection features which themselves introduce additional failure conditions. It is therefore recommended that the policy be expanded to allow exemptions to all lightning aspects of §25.981(a)(3), provided flammability requirements are met along with alternative prescriptive requirements for lightning aspects.		
Commenter: GAMA D-20		
The FAA should replace the numerical analysis method with a prescriptive approach when fault tolerance is shown to be impractical for the same reasons mentioned above (reference comment to page 9).	Page 11, Exemptions for New Type Certificate Programs Specifically, GAMA suggests the FAA modify paragraph 1.b to appear as follows: *1. In lieu of compliance with the requirements of § 25.981(a)(3),…. for any specific design feature if:* *a. providing fault … for that feature, and*	This comment is similar to comments B-7 and C-1, and the same response applies.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
	b. ignition sources due to that feature and all other non-fault-tolerant features are shown to *be unlikely by design.*	
Commenter: GAMA D-21		
Amendment 26-2 only applies to a very small segment of part 25 airplanes which have amendment 25-102 in their certification basis but not amendment 25-125.	Page 11, Exemptions for Certain Type Design Change Programs on Amendment 25-102 Airplanes GAMA requests that the FAA re-word this section to more accurately reflect the landscape of certification work which is underway. Mention of amendment 26-2 should be made with a note in this section as there may be but one product that will fall in the category being defined while a majority will not utilize amendment 26-2.	Agreed. The response to item D-18 applies to this comment. The policy memo will be revised to clarify the flammability requirements for pending TC projects that would be associated with an exemption.
Commenter: GAMA D-22		
Summary: Proposed policy is needed to address a certification environment where new airplanes that utilize the most thorough design techniques and contain the safest technology in history can not move forward.		We agree; that was the purpose of this policy memo. No change was made for this comment.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
Commenter: George Walters E-1		
	While I think that the FAA must be willing to work with the companies seeking certification under part 25 I'm concerned about this relaxation of the rule. While I agree that the original rule was probably unworkable, the latest special condition proposal goes too far in relaxing the rule. I'd like to make a few points. 1) It is my experience that sufficient layers of composite will effectively prevent puncture or burn through without respect to paint or other coatings and I'm assuming that Boeing has this thickness. 2) The rule requiring 3 independent layers of protection was unworkable and to relax that requirement makes sense. Neither Dassault nor Hawker could meet that rule but having been the direct effects DER for Hawker we made our best effort toward meeting the rule. 3) The rules/advisory material regarding lightning and flammability have failed to address systems, treating only structure. 4) I believe it is a common ground of agreement that if a flammable atmosphere	The commenter concurs with the need for the policy memo, but makes no specific proposal for a change to the memo. We infer that the commenter is proposing that dispatch with an inoperative fuel tank inerting system should not be allowed. That is not the subject of this memo. However, we acknowledge the commenter's concern about this issue. Decisions on allowable dispatch relief are made through a structured process involving an FAA Flight Operations Evaluation Board (FOEB). This board is chaired by the FAA Flight Standards organization, and the project Aircraft Certification Office (ACO) provides technical support to the FOEB. The ACO will work with the FOEB to ensure that it is fully aware of the safety implications of providing dispatch relief for any flammability reduction means. The FOEB process examines each proposed dispatch relief item on a case-by-case basis. This policy memo and the type certification requirements included in the special condition and exemption requirements are not intended to replace the FOEB process by dictating that

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
	does not exist then the presence of a spark is probably not of consequence. 5) An inerting system functioning properly can assure this condition. 6) This would seem to make the system and it's monitoring flight critical "DAL A". 7) It would also seem to indicate that an aircraft must have that as part of the MEL. As a result I cannot understand the position allowing operators of this equipment to dispatch without it. I believe that allowing dispatch without multiple layers of protection, at least two, which I believe is obtainable, places the Boeing Company, the operator, and the FAA at risk. As pointed out by your own people, many from Boeing (including at one time myself), this leaves the aircraft only one Failure from disaster. A disaster of this magnitude on a primarily composite airframe could put both the operator and Boeing out of business due to litigation. As a representative of the FAA I feel that requiring the inerting system to be active prior to and during flight is the only	dispatch relief will or will not be granted.

Comment	Requested Change	Disposition
	reasonable approach. Assuming that was the FAA position I think the relaxation of the rule is reasonable. Is there any effort to make this happen?	
Commenter: Gerald Eastman F-1		
	The reasons behind this change are problematic in that they show (in my belief) a strong FAA management bias against protecting the safety of passengers and crew when faced with choosing between such passenger/crew safety and the cost, schedule, and profitability concerns of what FAA management considers their most powerful and important "customer"—Boeing. Because of this FAA management bias that is intentionally placing the public that will fly on aircraft affected by this proposed policy change (primarily on the 787) at much higher levels of risk during lightning strikes in order to ensure relatively narrow Boeing cost, schedule, and profitability concerns, I propose that FAA management make any possible reason for that bias against public safety a part of the public record of this proposed change, especially when they have so inexplicably overruled the objections of their technical experts in this matter during the formulation of this proposed policy change.	Primarily, this comment states concerns about the FAA's negotiations with industry and requests information regarding the potential for inappropriate FAA motivation for issuing this policy memo. Comments specific to the proposed policy are similar to comment H-1, and the same response applies. No changes to the memo are proposed. No change to the memo has been made.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
	Note that the new policy of the new U.S. executive administration presupposes that all such material asked to be made part of the record of this proposed change is releasable to the public, in direct opposition to past practices in which agency secrecy ruled the day, even when material was not made public solely to prevent embarrassment of agency personnel involved in questionable if not illegal practices. Therefore, please make the following part of the record of this proposed change so that I and other interested parties can more closely examine possible reasons for this bias for Boeing economic interests and against public safety in more detail than is currently in print on the subject in newspaper articles, etc. This information will also be useful to the public in ascertaining the reasons behind otherwise inexplicable bias for Boeing and against the interests of the public in other matters before the FAA. Please make the following information a part of the permanent record of this proposed change. Please survey all FAA personnel who had	

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
	anything to do with this proposed change and make the data they provide a part of the record. For each FAA employee, list the employee's name, their current position in the FAA hierarchy, and approximate dates and times of the event, if known. 1. List all contacts each person has had with Boeing personnel, including dates, times, places and the duration in which the meeting occurred. 2. Have personnel list all items of any possible value they have received from Boeing, including, but not limited to, the following: a.) Bribes. b.) Kickbacks. c.) Job offers. d.) Vacations at Boeing expense. e.) Vacations at Boeing paid facilities. f.) Attendance at Boeing owned or leased or otherwise controlled locations (such as the Boeing Mariners' Suite at Safeco Field in Seattle, Boeing sponsored golf tournaments, etc.).	

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
	3. Have personnel list all current or former Boeing personnel they consider to be in the following categories, with names and position held at Boeing (or they used to hold at Boeing) before their departure. a.) Friends. (with which personal interests and FAA business was discussed). b.) Close friends. (with which personal interests and FAA business was discussed in a setting outside work locations). c.) Very close friends (with which personal matters almost exclusively were discussed in a setting outside work locations.) d.) Romantic relationships. e.) Not friends (with which only FAA business was discussed). 4. List of all items of any value FAA employees received from Boeing or former Boeing employees listed in item 3 above. 5. For all job offers from Boeing or Boeing connected personnel, list the following:	

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
	a.)Where and when that offer was extended. b.)Who extended the offer. c.)Under what conditions that offer was extended. d.)If the FAA employee has accepted that offer. e.)What were the salary, position, and location of the job that was offered. f.)If it was understood a policy change or other favor in their current position at the FAA was required to be done in order to claim the job offer, what was the exact favor required for the particular job offer. 6. Anything of monetary value or other value that has been promised by Boeing in the future for action Boeing wants FAA personnel to take. 7. Any knowledge of FAA personnel of former FAA personnel obtaining jobs at Boeing or at Boeing funded industry associations or subcontractors, including as much data as the FAA person remembers about that job, including the name of the former FAA person who took it, circumstances under which they became employed as noted, the date it was taken, any salary	

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
	and benefits the FAA person remembers were attached to the job. I understand the hesitancy to release this information as it may lead to charges against FAA personnel that have committed crimes. For those items in which an FAA employee does not wish to answer because they fear doing so will expose then to criminal sanctions, just list the employee's name and a phrase akin to "employee refuses to answer persuant to the 5th amendment to the Constitution" in the space that would have held their answer to the particular question. Of course, this list may not be all inclusive of everything that could explain bias by FAA personnel in this matter, so feel free to disclose additional info from each affected FAA employee that is uncovered in this process, erring on the side of more disclosure rather than less, as per the new policy from the executive branch of the federal government mentioned prior. This comment is lengthily due to the commenters effort to capture all data that may possibly instill bias in FAA personnel, however, of course, the data produced depends on the individual circumstances,	

Comment	Requested Change	Disposition
	and obviously does not need to be as lengthily if only a few of the data points (or any) are applicable to the particular employee. Remember that I am requesting data be made public from only any FAA employees that are involved in any way with this particular proposed policy change, including their management, up to and including the FAA administrator, so affected personnel should be minimal in number. If FAA management decides not to make this data public, please state in the disposition the specific CFR that precludes such disclosure, and answer the rest of my comments without prejudice for having made this comment.	
Commenter: Gulfstream G-1		
We believe that this proposed policy is necessary to provide clarification on the certification options in light of evidence that there is no proactical means to comply with 14 CFR part 25.981(a)(3)		No change is proposed or made.
Commenter: Gulfstream G-2		
It is inappropriate to apply 25.981 to structures. • When the rule was promulgated the preamble did not discuss that it would apply to structures. • There is no evidence that during the	Revise the FAA position relative to 25.981 and address lightning protection of fuel tank structure through 25.954. If novel and unique features exist then the FAA could issue special conditions. These	The FAA re-examined this question of the scope of § 25.981 after a similar position was formally submitted to the FAA by GAMA. The FAA made a determination that § 25.981is intended to include consideration of lightning protection and

