DISPOSITION OF PUBLIC COMMENTS

AC NO. 25.981-1C, TITLE: FUEL TANK IGNITION SOURCE PREVENTION GUIDELINES

Comment	Requested Change	Disposition
Commenter: AE-2 Lightning Committee		
General Various editorial changes throughout the document	Corrections to the editorials	**The FAA concurs**. Editorial corrections will be made. Correct as highlighted in the document.
Commenter: Transport Canada		
General AC 25.981-1 C pays significant attention to the effectiveness of bonding elements, such as "jumpers." It is suggested that the same level of emphasis exist for the structure of the tank. Production joints in metallic components (tank walls and support elements) must also have adequate electrical bonding (and protection against corrosion).		**The FAA partially** concurs. Since structural aspects of fuel tank safety are under review, this issue will be addressed in a later revision or release of additional guidance.
Commenter: Transport Canada		
General OEMs and others that must comply with SFAR #88 should be encouraged to follow the guidelines of AC 25.981-1C. However, consideration should be given to applicants that have been conscientiously following the guidelines of AC 25.981-1B.		**FAA Comment** The compliance time for SFAR 88 has passed so this comment is not relevant to this AC revision. We have removed all reference to SFAR 88 from the AC.
Commenter: Goodrich Corporation		
General The terms fuel, tank and vapor are used interchangeably – the correct term should be selected throughout the document.		**The FAA partially** concurs and changes to standardize have been made in several locations in the AC.
Commenter: Goodrich Corporation		
General This revision of the document does provide additional clarification to revision B, thus well		No action required.

Comment	Requested Change	Disposition
done.		
Commenter: GAMMA		
General Of primary concern is the issue of latent faults. Current practice at some manufacturers is to protect systems from inducing power into the fuel tank by means of shielding and electrical bonding. There is no obvious means to detect a failure within the tank. The only way to protect from a latent failure is to provide some type of suppression device. A complex device would be required to protect against both high voltage and high current. In turn, a means would be required to monitor the suppression device to protect against a latent failure of the monitor. The other option would be to avoid conductive devices in the fuel tank. Optical Fuel Quantity Indicating Systems would require a lengthy certification process, as the technology is yet unproven. One would still have to address problems of reliability, static build-up, dielectric breakdown, and other issues.		**The FAA does not concur.** We share the commenter's concern regarding latent failures but do not agree that latency cannot be addressed without providing some sort of suppression system. Guidance in the AC discussed the possible means to address latency. Monitoring, inspections as well as functional checks can be used to address this issue. We agree with the commenter that installation of suppression devices may introduce unneeded complexities since in the design. The need for transient suppression devices on wiring that enters the fuel tank would be based upon the specific design choices that are made. For example a manufacturer could provide physical separation of the electrical circuits that enter a fuel tank so that failures cannot cause high energy to enter a tank. However transient suppression technology has been applied by some manufacturers and is a viable technology to address unwanted electrical power from entering the fuel tank.
Commenter: GAMMA		
General There are a lot of terms within the AC that are not consistent with current terminology used within the lightning committee. The SAE		**The FAA does not agree that changes should be made at this time.** We believe the terminology used in the AC is appropriate and clear. However we are

Comment	Requested Change	Disposition
Lightning Committee is expected to develop a position on this material and report on it during their meeting the week of September 23. GAMA recommends that FAA review the SAE Lightning Committee's report and consider the use of consistent terminology.		initiating a project that will request advice from members of an advisory committee that will include members from the lightning committee as well as GAMA. Future changes to the guidance may result from this activity.
Commenter: Boeing		
Section 1. Purpose Recommend that any references to "SFAR 88" be deleted from this guidance material.	This AC provides guidance for demonstrating compliance with the certification requirements for prevention of ignition sources within the fuel tanks of transport category airplane. In the PURPOSE section, It sates that it is applicable to transport category airplanes for which a new, amended, or supplemental type certificate is requested. In light of this, we recommend that any references to "SFAR 88" be deleted from this guidance material, since relevant references to 14 CFR § 25.981 are contained in SFAR 88, and the requirement of the SFAR is for a one-time evaluation of existing airplane configurations (and, therefore, does not meet the stated purpose of this AC).	The FAA concurs. We will delete references to SFAR 88.
Commenter: AE-2 Lightning Committee		
Section 4(c) Advisory Circulars Add Note 1 at the end	Note 1: This version of AC 20-136 is not available as of 30 September 2002. Reference d(7) should be used until AC 20-136A is published. This is the same as AC 20-136A.	**The FAA concurs.** AC 20-136A has been published so the updated reference is added and reference (7) has been deleted.

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Commenter: AE-2 Lightning Committee		
Section 4(d) Society of Automotive Engineers (SAE) documents Additional document to be inserted	(6) ARP 5412, Aircraft Lightning Environment and related test waveforms (7) ARP 5413, Certification of Aircraft Electrical/Electronic Systems Against the Indirect Effects of lightning (8) ARP 5414, Aircraft Lightning Zoning (9) SAE ARP 1870 Aerospace Systems Electrical Bonding and Grounding for Electromagnetic Compatibility and safety (10) EUROCAE ED 107 Guide to Certification of Aircraft in a High Intensity Radiated Field (HIRF) Environment *(these additions complete the necessary references)*	Added reference 6, 8. Reference (7) has been cancelled since AC 20-136A was published. ARP 1870 has been deleted due to fact that airplane manufacturers follow their own design rules for bonding and grounding. AUROCAE ED 107 was added.
Commenter: Goodrich Corporation		
Section 4(e) Military Specifications MIL-B-5087B is a discontinued document.		**The FAA concurs**. Deleted reference.
Commenter: AE-2 Lightning Committee		
Section 4(e) Military Specifications This specification is outdated technically and the US DOD has discontinued it.		**The FAA concurs.** Deleted reference.
Commenter: AE-2 Lightning Committee		
Section 4(e) Military Specifications Add SAE to document number	*SAE* AS50881, Aerospace Vehicle Wiring (procurement document used to specify aerospace wiring, replaces MIL-W-5088).	**The FAA concurs.** Added reference to SAE documents.

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Commenter: AE-2 Lightning Committee		
Section 4(f) Other Can we use this data?	International Electrotechnical Commission (IEC), IEC60079-11, Electrical Apparatus for Explosive Gas Atmospheres.	**The FAA concurs.** Reference deleted as not used in text.
Commenter: Airbus		
Section 5 General Definitions should not be linked with compliance conditions of a regulation. A definition should remain factual and general enough to allow the certificator and applicant to agree on the conditions for which the definition must apply to.		**The FAA does not concur.** Section 5 definitions are general and are intended to clarify the terms used in the AC. It is also used to guide the reader to reasonably conclude what are the expectations for compliance.
Commenter: Boeing		
Section 5 General We recommend that the following changes to the definitions be made to improve clarity.	**<u>Paragraph 5.a. Auto Ignition Temperature.</u>** "The minimum ***vapor*** temperature at which an optimized flammable vapor and air mixture will spontaneously ignite." **<u>Paragraph 5.o. Maximum allowable surface temperatures.</u>** "A surface temperature within the fuel tank (the tank walls, baffles, or any components) that provides a safe margin under all normal or failure conditions, which is at least 50°F below the lowest expected ~~auto~~ surface-ignition temperature of the approved fuels. The ~~auto~~ ***surface*** ignition temperature of fuels will vary because of a variety of factors (ambient pressure, dwell time, fuel type, etc.). ~~but t~~ ***T***he value historically accepted for normal	**The FAA does not concur.** The word vapor does not add any more clarity. The nature of auto ignition itself is inclusive of vapor temperature which exists inside the tank. **The FAA does not concurs** with the suggested changes to 5(o). We do not accept the change to the word surface temperature. Autoignition temperature is a conservative factor that provides margin for establishing the allowable surface temperature. Using actual surface temperatures to establish the allowable temperature would change the standard established for compliance with § 25.981 set in 1971. This would allow a significantly higher temperature and

Comment	Requested Change	Disposition
	conditions without further substantiation for kerosene fuels, such as Jet A, under static sea level conditions, is 450°F. This results in a maximum surface temperature of approximately 400°F for an affected component surface. Add: ***For remote failure conditions of limited duration, it is acceptable to provide substantiation of actual hot-surface ignition temperatures (note that this is different than the auto-ignition temperature of the fuel), and demonstrate a 50°F margin below these temperatures."***	redefine the safety level intended by the rule.
	Paragraph 5.t. ~~Critical Inspection Item (CII).~~ ***Fuel System Limitation (FSL).*** We suggest changing the terminology in this paragraph's title because aviation industry Original Equipment Manufacturers (OEM) have already agreed that "FSL" is the preferred nomenclature	**The FAA concurs.** We agree with this suggestion and have revised the definition accordingly.
Commenter: Airbus		
Section 5 General Standardization of terms.	Definitions of terms should be standardized between Advisory Circulars in order to avoid confusion and maintain a consistent level of safety across aircraft systems.	**The FAA concurs** however no specific changes to the definitions were suggested by the commenter. No change was made as a result of this comment.
Commenter: Airbus		
Section 5 General As AC 25-8 is referenced in the NOTE. Airbus would like to know if this AC will be		The FAA is not currently planning on revising this document.

Comment	Requested Change	Disposition
revised and when?		
Commenter: Airbus		
Section 5(a) Change definition of Auto-ignition temperature.	Reword as follows: The minimum temperature at which ~~an optimized flammable vapor and air mixture will spontaneously ignite.~~ flammable mixtures will ignite when heated to a uniform temperature.	**The FAA partially concurs** and has changed the definition based upon this and other comments.
Commenter: AE-2 Lightning Committee		
Section 5(a) Auto-ignition temperature Isn't there a time limitation for this?		**The FAA does not concur.** Due to the differences of atmospheric conditions that may exist inside the fuel tank, it is difficult to establish a time limitation that applies to all conditions.
Commenter: AE-2 Lightning Committee		
Section 5(e) Spark Revise for clarification.	Change definition to read: <u>Electrical Sparks (Voltage Sparks)</u> A spark is initiated by a potential difference which causes an electrical breakdown of a dielectric, such as a fuel/air mixture, produced between electrodes which are initially separated, with the circuit initially carrying no current. *(To make a distinction from the definition of electrical arcs (below) and to make the definition consistent with terminology in common use within the lightning protection community. Note that the terms "electrical sparks" and "voltage sparks"*	**The FAA concurs.** The definition Spark has been further defined in terms of three types of Sparks, Electrical Sparks, Electrical Arcs and Friction Sparks. The AC sections referencing these definitions have been changed accordingly.

Comment	Requested Change	Disposition
	have been used interchangeably, so both are preserved here.) <u>Thermal Sparks (Electrical Arcs).</u> Electrical arcs occur between electrodes which are in contact with each other and carrying excessive current which results in melting at the contact points. This may result in electric arc plasma and/or ejection of molten or burning material (Thermal Sparks). *(To make a distinction from the definition of electrical sparks (above) and to make the definition consistent with terminology in common use within the lightning protection community. Note that the terms "thermal sparks" and "electrical arcs" have been used interchangeably, so both are preserved here.)*	
Commenter: Airbus		
Section 5(g) Explosion Proof Specific wording change proposal.	Reword as follows: Components designed and constructed so they will not ignite flammable vapors or liquids surrounding the component under any normal operating condition and any failure condition. ~~specified in § 25.981(a)(3).~~ Add: Further information on possible failure conditions that should be considered are specified in § 25.981(a)(3).	**The FAA concurs** and accepts the change. Components designed and constructed so they will not ignite flammable vapors or liquids surrounding the component under any normal operating condition and any failure condition. Add: Further information on possible failure conditions that should be considered are specified in § 25.981(a)(3).
Commenter: Smith		
Section 5(k) Ignition source Specific wording change.	Reword as follows:	**The FAA concurs** and accepts the change.

Comment	Requested Change	Disposition
	From "A source of sufficient energy to initiate combustion of the fluid." To: "A source of sufficient energy to ignite combustion of a fuel/air mixture."	A source of sufficient energy to ignite combustion of a fuel/air mixture.
Commenter: AE-2 Lightning Committee		
Section 5(k) Ignition source Specific wording change.	Reword as follows: Ignition source. A source of sufficient energy to initiate combustion of the flammable vapor. Surfaces that can exceed the auto-ignition temperature of the flammable vapor under consideration are considered to be an ignition source. Electrical Sparks (Voltage Sparks), Thermal Sparks (Electrical Arcs) and friction sparks are also considered as ignition sources if sufficient energy is released to initiate combustion. *(It is the vapor that ignites, not the fluid)*	**The FAA concurs**. Change accepted as modified in definition.
Commenter: AE-2 Lightning Committee		
Section 5(m) Intrinsically Safe The term "intrinsically safe, as used in this draft, seems to mean safe under normal operating conditions. Features, like current limiters, incorporated in system/equipment designs to prevent ignition sources due to failure conditions such as short circuits may not necessarily provide protection against more intense transients such as those induced by lightning.	Reword as follows: Intrinsically Safe. Any instrument, equipment, or wiring that is incapable of releasing sufficient electrical or thermal energy under normal operating anticipated failure conditions (see § 25.981(a)(3)) cause ignition within the fuel tank. It should be noted that equipment and wiring that is considered to be intrinsically safe may not be so when exposed to the lightning and HIRF environments.	**The FAA partially concurs**, and accepts the change with modification. Intrinsically Safe. Any instrument, equipment, or wiring that is incapable of releasing sufficient electrical or thermal energy under normal operating conditions, anticipated failure conditions (see § 25.981(a)(3)), or environment conditions which could cause ignition within the fuel tank. It should be noted that equipment and wiring that is considered to be intrinsically safe may not be so when exposed to the lightning and HIRF

Comment	Requested Change	Disposition
		environments.
Commenter: Airbus		
Section 5(m) Intrinsically Safe The use of the words "incapable" and "anticipated" should be clarified. These two terms are normally not associated with safety requirements. "Incapable" by definition is "not able to." If a piece of equipment is powered by 28V dc or 115V ac, it is difficult to demonstrate under failure conditions it could never release sufficient electrical or thermal energy to cause an ignition. "Anticipated" by definition is "expected to occur." If a failure mode that could release sufficient electrical or thermal energy to cause an ignition, is expected to occur it would have to be designed out. If "anticipated failure condition" is not removed, then it should be defined in reference to the existing regulations. Is an "anticipated" failure condition, equivalent to "probable" in 25.1309. Other information that should be provided in this AC and referenced is this definition are: the specification(s)/standards that are acceptable to determine the intrinsic safety energy and the definition of what level of energy is necessary to cause ignition considering various fuels / outside ambient temperature and altitude.	Reword as follows: Any instrument, equipment, or wiring that is incapable of releasing sufficient electrical or thermal energy under normal operating or anticipated failure conditions (see § 25.981(a)(3)) to cause ignition within the fuel tank. Add: Further information on possible failure conditions that should be considered are specified in § 25.981(a)(3).	**The FAA concurs.** Changed in accordance with AE-2 comment.

DISPOSITION OF PUBLIC COMMENTS

AC NO. 25.981-1C, TITLE: FUEL TANK IGNITION SOURCE PREVENTION GUIDELINES

Comment	Requested Change	Disposition
Commenter: Goodrich Corporation		
Section 5(m) Intrinsically Safe The definition of Intrinsically safe and the use of the term within the document is not consistent. See paragraph 8.c.		**The FAA concurs.** Use of term has been modified based on another comment.
Commenter: Airbus		
Section 5(o) Maximum allowable surface temperatures Why does the FAA apply auto ignition criterion to hot surface ignition? The temperature for hot surface ignition has been reported by research workers as being a function of many factors such as size and heated area and duration and consequently higher temperatures may be incapable of causing ignition. Is it not acceptable to use this information for failures?		**The FAA believes that no change is required.** The inconsistency due to area and duration in heating surfaces has prompted us to use auto ignition as the maximum allowable temperature. If maximum allowable temperature is used for a failure scenario, it would be difficult to establish a unified guideline for each case.
Commenter: Smith		
Section 5(o) Maximum allowable surface temperatures The value quoted as acceptable (450 F) is not consistent with paragraph 8(e)(2). The specific value should be deleted in this paragraph with a reference to paragraph 8(e)(2) added.		**The FAA does not concur.** Paragraph 8e(2) states that auto ignition is related to the pressure and temperatures inside the tank. Therefore to establish maximum limits each condition must be taken into account. For kerosene based fuel, 450F provides a margin of safety that encompasses most conditions that may be encountered.
Commenter: AE-2 Lightning Committee		
Section 5(o) Maximum allowable surface temperatures Is 50 degrees F a sufficient margin? 50	Change as follows: A surface temperature within the fuel tank	**The FAA concurs** with the proposed change. We will add in the appropriate temperatures Celsius in this definition.