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
SFAR 88 exercise that structure was addressed. • An analysis that assumes that a lightning strike will occur (probability of 1) combined with a latent failure of the structural protection features is extremely difficult to achieve. Any quantitative portion of this type of analysis would have questionable merit as the numbers would be difficult if not impossible to substantiate. Thus this type of approach is inappropriate for structures.	could require in addition to or in lieu of 25.954 that the lightning protection features of the fuel tank structure be fault tolerant. An acceptable definition for fault tolerant would need to be defined. Alternatively if the FAA has evidence that an unsafe condition is present the FAA could identify this as an unsafe condition under 14 CFR 21.21(b)(2).	consideration of structural aspects of fuel tank systems. The FAA agrees with the second part of this comment regarding the impracticality of compliance with § 25.981(a)(3) for fuel tank structure, and is issuing this policy memo to address that issue in the interim while further rulemaking is considered. No change has been made to the memo.
Commenter: Gulfstream G-4		
The policy does not address the expectations of the FAA relative to SFAR 88 exercise. If it is not practical for applicants to comply, how were these aircraft handled? Do they need to be re-assessed to ensure the structural aspects were considered? Does the FAA anticipate exemptions for these aircraft?	Add clarification to address aircraft that must meet SFAR 88.	SFAR 88 analysis is not the subject of this policy memo. (SFAR 88 did address structural issues, and several ADs are in work or have been issued to address issues with fasteners and with bonding of systems supporting structure.) No changes were made to the memo.
Commenter: Gulfstream G-5		
Definition of “fuel tank structure” is ambiguous. There are two aspects to this term that need to be clearly understood. Definition of a fuel tank and definition of structure.	Definition of Key Terms, Second paragraph Clarify the definition of fuel tank structure. Define a fuel tank as those compartments or storage bays intended by design to contain fuel.	This comment is similar to comment A-2, B-3, and D4, and the same response applies. Changes have been made to the memo to clarify the definition of fuel tank structure.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
	Define structure to include structural elements and associated fasteners, coatings, and sealants. In addition, attachment hardware associated with components mounted to structure such as fasteners attaching a mounting bracket.	
Commenter: Gulfstream G-6		
Within the policy it is not clear that Amendment 26-2 is not applicable to all aircraft but is focused on those with a seating capacity of greater than 30, payloads larger than 7500 lbs, etc. These are predominately aircraft in scheduled airline service as regulated by parts 121 and 125.	Page 4, second paragraph starting with "Amendment 26-2…" Provide clarification on the application of Amendment 26-2 and clarification as to why the limitation is relevant to part 25 and how this should be considered in applying the policy.	Agreed. The response to item D-18 applies to this comment. The policy memo will be revised to clarify the flammability requirements for pending TC projects that would be associated with an exemption.
Commenter: Gulfstream G-7		
The proposed policy for areas that need an exemption has no defined boundaries. Locating fuel tanks in lightning strike Zone 3 is an effective means protecting the fuel from the effects of lighting. The energy levels within lighting strike Zones 1 and 2 could be expected to be higher and of more of a direct concern. It should be noted that the FAA only required exemptions to date for those aspects of the fuel tanks contained in lightning zones 1 and 2.	Clarify that the need for exemptions is applicable to those portions of the fuel tanks located in lightning strike Zones 1 and 2.	The proposed policy memo is intended to cover all aspects of lightning protection of structure, and is not limited to Zones 1 and 2. The safety analysis requirement of the special condition and the prescriptive architecture requirement of the exemption conditions were intended to include coverage for zone 3 conducted current threats and design features. The exemptions granted to date addresses zone 1 and 2 issues because those were the areas addressed in the petitions for exemption.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
		No change was made to the memo regarding this comment on scope.
Commenter: Gulfstream G-8		
Within this section the FAA proposes that it is acceptable to consider the probability of lightning attachment, the distribution of lightning strike energy, and the probability of fuel tank flammability. The FAA's expectations are vague as to what would constitute an accepted methodology. • Traditionally lightning has been treated as a critical environmental condition under 25.1309. This is because lightning events typically occur during combined environmental conditions such as rain, icing, hail, turbulence, etc. Title 14 CFR 25.1309 was prescriptively written to consider protection of any system failure that would prevent the "continued safe flight and landing" of the aircraft. The intent of this regulation is to ensure protection against multiple environments and hazards. Through out Part 25, subparts C and D there are a number of requirements that ensure aircraft structure is protected from these same combined environmental events. To now single out lightning and assess it for its probability is suspect as it disregards the other accompanying environmental hazards. • The policy notes that there is no accepted	Last paragraph page 6. Strike the proposal for quantitative assessments from the policy in their entirety. Add specific considerations for qualitative assessments that will establish a robust ignition protection design	This comment raises some of the issues raised in comment C-1, and the same response applies. The policy memo has been changed to require a numerical probability analysis only if non-fault-tolerant design features are included in the design. The methods for estimating the probability of lightning strike and a lightning amplitude distribution are addressed in the response to comment C-1.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
methodology for calculating the probability of occurrence of a particular lightning hazard. It is difficult to assign numerical factors to the large number of possible lightning environment parameters and modes of interaction possible between lightning and the aircraft. Further, it has always been a concern that a simple multiplication of probabilities, such as the probability of lightning current of enough magnitude to of concern, times the probability of lightning striking a particular location, plus the probability of fuel vapor in a flammable condition, plus additional factors will yield a solution that meets the 10-9 requirement. In theory one could draw the conclusion that there is no need to consider protection. Quantitative probabilities should not supersede sound engineering judgment in applying an appropriate level of lightning protection. • AC33.4-3, while not directly applicable to compliance to 25.981, has been used in demonstrating compliance to certain part 33 regulations through a probabilistic approach to lightning protection. This AC has an established probability defined for lightning attachment (1 in 2500 of a strike with enough energy to result in damage to an engine control) and a methodology for calculating probability of distribution of		

Comment	Requested Change	Disposition
lightning strike energy including consideration of latent failures. However, the methodology for calculating the probability of distribution of energy assumes a small finite number of paths, as would be typical in an engine control. A metallic structure, and typical associated fuel system, could in theory have near infinite paths of energy distribution and could be potentially exposed to direct or indirect effects from a lightning strike on any portion of or near the aircraft. This makes an analysis similar to that described in AC33.4-3 difficult and of questionable merit. Based on the difficulties cited above, It would be of greater value to focus on critical lightning protection design features that utilize sound engineering judgment rather than require a numerical analysis.		
Commenter: Gulfstream G-9		
The term "arc/spark-free rivets" is used but is undefined. Typically arc/spark-free rivets are used in composite structure and enable bonding of the fastener to metallic mesh. The reference to use of arc/spark-free rivets in aluminum structure is particularly unclear. Is this in reference to ensuring a well	Examples of FAA Practicality Determinations Define arc/spark-free rivets and provide examples.	This comment is identical to comment D-6, and the same response applies. The FAA agrees that the term arc/spark-free rivet should be clarified. The FAA intended it to mean a fastener that is well-bonded to surrounding structure. The wording of the example has been changed to make this more clear.

Comment	Requested Change	Disposition
bonded fastener to the surrounding structure, to a specific type of fastener, or to a fastener that has been treated to be non-conductive?		
Commenter: Gulfstream G-10		
The policy states "Installation of sealant or cap seals over fastener heads / ends located inside fuel tanks to provide fault tolerance." The excessive use of sealant is not sound engineering or manufacturing practice. The integrity of the fuel tank sealant is dependent upon the underlying structure. There can be no assurance that when a failure of the underlying structure occurs the fuel tank sealant will continue to function as a barrier to electrical arcs. The installation of fuel tank sealant should be conducted in a prudent manner to ensure additional hazards are not introduced into fuel system. Misapplication and the deterioration of sealant could potentially result in clogging of fuel systems. Reference FAA airworthiness directive 89-18-08 relative to this issue. The effectiveness of the sealant is dependent on the skill of the technician in	Examples of FAA Practicality Determinations Change policy to reflect that over coating of fasteners be conducted in a prudent and judicious manner to ensure additional hazards are not introduced into the fuel system. Change the policy to reflect that it is practical in areas where a good electrical bond from the fastener to the structure cannot be assured such as non-interference fit fasteners or field repairs. But the use of sealant should be avoided in areas where repeatable manufacturing processes, such as interference fit fasteners, can assure electrical continuity. Provide guidance or reference to guidance on effects of degradation of sealant overtime and its impact to function as an effective electrical barrier.	This comment is identical to comment D-14, and the same response applies.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
its application. In areas that are hard to reach it will be difficult to ensure an adequate level protection is provided. Re-application of the sealant after inspections or repairs will be even more difficult to ensure. Difficult working conditions can result maintenance errors such as leaving tools behind in the tank. Reference FAA airworthiness directive AD 2006-10-15 relative to this issue. The removal of sealant to conduct structural inspections is a difficult task in a confined area introducing potential maintenance faults. For example potential scratching of highly loaded structure or the failure to remove the enough sealant to properly inspect structure. The ability of sealant over time as an effective electrical barrier is unsubstantiated. Since sealant does not eliminate arcing but rather ensures that the arc is not exposed to the potential flammable vapors inside the tank, it is only effective as long as there is integrity to the barrier. However, sealant deteriorates with age and with working of the structure. While continuity of the fuel tank will be		

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
detectable through leaks, continuity of an electrical barrier cannot be detected or assured. The scope of what fasteners the FAA found this to be practical needs to be defined. It is unclear why there would be any benefit – thus why it is practical – to add overcoat to fasteners in Zone 3, where current density levels would be low. As noted in AC25.981-2, fuel tank temperature has a significant impact on flammability. In encouraging this methodology, is the wing still considered a conventional aluminum wing? While the policy is relevant to what the FAA has found to be practical conspicuously absent is recognition that there are other means to effectively reduce electrical arcing from fasteners. The use of larger fasteners and / or the reduction of the total number of fasteners for example. Larger fasteners result in low current density and will be less likely to result in electrical arcing. It is self evident that less fasteners will result in less potential for electrical arcing. As noted elsewhere in the draft policy, the effects of manufacturing variability, aging, wear, corrosion, and likely damage must be considered in assessing potential		

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
failures. Because of the points above associated with each of these effects, we cannot concur that over coating fasteners is in itself an effective and practical means of ignition source protection		
Commenter: Gulfstream G-11		
The portions of the wing required to be addressed by the policy are not clearly defined. In the two exemptions to date the applicants addressed those portions of the wing impacted by direct effects of lightning Zones 1 and 2.	Examples of FAA Practicality Determinations Add guidance that applicants should locate as much of the fuel tank within Zone 3 as an effective means of protecting from lightning. Add guidance that the FAA envisions the need for exemptions for portions of the fuel tank in Zones 1 and 2.	This comment is similar to comment G-7, and the same response applies.
Commenter: Gulfstream G-12		
No definition is given for the FAA's expectations for demonstrating compliance relative to these design features that have been determined to be "practical". In exemption 9148 the FAA required the applicant to demonstrate the effectiveness of these design features through test – particularly relative to sealant over coating. It was unclear why this was required when these design practices are well documented.	Examples of FAA Practicality Determinations Provide specific guidance that .100" of sealant has been shown to be effective barrier for electrical arcing and can be accepted without further substantiation.	While the proposed exemption conditions would require an applicant to demonstrate that design features are independent, effective, and reliable, the policy memo is not intended to cover methods for demonstration of these attributes. This would be covered in issue papers or certification plans for each project. No change to the memo was made.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
Commenter: Gulfstream G-13		
Reference previous comments on Policy, last paragraph page 6 noted above. The draft policy proposes that "A safety analysis must show that: a catastrophic fuel tank vapor ignition in the fuel tank system due to lightning is extremely improbable. If the FAA is assuming the structure forms part of the "fuel tank system" then there is no definition of an accepted means of compliance for demonstrating that a vapor ignition is extremely improbable. Typically to demonstrate a scenario is extremely remote a quantitative analysis is conducted. Any such quantitative analysis of structure would have questionable merit since a method for calculating the probability of failure of structure has not been established.	Page 9, Special Conditions, Item 2a Clarify that a fuel tank system refers does not include the structure.	The FAA does not agree with the commenters proposed clarification. The FAA position is that § 25.981 applies to the whole fuel tank system, including its structural elements. The specific definition of fuel tank structure is discussed in the response to comment A-2 above.
Commenter: Gulfstream G-14		
The draft policy proposes that "for each failure mode of each particular type of design feature (such as a particular fastener or joint type), the occurrence of an ignition source due to each failure mode of the feature is extremely remote, assuming all instances of that feature (such as the particular fastener type) have failed in that	Page 9, Special Conditions, Item 2c Provide clarification as to the FAA's intent. Limit the consideration of the number of fasteners failing in any given mode to that which would not be detected.	This comment is similar to comments A8 and A-9, and the responses to those comments apply to this comment. The memo was changed to clarify the expectations in this area.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
mode." The FAA's expectation is unclear. If the intent is every fastener fails in the same mode at the same time this could potentially represent a catastrophic failure of the wing.		
Commenter: Gulfstream G15		
Calculating the probability of lightning strike and distribution is undefined. Same comment as provided above regarding last paragraph page 6.	Page 9, Special Condition, last paragraph See above.	This issue is addressed in the response to comment C-1.
Commenter: Gulfstream G-16		
The policy does not clearly define how to address applicants for a new TC that have a certification basis of post amendment 25-102 and pre-amendment 25-125. In particular it states the "The FAA does not expect to be able to make the finding required for an exemption from 25.981(a)(e) for a new aircraft type that does not meet the requirements of 25.981(b) at Amendment 25-125." However, the two exemptions issued to date did not demonstrate compliance to 25.981(b) at Amendment 25-125. This approach should still be acceptable for aircraft that are not complying with amendment 25-125.	Exemptions Provide clear guidance on how new TC applicants should address 25.981 whose certification basis does not include Amendment 25-125. Exemptions 8761 and 9148 should provide an acceptable basis for exemptions for pre-amendment 25-125 airplanes. These applicants should have to demonstrate that the flammability exposure is low and that the airplane complies with 25.981(c).	This comment is similar to comments D-8, D-18, and D-21, and the same response applies. The memo has been clarified to address this issue.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
Commenter: Gulfstream G-17		
It is not clear that if Amendment 26-2 is not applicable to the aircraft if the aircraft must meet the flammability requirements of 26-2 in order to obtain an exemption.	Exemptions for Certain Type Design Change Programs on Amendment 25-102 Airplanes Provide clarification on the FAA's intent. If Amendment 26-2 is not applicable there should be no requirement to demonstrate compliance to the fuel tank flammability standards.	This comment is similar to comments D-8, D-18, and D-21, and the same response applies. The memo has been clarified to address this issue.
Commenter: NATCA H-1		
NATCA strongly objects to the proposed new policy as it would result in a significant reduction in airplane safety. NATCA recommends that the denoted changes be made so that the proposed policy achieves an acceptable level of safety. The FAA should honor its post TWA800 commitment to preventing such accidents by assuring the aircraft our families and friends fly in are nominally free from flammable fuel tanks and not exposed to single point failures that can cause ignitions.		For the reasons discussed in the response to NATCA's specific comments below, the FAA does not agree that the proposed policy will result in a reduction in airplane safety. The FAA shares the commenter's goal of safe air travel, and agrees that single failures that cause fuel tank ignition events should not be allowed. The FAA understands NATCA's term "nominally free from flammable fuel tanks" to mean that level of flammability associated with an unheated aluminum wing tank. The FAA has set specific standards for allowable fleet average flammability for new design approvals. In addition, some application of those standards or a less stringent standard to previously approved airplane designs and to previously

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
		manufactured airplanes was included in that same rulemaking package (amendments 25-125, 26-2, 121-340, 125-55, and 129-46).
Commenter: NATCA H-2		
Please note that we agree with the intent of portions of the policy, such as the concept of allowing consideration of new fuel tank flammability reduction systems when determining whether the threat of a fuel tank explosion caused by a lightning strike has been effectively mitigated. The potential improvements in safety afforded by the introduction of reliable and effective "Flammability Reduction Means" may warrant some reduction in the current ignition prevention standards.		No specific proposed change to the policy memo was made.
Commenter: NATCA H-3		
NATCA also agrees with the concept (under appropriate conditions) that new designs can be certificated (aka FAA approved) via Exemptions, Equivalent Safety Findings, or Special Conditions in lieu of § 25.981(a)(3) compliance. However, the FAA Aircraft Certification Engineers we represent, whose job it is to develop and approve this sort of policy, report that this policy is substantially inadequate and being proposed by FAA Management over their objections and formal non-concurrence. Even though Mr.		This comment is outside the scope of the policy memo, and no change to the memo was made.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
John Hickey (former lead manager over Aircraft Certification) stated in a FAA town hall meeting in March 18, 2008, that this issue had been resolved, we do not agree. NATCA has already filed a grievance in regards to this matter and is protecting its engineers from any potential retribution and liability for the illicit and unjustified step backward in safety that would occur if this policy is implemented as proposed.		
Commenter: NATCA H-4		
Objection 1. This new policy memorandum would allow foreseeable single failures to lead to a catastrophic fuel tank explosion under operating conditions approved for the airplane. The occurrence of lightning is dramatically more likely to occur during a flight from Atlanta to Orlando in the summer than from Seattle to San Francisco in the winter. A lightning strike on an aircraft that has a single point failure source for ignition can result in a fuel tank explosion. The FAA has routinely stated in the past that lack of single fault tolerance is unacceptable, even unsafe in most cases. FAA policy memorandum 2003-112-15, titled "SFAR 88 - Mandatory Action Decision Criteria" states "For any *(fuel)* tank (with a high or	NATCA Recommendation 1. This policy memorandum must not allow any foreseeable single failures to lead to a catastrophic fuel tank explosion under operating conditions approved for the airplane.	The FAA infers that the commenter means environmental conditions where the term "operating conditions" is used. The risk assessment involved in showing compliance through this policy would acknowledge that the combination of environmental conditions necessary to create a vapor ignition event is very unlikely. Specifically, the probability of lightning strikes, the probability of critical lightning amplitude, the probability of critical attachment location, and the probability of flammable tank conditions all can be appropriately included in the risk assessment. The probability of flammable conditions would account for the performance and reliability of a flammability reduction means included in

Comment	Requested Change	Disposition
low flammability exposure time), any foreseeable single failure condition, regardless of probability and service experience, that may result in a potential ignition source within the fuel tank system is considered an unsafe condition and must be addressed by corrective action (i.e. AD)." The FAA is still issuing ADs (airworthiness directives) that mandate corrective actions for such single failures (NOTE l). The current standards (aka federal aviation regulations) require the airplane safely tolerate any foreseeable single failure under any anticipated operating conditions approved for the airplane. However, this new policy proposes to supersede these standards by allowing some known single failures such as certain fastener failures, structural element cracking and sealant failures. NATCA contends there is no credible way of finding acceptance of known single catastrophic failures to be in the public interest, much less equivalently safe to not allowing known catastrophic single failures (see also objections #2 & 4 below). We propose the FAA retain the current prohibition against single catastrophic failures. One means to do this would be to adopt our recommendations regarding objection #2 below.		the design. Although, the proposed memo would allow single failures that could create a vapor ignition event in the event of a critical lightning strike and flammable conditions, this is only allowed where necessary due to impracticality and where justified by a risk assessment showing that a fuel tank vapor ignition event is still extremely improbable. The FAA has found it necessary to address impracticality of compliance with § 28.981(a)(3) for lightning protection of fuel tank structure in two previous TC projects, and in several pending TC and design change projects. These practicality issues are not considered to exist for systems elements, and those elements are not the subject of this policy memo. It was not the intent of Amdt. 25-102 to impose impractical requirements for ignition source prevention, and the FAA has initiated a rulemaking project to address this. In the meantime, with the conditions imposed to minimize these risks and compensate for them with FRM, the agency's position is that the level of safety is equivalent (see below). In addition, the FAA notes that, under § 25.954, fault tolerance was not a requirement, so single