Comment	Requested Change	Disposition
degrees seemed like a small margin. Also, temperatures should be given in C as well as F since both are commonly used, and the units may become confused.	(the tank walls, baffles, or any components) that provides a safe margin under all normal or failure conditions, which is at least 50°F (10 C) below the lowest expected auto-ignition temperature of the approved fuels. The auto-ignition temperature of fuels will vary because of a variety of factors (ambient pressure, dwell time, fuel type, etc.), but the value historically accepted without further substantiation for kerosene fuels, such as Jet A, under static sea level conditions, is 450°F (232.2C). This results in a maximum surface temperature of approximately 400°F (204.4 C) for an affected component surface.	Regarding the 50 degree margin, we clarified that 450 °F could be used and that a 50 degree margin was acceptable to establish a limit of 400 degrees F. This is consistent with that provided in AC 25-8.
Commenter: AE-2 Lightning Committee		
Section 5(r) Transient Suppression Device (TSD) TSD's do not really limit energy, nor are they usually rated in terms of energy limitations. Voltage and/or current limitations are the usual ratings. Energy depends on time, and the time durations of let-through voltages and currents are not limited by TSD's.	Change definition to: A device that limits transient overvoltages and or overcurrents on wiring to systems such as the fuel tank quantity, fuel temperature sensors, and fuel level switches, etc. to a predetermined level.	**The FAA concurs.** Comment is accepted with modification. See rewrite of definition 5r.
Commenter: Airbus		
Section 5(t) Critical Inspection Item (CII) Is this definition the source of the Dual Inspection criteria?		Clarification provided to definition in the disposition of a similar comment.
Commenter: Airbus		
Section 6(a)(3) Regulatory History Other sections of part 25 require that ignition		**The FAA does not concur.** Proposed changes to not add clarity and imply that

Comment	Requested Change	Disposition
from lightning be prevented (§25.954), as well as ignition from failures in the fuel system (§25.901). Applicants have been required by §25.901 to complete a safety assessment of the fuel system and show that "no single failure or malfunction or probable combination of failures will jeopardize the safe operation of the airplane...." However, service history has shown that ignition sources have developed in airplane fuel tanks and have caused the heated center wing fuel tank ullage to ignite and to explode in several cases. The presence of ignition sources is due to unforeseen failure modes or factors that were not considered at the time of original certification of the airplane, including arcs, sparks, or hot surfaces within the fuel tanks. The fact that these failure conditions were not considered at the time of original certification may be attributed to several factors including the lack of standardized and rigorously enforced regulation/guidance material and the influence of age and maintenance on an aircraft through its operational life.		ignition sources have not occurred in newer designs. In fact, since the SFAR 88 analyses were completed, there have been over 20 unsafe conditions that required Airworthiness Directive actions. Several of these instances occurred on newer technology designs that had rigorous compliance oversight.
Commenter: Airbus		
Section 7(a) Objective The FAA suggests that lessons learned be used in order to help determine any unsafe conditions. Airbus agrees that under a traditional 25.1309 analysis, reviewing lessons learned would be a beneficial exercise.	Airbus therefore suggest that the FAA provide guidance on not only what is a NONACCEPTABLE design, but also what is an ACCEPTABLE (compliant). Lesson learned exercises should be performed only using the basis of an acceptable	**The FAA does not concur.** The intent of this AC is to provide information and general guidance (non-specific) to allow the applicant to make decisions of how to comply. The FAA

Comment	Requested Change	Disposition
However, Airbus believe (feedback from meetings through June 2002) that the FAA-forced assumptions invalidate the lessons learned exercise and make it very difficult to use a quantitative probability approach, especially the declaration of an "extremely remote" failure, within the compliance demonstration. The FAA-forced assumptions also render it difficult to evaluate the compliance effectiveness to "a fix" of a lesson learned, and also to then identify a corresponding maintenance plan.	design. Airbus also suggests that the FAA provide feedback on the effectiveness of the design feature in preventing ignition sources. Can this possibly come from the list of issues which result in changes/additions to FSL's? A possible suggestion would be that the FAA give a link/reference in the AC to their web page on which the information is held. This would give consistency of approach across the OEM's and an ongoing increase in standards applied to new designs.	does not dictate design. Rather, we provide performance based rules and guidance. The applicant can use the lessons learned to avoid future re-occurrence of the same event based on the knowledge gathered. But this detailed discussion is beyond the scope of this AC.
Commenter: Airbus		
Section 7(b) Safety assessments An example covering components developed post SFAR 88 approval should be also given.	Airbus requests that the FAA clarify the applicability of this paragraph to new and in-service designs. The example provided: "For example, certain components within fuel pumps have been changed to improve pump life, which defeated the original fail-safe features of the pumps." May be relevant to the pre-Dec 6th 2002 designs but not the post.	**The FAA does not concur.** This example provided is intended to be applicable to pre or post SFAR 88. See the clarification in the comment submitted by Boeing comments below.
Commenter: Boeing		
Section 7(b) Safety assessments We suggest that the "example" that is included in this paragraph be deleted, as indicated below, because it is too vague and does not add clarity to the subject.	"Safety assessments of previously certificated fuel systems may require additional considerations. For retroactive safety assessments, component sales records may assist in identifying if component failures and replacement are occurring. In addition, in some cases	**The FAA does not concur.** The example indicates that even though a component has been upgraded with new parts to improve its service life, the fail safe features were compromised or even degraded. For example using a steel

Comment	Requested Change	Disposition
	changes to components have been introduced following original type design certification without consideration of the possible effects of the changes on the system's compliance with the requirements to preclude ignition sources. ~~For example, certain components within fuel pumps have been changed to improve pump life, which defeated the original fail safe features of the pumps.~~ Therefore, results of reviewing this service history information, and a review of any changes to components from the original type design, should be documented as part of the safety analysis of the fuel tank system."	impeller rather than nonmetallic during the pump overhaul improves its service life. But the probability of sparks during dry run may increase.
Commenter: Airbus		
Section 7(c) List of Items (Bonding Straps) A wording change is suggested for clarity.	Corrosion of bonding strap wires resulting ~~in failure of wires~~ failure to provide required current paths.	**The FAA concurs, a**nd accepts the changes as written.
Commenter: AE-2 Lightning Committee		
Section 7(c) List of Items (Bonding Straps) Editorial changes Aging of self-bonding fuel system plumbing connections resulting in higher resistance bonding. (Bond straps that touch each other or other conductive surfaces inadvertently may be ignition sources. Of special concern where redundant straps are provided.)	Change to: Bonding Straps in Explosive Atmospheres Add bullet: Loose or intermittent contacts between bond straps and other conductive components	**The FAA does not concur**. The FAA is concerned with self-bonding fuel system plumbing connections regardless of atmosphere. 2nd comment is incorporated by adding a bullet.
Commenter: Boeing		
Section 7(c) List of Items (Float Switch Systems)	"Float switch wire chafing ***was observed, which might have*** ~~with~~ ***provided potential***	**The FAA concurs**. We revised the AC to reflect the requested changes.

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Modify the text of the second bullet for clarity.	***for*** subsequent electrical short to the conduit. ~~has burned a hole in the conduit allowing similar fuel leakage."~~	
Commenter: Boeing		
Section 7(c) List of Items (Electrostatic Charge) Revise the second bullet to remove the apparent "editorial" comment, and delete the third bullet.	"Spraying of fuel into fuel tanks through ~~inappropriately designed~~ refueling nozzles ***located at the upper portion of the tank."*** ~~"Spraying of fuel into fuel tanks from fuel pump motor cooling flow return ports that spray fuel into the tank. "~~	**The FAA concurs.** We revised the AC to reflect the requested changes.
Commenter: Smith		
Section 7(c) Fuel Quantity Indicating System (FQIS) Wiring Editorial change	First bullet, delete "and corrosion (copper or silver sulfur deposits) at electrical connectors" already included in bullet two. Second bullet, From "…(sulfide deposits)…" To "…(silver, copper or cadmium deposits)…" Third bullet, From "…FQIS wiring and structure causing chafing…" To "…FQIS wiring and structure or other wiring causing chafing…"	**The FAA concurs**. We accepted the proposed change with modification.
Commenter: Smith		
Section 7(c) FQIS Probes Editorial change	First bullet, From "…corrosion (copper or silver sulfur deposits) causing…" To "corrosion (silver, copper or cadmium oxide deposits) causing…"	**The FAA concurs**. We accepted with modification.

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Commenter: AE-2 Lightning Committee		
Section 7(c) (General) Add to list	Add: <u>Fuel Tubes, Vent Tubes, Conduits, Hydraulic Lines etc.</u> • Poorly conducting pipe couplings that may become thermal spark (electric arc) sources when exposed to electric currents, including lightning currents. • Insufficient clearances to surrounding structure • Intermittent electrical contacts in pipe couplings or at bond strap clamps. • Bonded couplings unable to conduct expected lightning or power fault currents without arcing. *(The fuel and vent pipes and conduits are current carriers and the couplings and fittings may become arc sources)*	**The FAA concurs**. We accepted with modification.
Commenter: AE-2 Lightning Committee		
Section 8(a) Fuel Ignition Source Editorial changes	Add the following: **<u>Fuel ~~TANK~~ Vapor Ignition Sources</u>.** *(It is the vapor that ignites)* a. The following are conditions that can result in ignition of fuel vapors within airplane fuel tanks or other flammable vapor areas: • Electrical sparks (voltage sparks)	**The FAA concurs**. We accepted title change and previously changed the bullet list.

Comment	Requested Change	Disposition
	• Thermal sparks (electrical arcs) • static discharges associated with refueling • filament heating • friction sparks • hot surfaces *(The above changes make the list more complete and consistent with changes in definitions of arcs and sparks)*	
Commenter: Boeing		
Section 8(a)(1) Fuel Ignition Source Revise this paragraph, as indicated below, to delete the reference to "sloshing," because data to establish its impact have not been presented.	"The conditions required to ignite fuel vapors from these ignition sources vary with pressures and temperatures within the fuel tank and can be affected by ~~sloshing or~~ spraying of fuel in the tank. Due to the difficulty in predicting fuel tank flammability and eliminating flammable vapors from the fuel tank, the regulatory authorities have always assumed that a flammable fuel air mixture may exist in airplane fuel tanks and have required that no ignition sources be present."	**FAA does not concur**. Sloshing may contribute to the conditions of fuel vapor inside the tank. Therefore, omission of the word is not accepted.
Commenter: AE-2 Lightning Committee		
Section 8(a)(2) Fuel Tank Ignition Sources Add wording changes	Add the following: (2) Any components located in or adjacent to a fuel tank must be qualified to meet standards that assure, during both	**The FAA does not concur.** Failure conditions are not listed in § 25.981(a)(3). No change made.

Comment	Requested Change	Disposition
	normal operating conditions and any failure conditions, specified in AC 25.981(a)(3) that ignition of flammable fluid vapors will not occur. This is typically accomplished by a combination of component testing and analysis. Testing of components to meet the appropriate level of explosion-proof requirements is carried out for various single failures, and combinations of failures, to show that arcing, sparking, auto-ignition, or flame propagation from the component will not occur. Testing of components has been accomplished using several military standards and component qualification tests. For example, military standard MIL-STD-810, Method 511, Procedure I and II, defines one method that has been accepted for demonstrating that a component is explosion proof. Section 9 of RTCA Document DO 160D has also been accepted for demonstrating that electronic equipment is explosion proof. (Adds a reference to the applicable regulations in the Background and regulatory history section of this AC.)	
Commenter: Airbus		
Section 8(a)(2) Fuel Tank Ignition Sources A wording change is suggested for clarity.	...Testing of components to meet the appropriate level of explosion-proof requirements is carried out for various single failures, and combinations of	**The FAA concurs**. We accepted, added reference to hot surface ignition.

Comment	Requested Change	Disposition
	failures, to show that arcing, sparking, auto-ignition, (add: hot surface ignition), or flame propagation from the component will not occur….	
Commenter: Boeing		
Section 8(a)(2) Fuel Tank Ignition Sources Modify the text of this paragraph, as indicated below, to improve its clarity and accuracy.	"Any components located in or adjacent to a fuel tank must be ~~qualified to meet standards that assure~~, ***designed and installed in such a manner that,*** during both normal and anticipated failure conditions, ~~that~~ ignition of flammable fluid vapors will not occur. This is typically accomplished by a combination of component testing and analysis. Testing of components to meet the appropriate level of explosion-proof requirements ~~is~~ ***may be*** carried out for various single failures, and combinations of failures, to show that arcing, sparking, ~~auto-ignition~~ ***hot surface ignition***, or flame propagation from the component will not occur. Testing of components has been accomplished using several military standards and component qualification tests. For example, military standard MIL-STD-810, Method 511, Procedure I and II, defines one method that has been accepted for demonstrating that a component is explosion proof. Section 9 of RTCA Document DO 160D has also been accepted for demonstrating that electronic equipment is explosion proof."	**The FAA concurs**. We accepted editorial changes.

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Comment	Requested Change	Disposition
Commenter: Airbus		
Section 8(b)(1) Electrical Sparks (Voltage Sparks) and Electrical Arcs (Thermal Sparks) Wording/editorial changes are suggested for clarity.	Electrical sparks or voltage sparks can occur between conductive elements that are isolated from each other, due to voltage differences between the conductive elements arising from electrical system malfunctions, lightning, electrical faults or other electrical conditions. Electrical arcs or thermal sparks can occur when conductive elements, in contact with each other, eject molten or burning material when the current across the contact points exceeds the current-carrying capability of the contact points. (See references in paragraphs 4f (8), (9), and ~~(12)~~ add: (11) of this AC.) Note: In the list of references there is no "(12)".	**The FAA concurs**. Accepted with modification.
Commenter: AE-2 Lightning Committee		
Section 8(b)(1) Electrical Sparks (Voltage Sparks) and Electrical Arcs (Thermal Sparks) Wording/editorial changes are suggested for clarity.	Add the following: b. Electrical Sparks (Voltage Sparks) and Thermal Sparks (Electrical Arcs) (). (1) Electrical sparks (voltage sparks) can occur between conductive elements that are isolated from each other, due to voltage differences between the conductive elements arising from electrical system malfunctions, lightning, electrical faults or other electrical conditions. Thermal sparks (Electrical arcs)can occur when conductive elements, in contact with each other, eject electric arc plasma and/or	The FAA deleted this definition since Electrical Sparks and Arcs are covered in “Definitions” section.