Comment	Requested Change	Disposition
(NOTE 1 For example, FAA Notice of Proposed Rulemaking, Docket No. FAA-2005-0640; Directorate Identifier 2005-NM-070-ADJ, RIN 2120-AA64, Proposed Airworthiness Directives; Boeing Model 747-400, 747-400D, and 747-400F Series Airplanes. The preamble states "As a result of the SFAR 88 design review activity. Boeing has found that certain single failure modes within the electric scavenge pump could cause heating and sparking,. which could create a potential ignition source inside the main fuel tank 2. This condition, if not corrected. could result in a fire or explosion in the main fuel tank 2 and consequent loss of the airplane.") The provision discussed in the memorandum's Special Condition section allowing entire classes of "known single failures" if the conditional probability of their resulting in a catastrophe is extremely remote. While possibly acceptable for randomly occurring individual single failures, this provision is clearly inadequate to cover endemic errors which could be present on every airplane throughout the fleet life of the airplane type. Only if the conditional probability were extremely improbable (e.g. have an		failures have historically been allowed for lightning protection of fuel tank structure, without catastrophic service history once adequate skin thickness was identified. The comment regarding lightning frequency is made in more detail under comment H-6, and the FAA response to this issue is made in that section. The decision criteria in policy memo 2003-112-15, were not applied at the time to structural lighting protection issues. The structural lightning protection related ADs identified during the SFAR 88 design studies were cases where vulnerability to creation of an ignition source in the event of lightning existed in the design in the absence of any failure. A fail safe standard for structural lightning protection was not actually applied as part of the AD board activity because design approval holders in general did not identify single failures in fuel tank structure as SFAR 88 non-compliance issues. Had the FAA attempted to apply that policy memo to the structure of existing airplanes at the time of the post-SFAR 88 AD boards, similar impracticality issues would have been identified. This policy memo is intended to provide an interim standard to resolve

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
average probability per flight hour of less than 1 x 10-9) could this be acceptable. Also, the provision in the memorandum's Exemption section regarding "non-fault-tolerant features", allows the entire average risk normally allotted a catastrophic failure condition to be used up by single failures. There is effectively no limit placed upon the risk that can be posed by all the multiple failures. How can this be shown to be "in the public interest"? This is like saying nobody is ever expected to win the lottery because the odds of one ticket winning are so low.		this dilemma. In discussing the prohibition against catastrophic single failures in the current regulations, the FAA infers that the commenter is referring specifically to the standards for structural lighting protection under § 25.981(a)(3) at amendment 25-102. (There are other limited areas in part 25 where potentially catastrophic single failures can be accepted, such as uncontained engine failures and landing gear structural failures.) The FAA has determined that it is in the public interest to allow single failures in this case because of the remoteness of the conditions that must exist in order for those failures to be catastrophic (flammability and a critical lightning strike), and because addressing certain single failures through structural design changes or inspections has been shown to be impractical. As stated above, such failure conditions would only be allowed where the applicant can show it is necessary due to impracticality, and can show that a catastrophic event is extremely improbable. Failure to acknowledge and reasonably accommodate such single failures was determined to have an

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
		unacceptable economic impact on the industry and the public. The FAA therefore does not agree that the proposed allowance for single failure conditions should be eliminated. The FAA assumes that the comment referring to a special condition "known single failures" is referring to paragraph 2.c. of the special conditions. This paragraph was intended to limit the risk that could arise from a design error or manufacturing defect that leads to many similar failures existing on an individual airplane due to one cause. This requirement was deleted as part of the change to a prescriptive architecture requirement for special conditions. The FAA has determined that an equivalent level of safety to direct compliance with § 25.981(a)(3) will be achieved through application of the proposed special condition requirements. The FAA considers that, instead of only concentrating on fault tolerance for ignition source prevention, significantly reducing fuel tank flammability exposure in addition to preventing ignition sources is a better approach to lightning protection

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
		for the fuel tank. In addition, the level of average fuel tank flammability achieved by compliance with these special conditions is low enough that it is not appropriate or accurate to assume in a safety analysis that the fuel tanks may always be flammable. Section 25.981(a) requires applicants to demonstrate that an ignition source could not result from any single failure, from any single failure in combination with any latent failure condition not shown to be extremely remote, or from any combination of failures not shown to be extremely improbable. In lieu of this requirement, this policy sets alternative requirements for ignition protection for which compliance has been determined to be practical. Section 25.981(b) at Amendment 25-125 sets limits on the allowable fuel tank flammability. The proposed special conditions apply the more stringent standard for warm day flammability performance applicable to normally emptied tanks within the fuselage contour from § 25.981(b) and part 25 Appendix M to all fuel tanks on an airplane as a compensating feature for the use of the proposed alternative ignition source

Comment	Requested Change	Disposition
		prevention requirements. The commenter expressed concern that, in the exemption conditions, the FAA is allowing the entire allotment of allowable risk to be used up by the sum of the failure scenarios involving non-tolerant features. The FAA agrees that the required assessment uses the extremely improbable standard for the single failures alone. However, this is considered to be acceptable because the risk assessment is expected to be dominated by the non-fault tolerant features, and that fault tolerant features would not contribute significantly when compared to the risk posed by the non-fault tolerant features. The risk due to failures of fault tolerant features is considered to be adequately controlled by the requirement that the fault tolerant features be independent, effective, and reliable.
Commenter: NATCA H-5		
Objection 2. The proposed Special Condition criteria within this new policy memorandum does not provide an equivalent level of safety (ELOS) to compliance with § 25.981(a)(3) as required by § 21.16. This policy claims the presence of fuel	NATCA Recommendation 2a. Until such time as technical experts have created and validated credible models for predicting the actual probability of flammability, NATCA recommends the FAA retain the existing policy of requiring the conservative simplifying assumption that the fuel tanks are always flammable for the	The commenter appears to have misunderstood the flammability requirements associated with special conditions under the proposed policy. The special conditions go beyond the requirements of Amdt. 25-125 because they would impose the FRM requirement on main tanks, not just center tanks. In

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
tank flammability reduction means meeting the provisions of § 25.981 (b) at Amendment 125 balances out the proposed reduction in the level of ignition prevention, thus providing an equivalent level of safety. This requirement would allow the fuel tanks to be flammable for three percent of every flight. Furthermore it includes allowances for the inerting system to be inoperative for up to 10 days. This means on some warm day flights, like that of TWA800, the fuel tanks could be flammable for most of the flight. NATCA finds the FAA has failed to substantiate their claim of equivalency and in fact many subject matter experts find that claim to be preposterous. This policy is a significant change from current engineering regulations, traditional fail safe aircraft design objectives, and sets a precedent that could reverse decades of safety improvements. If the FAA wants to lower the level of safety, then it must publish this as a proposed new rule open for public comment and scrutiny. The FAA cannot legally make regulatory changes via a policy memorandum as proposed here. Obviously a part time reduction in risk of a couple percent over a portion of the fuel tank vapor space cannot possibly equal a	purposes of doing traditional probability analyses. (NOTE 2) (NOTE 2 AC 25.981-1C. "FUEL TANK IGNITION SOURCE PREVENTION GUIDELINES", dated 9/19/2008. Paragraph 10.c.(1) states "The analysis should assume that the environment inside the fuel tank is always flammable.")	addition, the more stringent requirements of part 25 Appendix M would be applied to all fuel tanks rather than just normally emptied tanks within the fuselage contour. Finally, policy says it may be necessary to exceed the requirements of Amdt. 25-125 to comply with the probabilistic requirements of the special conditions. Also, the commenter's statement that a fuel tank can be flammable for up to 3% of each flight is inaccurate. The fleet average Flammability Exposure Evaluation Time is limited to 3%, including both FRM performance and FRM reliability factors, each of which is limited to no more than 1.8%. This is calculated on a fleet average basis, so some individual flights can be flammable for more than 3% of the flight. (See App. M25.1(a), which must be met as a condition under the policy on special conditions.) Regarding the subject of equivalent safety, the commenter's argument seems to be based on the assumption that compliance with § 25.981(a)(3) at Amdt. 25-102 in itself provides an extremely high level of safety against which special conditions must be measured for equivalency. But in the recent adoption of Amdt. 25-125, the

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
permanent hundred thousand fold increase in risk over the entire vapor space as would be required to provide an equivalent level of safety. Actually, this policy allows TWA800 type accidents every so often rather than minimizing the factors that caused it. Consider the following factors: I. A credible evaluation of risk must include not only the predicted risk, but also the uncertainty in that prediction. This FAA's new policy introduces the potential for substantial additional uncertainty by allowing credit for the predicted conditional probabilities of both flammability and lightning strike threat characteristics which are both not well understood, are not independent, and clearly not randomly distributed within the fleet. Following are four examples: a. The probability of flammability and lightning are known to have common influence variables, such as ambient temperature. However, to date safety analysts have not determined how to take these dependencies into account within probability analyses. There are also some		FAA acknowledged, and in fact based the justification for the rule on, the reality that even full compliance with Amdt. 25-102 would only be 50% effective in preventing fuel tank explosions. The FAA reached this conclusion based on the recognition that many ignition sources are the result of human error, which no degree of probabilistic analysis can identify or prevent. This is a key element of the rationale for the policy, and is discussed at some length on p. 4 of the proposal: > As stated in the FTFR rule preamble, these changes were made because the FAA recognized that measures in Amendment 25-102 aimed at ignition source prevention would not alone be sufficient to prevent future fuel tank explosions on transport airplanes. That preamble stated, > > Predicting the effectiveness of ignition prevention actions is challenging, since many ignition sources are the result of human error, which cannot be precisely predicted or quantitatively evaluated. Despite extensive efforts by the FAA and industry to prevent ignition sources, we continue to learn of new ignition