Comment	Requested Change	Disposition
	molten or burning material when the current across the contact points exceeds the current-carrying capability of the contact points. (See references in paragraphs 4f (7), (8), and (11) (*check revised reference numbers. I did. The corrected numbers shown are correct*) of this AC.) *(This change is to be consistent with the arc/spark definition changes)*	
Commenter: AE-2 Lightning Committee		
Section 8(b)(2) Electrical Sparks (Voltage Sparks) and Electrical Arcs (Thermal Sparks) Wording/editorial changes are suggested for clarity.	Add the following: (2) Laboratory testing has shown that the minimum ignition energy required to ignite hydrocarbon fuel vapor is 200 microjoules if all of this energy is released in the spark. Therefore, for electrical or electronic systems that introduce electrical energy into fuel tanks, such as fuel quantity indicating systems, the energy introduced into any fuel tank should be less than 200 microjoules during either normal operation excluding lightning and HIRF encounters (see next paragraph) or operation with failures (note that in the past some components have been qualified to standards that allow 320 microjoules and this level is not acceptable for showing intrinsic safety). To ensure that the design has adequate reliability and acceptable maintenance intervals, a factor of safety	We did not adopt the proposed change. Resistance in test wiring is minimized but the energy is calculated based on capacitance and charge voltage. The energy released in spark is not directly measured. The 200uj level is not specific to normal operation so HIRF and lightning need not be mentioned in this paragraph. This paragraph has been modified based on Airbus comment regarding normal operations. Based on parenthetical concern, paragraph was modified.

Comment	Requested Change	Disposition
	should be applied to this value when establishing a design limit. For example, a maximum energy of 20 microjoules is considered an intrinsically safe design limit for fuel quantity indicating systems. *(The requirement above is too broad to be complied with for lightning-induced energies. Some parts of the tank and systems may dissipate more than 200 microjoules during a lightning strike. This cannot be avoided, but need not become an ignition source. Also, during verification tests, it is very difficult to measure energy dissipations, or even potential energies. What is commonly measured are induced voltages and currents, so the ignition source free conditions are usually described in these terms. Be assured that the sensitivities of ignition source diagnostic tools employed in lightning certification tests are calibrated in terms of their abilities to detect light or fuel vapor ignitions resulting from 200 microjoule sparks of very short duration.)*	
Commenter: Airbus		
Section 8(b)(2) Electrical Sparks (Voltage Sparks) and Electrical Arcs (Thermal Sparks) Wording/editorial changes are suggested for clarity.	Laboratory testing has shown that the minimum ignition energy required to ignite hydrocarbon (add: <u>compounds in jet)</u> fuel vapor is 200 microjoules (add: <u>this minimum energy will increase with altitude</u>) during the duration of the spark.	**The FAA does not concur.** Comment not accepted. Editorial without any need for clarity. Minimum energy & altitude not related to 200uj limitation.

Comment	Requested Change	Disposition
	Therefore, for electrical or electronic systems ….	
Commenter: Airbus		
Section 8(b)(2) Electrical Sparks (Voltage Sparks) and Electrical Arcs (Thermal Sparks) Airbus agree to the 200 microjoules limit and the fact that this limit should be designed into the system with some margin. Airbus does not agree that the FAA should set a safety factor of 10 with NO substantiation. Airbus requested the FAA as part of its SFAR 88 reviews to show why a factor of 10 was chosen. Airbus stated that this seemed severe when considering accepted aircraft industry design practices. Airbus contends that no data exists showing that a system built to 20 microjoules is any safer than one built to 200 microjoules; 200 microjoules already has a built margin. Although the source of ignition was never found in the recent CWT explosions, one could debate whether an energy of over 200 microjoules entered the system, given its initial system design. SFAR 88 reviews have indicated that the FAA do not intend to provide the applicant of in-service or derivative aircraft with an alleviation to this safety factor. Verbal comments were that a running at an energy level of 65 to 100 microjoules was unacceptable. However, to achieve a lower level the whole system would		**The FAA concurs**. FAA accepted with modification based published FAA Technical Center report. A safety factor of 4 was used based on engineering judgment.

Comment	Requested Change	Disposition
have to be redesigned and replaced. If the safety benefit of maintaining in tank energy in the region of between 20 to 200 micro joules is unquantified then Airbus does not see how this element can be part of the AD economic impact study, resulting in potentially major changes to the inservice fleet without safety or economic justification. In summary, Airbus do not agree that the FAA impose margins without justification. If the FAA chooses to remain with this margin until an applicant proves, through its own research and development program, that a lesser safety factor is acceptable, then Airbus request that the 20 microjoule limit be evaluated against new designs only. Inservice/derivative aircraft designs should be allowed to show that there is a margin against the 200 microjoule limit and should not be imposed a fixed safety factor.		
Commenter: Airbus		
Section 8(b)(2) Electrical Sparks (Voltage Sparks) and Electrical Arcs (Thermal Sparks) Specific word change proposal	...To ensure that the design has adequate reliability and acceptable maintenance intervals, a factor of safety should be applied to this value when establishing a design limit. For example, ~~a maximum energy of 20 microjoules is considered an intrinsically safe design limit for fuel quality indicating systems.~~ new fuel systems should be built to the lowest energy possible. Systems with a maximum energy of 20 microjoules or lower are considered technologically feasible. For	**The FAA partially concurs**. We Partially accepted. See paragraph 8b(2). See Airbus comment disposition above.

Comment	Requested Change	Disposition
	systems already in service or on a derivative aircraft, the applicant should show that the energy limits are below 200 microjoules considering normal and failure conditions. The residual risk should be justified using factors such as in-service experience.	
Commenter: Boeing		
Section 8(b)(2) Electrical Sparks (Voltage Sparks) and Electrical Arcs (Thermal Sparks) Modify this paragraph, as indicated below, to include information from FAA report DOT/FAA/CT-94/74.	"Laboratory testing has shown that the minimum ignition energy required to ignite hydrocarbon ***jet*** fuel vapor is ~~200~~ ***630*** microjoules[1] during the duration of the spark. Therefore, for electrical or electronic systems that introduce electrical energy into fuel tanks, such as fuel quantity indicating systems, the energy introduced into any fuel tank should be less than 200 microjoules during either normal operation or operation with failures ***which provides a safety factor of approximately 3***. ~~(note that in the past some components have been qualified to standards that allow 320 microjoules and this level is not acceptable for showing intrinsic safety)~~. To ensure that the design has adequate reliability and acceptable maintenance intervals, a factor of safety should be applied to this value when establishing a design limit. ~~For example, a maximum energy of 20 microjoules is considered an intrinsically safe design limit for fuel quantity indicating systems.~~"	**The FAA makes no changes.** The standard is 200uj is the standard using reference cited in section 8b(2) – no change.

Comment	Requested Change	Disposition
	Also, replace the text of Footnote #1 with the following text: [1]~~The 200 microjoule level comes from various sources. The most quoted is Lewis and VonElbe, "Combustion, Flames and Explosions of Gases," that has a set of curves for minimum ignition energy for the various hydrocarbon compounds in Jet fuel, and they all have similar minimum ignition energy levels of around 220 microjoules. The 20 microjoule limit is a safety factor on the 200 microjoule level.~~ *" [1]Reference FAA report DOT/FAA/CT-94/74, which shows a 200 microjoule spark energy limit has a safety factor of 3 based on a 1 in 10,000 probability of ignition at 600 microjoules for Jet Fuel. Additional margin also exists due to the electrode losses, as the spark energy is only a fraction of the circuit energy. The spark energy value is estimated to be less than 20% of the total circuit energy value."*	
Commenter: AE-2 Lightning Committee		
Section 8(b)(3) Electrical Sparks (Voltage Sparks) and Electrical Arcs (Thermal Sparks) Editorial changes	Change to: The effects of environmental conditions, such as lightning strikes and HIRF with the potential to create electrical sparks and arcs in the fuel tank should be limited so	**The FAA makes no change.** No change, editorial comment adds little to clarity. ARP 5416 test methods are used instead of those in AC 20-53A.

Comment	Requested Change	Disposition
	that the energy from any electrical spark or arc from the electrical transient is less than 200 microjoules. The external lightning environment is defined in SAE ARP 5412 and the HIRF environment in defined in FAA Notice N8110.71 dated April 1998: (Interim HIRF Policy) *(This preserves the 200 microjoule criteria with respect to lightning and HIRF-induced arcs or sparks only. It adds the lightning and HIRF environment references)* Since it is impractical to determine the energy associated with a lightning-induced transient, prevention of ignition sources due to induced transients in electrical wiring must be accomplished by preventing electrical sparks. *(Focuses attention on prevention of sparks and arcs, (of whatever energy) as the means of protection against lightning-induced ignition sources)* *(Relocated above)* Lightning and HIRF-induced currents conducted in mechanical components and structures such as fuel tank plumbing,	Electrical arcs and sparks are tested to the 200uj standard.

Comment	Requested Change	Disposition
	access panel fasteners, structural fasteners and other interfaces must not produce electrical spark (voltage spark) or thermal spark (electrical arc) ignition sources. *(This change adds both ignition source possibilities, consistent with changed definitions)* Testing to verify absence of ignition sources caused by lightning as recommended by FAA AC 20-53A should include detection techniques with ability to detect electrical sparks (voltage sparks) of at least 200 microjoules, and should be conducted in the presence of those latent fault conditions which have been identified. Optical detection methods and combustible vapor ignition detection methods used to show compliance for electrical transients caused by environmental conditions should detect sparks with energy levels of 200 microjoules or less. Optical detection methods consist of subjecting a fuel tank structures and/or fuel system components and installations to a simulated lightning currents while a specific camera/lens/film configuration is positioned to view the test speciumen(s) with the shutter open. A test is passed if no spark is visible on the developed film. *(This change clarifies that it is only the*	

Comment	Requested Change	Disposition
	electrical spark (voltage spark) whose energy has been determined to be 200 microjoules to ignite a fuel vapor. The energies associated with thermal sparks (electrical arcs) have not usually been measured, and are not as easy to measure, as are the energies associated with electrical sparks (voltage sparks) where the spark energy is assumed to be the energy stored in a capacitor that is discharged to make the spark. Thermal sparks (electrical arcs) are usually characterized in terms of current and time, and the amounts of current and times. There are no precise criteria, since the amount of current, or time needed to create an arc depends on the mechanical configuration of the potential arc source. Experience has shown that detection methods capable of detecting 200 microjoule sparks have successfully detected thermal sparks (electrical arcs) capable of igniting fuel vapors. Combustible vapor ignition detection methods use specific combustible gas mixtures that have an ignition probability of 90% from a 200 microjoule spark. Fuel system components, systems, or fuel tanks are tested in the presence of the combustible vapor. A test is passed if the vapor does not ignite during the test, but does ignite using a 200 microjoule spark.	

Comment	Requested Change	Disposition
	(This change is to be consistent with the method now being used to establish that an ignitable vapor or gas to be used for lightning ignition source tests is sufficiently sensitive to 200 microjoule sparks. The 90% criteria is being incorporated in the new lightning test standard (to be published as SAE ARP 5416)	
Commenter: Airbus		
Section 8(c) Filament Heating Current Limit The FAA requires an additional compliance criteria - current limit - to be met prior to finding the design compliant and "intrinsically safe." This criteria was introduced in AC 25.981-1B and refined AC 25.981-1C. Airbus agree with the FAA that the current limit and its behavior in the presence of a filament (filament heating) should be part of the compliance criteria. Airbus do not agree with the current limits defined by the FAA in §8.c. Airbus request the FAA to base the maximum current limit on the actual aircraft configuration and the allowable maintenance practices. The FAA set the maximum current limit based on two assumptions: steel wool is present in the fuel tank and that the surfaces carrying the current are bare (no protective coatings). The FAA does not allow the		**The FAA concurs.** We deleted energy levels and revised current levels based FAA report DOT/FAA/AR-TN05/37. Revised margins. Factor of safety is now 4. Assuming of worst case filament and no credit for coatings or mitigating design features paragraph does not mention the coatings etc or the factor of 4.

Comment	Requested Change	Disposition
applicant to vary the maximum current limit based on the configuration of the fuel system or the material allowed in the tank. This fact was confirmed within the SFAR 88 reviews held between Airbus and the FAA. Airbus was told it could not take credit for the fact that it prohibits use of steel wool in all of its tanks. Airbus was told it could not take credit for the protective coating that it puts on its probes to prevent metal to metal contact. Airbus does not agree with the FAA setting an unjustified factor of safety. Airbus considers tests used to derive the 60 milliamps RMS already has conservatism built in. An additional, non justified, factor of safety adds more conservatism, but the additional benefit remains non-quantifiable. If the FAA chooses to remain with this limit and margin until an applicant proves, through its own research and development program, that a lesser safety factor is acceptable, then Airbus request that the design limits, as provided in §8.c's example should be evaluated against new designs only. In-service / derivative aircraft designs should be allowed to show that the current is within the 60 milliamps figure in steady state condition. Maintenance instructions to prohibit steel wool, as well as a protective feature on the probes and in-service experience should be used as compensating factors for the higher		

Comment	Requested Change	Disposition
current. Airbus are aware of several studies regarding "safe" in-tank current limits across the industry. Airbus request that the FAA publicly release any data that they become aware of that leads to a revision of the currently assumed safety factor, to ensure there is a common understanding for all Airworthiness Authorities, airframe manufacturers, equipment manufacturers and operators. Airbus also question whether the criteria for filament heating should not be related to temperature, or more specifically the absence of flames. Was the wire wool test an ignition source due to the fact it burned flames rather than a hot surface? Because this section deals with filament heating, is it appropriate to include references to energy levels? Should the reference to transient energy levels of up to 50 microjoules be quoted in §8(b)(2) instead?		
Commenter: Airbus		
Section 8(c) Filament Heating Current Limit Specific word change proposal	Analyses and testing indicate a small piece of steel wool will ignite jet fuel when a current of approximately 60 milliamperes root-mean-square (RMS) is applied to the steel wool.1 Therefore, for electrical or electronic systems that introduce electrical energy into fuel tanks, such as fuel quantity indicating systems, the electrical	**The FAA does not concur**. Change is not accepted but standard was revised based on Airbus comment.

Comment	Requested Change	Disposition
	current introduced into any fuel tank should be limited. Because there is considerable uncertainty associated with the level of current necessary to produce an ignition source from filament heating, a factor of safety should be applied to this value when establishing a design limit. For example, new fuel quantity indicating systems should be built using the lowest maximum steady-state current limit. Systems that have a maximum steady-state current of 30 milliamperes RMS, the transient current to 150 milliamperes (RMS) and failures that result in steady-state currents above 10 milliamperes RMS are considered technologically feasible. For systems already in service or on a derivative aircraft, the applicant should show that the current limits are within 60 milliamperes (RMS) limit with the provisions that steel wool is prohibited from use in the tank and a review of the component installation shows that exposed surfaces are protected or installed to preclude debris from being trapped.. The residual risk should be justified using factors such as in-service experience. ~~A maximum of steady-state current of 10 milliamperes RMS is considered an intrinsically safe design limit for fuel quantity indicating systems. Current levels above 10 milliamperes RMS, particularly for failures and transient conditions, could~~	

Comment	Requested Change	Disposition
	~~also be considered acceptable, provided that proper substantiation by test and/or analysis justifies them as intrinsically safe. For example, for transient conditions, it is acceptable to limit the energy in the transient to 50 microjoules and the transient current to 150 milliamperes (RMS), and failures that result in steadystate currents above 10 milliamperes RMS should be improbable and not result in steady-state currents greater than 30 milliamperes RMS.~~	
Commenter: Boeing		
Section 8(c) Filament Heating Current Limit Revise the text of this paragraph, as indicated below, to include an uncertainty factor of 1.5. Data to support other data mentioned are not available for review/conclusion.	"Analyses and testing indicate a small piece of steel wool will ignite jet fuel when a current of approximately 60 milliamperes root-mean-square (RMS) is applied to the steel wool. Therefore, for electrical or electronic systems that introduce electrical energy into fuel tanks, such as fuel quantity indicating systems, the electrical current introduced into any fuel tank should be limited. Because there is ~~considerable~~ uncertainty associated with the level of current necessary to produce an ignition source from filament heating, a factor of safety should be applied to this value when establishing a design limit. A maximum of steady-state current of ~~10~~ ***40*** milliamperes RMS is considered an intrinsically safe design limit for fuel quantity indicating systems. ~~Current levels above 10 milliamperes RMS, particularly~~	**FAA partially concurs.** We revised steady state current level to provide a safety margin of 4 for normal operation and for failures a factor of 2 is used based on engineering judgment.