Comment	Requested Change	Disposition
concerns that there may be direct dependencies, such as the effects that resistive heating during a lightning event, may have on flammability in vapor immediately adjacent to a potential ignition source. b. Technical experts don't know how to predict the actual probability of flammability. At this time, only the change in probability of a fuel tank being flammable relative to an assumed baseline level can be estimated. Even that capability is known to be questionable. For example, fuel flashpoint data came from weathered fuel samples over a one year period, the model doesn't differentiate between 3% per flight and 3% of the flights fleet wide, etc.). This renders capricious any direct comparison between the predicted probability of flammability and most other predicted probabilities.		sources. Some of these ignition sources are attributable to failures on the part of engineering organizations to identify potential ignition sources and provide design changes to prevent them. Others are attributable to actions by production, maintenance, and other operational personnel, who inadvertently compromise wiring and equipment producing ignition sources. Regardless of the causes, we believe that ignition prevention actions, while necessary, are insufficient to eliminate ignition sources. So the level of safety that special conditions must be equivalent to is not the theoretical level assumed by the commenter, but the actual level, as the FAA acknowledged and used in the analysis to justify the FRM rule. Thus, the FAA concluded in the proposed policy that the significant additional improvement in lightning protection provided by significantly exceeding the flammability requirements of part 25 Appendix M for all fuel tanks provides an equivalent level of safety to the only partially effective ignition prevention requirements.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
		Section 25.981(b) at amendment 25-125 sets fleet average flammability limits, and does not set a limit on the flammability for individual flights. In addition, that amendment stated that any MMEL relief for a given design would be determined through the FOEB process, which would examine the specific design and operation proposed. This process allows MMEL relief for the FRM to be granted if determined appropriate by the FOEB. The fuel tanks will be flammable during portions of flights conducted on hot days if the FRM is inoperative. The FAA infers that the commenter is comparing the proposed standards to the regulations that have traditionally been applied to systems, and is concerned that the proposed approach for structural lightning protection would result in a lower level of safety compared to that which would result if the FAA applied the approach in section 25.981(a)(3) to structural lighting protection. The FAA points out that these standards have not traditionally been applied to structural lightning protection, and, in fact, when the FAA and applicants attempted to apply them to that area, the practicality issues that led to the policy memo arose. This led

Comment	Requested Change	Disposition
		the FAA to develop the special conditions contained in the proposed policy as a way to achieve a level of safety equivalent to that intended by section 25.981(a)(3). This was already discussed above. Regarding the comment that the FAA cannot use a policy memo in lieu of rulemaking, this policy memo describes how changes would be made to the certification basis for specific projects, and the resulting proposed special conditions or exemptions would be published following the standard regulatory processes. Initial special conditions or exemptions that significantly differ from previously published special conditions or exemptions would be issued or granted after a comment period. The FAA does not agree that the proposed policy would allow TWA 800 type accidents to occur periodically. The rate of fuel tank vapor ignition events in the transport airplane fleet has been on the order of 1x10E-8 events per flight hour. The combination of ignition source prevention improvements and flammability exposure control achieved through amendments 25-102, 25-125, and 26-2, combined with the treatment of structural

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
		lightning protection in the proposed policy, is expected to reduce the rate of fuel tank explosions by at least one order of magnitude. The FAA acknowledges that there is uncertainty involved in the prediction of the probability of lightning and the probability of flammability. As is normally required for structured system safety assessments, the applicant will be required to justify the probability numbers used in the analysis. Where uncertainty exists the applicant will be required to use and justify a conservative assumption. The FAA does not consider it necessary to conservatively assume that the probabilities of lightning and flammability are equal to one for the purpose of the risk analyses required in the proposed policy. The FAA acknowledges that there may be some dependency between fuel tank flammability, which can be driven by outside temperature, and probability of lightning, which is to some extent related to warm ground level temperatures. Applicants would be expected to account for such dependencies in their safety analyses. The FAA is not aware of potential ignition sources due to failures in

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
		existing or proposed designs that would have sufficient energy to themselves create flammable conditions. In addition, the lightning currents in aircraft structure are of such short duration that they do not cause a significant amount of resistive heating of the fuel tank structure, and therefore the structure would not change the tank flammability. The FAA agrees that the level of flammability predicted by the model used in Amendment 25-125 may not be an exact representation of the actual statistical level of flammability. However, the FAA considers that model to be of sufficient accuracy to allow an estimate of flammability to be made and used in the required risk analysis. The FAA therefore does not agree with the commenter's proposal that fuel tanks always be assumed to be flammable. The FAA acknowledges that this is different from the more conservative position taken in the preamble to Amendment 25-102 and AC 25.981-1C. However, the preamble to amendment 25-102 recognized , as FRM technology develops, a "balanced" approach may be better. This is discussed in detail in the policy memo.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
Commenter: NATCA H-6		
c. Any allowance for the probability that a lightning strike will not attach within an area of susceptibility or not have sufficient energy to cause an ignition source given a specific failure mode in a specific location would require a significant amount of novel testing and/or analysis for each fault location. It is our understanding that neither the FAA nor the industry has conducted any testing to support this concept. Then there's the open question:, If a more realistic lightning strike energy distribution model is to be validated and used in lieu of the traditional simplifying assumption that all strikes are at a single specified "severe strike" level, then in addition to considering the probability that a given strike will be less severe than the traditionally specified level, why shouldn't this model also have to consider the realistic probability that a given strike will be more severe than the traditionally specified "severe strike" level? Substantial credible data clearly shows vast differences in the probability of lightning strikes as a function of geographic location, ambient temperatures, etc. For example, about 78% of all	NATCA Recommendation 2b. When new or novel aircraft designs are proposed, accelerated life testing and fleet leader programs should be required to assure that all failure modes, effects and rates are acceptably validated.	Any assumptions about the probability of attachment to a given area of the aircraft will be required to be justified using published industry data or service data. For a given failure of a design feature, any assumptions that lightning below a given amplitude will not create an ignition source must be substantiated by test. If an applicant proposes to use a distribution of lightning strike amplitude, they will be expected to use published scientific data for that distribution. The published scientific data for lightning amplitude distribution includes strike amplitude data above the specified “severe strike” level that is normally used when a lightning amplitude distribution is not used. The FAA agrees that there are different rates of lightning ground strikes in different geographic areas and at different times of the year. However, the FAA does not agree that this characteristic is correlated with the rate of aircraft lightning strike events in those areas and at those times of the year. For example, the

Comment	Requested Change	Disposition
lightning flashes occur between 30N and 30S latitudes. The density of ground flashes in Brevard County, Florida, in August is about 55 times the world monthly average (averaging 6676 total), in December that same county experiences only 1/40th of the world monthly average (averaging 3 total). (See accompanying Powerpoint file "Nonrandom Distribution of lightning").) These are some of the reasons the current FAA regulations require the conservative simplifying assumption that a specification level lightning strike will be encountered on every flight, that is, the probability of severe lightning strike = 1 when performing a fuel tank ignition prevention analysis. (NOTE 3) (NOTE 3 AC 25.981-1C,Paragraph 10.c.(5):"The severity of the external environmental conditions that should be considered when demonstrating compliance with § 25.981are those established by certification regulations and advisory material (e.g., HIRF, lightning) regardless of the *associated* probability of exposure to any external environment. For example, the probability of lightning encounter should be assumed to be one.")		lightning strike density in Florida is due to predictable thunderstorms that occur during the summer. Since these thunderstorms are well defined, predictable, and easily observed visually and with weather radar, aircraft operators typically do not intentionally fly through these thunderstorms. Also, the lightning flash density is high during these thunderstorms, but the lightning amplitude tends to be low. Review of aircraft lightning-related accident and incident reports shows that the accidents and incidents are not correlated to summer thunderstorms. The basis for comparison in showing that a proposed special condition provides an equivalent level of safety is § 25.981(a)(3), not the ARAC draft working group report referenced by the commenter. The FAA's justification for a finding that the proposed special conditions will provide an equivalent level of safety to compliance with § 25.981(a)(3) is provided below in the response to comment H-8. While the policy would permit single failures that, only when combined with flammable conditions and a critical lightning strike, could result in a catastrophic event, such failures would only be permitted where it

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
d. The FAA's new policy also fails to adequately address "specific risk". As defined by an Aviation Rulemaking Advisory Committee (ARAC), "Specific Risk" is: "*The risk* on a *given flight due to* a *particular condition. The Specific Risks of Concern (SRC) are when the airplane is one failure away from* a *catastrophe, or when the risk* is *greater than the average probability criteria provided in AC/AMJ 25.1309 Arsenal for hazardous and catastrophic failure conditions, on* a *given flight due to* a *particular condition."* In this case, the particular conditions could simply be a flight where the aircraft is flying in or near a thunderstorm, operating with the fuel tanks flammable, operating with a wing skin fastener improperly installed or failed, or some combination of these and other relevant "particular conditions". The current regulations do not allow anticipated latent failures to leave you one failure away from a catastrophe, while the proposed policy would allow the as built airplane to be one failure away from a catastrophe. This is obviously not equivalently safe. e. While the provision in each section of the new policy intended to maximize the integrity of protection features and to		is impractical to eliminate them and where it is shown that a fuel vapor ignition event is extremely improbable. While this approach differs from the traditional approach to single failures, it is considered acceptable in this case because lightning itself is a remote event. In developing the proposed policy, the FAA determined that relief from the requirement of § 25.981(a)(3) was warranted for areas where it was shown to be impractical to meet that regulation, and where it could be shown that an acceptable level of safety would be provided by meeting a different standard. The FAA agrees that the proposed policy memo does not cover the details involved in demonstrating compliance with the proposed requirements. The proposed policy memo is only intended to provide the conditions under which the FAA will issue special conditions and exemptions for structural lightning protection. Such special conditions and exemptions will be issued as separate regulatory actions, and will involve separate, project specific issue papers. Methods of compliance will be documented in additional issue papers and certification plans for each project. Those

Comment	Requested Change	Disposition
account for any known shortcomings within the probability analysis lays out admirable theoretical objectives, it lacks sufficient detail to define, much less assure, an acceptable minimum level of effectiveness. The failure causes, as well as the means of prevention, are unique for each component installation and must be learned via analysis, test and/or service experience. The use of service experience must be carefully regulated for new or novel aircraft designs. A substantial database of testing is required along with substantial experience with the integrity assurance methods used before any given level of failure prevention can be deemed assured.		methods of compliance could involve validation methods such as accelerated life testing or fleet leader programs, but those methods are not specifically required by the policy memo because other validation methods, such as engineering analysis or qualification testing, may be shown to be sufficient by the applicant.
Commenter: NATCA H-7		
II. As noted above, the risk reduction associated with the lower allowable probability of flammability is not directly determinate. The FAA grants unsubstantiated value to this risk factor and fails to conclude that it is insignificant when compared to the greater risk of an ignition source allowable under this new policy. Not only is the relative reduction in predicted probability of flammability only a few percentage points, that reduction only impacts a portion of the total fuel tank vapor space. For example, many so called	NATCA Recommendation 2c. We recommend that the proposed policy memo be changed so that an equivalent level of safety to the existing ignition prevention standards of § 25.981(a)(3) should only be allowed when it takes a non-dispatchable failure (i.e. operationally detectable failure with no MMEL relief) to allow the fuel tanks to ever become flammable	The FAA infers that the commenter is proposing that the policy memo be changed to require airplanes to always dispatch with inerting systems operative. The method for determining dispatch relief is not the subject of this policy memo. Allowable dispatch relief for inerting systems will be determined through the normal FAA Flight Operations Evaluation Board (FOEB) process (see the response to comment E-1 above). No change has been made to the policy memo.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
"center wing tanks" extend over a large portion of the wing and hence would already have been covered by amendment 25-102 or amendment 25-125. In contrast, the probability of ignition could be allowed to be thousands, even millions of time higher. Simply allowing credit for the average lightning strike rate would allow the probability of an ignition source being present to go up ten thousand times. This doesn't take into account the potential risk increase associated with allowing aircraft to be critically dependant on the actual integrity of a given component on a given day. The FAA's new policy now creates a type of Russian roulette with the aircraft's fuel tank components. Until such time that future testing and service experience creates an approved database documenting the failure distributions for these components, the FAA cannot credibly predict the maximum increase in specific risk this is expected to pose to some airplane(s) during the fleet life. As stated earlier, the current FAA regulations (specifically under 25.981(a)(3)) recognize that the risk of ignition is ever present and increases during the life of the aircraft. However, this new policy proposes to allow		

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
operation with the flammability reduction means (FRM) inoperative and reduces the requirements for ignition source prevention, either of which would then allow the aircraft to no longer meet safety standards. The existing requirements (amendment 25-125) for an FRM do not require the FRM prevent a fuel tank from being flammable: throughout any one flight, even when the FRM is functioning normally. The requirements are based on a fleet wide flammability exposure. This is acceptable because the FRM requirements complement the existing (amendment 25-102) fuel tank ignition prevention requirements. The new policy changes this and effectively now says to those unlucky enough to be on a flight where the FRM is inoperative and they are looking out at a thunderstorm: "Don't worry; certainly there aren't any of the "known single failures" on your aircraft? After all, what are the odds a fastener could be improperly installed? What are the odds that we didn't analyze the energy required to cause a spark in an odd shaped fracture?"		

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
Commenter: NATCA H-8		
For example, the design could include "full time inerting" of all fuel tanks, not just a part-time inerting system like an FRM and certainly not an FRM with FAA approval to dispatch an airplane full of passengers on a flight when the FRM is known to be inoperative. As noted in a March 5, 2006 Seattle Times article a Boeing Safety Team made a similar recommendations that dispatch with the planned 787 FRM inoperative not be allowed. Even in the preamble to amendment 25-102, the FAA's own response to a comment that urged the FAA to maintain the assumption that fuel tanks are always flammable, the FAA "affirmed that we are not considering a change to the current philosophy of assuming a flammable ullage. However, if technological changes are developed, such as full-time fuel tank inerting, and prove to be a superior method of eliminating the risk of fuel tank ignition, the FAA could consider a change in this philosophy in future rulemaking."	NATCA Recommendation 2d. We recommend the FAA stick by their statement in the preamble and not change the current ignition prevention regulations and policy unless a reliable full-time inerting system is provided. To be clear, a full-time inerting system would keep a fuel tank inert at all times when it is functioning, unlike an FRM.	This comment is a further discussion of the subject and recommendation covered by comments H-5 through H-7 above, and the response to comment H-5 applies. Under this policy, the FAA will require applicants to show that fuel tank explosion due to structural lighting protection issues is extremely improbable. In context of part 25, this means that catastrophic failure will not occur during the life of the fleet of airplanes of a particular type. This policy establishes a design architecture requirement and a degree of analytical rigor that, if satisfied, we believe will enable us to make this finding. Except where it is shown to be impractical, fault tolerance for structural ignition protection features is required. Fault tolerance in combination with the required failure minimization requirement for these features and the flammability requirement is expected to result in vapor ignition events due to the fault tolerant features being extremely improbable without further showing. For features where fault tolerance is impractical, applicants are required to perform a rigorous quantitative analysis to show that a vapor ignition event

Comment	Requested Change	Disposition
		due to all non-fault-tolerant features is extremely improbable. If fuel vapor ignition events can be shown to be extremely improbable, that is considered to be equivalent to the intent of section 25.981. At the time the statement in the preamble to Amendment 25-102 regarding the potential for a change in philosophy was made, "full-time inerting" was given as an example of a technology that could drive such a change. Based on the previous discussion, we have concluded that full time inerting is not necessary to show an equivalent level of safety.
Commenter: NATCA H-9		
Objection 3. This proposal claims compliance is and will remain impractical without any substantiating evidence or rationale. In fact the FAA quotes industry statements of impracticality but they have not even identified any objective criteria by which practicality should be judged. Quotes are not technical facts. NATCA contends there needs to be standard procedures and objective criteria added to this policy with regard to showing it is either not technologically feasible or economically	NATCA Recommendation 3. This new policy memorandum cannot violate current regulations and orders by allowing for the concept of "impractical". An aircraft manufacturer can, at best, only request an exemption to any applicable regulations. Otherwise, they must redesign the aircraft to meet, or provide an equivalent level of safety to, all applicable regulations.	The FAA considers impracticality to be an acceptable basis for showing that a regulation is inappropriate under the special conditions provisions of § 21.16. The policy memo acknowledges that applicants on specific projects have shown that compliance with § 25.981(a)(3) is impractical for structural lightning protection, and the policy memo outlines how the FAA will address such cases in the future. In order to be eligible to receive special conditions or exemptions, applicants are required to show that compliance is impractical for each design

Comment	Requested Change	Disposition
cost beneficial to comply. After all, the whole point of adopting the current fuel tank ignition prevention provisions was to improve "the state of the art", so it should be no surprise that the industry the FAA is entrusted to regulate is finding it difficult to comply with designs based upon the current "state of the art".		area where application of special conditions or exemptions is proposed. The FAA will consider arguments that compliance is impractical on a case-by-case basis. Examples of previous findings of practical and impractical design solutions are provided in the proposed memo. On the other hand, if one applicant shows that it is practical to eliminate a potentially catastrophic single failure, any other applicant would typically not be able to show that eliminating that particular failure is impractical. This policy is intended to provide a method for setting certification requirements until such time as further rulemaking to address fuel tank structural lightning protection is completed. The commenter's position that strict criteria should be established for "impracticality" is unrealistic, since the evaluation must be made on a case-by-case basis to consider the unique aspects of each design, and the state of technology at the time. Its assertion that "impracticality" is inconsistent with finding equivalency misses the point. Impracticality isn't an element of the FAA's finding of equivalency. Rather, the proposed policy is that, where practical, the FAA will

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
		require full compliance rather than entertain alternatives, whether equivalent or not. Per § 21.16, the FAA issues special conditions only when the applicable standards are inadequate or inappropriate. Full compliance is inappropriate only if it can be shown to be impractical.
Commenter: NATCA H-10		
Objection 4. Adoption of this policy appears to exceed the discretion afforded the FAA under the law. For all the reasons noted above and more, this policy memorandum could in no way be credibly found to provide an equivalent level of safety to compliance with the existing § 25.981 (Amendment 125). So, according to § 21.16, it would certainly appear the FAA does not even have the authority to issue Special Conditions as proposed in the Memo. In fact, it's questionable that these could truly be found to be in the public interest, as is legally required for the FAA to even grant Exemptions as also proposed in the Memo. NATCA is concerned that if the FAA adopts this Policy, it likely constitutes an abuse of discretion that would put our Members outside Torte Claims protection. As such NATCA is taking all the steps necessary, including the filing of	NATCA Recommendation 4. The FAA should not issue this proposed policy memorandum. If the agency wishes to pursue lowering the § 25.981 safety standards, then it should do so in a manner consistent with its legal discretion and the public interest. As a minimum that would mean releasing a modified version of this controversial policy memorandum which adopts the NATCA recommendations noted herein. Ultimately however, NATCA recommends the FAA undertake formal rulemaking in this regard, perhaps utilizing the services of ARAC to assure all interests, including those of NATCA, are represented.	The discussion of the FAA's finding that the proposed special conditions would provide an equivalent level of safety is discussed in the response to comment H-5 above. The FAA does not agree that the policy memo should not be issued. The FAA has initiated a rulemaking project to address this issue in the long term as proposed by the commenter. The commenter misunderstands the Federal Tort Claims Act. Its members are not at risk of liability as long as they are functioning within the scope of their employment as identified in FAA Order 2300.2A. In implementing a properly adopted agency policy, they are clearly functioning within that scope.