Comment	Requested Change	Disposition
	~~for failures and transient conditions, could also be considered acceptable, provided that proper substantiation by test and/or analysis justifies them as intrinsically safe. For example, for transient conditions, it is acceptable to limit the energy in the transient to 50 microjoules and the transient current to 150 milliamperes (RMS), and failures that result in steady-state currents above 10 milliamperes RMS should be improbable and not result in steady-state currents greater than 30 milliamperes RMS."~~	
Commenter: AE-2 Lightning Committee		
Section 8(c) Filament Heating Current Limit Revise text for clarity	Filament Heating Current Limit. Analyses and testing indicate a small piece of steel wool will ignite jet fuel vapor when a current of approximately 60 milliamperes root-mean-square (RMS) is applied to the steel wool.[1] Therefore, for electrical or electronic systems that introduce electrical energy into fuel tanks, such as fuel quantity indicating systems, the electrical current introduced into any fuel tank in the event of a system fault should be limited. Because there is considerable uncertainty associated with the level of current necessary to produce an ignition source from filament heating, a factor of safety should be applied to this value when	**The FAA does not concur**. Comment not accepted as proposed. Paragraph rewritten based on Airbus comment. Faults from all sources are included in current limits and lightning considerations are added.

Comment	Requested Change	Disposition
	establishing a design limit. A maximum of steady-state current of 10 milliamperes RMS is considered an intrinsically safe design limit for fuel quantity indicating systems. Current levels above 10 milliamperes RMS, particularly for failures and overvoltage/current transient conditions, could also be considered acceptable, provided that proper substantiation by test and/or analysis justifies them as intrinsically safe. For example, for overvoltage/current conditions it is acceptable to limit the energy to 50 microjoules and the current to 150 milliamperes (RMS), and failures that result in steady-state currents above 10 milliamperes RMS should be improbable and not result in steady-state currents greater than 30 milliamperes RMS. The current limitations described above are applicable for system operational conditions and not for lightning strike conditions. *(The changes marked above are intended to prevent confusion with the requirements for protection against lightning-induced transients in Section 10 c(10).* *Also, is this paragraph compatible with installation of pumps inside the fuel tanks?)*	

Comment	Requested Change	Disposition
Commenter: Transport Canada		
Section 8(c) Filament Heating Current Limit In this subsection, AC 25.981-lC makes a significant change from AC 25.981-1B. While the quoted current limit in a small piece of steel wool to ignite jet fuel has increased from 3040mA RMS to 60mA RMS, there appears to have been a simultaneous reduction in the allowed design current limit. The allowed design limit for steady state operation has decreased from the -1 B level of 30m A RMS, with a safety factor applied, to 10mA RMS in -IC. Therefore, AC 25.981-lC seems to imply that a safety factor of 6 is expected for steady state operation, and a safety factor of 2 is expected for failures that result in steady state operation above 10mA RMS. Additionally, such failures must be improbable. It is our opinion that designs that have used the value of 30mA RMS with a factor of safety applied, based on the guidelines of AC25. 981-1 B, should continue to be acceptable, despite the fact that they do not meet the 10mA RMS normal steady state operation expected by AC25.981- I C. While it is appropriate for the AC to identify that a factor of safety must be applied when establishing a design limit, the AC should state		The FAA has addressed this comment. The limits have been revised based on FAA Tech Center data.

Comment	Requested Change	Disposition
that the applicant can propose a factor of safety, and that the applicant must show this factor of safety		
Commenter: Airbus		
Section 8(d) Friction Sparks Modify the text of this paragraph, as indicated, to improve clarity.	"Service experience has shown that pump inlet check valves, inducers, nuts, bolts, rivets, fasteners, lockwire, roll pins, cotter pins, drill chips, and manufacturing debris, etc. have been inducted into fuel pumps and contacted the impeller resulting in the possibility of metallic deposits on rotating and stationary components within the pump. This condition ~~could~~ ***may*** result in creation of friction sparks and should be an assumed failure condition when conducting the system safety assessment. Fail-safe features as described below in paragraph 10.b.(2) have been used to mitigate this hazard."	**The FAA concurs** and accepts the editorial changes.
Commenter: Boeing		
Section 8(e) Hot Surface Ignition Modify the text of this paragraph, as indicated, to allow for a more detailed evaluation under failure conditions.	Guidance provided in AC 25-8, Auxiliary Fuel System Installations, defines surfaces that come within 50 degrees of the auto-ignition temperature of the fuel air mixture for the fluid as ignition sources. The FAA has historically accepted 400°F for maximum surface temperatures for kerosene type fuels. (Maximum surface temperature considerations for areas outside the fuel tank are discussed later in this AC.) ***"****For remote failure conditions of limited duration, it is acceptable to provide substantiation of actual hot-*	**The FAA concurs and a**ccepts the recommended changes.

Comment	Requested Change	Disposition
	surface ignition temperatures (note that this is different from the auto-ignition temperature of the fuel), and demonstrate a 50°F margin below these temperatures."	
Commenter: Airbus		
Section 8(e)(1) Maximum Surface Temperature Airbus considers that the text rules out the possibility of going over 200 deg C even with limited duration events such as with lightning strikes hot spots (discussed in AC20-53A user's manual page 5). Airbus notes that in-tank there can be specific small heated surfaces caused by electrical currents- data in report AFAPL. TR-75-70 also suggests that higher temperatures can be tolerated.		The FAA revised text per Boeing recommendation above.
Commenter: GAMMA		
Section 8(e)(2) Flammable Fluid Properties The autoignition temperature of Jet A fuel has been changed from "approximately 435°F" to "approximately 450°F." The reason for lowering the autoignition temperature of Jet A fuel is not clear. GAMA requests that FAA provide some discussion/reason for this change.		The 435F value is carried forward from the earlier release of this AC in 1971. We further clarified that the 450 could be used and that a 50 degree margin was acceptable to establish a limit of 400 degrees F. This is consistent with that provided in AC 25-8. We clarified the 435 as an approximate value in the discussion.
Commenter: Boeing		
Section 8(f) Fuel System Electrostatics Delete this entire paragraph and replace it with the following text. This information reflects our recent discussions with FAA Specialists concerning this issue.	Replace with the following text: *"Electrostatic charges are generated in liquid hydrocarbons when they are in motion with respect to another surface such as fueling hoses, filters, nozzles, and*	**The FAA partially concurs.** We have included much of the suggested text.

Comment	Requested Change	Disposition
	aircraft plumbing. The references in paragraphs 4d (5) and 4f (10) of this AC provide information on this subject. During airplane refueling, jet fuel is loaded either from a tanker truck or from an airport hydrant system. Flowing fuel can generate an electrical charge especially flow through fuel filtration. The accumulation of charge in the fuel is a function of many factors. If the fuel conductivity is low, the relaxation time for dissipation of the electrical charge is long. As a consequence, the fuel may accumulate an electrical charge inside an aircraft fuel tank. This electrical charge may produce a high potential on the fuel surface and an electrical discharge to structure. This is particularly a concern when large unbonded objects are located inside an aircraft fuel tank. If the vapor space fuel/air mixture is in the flammable range, ignition of the mixture is possible, resulting in a fuel tank explosion and fire. *(1) The effects of electrostatic discharge must also be considered as part of any aircraft fuel system design as it represents a potential ignition source within the fuel tank system. The safe operation of aircraft with respect to an electrostatic discharge is considered to vary with fuel properties, as well as tank and fuel system geometry. Adherence to industry standards, analysis,*	

Comment	Requested Change	Disposition
	and validation tests are necessary to evaluate this phenomenon for a particular airplane model. *(2) Charge accumulation is influenced by many factors. Fuels from different parts of the world and from different refineries will have different charging tendencies based on fuel properties and the presence of contaminants or additives. Without a static dissipator additive, typical Jet A fuel has a low electrical conductivity. A static dissipator additive will increase the charging rate of fuel but at the same time greatly improve the conductivity of the fuel to rapidly dissipate the developed charge.* *(3) Methods of minimizing the developed charge have been developed and are in place on transport airplanes including restrictions on discharge port fuel velocity in accordance with established electrostatic guidelines. Flow velocities are limited to 6 (20 ft/sec) meters per second for flow for tubing and 3 (10 ft/sec) meters per second for discharge into an aircraft fuel tank. These limitations are met by incorporating multiple discharge ports into multiple bays and increasing the diameter of piping. Discharging fuel near the bottom of the tank minimizes fuel spray, a contributor to static charge development.*	

Comment	Requested Change	Disposition
	(4) Methods of relaxing the charge have also been developed. Bonding straps are used on fuel components and plumbing lines to allow the charge to dissipate to the tank structure. During refueling, the airplane is bonded to the refueling vehicle with a separate bonding wire to provide an electrical path back to fuel filtration, which is the principal electrostatic charge generator. A static dissipator fuel additive may also be used to increase fuel conductivity, to quickly dissipate the developed charge. However, the FAA does not currently require this type of additive, unless specifically specified as part of the type design approval. *(5)Applications of the above methods and adherence to industry practices and guidelines on electrostatics should be identified for each airplane model. Airline operation and practices regarding airplane refueling should also be evaluated to verify that the procedures necessary for safe operation of the specific airplane model are in place and followed. Restrictions, if any, on refuel rates, fuel properties, and the requirement for fuel additives should be identified."*	

Comment	Requested Change	Disposition
Commenter: GAMMA		
Section 8(f) Fuel System Electrostatics The proposed AC adds this new paragraph to provide additional guidance information about fuel system electrostatics. Subparagraph (4) states that methods of relaxing the charge have been developed and that the aircraft should be grounded during fueling operations. Subparagraph (5) continues to state that applications of the above methods (subparagraph 4) and adherence to industry practices and guidelines on electrostatics, such as provided by the NFPA and ASTM should be identified for each airplane model for compliance with the SFAR. FAA's guidance in subparagraph (4) conflicts with the NFPA 407 standard for aircraft fuel servicing. NFPA 407 section 5.4.1 states that "grounding during aircraft fueling shall not be permitted." Since the AC refers to the NFPA standards as guidance, GAMA recommends that FAA address the disagreement between grounding positions during refueling.		The FAA has revised this paragraph per Boeing comment above. We believe it addresses this comment too.
Commenter: Airbus		
Section 8(f)(1) Fuel System Electrostatics This paragraph only seems to be applicable to the SFAR 88 demonstration, when in fact it's probably a general recommendation for both new and existing aircraft. This paragraph, as well as the rest of the AC, should be checked to ensure that future and SFAR only requirements are clearly		The FAA has revised this paragraph per Boeing comment above. We believe it addresses this comment too.

Comment	Requested Change	Disposition
defined. Airbus also requests clarification on this paragraph. Specifically, this paragraph is talking about high potentials on the fuel surface. However general practices tend only to identify possible approaches to alleviate electrostatic charging i.e. pipe velocities elimination of unbonded parts etc. What standard should be used to perform the analysis and validation tests –against what criterion - surface potential? Will we be expected to apply a margin in the same way as the one applied to ignition energy? What is the industry standard for acceptable surface potentials?		The standards that are currently in use are NFPA and ASTM and are currently called out in the AC.
Commenter: AE-2 Lightning Committee		
Section 8(f)(3) Fuel System Electrostatics Editorial addition .	(3) Methods of minimizing the magnitude of the developed charge have been developed and are in place on transport airplanes including: (1) The refuel plumbing is sized and is orificed to maintain maximum flow rates in accordance with the electrostatic guidelines established by the NFPA and the ASTM; and (2) Flow velocities of 6 to 7 meters per second are considered acceptable after the discharge port is covered with fuel. The guidelines also indicate that the flow velocity should be held to less than 1 meter per second until the discharge port is covered with fuel. This criteria is met by incorporating	**The proposed changes are not accepted.** The resistive checks are not traceable to a standard for verification. Further, it is in-practical to establish procedures to accurately measure the resistance out on the field. The color of antistatic additives are not always black, therefore the suggested color (black) is omitted from the recommendation.

Comment	Requested Change	Disposition
	multiple refuel discharge ports, lowering the flow velocity, and locating them at or near the bottom of the tank. This location minimizes fuel spray, a contributor to static charge development, and provides for the ports to be covered in the early stages of fuel flow as the refuel rate varies from 1 meter per second up to the full flow of 6 to 7 meters per second. Foams used for ignition suppression within fuel tanks, and other non conducting objects may accumulate and retain charge. These items may have to be treated with antistatic additives to prevent charge accumulation. Surface resistivities should be between 100 and 1000 megohms/square. The existence of antistatic additives in present fuel system components can usually be confirmed with visual inspections of these components, where the additive is usually a black surface. *(check this)* *(The above addition addresses the effects of fuel flowing through foams that are sometimes used for flame retardant and explosion prevention in fuel tanks)*	Foams used for ignition suppression within fuel tanks, and other non conducting objects may accumulate and retain charge. These items may have to be treated with antistatic additives to prevent charge accumulation.
Commenter: Transport Canada		
Section 8(f)(3) Fuel System Electrostatics AC 25.981-1C states that it is acceptable to minimize the magnitude of developed charge during refueling by locating the fuel discharge port at or near the bottom of the tank As such,		**The FAA concurs.** We agree with the commenter and have modified the text to provide additional clarity to methods of compliance.

Comment	Requested Change	Disposition
fuel spray is minimized and provides for the fuel ports to be covered in the early stages of fuel flow as the refuel rate varies from 1 mls up to the full flow of 6-7 mls. Whereas it is not the stated intention of the FAA to require a 2-speed refueling system for all aircraft, clarification is required as to what the FAA considers to be a nominal time allowable during refueling to cover a fuel discharge port located at or near the bottom of the tank.		
Commenter: Airbus		
Section 8(f)(4) Fuel System Electrostatics Airbus requests that the FAA review its requirement for fuel anti-static agents to ensure consistency.		FAA Comment Document reviewed for consistency and found adequate. No change incorporated.
Commenter: United Airlines		
Section 8(f)(4) Fuel System Electrostatics Research shows that the use *of* fuel system anti-static additives appears to have limited value in fuel system safety. The cost to establish the capability to utilize fuel system anti-static additives would be cost prohibitive.		**The FAA does not concur**. Currently such additives are used in various parts of the world, and the FAA believes they are effective. No data was provided by the commenter to support the position that the additives are cost prohibitive. No change made.
Commenter: Airbus		
Section 9(a)(2) Routing of Pump Wire Supply Airbus agree with the FAA recommendation provided in §9.a.(2). However, Airbus would like the FAA to provide examples of what type of design would be considered "impractical." Airbus experience shows that routing fuel pump wires outside the fuel tank ,along the		**The FAA concurs.** We have clarified this section to clarify acceptable compliance means.

Comment	Requested Change	Disposition
aircraft skin, increases the aircraft drag and weight. This penalty, however, has been accepted as a penalty worth having in order to ensure safety (single failure of 115V sparking into fuel tank ullage). Airbus would like to clarify whether the FAA consider the drag and weight increase an "impractical structural consideration." Airbus would also like this paragraph to clarify the type of design needed to render in tank 115V fuel pump wires equivalent to wiring routed outside the tank. During a recent FAA meeting the FAA commented that the two installations are considered equivalent if the inside fuel tank wire is routed inside a double walled conduit. If this is true, then §9.a.(2) should include this information with substantiation.		
Commenter: AE-2 Lightning Committee		
Section 9(a)(2) Routing of Pump Wire Supply Editorial addition	Routing Of Pump Power Supply. If practical, fuel pumps should be located such that electrical power for the pumps is routed outside the fuel tanks in such a manner that failures in the electrical power supply cannot create a hot spot inside the tank or arc into the fuel tank. However care should be taken that such rerouting does not expose the pump electrical wiring to experience higher electromagnetic environment-induced transients that may damage the wiring or pump insulation. This may require that some rerouted wiring	The suggested changes would be part of the basic certification of the wiring system. A note was added to address this comment.

Comment	Requested Change	Disposition
	be provided with additional electromagnetic shielding. Alternately, or in addition, the pumps and power sources may have to be qualified to a higher lightning induced transient level, usually by test. *(This change adds a caution that rerouting of electric power (and other electrical conductors from within a tank to the exterior of a tank may increase the exposure of that wiring to electromagnetic fields produced by lightning currents in the airframe, so that additional shielding against such fields might be necessary)*	
Commenter: Boeing		
Section 9(a)(3) Location of Pump Inlet Modify the text of this paragraph to improve clarity.	~~"Another~~ ***Other*** design practice***s*** that should be considered is locating fuel pumps such that the pump inlet remains covered with fuel throughout the airplane operating envelope ***or incorporating flame arrestor technology***. The following methods should be effective under pitch and roll attitudes, and negative G conditions, anticipated to occur in service***.*** ***For tanks that utilize motor driven fuel pumps and the tank is routinely emptied, accepted design practices include shutting off the motor driven pumps prior to uncovering the fuel pump inlet and installation of a flame arrestor in the scavenge pump inlet line, or scavenging***	**FAA partially concurs** and has modified the paragraph to add clarity.

Comment	Requested Change	Disposition
	the remaining fuel with ejector pumps."	
Commenter: Airbus		
Section 9(a)(3)(b) Location of Pump Inlet Airbus disagrees that negative G conditions should be part of the SFAR 88 requirement. Negative G is created under an emergency descent situation. The aircraft is in this state for a maximum of 8 seconds. The pump inlet design may be compromised for a very small risk window. FAA is asked to reconsider its position on Negative G.		The reference to SFAR 88 has been removed from the AC. Negative G is part of the airplane operating envelope and needs to be considered. Applicants may be able to show through analysis that the duration of negative g does not allow sufficient time for ignition to occur. This may be design dependent and is the responsibility of the applicant.
Commenter: Airbus		
Section 9(a)(3) Location of Pump Inlet Proposal for wording change.	Another design practice that should be considered is locating fuel pumps such that the pump inlet remains covered with fuel throughout the airplane operating-envelope. The following methods should be effective under pitch and roll attitudes, ~~and negative G conditions,~~ anticipated to occur in service.	Addressed in the above comment.
Commenter: Airbus		
Section 9(a)(3)(b) Auxiliary Tanks Proposal for wording change.	For auxiliary tanks that utilize motor driven fuel pumps and the tank is routinely emptied, accepted design practices include shutting off the motor driven pumps prior to uncovering the fuel pump inlet and installation of a flame arrestor in the scavenge pump inlet line, or scavenging the remaining fuel with ejector pumps. These methods should be effective	Not accepted as stated above.

Comment	Requested Change	Disposition
	under pitch and role attitudes, ~~and negative G conditions,~~ anticipated to occur in service, but not when the main fuel tank quantity is deplete during fuel exhaustion conditions.	
Commenter: AE-2 Lightning Committee		
Section 9(a)(3)(b) Auxiliary Tanks Add last sentence for clarification.	Add sentence: For auxiliary tanks that utilize motor driven fuel pumps and the tank is routinely emptied, accepted design practices include shutting off the motor driven pumps prior to uncovering the fuel pump inlet and installation of a flame arrestor in the scavenge pump inlet line, or scavenging the remaining fuel with ejector pumps. The performance of the flame arrester in each installation should be verified by test. *(This adds a recommendation that flame arresters be tested to verify their effectiveness in specific installations. The ability of a flame arrester to stop a flamefront is dependant upon its installation, and an arrester that is effective in one installation may not be effective in another)*	**The FAA concurs** and addressed this comment.
Commenter: Airbus		
Section 9(a)(4)(a) Intrinsically Safe Wiring Airbus considers this paragraph to be rulemaking by AC. This paragraph already assumes that today's fuel systems are not adequate and that a certain design feature is needed. Should the FAA consider this		**The FAA does not concur**. This is not rulemaking by AC. The energy levels provided by intrinsically safe are intended to be guidance and are based on technical data. Applicants may choose to show electrical systems intrinsically safe. But

Comment	Requested Change	Disposition
request as a new rule? As a corollary to this comment, recent developments in inerting systems could possibly be viewed by an applicant as an ignition protective feature. To date, inerting has always been considered as a means to limit flammability, only. If the FAA change their policy, and decide to regulate the hazard "fuel tank explosion", by allowing tradeoff between ignition prevention and flammability reduction, then the regulation as well as the advisory circular should be revised. This regulatory policy change would also ensure a correct evaluation of the MMEL (state without inerting) and would avoid a degradation in the overall level of safety.		this is not required if other protective means are provided.
Commenter: AE-2 Lightning Committee		
Section 9(a)(4)(a) Intrinsically Safe Wiring Add editorial changes.	(a) Intrinsically Safe Wiring. All wiring that is intended to conduct intrinsically safe levels of electrical power into or though the fuel tanks should incorporate protective features that prevent exceeding the intrinsically safe levels of paragraphs 8b and c. of this AC. This wiring should also be protected from lightning and HIRF-induced transients. The following protective features could be used to support that objective: *(Again, "systems considered to be "intrinsically safe" may not be so in lightning and HIRF environments)*	Accepted with modification.

Comment	Requested Change	Disposition
	1 Separation and shielding of the fuel tank wires and circuits from other airplane wiring and circuits and lightning and HIRF electromagnetic fields, and/or 2 Installation of transient suppression devices, to preclude unwanted electrical energy and transient overvoltages/currents from entering the tank. *(These changes are to be consistent with changes made earlier)*	
Commenter: Airbus		
Section 9(a)(4)(b)(1) Higher Energy Wiring The applicant is told to evaluate his system and to demonstrate that good design features are in place. During the recent SFAR 88 reviews, the FAA has not been able to state where and what the good features are for high energy wires routed outside the tank. Features that have been incorporated to preclude maintenance errors have been ignored due to the overlying assumption that a maintenance error can occur anywhere and is always a probability of 1 and therefore a GFI is needed at all cost.	Airbus request that these paragraphs be further enhanced to clarify what is an "acceptable" configuration, especially for wires routed outside the tank.	**The FAA does not concur.** Service experience shows that these guidelines have merit in preventing single catastrophic failures.
Commenter: Boeing		
Section 9(a)(4)(b)(1) High Energy Wiring Revise the text of this paragraph to allow the applicant to use alternative design approaches.	"Wiring should not be routed through metallic conduit inside the fuel tank or adjacent to fuel tank surfaces such that damage, inappropriate maintenance, or other failure/wear conditions could result in arcing to the conduit or metallic tank surface and development of an ignition	**The FAA does not concur.** Service experience shows that single failures from chaffing against metallic conduits has occurred so designs must address this failure condition.

Comment	Requested Change	Disposition
	source in the fuel tank. If metallic or other conductive conduit materials are used, the single failure of electrical arcing of the wiring to the conduit, adjacent tank surfaces, or structure should be assumed to occur ***unless the applicant substantiates that provisions within the design configuration prevents chafing and provides acceptable characteristics.*** In addition, circuit protective features or other features should be incorporated to preclude development of an ignition source in the fuel tank. Methods that may be used to address this foreseeable failure condition include the use of circuit protective features such as dual conduits, thick wall conduit, and/or fast-acting ground fault interrupter (GFI) circuit breakers."	
Commenter: AE-2 Lightning Committee		
Section 9(a)(4)(c) Wire Separation Add changes for clarity	Wire separation. Wiring designs used on transport airplanes vary significantly between manufacturers and models; therefore, it is not possible to define a specific universal separation distance or the characteristics of physical barriers between wire bundles to protect critical wiring from damage. Intrinsically safe wiring for fuel tanks must be protected from induced currents caused by lightning, power system switching transients, or electromagnetic interference (EMI) due to close proximity to other airplane wiring. In addition, damage to wire insulation can	**The FAA concurs.** Accepted as written.

Comment	Requested Change	Disposition
	result in unwanted electrical energy being transmitted into the fuel tank, if the damaged wire can come into contact with the conductor of another wire that is not intrinsically safe. Of particular concern is the possibility of a wire bundle fire that exposes and breaks wires that are not intrinsically safe and also damages the insulation of intrinsically safe wiring that is in close physical proximity. The broken wires may still be energized and could contact conductors of the damaged intrinsically safe wire. If physical separation is used to protect intrinsically safe fuel system wiring from other wiring or to protect fuel tank walls from high power wiring, the minimum physical separation must be established by the applicant. The applicant should conduct an analysis to verify that current and energies greater than those specified in paragraphs 8b and c. of this AC will not be applied to intrinsically safe wiring, considering the factors listed below. *(This adds the other possible sources of interference or damage)*	
Commenter: Airbus		
Section 9(a)(4)(c) Wire Separation Is the "minimum physical separation distance" really left up to the applicant? A recent IOR on wire separation discussed fixed distances of 2" or 6," depending on the installation. If the FAA intends to have "fixed" values then they		Yes, separation is up to applicant to address. Additional guidance can be found in AC 25.1701-1.

Comment	Requested Change	Disposition
should be placed in the AC and not in a follow-up IOR. Airbus favor the current wording of the AC and suppression of the IOR criteria.		
Commenter: Airbus		
Section 9(a)(4)(c) Inspection The FAA should be more specific in advising the applicant on what type of configuration needs to be inspected. For instance, does an installation of a TSU automatically cancel this inspection request? The FAA recommend using nondestructive testing. Airbus recommend the FAA provide more guidance in this area (this AC or another AC) because as far as we know, a tool has not yet been developed to perform the recommended inspection. (Tool is being developed as part of ASTRAC working group.) Airbus would also like to point out that colour coding is a design driven requirement and is recorded in the AMM.		The need for inspections will depend upon what is needed to show compliance with § 25.981 as well as the EWIS rules. Color coding of the wiring may be used as the identification means for critical fuel tank system wiring for showing compliance to § 25.981. Other means may be needed to show compliance with the EWIS regulations. No change was made in response to this comment.
Commenter: Airbus		
Section 9(a)(4)(f) Circuit Breakers Airbus requests that the FAA expand on the type of demonstration that is acceptable to show that circuit breakers are acceptable and that GFIs are not needed.	Expand on the type of demonstration that is acceptable.	Each fuel system is unique so specific design guidance is inappropriate. However GFIs and arc fault circuit breakers can be used to address arcing faults.
Commenter: Airbus		
Section 9(a)(4)(i) Use of Silver in fuel tanks It should be pointed out that "criticality" is defined during the design process. It is only reported in the maintenance documentation.		**The FAA concurs.** The text has been revised to eliminate the use of “critical” in the paragraph.
Commenter: United Airlines		

Comment	Requested Change	Disposition
Section 9(a)(4)(i) Use of Silver in fuel tanks We are not aware *of* any research that conclusively demonstrated that silver-sulfide deposits between exposed conductors can reduce the resistance between conductors and can ignite fuel vapor when exposed to very low levels of electrical energy such as those normally found in a fuel tank FQIS system. Our understanding of research done by Boeing demonstrated that high levels of energy were required to break down the deposits. These were far greater levels of energy than would ever be found in a fuel tank. We are concerned that action may be unnecessarily required to either remove corrosion from in-tank components or replace components without sufficient justification.		**The FAA does not concur**. The paragraph has not been modified accordingly.
Commenter: Boeing		
Section 9(a)(4)(i) Use of Silver in fuel tanks We suggest that this entire paragraph be deleted. No data or service experience has been presented that supports this paragraph's conclusion.	~~"Silver can combine with sulfur and form silver-sulfide deposits between exposed conductors (terminal block connections, etc.). The silver-sulfide deposits reduce the resistance between conductors and can ignite fuel vapor when exposed to very low levels of electrical energy. The energy levels that have been shown to ignite fuel vapor during laboratory tests approach the levels normally used on fuel quantity indicating system wires and probes. In general, silver or silver-plated electrical components should not be used inside fuel tanks where sulfides could form in critical locations and cause an ignition source~~	**The FAA does not concur**. Paragraph not modified:

Comment	Requested Change	Disposition
	~~(including wire, connections, terminal blocks, etc.). Nickel-plated copper wire does not form similar conductive deposits. Nickel-plated copper wire has been shown to provide satisfactory performance when used inside fuel tanks for fuel quantity indicating system wires. In certain instances, silver components have been used to replace the original type design components during fuel tank maintenance (e.g., silver nut used to replace nickel-plated nut). If use of silver in electrical components and wiring in the tank is determined to be critical, it should be defined as a critical Design Configuration Control Limitation."~~	
Commenter: Smith		
Section 9(a)(4)(i) Use of Silver in fuel tanks Editorial changes	From "Silver can combine with sulfur and form silver-sulfide deposits…" To "Silver can combine with water or water vapor and form silver-oxide deposits…" From "The silver-sulfide deposits reduce the resistance…" To "The silver-oxide deposits reduce the resistance…" From "The energy levels that have been shown…" To "The energy levels (dc only) that have been shown…" From "…inside fuel tanks where sulfides could form…" To "…inside fuel tanks where oxides could form…"	**The FAA concurs.** We have incorporated the editorial changes.

Comment	Requested Change	Disposition
	From "Nickel plated copper wire does not form similar conductive deposits." To "Nickel plated copper wire may form similar conductive deposits if the nickel plating is damaged as do cadmium plated components, and these deposits can lead to system performance degradations but are not ignition sources."	
Commenter: Airbus		
Section 9(4) General Airbus suggests that the FAA add an additional paragraph to section 9 to discuss the undesirable use of steel wool in fuel tanks. This paragraph is especially important considering the FAA feel that the presence of steel wool poses a safety risk. A paragraph stressing the importance of not using steel wool will increase the safety of the fuel system (in a similar manner as done in §9.i; Use of silver in fuel tanks).	Add a section 9(j) "Use of Steel Wool."	**The FAA concurs**. We added a new section for steel wool effects inside the fuel tank.
Commenter: Airbus		
Section 10(a) Ignition Source Failure Analysis The phrase "to substantiate that ignition sources will not be present in the fuel tanks" contradicts the requirements of §10.a.(1) which allows for a combination producing an ignition source, providing it is shown to be EXTREMELY IMPROBABLE.		**FAA does not concur** with the comment. To substantiate that ignition sources will be present, the FAA has defined the requirements in § 25.981(a)(3). Further, the paragraph states in a single failure there cannot be an ignition source. In a <u>single failure</u> in combination with each <u>latent failure not shown to</u> be extremely remote. For <u>all combination</u> of failures not shown to be extremely probable.

Comment	Requested Change	Disposition
Commenter: Boeing		
Section 10(a) Ignition Source Failure Analysis Delete the reference to SFAR 88 that appears in this paragraph. (See our comments under section titled "General Comments.")	"Compliance with § 25.981 ~~and SFAR No. 88~~ require each applicant to develop a failure analysis for the fuel tank installation to substantiate that ignition sources will not be present in the fuel tanks. The requirements of this section are in addition to the more general propulsion failure analyses requirements of §§ 25.901 and 25.1309 that have been applied to propulsion installations."	**The FAA concurs** and has accepted the change.
Commenter: AE-2 Lightning Committee		
Section 10(a) Ignition Source Failure Analysis How is this to be interpreted as regards lightning strikes? Accepted methodologies for determining fuel vapor ignition source probabilities due to lightning do not exist. The procedures in FAA AC 20-53A should be followed to verify adequacy of protection against lightning related ignition sources. This means demonstrating the absence of arcs or sparks in the presence of a defined lightning environment		**The FAA concurs.** AC 20-53B was added to the references. In addition an Aviation Rulemaking Committee is currently being formed to address this issue.
Commenter: Airbus		
Section 10(a)(1) Ignition Source Failure Analysis In view of the FAA interpretation, Airbus consider that the second bullet of this regulation "each single failure, regardless of its probability of occurrence, in combination with any latent failure condition not shown to be		**The FAA does not concur.** The rule has been published as written. Any alternate wording will likely to contradict the rule and cause confusion.