Comment	Requested Change	Disposition
grievances, to protect our Bargaining Unit Employees should FAA Management continue to show poor judgment and adopt this Policy.		
Commenter: SAE / EUROCAE I-1		
We agree with the overall objective to prevent the ignition of vapors in the fuel tank. While we have historically conducted safety assessments that have led to an outstanding safety record for lightning protection of fuel tanks, we also agree that the safety assessment methods and robustness of design can be improved. However, we disagree with the methodology of using numerical analysis to assess compliance for lightning for a few reasons, as described below. First, there is little available source data relevant to lightning attachment and threat interaction with aircraft and what is available requires numerous simplifying assumptions to even be useable in a numerical analysis. Examples of required assumptions would include what data sources are appropriate to represent lightning attachment to aircraft, what parameters and waveforms of lightning are relevant to this problem, and what criteria constitutes sufficient data to make statistical assessments of distributions for	Page 9 Special Conditions Replace the numerical analysis requirement with a prescriptive approach that yields an equivalent level of safety. Specifically, replace 2 a, b and c with the following: 2. The applicant must show that the design includes at least two independent, effective, and reliable lightning protection features (or sets of features) such that fault tolerance is provided for each area of the structural design area proposed to be exempt from the requirements of that regulation. Fault tolerance is not required for any specific design feature if: a. providing fault tolerance is shown to be impractical for that feature, and b. ignition sources due to that feature and all other non-fault-tolerant features are shown to be unlikely by design. Delete the last sentence of 3 concerning	This comment is similar to comment B-7, and the same response applies.

Comment	Requested Change	Disposition
the parameters of interest. Such assumptions would vary widely across industry resulting in inconsistent application between applicants. This problem is the major reason why industry has defined standard criteria based upon a severe set of lightning waveforms and prescriptive methodologies for implementing and assessing lightning protection designs relative to all past regulatory guidance. The validity of this approach is recognized by FAA through its published advisory material. Second, failure rates relevant to lightning protection functions of structural elements are unavailable and not easily estimated. Many key elements of lightning protection design are primarily driven by other requirements, such as structural integrity or fuel tank integrity against leakage. While it is important and necessary to ensure that the lightning protection function aspects of these kinds of design features are known and controlled, failures associated with these elements may or may not be relevant to lightning protection or degradations that are not typically accounted for as failures may still be relevant to lightning protection. Also, general failure data of structural elements is not readily and	residual risk, leaving the following: 3. The applicant must show that the design, manufacturing, and maintenance programs include all practical measures to prevent failures of structural lightning protection features due to manufacturing variability, aging, wear, corrosion, and likely damage. Revise the background material to be consistent with this approach.	

Comment	Requested Change	Disposition
publicly available leading to inconsistent approaches and assumptions amongst applicants. So while there are no specific probability distributions widely accepted and publicly available for lightning attachment and waveform definitions (such as current amplitude distribution), it is generally accepted by the aviation authorities to be conservatively estimated to be on the order of 10-5 per flight hour when combining probability of lightning attachment to an airplane coupled with the likelihood of a high amplitude or energy event. When coupled with flammability exposure per requirements of 3%, this indicates the likelihood of lightning attachment during a flammable condition will be improbable, per the definitions of AC 25.1309-1A. To meet the intent of the rule and draft policy the ignition source prevention features would therefore also need to be unlikely to meet the top level objective of 2a. We believe this can be adequately met by providing fault tolerant ignition source protection for lightning without requiring a numerical analysis. Where it can be shown to be impractical to eliminate all single failures to achieve fault tolerance and such failures are not widespread (i.e. result in		

Comment	Requested Change	Disposition
limited exposure), mitigating factors such as inspections or increased design robustness can also be applied to make such conditions unlikely. This can also be accomplished through qualitative assessment without requiring a numerical analysis. We believe similar rationale applies to equivalency with paragraphs 2 b and c. For 2 b, assuming an FRM inoperative the probability of lightning in conjunction with the inherent flammability of the tank is still on the order of being improbable, so meeting the ignition source prevention feature criteria identified above would meet or exceed the 10-8 criteria. For 2c, the standard is extremely remote and the probability of lightning in conjunction with the ignition source prevention criteria defined above easily meets the extremely remote criteria. The last sentence in 3 would also be deleted to be consistent with the logic above. Therefore, we believe that a prescriptive approach can be defined to meet the intent of paragraph 2 of the special conditions which will provide an equivalent level of safety and be more effective in achieving that level of safety consistently across industry. The recommended approach will yield a		

Comment	Requested Change	Disposition
more consistent and standardized methodology to provide lightning protection for fuel tanks with an equivalent level of safety relative to 25.981a3. The uncertainties noted in our comments related to probability analysis recommended in the draft policy as well as the application of that safety analysis will result in inconsistent design integrity amongst applicants and incorrect conclusions regarding safety, in part due to the necessity of including unsubstantiated numerical factors. This inconsistency in approach has already been demonstrated in the certification of recent airplanes.		
Commenter: SAE / EUROCAE I-2		
Same comment intent as the above comment (Page 9, Special Conditions) regarding approach to single failures as applied to exemptions	Page 11 Exemptions for New Type Certificate Programs Replace the numerical analysis requirement for when fault tolerance is shown to be impractical with a prescriptive approach that yields an equivalent level of safety. Specifically, modify 1.b as shown in the following: 1. In lieu of compliance with the requirements of § 25.981(a)(3), the	This comment is similar to comment B-9, and the same response applies.

Comment	Requested Change	Disposition
	applicant must show that the design includes at least two independent, effective, and reliable lightning protection features (or sets of features) such that fault tolerance is provided for each area of the structural design area proposed to be exempt from the requirements of that regulation. Fault tolerance is not required for any specific design feature if: a. providing fault tolerance is shown to be impractical for that feature, and b. ignition sources due to that feature and all other non-fault-tolerant features are shown to be unlikely by design.	
Commenter: SAE / EUROCAE I-3		
This policy does not clearly delineate the criteria or interfaces that distinguish fuel tank structure and system installations. The definition of fuel tank structure in the policy discusses features like fasteners, coatings, and sealant that are parts of system installations and their structural interfaces as well as structural elements and joints. For any system elements that are directly attached to structure, their interfaces are similar in lightning protection aspects to structural joints and should be eligible to be covered by this policy. Examples of these interfaces include pumps, valves, drains and vents.	Page 2 Definition of Key Terms Recommend modifying the definition of fuel tank structure as follows: For the purpose of this policy, “fuel tank structure” is considered to include structural members, such as airplane skins, joints, ribs, spars, stringers, engine mounts, landing gear and associated fasteners, brackets, coatings and sealant. In addition, attachment hardware associated with components mounted to structure, such as pump and valve housings, drains and vents, are also considered part of fuel	This comment is similar to comment A-2 and B-3, and the same response applies.

Comment	Requested Change	Disposition
Lightning protection elements of systems attachments to structure are similar to structural design. Definition of fuel tank structure should be clarified to address this.	tank structure.	
Commenter: SAE / EUROCAE I-4		
While this policy states applicability only to lightning protection of fuel tank structure, there are similar issues of impracticality in direct compliance to 25.981a3 regarding lightning protection of system installations in the fuel tank. From a practical standpoint, the protection of fuel tank systems is no different than protection of fuel tank structure in methods as well as conditions required for the top level event (i.e. lightning, flammability and an ignition source.) Achieving three independent, reliable and effective layers of lightning ignition source prevention design is impractical in many cases, as the lightning protection methods rely heavily on similar techniques as for structural lightning protection, such as electrical bonding of joints. Trying to achieve a third layer of protection will often result in introduction of new failure modes and potentially decrease the overall safety of the airplane. For example, addition of a redundant bond strap that creates a short circuit which draws lightning current could	Page 7 Eligibility for Consideration Under This Policy Include all aspects of lightning protection, both fuel tank structure and systems, in application of this policy. Expand the applicability of the policy as follows: The relief from § 25.981(a)(3) provided by this policy is intended to be limited <u>to lightning protection of fuel tank structure and integral tank systems</u> for which compliance with § 25.981(a)(3) is shown by the applicant and determined by the FAA to be impractical. ~~General design areas for which the TAD has determined compliance with § 25.981(a)(3) can be impractical include structural members and joints, fasteners, coatings, and sealants.~~ Determinations of practicality are somewhat subjective and can be dependent on the proposed design. Practicality determinations that are outside of the examples provided below should be	This comment is similar to comment A-2 and B-3, and the same response applies.

Comment	Requested Change	Disposition
result in a greater safety risk than leaving it off. The same issues identified for structural lightning protection regarding impracticality of using numerical analysis methods and documented in other comments apply to systems as well. The same factors that contribute to a fuel vapor ignition due to lightning apply whether it is structure or systems. In addition, lightning protection methods for systems and structure are generally similar so can have similar impracticality challenges. Therefore, this policy should be applicable for systems as well as structural lightning protection.	submitted to the TAD for review to ensure standardization. Revise the background material to be consistent with this approach.	
Commenter: SAE / EUROCAE I-5		
The following statement is inaccurate in this section: "In addition, industry and FAA practice has been to assume that a defined worst-case lightning waveform would be associated with every lightning attachment." The SAE lightning environment standards do not define a "Worst Case Lightning Waveform". In fact there is never one unique waveform. There are usually stroke and intermediate/continuing	Page 3 Current Regulations and Advisory Material Suggest modifying the existing test in that paragraph to result in the following: "In addition, industry and FAA practice has been to assume that a defined set of severe lightning current components would be associated with every lightning attachment to the aircraft."	Agreed. This comment is similar to comment B-4, and the same response applies. That comment proposed a slightly different change to address the same concern. The memo has been revised to address that comment.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
currents. Which of these, and how much of each, is "worst case" depends on specific design features. For example: a 5 kA intermediate current of 5 ms duration might cause more hazardous effects than a 200 kA stroke current of 0.5 ms duration. So what is actually worst case depends on the structure designs. Because industry practice does not define a worst-case lightning waveform, we suggest this statement be corrected. An inaccurate statement about industry practice regarding lightning is made and should be corrected.		