Comment	Requested Change	Disposition
extremely remote…", is impractical to meet and should be revised. An alternative wording may be to state that an ignition source shall not be produced by a combination of two failures where one of the failures is latent, i.e. in the event of the latent failure, the aircraft is flying one failure away from a CATASTROPHIC condition. Airbus believe that this is the situation that the FAA is trying to prevent.		
Commenter: Smith		
Section 10(b)(1) Additions to Figure 1	Figure 1 should have three branches under "ELECTRICAL COMPONENTS", "Fuel Level Sensors", "Temperature Probes", "Fuel Quantity Indication System".	**The FAA concurs**. Proposed changes have been incorporated into the Figure 1.
Commenter: AE-2 Lightning Committee		
Section 10(b)(1) Changes to Figure 1 Change upper right box to include EMI, HIRF too. Add additional blocks to cover scope of lightning assessment about fasteners and skins, couplings, etc. We could not open this block diagram to add in the recommended blocks.		**The FAA concurs.** Figure 1 is changed – the block currently entitled, "Electrostatic or Lightning", is changed to "Electrostatic Charging, Lightning, HIRF & EMI." Add box under "Electrostatic Charging…, Entitled "Fuel Tank Structure Lightning Protection" with note stating the following: Note: Fuel tank structure lightning protection is not addressed in this AC. Guidance in this area is currently under development. See Transport Airplane Policy on this subject.
Commenter: Goodrich Corporation		
Section 10(b)(10) Line Replacement Unit (LRU) Design Evaluation The paragraph discusses any device that meets		AC 25.981-1B refers to UL 913. U.S. Air Force experience indicates this standard may not be sufficient.

Comment	Requested Change	Disposition
UL 913 is considered acceptable. It then further discusses "Ideally" higher power (what are these), physical barrier (from what threat?), three inches between traces is an implementation – the requirements are in UL 913. Fire compromising intrinsically safe circuits would seem to be in conflict to the definition. I would delete the last two sentences and state any additional conditions that need to be considered as part of the LRU design considerations.		Over-current faults and internal fires can compromise wire trace separation. Failures can be external and internal events. External include over voltage or over current, high humidity, temperature, vibration, shock, and contamination. Internal failures include manufacturing defects or flaws in the conductor, substrate or coating. To reduce catastrophic PWB failures, it must isolate and physically separate critical signals. The appropriate separation distance of 3 inches has been determined to be adequate.
Commenter: Airbus		
Section 10(c)(1) Fuel Tank Flammability Airbus would like clarification on this paragraph - If an applicant is considering implementing an inerting system, does the applicant still need to consider that the fuel tank is flammable in order to take into account MMEL considerations or inerting system failure conditions?	Clarification of the paragraph.	**The FAA does not concur**. Section 25.981 requires both ignition prevention and flammability be addressed separately. The flammability of the tank should be considered as provided for in the AC guidance.
Commenter: Boeing		
Section 10(c)(1) Fuel Tank Flammability Delete the term "sloshing" from this paragraph. Its impact ignition characteristics have not been established.	"The analysis should assume that the environment inside the fuel tank is always flammable. The conditions required to ignite fuel vapors from ignition sources vary with pressures and temperatures within the fuel tank and can be affected by ~~sloshing or~~ spraying of fuel in the tank. Due to the difficulty in predicting fuel tank	**FAA does not concur.** There is evidence that sloshing contributes to the development of fuel vapor inside the tank. The magnitude of the effect has not been quantified. Therefore, omission of the word is not accepted

Comment	Requested Change	Disposition
	flammability, the FAA has always assumed that a flammable fuel air mixture exists in airplane fuel tanks and has required that no ignition sources be present. The system safety analysis should be prepared considering all airplane in-flight, ground, service, and maintenance conditions, assuming that an explosive fuel air mixture is present in the vapor space of fuel tanks and vent systems at all times, unless the fuel tank has features that mitigate the effects of tank ignition (e.g., polyurethane foam)."	
Commenter: Smith		
Section 10(c)(1) Fuel Tank Flammability Editorial changes	Change from "…features that mitigate the effects of tank ignition (e.g., polyurethane foam)." To "…features that mitigate the effects of tank ignition (e.g., polyurethane foam, inerting)."	**The FAA does not concur** with this change since the proposed change would be contrary to the rulemaking for § 25.981.
Commenter: Smith		
Section 10(c)(2) Intrinsically Safe Editorial changes	Change title to "Ignition Source Definition" From "…event (e.g. polyurethane foam, adequate structural margin), the SSA…" To "…event (e.g. polyurethane foam, inerting, adequate structural margin), the SSA…"	See above.
Commenter: AE-2 Lightning Committee		
Section 10(c)(2) Intrinsically Safe Define what is safe not what is not safe.	Intrinsically Safe. Failures that produce levels inside fuel tanks that are below intrinsically safe levels are not considered	**The FAA concurs**. The definition in 10(c)2 is deleted.

Comment	Requested Change	Disposition
	to be ignition sources.	
Commenter: Airbus		
Section 10(c)(3) Failure Condition Classification Would an inerting system change the failure condition classification of a fuel tank ignition event?	Clarification of the paragraph.	The current regulation has two distinct requirements. One requires evaluation of ignition sources. The other, fuel tank flammability. Therefore the SSA for ignition sources must show compliance with § 25.981(a) independently from § 25.981(c). No change to the AC was made as a result of this comment.
Commenter: Airbus		
Section 10(c)(4)(a) Latent Failures During the SFAR 88 reviews, it seemed that there are no acceptable arguments. Any argument Airbus used consisting of the traditional safety factors -- in-service experience, lab testing, manufacturing procedures, quality procedures, etc. were deemed in adequate. The additional guidance could save time and money within the design development and certification. Airbus would also like to point out that the word "anticipated" is again being used without any definition within the AC.	Requests that the FAA to provide additional guidance on how to show that a latent failure condition is "extremely remote."	If a specific failure event is considered possible but not foreseeable within a current knowledge, it is considered an extremely improbable occurrence (e.g., catastrophic wing failure). The current knowledge is historical experience, in addition to scientific/engineer judgment. If the failure in question **<u>has happened</u>**, its occurrence in the future **<u>cannot be considered</u>** extremely improbable. A numerical probability number of $1x10^{-9}$ is generally acceptable by FAA as meaning of “extremely improbable”, providing the calculation assumptions and methodology are both relevant and appropriate. The real test of extremely improbable is foreseeability within current knowledge, rather than sole reliance on a $1x10^{-9}$ calculation.

DISPOSITION OF PUBLIC COMMENTS

AC NO. 25.981-1C, TITLE: FUEL TANK IGNITION SOURCE PREVENTION GUIDELINES

Comment	Requested Change	Disposition
Commenter: Transport Canada		
Section 10(c)(4)(a) Latent Failures It is not clear if this inspection is to be applied to all aircraft.		No FAA response since we cannot determine what is requested.
Commenter: Boeing		
Section 10(c)(4)(a) Latent Failures Revise the text of this paragraph to improve clarity and eliminate redundancy.	"In order to eliminate any ambiguity as to the restrictions on latent failures, § 25.981(a)(3) explicitly requires that any anticipated latent failure condition not leave the airplane one failure away from a catastrophic fuel tank ignition. In addition to this § 25.981(a)(3) limitation on latency, § 25.1309(c) limits latent failure conditions to those that do not create an "unsafe system operating condition." Consequently, if a latent failure condition is not extremely remote (i.e., it is anticipated to occur) and it creates an "unsafe system operating condition," then "warning information must be provided to alert the crew" and "to enable them to take appropriate corrective action." These applicable regulatory restrictions on latency notwithstanding, there are practical limitations on the available means of compliance. For example, detecting a failure condition requires a finite period of time and there are not always "appropriate corrective actions" that can be taken during the flight. Consequently, for the purposes of compliance with § 25.981(a)(3), the period of latency for any anticipated significant latent failure condition, ***which***	The FAA partially concurs and incorporated changes to this section of the AC.

Comment	Requested Change	Disposition
	cannot be made detectable during a flight cycle, should be minimized ~~and not allowed to exceed one flight cycle~~. For the purposes of § 25.1309(c) compliance, any time the airplane is operating one failure away from a catastrophic fuel tank ignition should be considered an "unsafe system operating condition," recognizing that sometimes the only "appropriate corrective action,***" when problem detection is available,*** is to continue on to your destination but not to initiate another flight without making appropriate repairs as long."	
Commenter: AE-2 Lightning Committee		
Section 10(c)(4)(b) Latent Failures The paragraph will be very difficult if not impossible to comply with. What is the probability of a failed bond strap, or loose coupling, for example? This point raises the question of why fuel tank protection must always rely upon electrical bonding (presumably to make conductive paths out of everything). It is often more reliable to depend on an insulator to prevent current from flowing at all, than to rely upon a bond to stay sufficiently conductive that when current flows it will not produce an incendiary arc.		FAA is in agreement with the comment. However, experience has shown that broken ground wires are more easily detected during inspections than the loose coupling.
Commenter: Airbus		
Section 10(c)(4)(c) Latent Failures The "NOTE" should be revised if the policy is change following the SFAR 88 reviews. The more people in the tank, the more damage that	Clarify the scope of the inspections.	The inspection criterion depends upon the outcome of the safety assessment and the established ALI that are required by the rule. If the safety of the system is

Comment	Requested Change	Disposition
is likely to be created - even by inspectors. Airbus would like to clarify that the scope of the inspections will need to be agreed with the authorities prior to the development of any procedures, standards, etc. The CMCC working group process will be used to develop the maintenance program/tasks.		dependent upon a single inspection, redundant review is required. The argument that inspections may create unsafe conditions due to tank entries does not absolve the applicant from showing the inspection intervals meet the requirements of the rule and that redundant inspections are defined when needed.
Commenter: United Airlines		
Section 10(c)(4)(c) Latent Failures If this is intended to be a Required Inspection Item, we suggest the use of RII, not RII is utilized to inspect an item following aircraft action, e.g. alteration or repair and not to accomplish an initial inspection prior to repair or alteration. A requirement for dual inspection results in multiple non-routine write-ups noting discrepancies and becomes very redundant. Multiple inspectors should not be utilized. It would be more realistic to define individual precise inspection requirements for each item, noting the level of required inspection of General (GVI) or (DVI) Detailed and leave it to the operator to ensure it is properly accomplished.	Suggest the use of RII, not RII is utilized to inspect an item following aircraft action, e.g. alteration or repair and not to accomplish an initial inspection prior to repair or alteration.	Revised the CII to FSL per Boeing comments below.
Commenter: Boeing		
Section 10(c)(4)(c) Latent Failures Replace the phrase "critical inspection item (CII) with "Fuel System Limitation (FSL)," to reflect current industry terminology.	"Any inspection that is identified to assure integrity of items identified as critical design configuration control limitations should be identified in the limitations section of the instructions for continued airworthiness as a ~~critical inspection item (CII)~~ ***Fuel System Limitation (FSL)***. If	Accept the change. Should be identified in the limitations section of the instructions for continued airworthiness as a ~~critical inspection item~~

Comment	Requested Change	Disposition
	this means is used, the limitations section should include the following:”	~~(CII)~~ ***Fuel System Limitation (FSL)***
Commenter: Transport Canada		
Section 10(c)(4)(c) Latent Failures This AC introduces a new definition, the Critical Inspection Item (CII). It is suggested that this tem1 be deleted or changed to "Airworthiness Limitation Item (ALI)" which is already commonly accepted in Industry and known to be a mandatory requirement, and which already includes the CII within its definition. A CII introduces a new definition, confusion and divides sections of the Airworthiness Limitations unnecessarily. At the maintenance level a CII can be readily confused with an Rn, which is also a critical inspection item but one, which is not part of the design standards. In both paragraph 5.t and paragraph 1O.c.(4)(c), ClI are defined with reference to the newly introduced term "Critical Design Configuration Control Limitations" (CDCCL). The provision of a definition of CDCCL within this AC may be beneficial. It is our understanding that cn are to be considered as non-escalatable tasks (akin to I-star CMR). Further, an applicant cannot dispose such tasks as MRB tasks (e.g. MSG-3 Route 8 Safety Task), since		Addressed in the Boeing comment above. The CII was changed to more universally accepted term Fuel system Limitation (FSL).

Comment [SM1]: RII?

Comment [SM2]: 1?

Comment	Requested Change	Disposition
MSG methodologies are not consistent with the requirements of Sec. H25.4 (a)(2). Transport Canada suggests that further details on this issue be included in the body of the AC. We also understand that the use of a third newly defined term is being promulgated, a "Fuel System Limitation" (FSL). Discussion and definition of the FSLs may provide added value and completeness to the AC. An example showing an acceptable means of presenting Fuel System Limitations, mandatory replacement times, inspection intervals, related inspection procedures, and all CDCCL approved under Sec. 25.981 for the fuel tank system may be useful to aid in a uniform industry understanding of these new Instructions for Continued Airworthiness, per revised Appendix H to Part 25.		
Commenter: Smith		
Section 10(c)(5) Failure Conditions Change wording for clarity.	Delete first sentence and rename to “Failure Probability Definitions”. Insert new title “Failure Conditions” before paragraph (a). Change reference in paragraph (a) from paragraph 7g to 7c. Renumber remaining paragraphs.	Accept the change.
Commenter: Airbus		
Section 10(c)(5) Failure Conditions Again by definition "likely" is "to be	Airbus requests the FAA to define "likely" damage.	Comment accepted: Likely damage is anticipated to occur or foreseeable.

Comment	Requested Change	Disposition
expected." If damage is expected then design or maintenance precautions would be taken. It is the unexpected that are a problem.		Typically likely damage is damage that engineering judgment or past experience would lead one to conclude that an occurrence is foreseeable. For instance a wire bundle located where a mechanic would use it as a hand hold, dropping of a wrench, bending of a fuel probe located where a mechanic could use it to push off and move around in the tank, etc.
Commenter: Airbus		
Section 10(c)(5)(a) Failure Conditions Again, SFAR 88 meetings have revealed that substantiation against the "fail-safe" criteria in AMJ 25.1309 (referenced in SFAR 88 preamble) was not acceptable because some of the ways to show a fail safe design were not really fail safe, i.e. quality procedure. Another example is multiple layers of insulation. Multiple layers of insulation are standard practice and are accepted as giving better protection than one layer. However, it would probably be unacceptable to show them ANDed in a fault tree. FAA should also clarify how the applicant can gain credit should be considered for maintenance clear-up and cleanliness procedures post tank exit.	The FAA should provide additional guidance on the "type of substantiation that is acceptable" in order to gain credit for fail-safe features.	FAA does not concur. Guidance to show a failure mode does not defeat multiple features should not be needed. Common engineering judgment would conclude that multiple layers of insulation that can be defeated by the failure mode of abrasion does not provide independent fail safe features.
Commenter: Boeing		
Section 10(c)(5)(a) Failure Conditions Revise this paragraph by deleting the last sentence, which is clearly an editorial statement.	"Delete last sentence of paragraph; fail-safe features depend on configuration The analysis should be conducted considering the deficiencies and anomalies listed in paragraph 7(g) of this AC, failure modes identified by the review of service	Accept the changes.