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
Commenter: Vince Weldon J-1		
In his February 8, 2008 Seattle Times front page article about your plan to ease lightning rules for the 787, Dominic Gates, the Times aerospace reporter, stated that Tomaso DiPaolo, NATCA's aircraft-certification national representative, charges that when FAA engineers raised their safety concerns internally management simply removed them from the team developing your new policy that these comments address. Mr. Gates continued: The FAA ignored its own technical people, he said, while making sure Boeing agreed with the policy change. "It's another example of the FAA getting too close to industry: said DiPaolo. "It appears that whatever Boeing wants, Boeing gets." A Boeing internal document reviewed by the Seattle Times shows the company had a "team to assist FAA in wording of interpretation" of the lightning rule for the 787 as far back as August 2004, just eight months after the new jet program launched. The FAA's (Ali) Bahrami (your Boss) insisted that the policy change has been crafted to work for all airplane manufacturers with no special treatment		The commenter makes no proposal for a change to the policy memo. At the close of the comment, a request is made that is specific to the Boeing Model 787 certification program. We infer that the commenter is proposing that the policy memo be changed to require airplanes to always dispatch with inerting systems operative. The method for determining dispatch relief is not the subject of this policy memo. Allowable dispatch relief for inerting systems will be determined through the normal FAA Flight Operations Evaluation Board (FOEB) process. No change has been made to the policy memo. Based on the safety analysis work performed to date on the Model 787, and the general work performed to develop the proposed policy, the FAA at this time has no reason to conclude that dispatch of an airplane that complies with the proposed requirements with its inerting system inoperative is an unsafe condition. Again, this condition will be analyzed as part of the FOEB process for each certification program. In addition, the FAA does not agree that

Comment	Requested Change	Disposition
for Boeing. "Boeing is only one customer," Bahrami said. So, Boeing is an FAA's customer. Very telling. Isn't the old saying:"The customer is always right?" Mr. Bahremi's insistence that Boeing received no special treatment is, to me, not credible. Boeing was the only company working with the FAA on this issue in 2004, as Mr. DiPaolo noted above. Also, this disclosure in the Seattle times shows is that the FAA has the same kind of questionable "Customer Service Initiative" relationship with the manufacturers as they have been shown to have with the airlines, as recently uncovered by the U.S. Congressional Hearings held in 2008. So, putting all this together it is obvious that Boeing was influencing the elimination of requirements that their design could not meet, that would set a corrupt precedent for other manufacturers to also take advantage of. Even the retribution from FAA Managers, rendered to concerned and righteous FAA employees, also surfaced at the above mentioned Congressional Hearing, who were simply trying to do their best to properly regulate the airlines, Is similar to the ostracism of righteous FAA employees		operation of a composite airplane that meets the proposed standards would be less safe than operation of an airplane of a current, traditional airplane design. The existing fleet of transport airplanes were certificated under a standard that did not include a requirement for fault-tolerant design. The proposed standards would require fault tolerance as a general requirement, and, where fault tolerance is shown to be impractical, would require a risk assessment showing that a catastrophic accident is not expected in the life of the fleet. The proposed standards also require compliance with the new flammability requirements in Amendment 25-125, which did not exist at the time the existing fleet of transport airplanes was certificated. These new standards reduce the average flammability below that which would exist on a conventional aluminum airplane design.

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
on your policy team, because they raised serious concerns that were not welcomed, but should have been. I understand that this kind of disgraceful retribution has been rendered to dozens of concerned FAA employees. From the above disclosures, it is clear that the public is being put at significant risk because the FAA is now regulating the industry using, basically the same type of cozy nefarious relationship approach that the corrupt SEC has been found to have used, again through a Congressional Hearing, allowing the notorious Madoff to swindle investors out of $50 Billion. Therefore, I believe that both of these regulatory agencies need, as Aviation writer John Nance has recently stated about the FAA, to be rebuilt from the ground up. It appears that rather than serving the flight safety interests of the public, the FAA is instead focusing on maintaining such personal interests as revolving door career advancement opportunities, as exemplified by their former leader, Blakey, who promoted the "Customer Initiative" approach. Immediately after leaving the FAA not too long ago, she became the		

Comment	Requested Change	Disposition
very well paid head of a major aerospace industry lobbying association. The FAA's prime focus should be to protect the public. Many of us are very concerned about what has transpired, as discussed above. This type of conduct is not what previously enabled the high level of public trust In commercial aviation, so carefully built up over several decades. Yes, you can brag about the great safety record achieved. But this happened because of the integrity of the former FAA, not because of the version that is in charge now, that is in the process of losing what was once a great reputation. The safety cheating that is going on is a growing scandal. An example of this is the arguments that Boeing made opposing a requirement to uphold existing crashworthiness (the safety level already achieved) in their comments on the A380 Crashworthiness Special Conditions, issued by the FAA in 2005. This was at about the same time they were "assisting" you on the lightning strike protection wording, noted above, in late 2004. About this same time I was the customer for an official Boeing ethics investigation into alleged 787 corrupt decisions, as the leader		

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
of a group of concerned senior engineers. Some of our concerns, including that causes of an inevitable major schedule slippage, have already been vindicated. Others, including the failure to uphold existing safety for lightning strike protection and crashworthiness. using a composite structure, are in the process of becoming vindicated. Boeing still carries on their publicly accessible Flight Safety website the promise to never adopt a new technology, no matter what its potential benefits might be, if it compromises the level of safety already achieved for any aspect of safety. Lightning strike protection safety is one of those aspects. Lightning striking a jetliner is routine, A few years ago I was on a 737 approaching Sea Tac. Shortly before reaching the runway the plane was struck by lightning. The very loud sound of the strike (like an explosion) created momentary consternation among the passengers. The pilot's assurances soon calmed thing down. As you know, each commercial jetliner gets struck by lightning, on average, twice a year. In some geographical locations it is significantly more often. Will people, especially in the latter locations, be willing		

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
to fly on what has become known as a safety compromised airplane regarding lightning strike? Good reputations are hard to earn, and can be lost quickly. In my opinion, our job should be mainly governed by your responsibility to make sure that the public is not cheated concerning flight safety. To accomplish this. you must focus on regulating that the design at least provides existing safety. If it does not, then the design must be changed until it does, not the requirements lessened. Allowing 10 days of flying without the fuel-inerting system functional is not doing this, nor is even 1 day of flying in the this seriously unsafe condition. The plane must be grounded until the system is functional, or the passengers must be warned about its relatively unsafe status.! You must not try to escape this responsibility by comparing this with the standard practice of allowed flight, without notifying the passengers, when mundane malfunctions occur which cannot cause catastrophic failure. With a lightning strike, a tiny spark can result in an exploding wing, which is always 100% fatal unless the plane is sitting on the ground, Composite wing structure is		

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
grossly substandard to aluminum structure with regard to inherent lightning strike protection safety In so many ways. You know it and so do I. For example, composite structure can have several hundred times more electrical resistance than aluminum. Thus, a metallic "band-aid" has been added to the composite structures at its outer mold line, which is not nearly as effective as the highly conductive aluminum structure. Further, after sitting for hours in the sun in the tropics the interior of a wing becomes very hot, heating the interior fuel vapors. Upon takeoff and climb-out an aluminum wing quickly cools the wing interior, due to its excellent thermal conductivity and reflectivity. Composite structure does not possess these characteristics, so the fuel vapors stay hot for a much longer time. This is one of the reasons why the 787 has fuel-inerting in the wing, but the 747-8, in development, only has this feature in the wing center tankage. Numerous troubling ramifications for a composite structure airframe result from such negative safety related differences between aluminum and composite structure airframes. This is generally obfuscated by focusing on the alleged		

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
lighter weight and lower cost of composite structure. The latter is not even true, but is wishful thinking. The former is barely true. after all the real world considerations have been taken into account. These include the need for thousands of relatively heavy, very precise and difficult to install fasteners not required by an aluminum airframe. With well -known inspection shortfalls that could be gotten away with using aluminum structure. often resorted to in order to meet schedules, this will not be allowable for composite airframes. Thus, it will not be left to chance that flight safety will be severely compromised. For example, with all these single point failures, if the fuel-inerting system Is non functional, yet the jetliner is allowed to fly loaded with passengers, the chances that a nightmare, rather than a dream, will occur are significantly increased. There are so many other problems. in this safety arena of lightning strike protection for a composite structure airframe, that I have not even touched on, and it would take pages more to adequately discuss them. But I don't need to in these brief comments, because in an article in the Seattle Post-Intelligencer on March 11,2007, by James Wallace, the then head		

DISPOSITION OF PUBLIC COMMENTS

POLICY MEMO. NO. ANM-112-08-002,
TITLE: Policy on Issuance of Special Conditions and Exemptions Related to Lightning Protection of Fuel Tank Structure

Comment	Requested Change	Disposition
of 787 systems. Mike Sinnett admitted: "If the 787 wings were aluminum, rather than composite, Boeing probably would have elected to have a fuel-inerting system for only the center fuel tank (like the inerting system for the 747-8, in development -my comment). Wallace noted that Sinnett also said, in the same article, that Boeing decided it would be best to have a fuel-inerting system on all the tanks on the 787, and that: "In the beginning, we did not have the analysis that we needed to demonstrate that we had to inert wing tanks," he said. "We thought it would be a good thing to do, and the analysis is now bearing that out." From this, it is clear that aluminum wings are inherently superior to composite structure ones, regarding lightning strike protection safety. Therefore, flight of the composite structure 787, without the fuel-inerting system being functional, will subject the passengers to significantly less safety than that provided by current jetliners. Please help redress this safety neglect being perpetrated, as discussed above		