Comment	Requested Change	Disposition
	information (including review of supplier service data), and any other failure modes identified by the functional hazard assessment of the fuel tank system. For example, the presence of conductive debris such as lockwire, steel wool, nuts, bolts, rivets etc., should be assumed. Section 25.981 specifically requires that the effects of manufacturing variability, aging, wear, corrosion, and likely damage must be considered when demonstrating compliance. Credit for fail-safe features must be substantiated. For example dual layers of insulation on wires or addition of sleeving has been claimed as providing fail-safe features. ~~Service history would not support this assumption."~~	
Commenter: Airbus		
Section 10(c)(5)(b) Failure Conditions The FAA needs to clarify how an applicant should consolidate the "FAA design analysis," which doesn't allow credit to be taken for the robustness of an installation, and the methods allowed to be used to determine the maintenance task intervals. Intervals determined using the FAA analysis are too conservative and do not fit into standard aircraft maintenance practice intervals. FAA should also clarify how the applicant can gain credit for the fuel system limitations imposed through the maintenance program.	Request for clarification	Outside the scope of this AC.
Commenter: Airbus		
Section 10(c)(6) External Environment		Currently there is no industry standard for

Comment	Requested Change	Disposition
The FAA request that the probability of a lightning encounter be equal to one, even though there is an established industry statistic of the probability of encountering a lightning strike. Airbus agree that a system should be evaluated looking at what happens if lightning hits the airplane. However, modifications should be determined using the actually probability of the event. This philosophy is concurrent with the lightning regulations and is also substantiated by inservice experience. There have been no catastrophic accidents due to lightning strikes since the introduction of the lightning regulations. It is noted that CWTs are not considered susceptible to lightning strikes due to their location in the fuselage.		lightning probabilities. FAA has initiated rulemaking activities for lightning protection of fuel tanks. Until completely, the current standard is to assume lightning probability of 1. Paragraph has been modified to eliminate the reference to HIRF special conditions since new rules have been added to part 25.
Commenter: AE-2 Lightning Committee		
Section 10(c)(6) External Environment Requested change for clarity.	External Environment. The severity of the external environmental conditions (e.g., HIRF, lightning) that should be considered when demonstrating compliance with § 25.981 are those established by certification regulations, advisory material, notices, and any special conditions regardless of the associated probability of exposure to any external environment. For example, the probability of a lightning encounter should be assumed to be one. *(The lightning environment is established in Advisory Circular; the HIRF environment is presented in an FAA Notice and draft Advisory Circular)*	Currently there is no industry standard for lightning probabilities. FAA has initiated rulemaking activities for lightning protection of fuel tanks. Until completely, the current standard is to assume lightning probability of 1. Paragraph has been modified to eliminate the reference to HIRF special conditions since new rules have been added to part 25.

Comment	Requested Change	Disposition
Commenter: Boeing		
Section 10(c)(7) External Sources of Tank Auto-ignition Revise the text of this paragraph for clarity.	"The possibility of fuel tank ignition due to ~~auto-~~ ***surface*** ignition sources created by external tank heating should be considered. This includes heating of the tank due to operation or failure of systems outside the tank within both the pressurized and unpressurized areas of the airplane, such as overloaded electric motors or transformers, failures in the pneumatic system and/or ducting that could cause localized heating of tank surfaces. In addition, the possibility of localized heating due to external fires must be considered."	Accept the changes.
Commenter: Smith		
Section 10(c)(7)(b) External Sources of Tank Auto-ignition Addition of another bullet	Add new bullet "areas around auxiliary tanks."	Accept the changes.
Commenter: AE-2 Lightning Committee		
Section 10(c)(7)(b) External Sources of Tank Auto-ignition Editorial changes	Change to: the wing leading and trailing edges, (including any adjacent compartment such as the strut)	Accept the change.
Commenter: Airbus		
Section 10(c)(7)(b) External Sources of Tank Auto-ignition The current wording does not allow the applicant to use ventilation as an acceptable means of compliance.	In general, the fire protection philosophy for any area considered a flammable fluid leakage zone is to assume that flammable vapors may be present in the zone and to minimize the	Ventilation alone does not substantiate compliance. Change is not accepted.

Comment	Requested Change	Disposition
	probability of ignition of the vapors (§ 25.863(a)). This has typically been accomplished by using various standards of explosion-proof components and good wiring practices or sufficiently ventilating the area to preclude the development of flammable vapors. SFAR No. 88 requires a safety review of flammable fluid leakage zones adjacent to fuel tanks to determine that the design complies with the requirements of §§ 25.901 and 25.981. Flammable fluid leakage zones include areas such as: • the wing leading (including any adjacent compartment such as the strut) and trailing edges, • fairings located below the fuel tanks, • fuel pump enclosures, and • unpressurized areas of the fuselage surrounding fuel tanks located in the empennage. Components located in these areas have been required to meet explosion-proof requirements if the zone has not been demonstrated to be non-flammable. These components or systems must be included in the analysis. Examples of equipment include, but are not limited to, ECS packs, motors, power assisted valves, fuel pumps, hydraulic pumps/motors, certain flight control actuators, ECS controls, and	

Comment	Requested Change	Disposition
	valves.	
Commenter: Boeing		
Section 10(c)(7)(b) External Sources of Tank Auto-ignition Modify the text of this paragraph to improve clarity.	"In general, the fire protection philosophy for any area considered a flammable fluid leakage zone is to ~~assume that flammable vapors may be present in the zone and to~~ minimize the probability of ignition of ~~the~~ vapors (§ 25.863(a)). This has typically been accomplished by ~~using various standards of explosion-proof components and good wiring practices.~~ ***some combination of the following precautions:*** • ***grounding and bonding of electrical equipment,*** • ***qualification of electrical equipment as explosion proof,*** • ***sealing of electrical connectors,*** • ***proper support and separation of wire routing,*** • ***drainage provisions in the leakage zone,*** • ***ventilation of the leakage zone in-flight, and*** • ***immediate maintenance action to correct running leaks in these areas.*** ~~SFAR No. 88 requires~~ ***A*** safety review of flammable fluid leakage zones adjacent to	. FAA does not agree with the proposed changes. The assumption that flammable vapors may be present in the zone is needed to clarify that this must be considered when demonstrating compliance.

Comment	Requested Change	Disposition
	fuel tanks ~~to~~ ***will*** determine that the design complies with the requirements of ~~§§ 25.901 and 25.981.~~§ 25.863(a). Flammable fluid leakage zones include areas such as: ▪ the wing leading (including any adjacent compartment such as the strut) and trailing edges, ▪ fairings located below the fuel tanks, ▪ fuel pump enclosures, and ▪ unpressurized areas of the fuselage surrounding fuel tanks located in the empennage. ~~Components located in these areas have been required to meet explosion-proof requirements.~~ These components or systems must be included in the analysis. Examples of equipment include, but are not limited to, ECS packs, motors, power assisted valves, fuel pumps, hydraulic pumps/motors, certain flight control actuators, ECS controls, and valves.”	
Commenter: Smith		
Section 10(c)(7)(c) Surface temperatures in areas adjacent to fuel tanks Editorial correction	Delete extra period at end of first sentence.	
Commenter: Boeing		
Section 10(c)(7)(c) Surface temperatures in areas adjacent to fuel tanks	“The FAA has approved installations,	**The FAA concurs.**

Comment	Requested Change	Disposition
Modify the text of this paragraph to allow for substantiation of surface temperatures different from that quoted in AC.	where surfaces adjacent to the tank experience temperatures in excess of the ~~400°F~~ internal fuel tank ***surface*** temperature limit.. Manufacturers have substantiated that the conditions (ambient pressure, dwell time, fuel type, etc.) within these areas are such that a higher value may be used. For example, a maximum allowable surface temperature of 400°F, with a transient excursion up to 450°F for a maximum of two minutes, has been approved. The excursion above 400°F occurs only during failure conditions such as failure of the engine pneumatic system to regulate temperature, or duct rupture. Approval of these elevated temperatures has been based on compensating design features, such as an over-temperature shutoff of the pneumatic system so that the surface temperatures adjacent to the tank cannot exceed the accepted 450°F value. Internal tank surface temperatures should not exceed the surface temperature limit for the fuel type used as described in paragraph 8(e) of this AC, ***unless a higher maximum allowable surface temperature is substantiated.”***	
Commenter: Smith		
Section 10c(8) Electrical Ignition Sources Clarity	From “…or corrosion (copper or silver sulfur), in combination…” To “…or corrosion (copper, cadmium or silver	Accept the recommended change.

Comment	Requested Change	Disposition
	oxides), in combination…”	
Commenter: Airbus		
Section 10(c)(8) Electrical Ignition Sources Airbus requests clarification - The results of the analysis are a direct function of the assumptions that are taken. The FAA assumptions do not allow an applicant to take credit for "good" design features, especially those designed to prevent maintenance errors. This paragraph implies that a "good design" is one that incorporates a TSU or wire separation/segregation (see §9.(a).(4).(a)). How can an applicant substantiate analysis assumptions other than those impose here? Are OEMs to take out features that help ease maintenance because they're considered useless anyway?	Request for clarification.	Disagree. The language is quite neutral and does not suggest one method or another in establishing the design.
Commenter: Boeing		
Section 10(c)(8) Electrical Ignition Sources Modify the text of this paragraph to delete the reference to silver sulfur. Data to substantiate conclusion on silver sulfur are not available.	“The applicant should perform a failure analysis of all fuel systems and sub systems with wiring routed into fuel tanks. Systems that should be considered include fuel pump power and control and indication, fuel quantity indication, fuel temperature indication, fuel level sensors, and any other wiring routed into or adjacent to fuel tanks. The analysis should consider system level failures, failures within line replaceable units (LRU) and component level failures discussed below. The analysis should include existence of latent failures and subsequent failures that may lead to an ignition source within the	Accepted. Eliminated specific corrosion types for the analysis.

Comment	Requested Change	Disposition
	fuel tank. Examples include undetected failures of tank components or wiring, the undetected presence of conductive debris, damage to FQIS or level sensor probes, or corrosion (copper ~~or silver sulfur~~), in combination with external failures such as hot shorts or induced transients (EMI and lightning). In addition, the applicant should provide a description of the protective means employed in the fuel system wiring. This should include a description of features such as separation/segregation, transient suppression devices, and shielding of wiring and methods employed to maintain configuration control of critical wiring throughout the life of the airplane.	
Commenter: AE-2 Lightning Committee		
Section 10(c)(9)(a) Electrical Short-Circuits Editorial changes	(a) One method that may provide protection of circuits that enter fuel tanks from overvoltages or overcurrents that originate outside of the tanks is the incorporation of a transient suppression device (TSD) on the circuit close to the point where those wires enter fuel tanks, Considerations should also be given to protection of wiring between the transient protection devices and the tank if the protection devices are not located at the tank entrance, and also to the possibility of transients being induced in the wiring between the TSD's and the electrical devices in the fuel tanks. Caution should	Accepted with modification.

Comment	Requested Change	Disposition
	be exercised when using TSD's to be sure that the TSD addresses both voltage and current suppression. (Adds a caution that unless the TSD is installed right at the entrance to a fuel tank there may be some induced voltages due to lightning and HIRF in the circuits between the TSD and the tank. In some cases a TSD may increase the amount of any such voltage that would appear at the tank units)	
Commenter: AE-2 Lightning Committee		
Section 10(c)(9)(b) Electrical Short-Circuits Editorial changes	(b) Another method of protection that has been used to provide a fail-safe design with respect to electrical shorts is separation of wiring to electrical devices in the fuel tanks from electrical power wires and circuits, combined with physical barriers between wiring that enters fuel tanks and any electrical power-carrying wires in the aircraft installation. The effects of electrical short circuits, including hot shorts, on equipment and wiring that enters the fuel tanks should be considered, particularly for the fuel quantity indicating system wiring, fuel level sensors, and probes. Latent failures from factors such as contamination, damage/pinching of wires during installation, or corrosion on the probes, connectors, or wiring should be considered when evaluating the effects of short circuits. The wire routing, shielding, and segregation outside the fuel tanks, including within the FQIS components	Accepted with modification.

Comment	Requested Change	Disposition
	(e.g., gauging units), should also be considered when evaluating the effects of short circuits. The evaluation should consider both electrical arcing and localized heating that may result from short circuits on equipment, fuel quantity indicating system probes, and wiring. The evaluation of electrical short circuits should include consideration of shorts within electrical equipment, and wiring from the equipment into the fuel tank. Prevention of fuel ignition from electrical shorts to wiring that enters fuel tanks may require specific wire and circuit separation and wire bundle shielding. *(This paragraph deals with FQIS circuits; also a better term is "Barrier")*	
Commenter: Airbus		
Section 10(c)(10) Line Replacement Unit (LRU) Design Evaluation Who will be developing the new industry standard and when? Where did the 3" requirement come from (substantiation), and how does it affect other existing standards related to computer hardware design? Airbus is not aware that inservice experience of modern, fly by wire aircraft, showed the industry specifications to be inadequate and unsafe.	Request for clarification.	AC 25.981-1B refers to UL 913. U.S Air Force experience indicates this standard may not be sufficient. Over current faults and internal fires can compromise wire trace separation. Failures of PWB can be external and internal. External failures include over voltage or over current, high humidity, temperature, vibration, shocks and contamination. Internal failures include manufacturing defects or flaws in the conductor, substrate, or coating, and flaws that reduce conductor separation or cross section. Physical separation can be suggested by

Comment	Requested Change	Disposition
		manufacturers if substantiated to be safe. **No change was made to the AC**.
Commenter: Smith		
Section 10(c)(10) Line Replacement Unit (LRU) Design Evaluation The last sentence sets a requirement for 3 inch separation between "limiting devices and system circuitry to limit the amount of power or current transmitted to the fuel tank". What is meant to be the distinction here? The two descriptions seem to be referring to the same circuitry. Also, the requirement should not be for a fire within the LRU. Most LRUs will be sealed or semi-sealed such that there is insufficient oxygen to sustain a fire. The requirements also specify non-flammable circuit board material. The requirement should be that it must be demonstrated by test or analysis that any failure or combination of failures not shown to be extremely remote can not lead to a compromise of the tank circuit intrinsic safety when under any of the conditions specified in this document. These are the requirements of Section 25.981(a)(3), so this statement seems to be redundant, unnecessary, and overly restrictive.		Not all LRU are sealed. There have been incident reports that PWB traces melted due to high current and the material burned and caught fire. No change was made to the AC.
Commenter: AE-2 Lightning Committee		
Section 10(c)(11)(a) Electromagnetic Effects, including Lightning, Electromagnetic Interference (EMI), and High-Intensity Radiated Fields (HIRF) Add the following words for clarity.	(a) The effects of electrical transients from lightning, EMI, or HIRF on anything conductive (e.g. fuel tank plumbing, structure, fuel, equipment and wiring) within the fuel tanks should be considered,	Accepted with modification.

Comment	Requested Change	Disposition
	particularly for the fuel quantity indicating system wiring and probes. Latent failures from factors such as contamination, damage, or corrosion on the probes or wiring should be considered when evaluating the effects of electrical transients. The wire routing, shielding, and segregation of conductors (e.g. plumbing, component casings, wiring, etc.) outside the fuel tanks should also be considered when evaluating the effects of electrical transients, because the transient generation and coupling to conductors may occur outside the fuel tanks. The evaluation should consider both electrical sparks (voltage sparks) and thermal sparks (electrical arcs) and localized heating that may result from lightning, EMI, and HIRF transients on the fuel tank system, fuel quantity indicating system probes, and wiring. *(This change to be consistent with changes in the arc/spark definitions)*	
Commenter: AE-2 Lightning Committee		
Section 10(c)(11)(c) Electromagnetic Effects, including Lightning, Electromagnetic Interference (EMI), and High-Intensity Radiated Fields (HIRF) Moved the transient protection verification recommendation from (d) into (c); adds completeness.	(c) The evaluation of electromagnetic effects from lightning, EMI, or HIRF should be based on the specific electromagnetic environment of a particular aircraft model. Standardized tests, such as those in RTCA DO-160, Sections 19, 20, and 22, are not sufficient alone, without evaluation of the	Accepted.

Comment	Requested Change	Disposition
	characteristics of the specific electromagnetic environment and induced transient levels assigned to systems installed within a particular aircraft model, to show that appropriate standardized DO-160 test categories, procedures and test levels are selected. Simulation of various latent failures of fuel system components within the tanks may be required to demonstrate the transient protection effectiveness. Effectiveness of the transient protection features should be verified using the appropriate DO-160 test procedures and test levels determined above.	
Commenter: AE-2 Lightning Committee		
Section 10(c)(11)(e) Redundancy of bond paths Editorial changes Remove the TWA accident reference, since inspections have been made before and since for other reasons; adds a caution about adding redundant bond straps.	Change to: (e) Redundancy of bond paths. Failure of bonding jumpers is generally considered a latent failure, since there is no annunciation or indication of the bonding failure. The airplane fleet fuel tank inspections have shown that failure of bonding jumpers, due to damage, wear, or manufacturing errors, was not unusual. Based on this, it would be difficult to show that failure of a single bonding jumper is extremely remote or extremely improbable. Therefore, the electrical bonding jumper or other bonding provisions must consider the consequences of these latent failures. This may result in	**The FAA does not concur.** Paragraph unchanged.

Comment	Requested Change	Disposition
	designs that incorporate electrical bonding redundancy, if the failure of a single electrical bonding feature could create a fuel ignition source. However it should be noted that the addition of redundant bond paths may in some cases increase the magnitudes of lightning-induced currents that flow in bonded components such as fuel pipes. Therefore additional bonds, when considered necessary, should be implemented in a way that does not increase lightning-induced currents or otherwise cause a potential hazard that did not previously exist. Care is to be taken that redundant bonds do not become equally degraded due to corrosion, vibration or other environments.	
Commenter: Airbus		
Section 10(c)(11)(f) Self-bonding couplings Could credit be taken for self-bonding couplings if a check of the coupling could be developed? The concerns raised are mostly linked to aging. An applicant should be allowed to take credit for its initial design, manufacturing and quality procedures to show the delivery standard is acceptable. If the answer is yes, then additional guidance should be added.		Accepted with modification.
Commenter: AE-2 Lightning Committee		
Section 10(c)(11)(f) Self-bonding couplings	Change to: Fuel Pipe couplings. In general, conventional couplings that are bonded by	**The FAA does not concur.** This change is outside the scope of the intent of the paragraph which is to address single

Comment	Requested Change	Disposition
	a separate bond strap across the coupling and self-bonding flexible fuel couplings are not considered to have dual bonding paths because experience has shown single-point failures can cause loss of function. Self-bonding flex couplings have failed because of missing bonding springs, anodizing on bonding surfaces, and incorrect installation. These factors would need to be addressed before the self-bonding couplings would be considered to provide dual bond paths. Even though couplings may be self bonded or equipped with parallel bond straps in the installation, there is some current level that will produce arcing at the coupling and an ignition source. Therefore, the current carrying capability of self bonded couplings must be verified to be higher than the expected pipe current levels, including a sufficient margin to account for variations in arc thresholds among similar parts, and the effects of flight environments such as vibration, fuel, water, and corrosion on the arc threshold of the coupling. *(Clarifies that these are pipe couplings, adds reference to couplings with separate bond straps as well as "self bonded" couplings; adds caution that no matter how much bonding is provided to couplings, there is some current level that*	failures in the safety assessment.

Comment	Requested Change	Disposition
	will cause them to arc and provide ignition sources)	
Commenter: AE-2 Lightning Committee		
Section 10(c)(11)(g)(2) Editorial changes This change is needed because the aircraft tests to date really have not been done to determine bonding requirements. They have been done instead to measure the amplitudes of lightning currents that flow in fuel pipes, and/or measure the amplitudes of lightning-induced transients in FQIS circuits. This data has been used to set test criteria for potential ignition sources, such as FQIS probes and pipe couplings.	Change to: Some airplane TC holders have performed tests and/or analyses on their airplanes to determine the lightning and EMI/HIRF induced current levels and the specific requirements for electrical bonds that must safely conduct these currents. Others have estimated bond currents based on previous test experience or analyses, and have designed and tested their bonds to safely conduct significantly higher currents. The approach is a decision each TC holder must make based on the specific situation for that TC holder's airplane models.	**The FAA does not concur.** The intent of this paragraph was to address the need for a bonding specification by the FAA.
Commenter: AE-2 Lightning Committee		
Section 10(c)(11)(h) Bonding Integrity Checks Added words for clarity.	(h) Bonding integrity checks. The requirements of the SFAR may result in a need to verify the integrity of fuel tank bonds. Past experience has shown measurement of bond resistance to be the desired method of assuring bond path integrity. During bonding resistance measurements, damage of protective finish of components may be caused in order to penetrate the insulating anodized surface layer, which may lead to subsequent corrosion damage. This concern has resulted in some TC holders defining non-intrusive inspections for electrical bonding. These inspections may include detailed	Accepted with modification. Additional comments on bonding and ignition sources are beyond the intent of this paragraph.

Comment	Requested Change	Disposition
	visual inspections, if the quality of the electrical bonding feature can be adequately assessed by visual cues, such as visible corrosion, breakage, tightness, or missing bonding provisions. For the fuel tank SFAR, this method would not by itself be adequate. Other inspections include inductively-coupled loop resistance measurements to eliminate the need to disconnect bonding jumpers or to penetrate corrosion-prevention coatings. In any case, the need for and the method of inspection must be defined based on the specific situation for the TC holder's airplanes. The need for and the method of inspection should be a result of the assessments and evaluations carried out to determine the specific electrical bonding requirements noted above. It should be noted that bonding and bond resistances may not be the only criteria for verifying the ignition source free capability of a coupling or other electrical interface. Bond resistance may be a good indicator of consistency among manufactured and/or installed parts, but there is no firm relationship between a specific bond resistance and whether or not a bonded interface is an ignition source or not. Other criteria such as the inductance of the bond path(s), surface contact areas, corrosion control features, tightness, and	

Comment	Requested Change	Disposition
	stability are of equal importance in establishing the ignition source free capability of a bond. Related Documents 4d(1) and 4d(7) provide additional guidance for design of electrical bonds. This adds the caution that bond resistance is not a reliable indicator of ignition source free condition of an electrical bond or joint, and points to the other factors that are equally, if not more, important.	
Commenter: Airbus		
Section 10(c)(11)(h) Bonding Integrity Checks Request for clarification.	The FAA should clarify what are the "acceptable" measures to inspect bonding and what is the type of substantiation that an applicant needs to present to validate its method of inspection and interval.	**The FAA does not concur.** This is the responsibility of the airplane manufacturer and should be consistent with the bonding employed.
Commenter: Transport Canada		
Section 10(c)(11)(h) Bonding Integrity Checks The AC should clarify if the requirements to verify the integrity of fuel tank bonds would be part of the Airworthiness Limitations section.		We agree that in general most bonds are critical and inspections would be defined as an ALI. We added text to clarity the point that engineering analysis determines the importance of the bond integrity and the need to be defined as an Airworthiness Limitations section.
Commenter: AE-2 Lightning Committee		
Section 10(c)(11)(i)(2) Bonding Corrosion and Integrity Editorial changes for clarity.	Add the following: The level of corrosion observed on bonding features, specifically on bonding jumpers, varied greatly across airplane fleets. While some airplanes within a fleet, and certain locations within the fuel tanks	Accepted as written.

Comment	Requested Change	Disposition
	showed no evidence of corrosion, other airplanes and locations exhibited higher levels of corrosion. Inspection results reported to the FAA indicate materials used in certain bonding jumpers (tin plated copper) may be more prone to corrosion. Nickel plated copper wire does not experience similar corrosion. Corrosion programs for airplane structure have long recognized the variability of corrosion within the fleet. Factors that influence the level of corrosion of bonding jumpers include fuel type (sulfur content, etc.), presence of water in the fuel tank, installation effects such as cracking of the tin plating when the jumper is installed, temperature, humidity, and chemicals used for preparation of the fuel tanks prior to airplane storage, etc. While certain levels of corrosion or discoloration may be acceptable between inspection intervals, demonstration of compliance should include substantiation that the materials used in the bonding jumpers are appropriate for use in the fuel tanks in consideration of proposed inspection intervals. This substantiation should include test data that considers the variability in corrosive environments and factors noted above that may exist on in-service and storage of airplanes in the fleet. *(This adds an example of a wire treatment that does not cause corrosion)*	

Comment	Requested Change	Disposition
Commenter: GAMMA		
Section 10(d) Inspection The first sentence of this paragraph states that a "means must be provided to allow for the direct visual inspection of the wiring..." The second sentence then contradicts the first by stating that "non-destructive inspection aids may be used where it is impracticable to provide for direct visual inspection…" GAMA recommends that FAA clarify the first sentence by removing the term "must" so as to provide for the use of non-destructive inspection aids where it is impracticable for direct visual inspection. Considering the intent of this paragraph, GAMA requests that FAA also include in the AC an acceptable means of compliance for the inspection (visual or non-destructive) of wiring within a conduit which would identify wire chaffing.		**The FAA concurs.** The word "must" is replaced with "should" and the word "direct" is deleted.
Commenter: Airbus		
Section 11(b)(1) Maximum Component Temperature for Qualification of Fuel System Components The term "high localized temperature" should be defined.	Request for definition.	**The FAA does not concur.** Localized is the immediate area in which the high temperature source exists. The surface temperatures cannot exceed the defined limits, as determined using the methods in the AC, for the critical fuel type approved for the airplane.
Commenter: Airbus		
Section 11(b)(2) Maximum Component	Request for definition.	**The FAA does not concur.**

Comment	Requested Change	Disposition
Temperature for Qualification of Fuel The term "elevated surface temperature" should be defined. Airbus are also wondering if this is a new requirement, or will FMEA's produced to meet § 25.1309 requirements be sufficient?		This is not a new requirement. It is the temperature above normal temp that exists in the area indicating an abnormal condition or failure. Section 25.981 specifically limits surface temperatures and this requirement is in addition to § 25.1309.
Commenter: Airbus		
Section 11(c)(1)(c) Maximum Component Temperature for Qualification of Fuel Two-phase operation of three-phase electrical fuel pumps is the only acceptable automatic protective means "arc/ground fault interrupters." If not, then another example of an acceptable configuration should be provided.		**The FAA concurs. We have changed the AC to recognize that theremay be other means.**
Commenter: GAMMA		
Section 11(c)(1)(d) Dry Operation of fuel pumps Although not highlighted as a change in the proposed revised AC, one of the acceptable fail-safe means to preclude dry run operation of airplane fuel pumps has significantly changed: Current AC: Incorporation of automatic pump shutoff features into the fuel pump or airplane to preclude dry run operation past the dry run qualification demonstration time. Proposed AC: Incorporate automatic pump shutoff features into the fuel pump or airplane		FAA does not concur. The wording change was made due to the realization that during dry running there may be ignition sources created due to overheating of the pump components and possible debris entering the pump inlet. The original wording could be misinterpreted to mean an applicant could design a pump to dry run provided the dry run time did not exceed the qualification dry run time. Dry running of fuel pumps is not considered a good design practice and automatic shutoff of fuel pumps is considered to be needed for any pump that

Comment	Requested Change	Disposition
to preclude dry run operation. GAMA does not believe it is appropriate to remove the "past the dry run qualification demonstration time" and requests that FAA provide adequate justification for this significant change. GAMA's position is that the fuel pump dry run qualification tests demonstrate that it is designed/qualified to safely run in a dry condition for a defined time period in addition to demonstrate that that fuel pump performance was still adequate following the dry pump operation. As FAA states, "indefinite dry operation of pumps may result in surface temperatures above the autoignition temperature of the fuel," not the dry run qualification demonstration time.		could uncover regardless of the fuel pump qualification demonstration duration. The AC text was modified as follows to clarify the need for dry run protection: . Indefinite dry operation of pumps may result in surface temperatures above the auto-ignition temperature of the fuel **or expose the pump to dry run operation where debris from the fuel tank could enter the impeller and cause sparks.** ~~The dry run qualification time does not take in to consideration that a sustained dry run past the measured qualification period raises the temperatures of internal components to the point of effecting the establish tolerances. The internal heat build up of components may cause rotating part such as an impeller contact the casing generating sparks..~~
Commenter: Airbus		
Section 11(c)(1)(h) Failed Bearings Many pumps are designed with protective features as part of their integral configuration. Guidance should be provided on when an applicant can take credit for these features considering that the FAA consider maintenance can alter the configuration at any time.	Add: (10) Fuel tank structural fasteners and fastener sealant condition. (11) Control of the thicknesses of exterior surface paints and other surface finishes to original type certification limits on lightning attachment dwell times. *(These are two more design control limitations)*	**The FAA does not concur.**. Beyond the scope of this AC.
Commenter: Transport Canada		
Section 11(c)(1)(h) Failed Bearings		**The FAA does not concur.**

Comment	Requested Change	Disposition
The term "overhaul" should not be part of the Airworthiness Limitations section. Please note that the current terminology is "restoration", and overhaul is no longer used. Restoration times are based on wear rates, which are inclusive of the inspection and reliability process. Mandating an overhaul time as an airworthiness limitation suggests that all operators must operate to the same overhaul time, a concept that carries with it the 1950-60's view of engine maintenance and a view simply not worth considering. Concerns with overhaul/restoration times and inspections should be noted and passed to the respective MRB holders for consideration and amendment to the MRB process.		The term overhaul does not mean that all operators are mandated to the same overhaul period. The term overhaul is still widely used in the maintenance and changing to restoration does not add any more clarity. The commenter also questioned the need for mandating overhaul times and the lack of flexibility for operators to request changes to the overhaul times when they are defined as a CDCCL. This is outside the scope of this AC since the need for CDCCL was discussed in the preamble to Amendment 25-102.
Commenter: Airbus		
Section 12(a) and 12(b) Instructions for Continued Airworthiness of the Fuel Tank System Critical design configuration control limitations, additional guidance material is needed, especially examples on how to conduct the assessment and reasoning used to take the decision. Airbus requests to clarify that it is up to the "designers" to compile the critical configuration control limitations list and not the maintenance.	Additional guidance material needed.	**The FAA does not concur.** No change was made to the AC due to this comment. The AC is clear that CDCCL identify those features of the fuel tank system design that are critical to ignition source prevention for airplane safety. The DAH has the responsibility to determine the critical design features based upon the results of the safety assessment.
Commenter: Airbus		
Section 12(c) Any Fuel Tank System Components It is stated that "standard practices" defined in	Additional guidance material needed.	**The FAA does not concur.** No change was made to the AC as a result of this comment. The preamble to

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AC 25.1309 can be used for evaluation of component failures and construction of the maintenance program. Does this analysis really allow for use of in-service experience and the probability of occurrence based on the design features incorporated or does the design need to be evaluated considering the FAA assumptions that the component is already degraded? The requirements of 12(c) should be cross referenced with the requirements of the SSA.		Amendment 25-102 had extensive discussion of the intent of the amendment to require a safety assessment of the fuel tank system that is more extensive than that require by traditional 25.1309 methods alone. For example 25.981 requires consideration of manufacturing variation, wear etc in assessment, as well as consideration of specific risk. We did state use of basic safety assessment methods currently used for showing compliance to 25.1309 could be used as the basis of the analysis, but that the additional requirements in the rule would need to be addressed.
Commenter: Airbus		
Section 12(d) Maintainability, both in design and procedures Airbus considers that credit should be given to the design if maintainability is demonstrated. The FAA should reference additional guidance material on Human Factors Analysis for maintainability.	Additional guidance material needed.	**The FAA does not concur.** The requested human factor discussion is Beyond the scope of this AC.
Commenter: Airbus		
Section 12(e)(2) Visible Identification of Critical Design Configuration Limitations The FAA recommend the use of pink wiring. Investigations within Airbus has shown that pink wiring may be in use on some aircraft in order to indicate flight control systems. Before the FAA makes an industry recommendation, the industry should be consulted and a standard color specification should be defined.	Standard color specification should be defined.	**The FAA does not concur**. The AC clearly states that the industry and regulatory authority should determine the color coding. It further states that some manufacturers have used color pink in their fuel tank wiring system. FAA does not mandate that every manufacturer should use color pink and offered use of this color

Comment	Requested Change	Disposition
		as a suggestion. Each manufacturer can select a unique color but it is desirable for one standard color to be selected since this would provide consistency across the industry and simplify maintenance actions.