Memorandum

U.S. Department
of Transportation

Federal Aviation Administration

Subject: INFORMATION: Policy Statement on Process for Developing SFAR 88-related Instructions for Maintenance and Inspection of Fuel Tank Systems

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From: Manager, Transport Airplane Directorate, Aircraft Certification Service, ANM-100

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To: See Distribution

Regulatory Reference: SFAR 88

SUMMARY

The purpose of this policy statement is to provide standardized guidance regarding compliance with the requirements in Special Federal Aviation Regulation Number 88 (SFAR 88), pertaining to the development of instructions for maintenance and inspection of fuel tank systems.

SFAR 88 requires certain holders of Type Certificates (TCs) and Supplemental Type Certificates (STCs) for large transport airplanes to conduct a safety review of the fuel tank systems. (Those TC and STC holders are referred to as "design approval holders" in this policy statement.) Based upon the ignition source prevention features identified in that safety review, the design approval holders will develop instructions for maintenance and inspection of the fuel tank systems in order to maintain those ignition source prevention features of the fuel tank system that preclude the existence or the development of an ignition source.

The FAA has developed this policy statement in association with the European Aviation Safety Agency (EASA). Public comments were received and, where necessary, changes were made to the draft policy statement. The FAA will transmit this final policy to the affected design approval holders for large transport airplanes in the United States. We will also transmit it to foreign regulatory authorities for their use. In addition, EASA plans to publish this policy statement as harmonized guidance.

Instructions for maintenance and inspection developed by the design approval holders using the guidance in this policy statement are to be approved by an FAA Aircraft Certification Office (ACO). Those approved instructions can be used by operators to propose changes in their maintenance programs needed to maintain the ignition prevention features of the fuel tank system for the operational life of the airplane. The changes to the maintenance programs are to be reviewed and approved by the operator's Principal Inspector.

CURRENT REGULATORY AND ADVISORY MATERIAL

1. Federal Aviation Regulations

a. SFAR 88, Amendment 21-78, effective 6/1/01, and subsequent amendments
b. § 25.901, Installation (Powerplant)
c. § 25.981, (Amendment 25-102), Fuel tank ignition prevention
d. § 25.1529, (Amendment 25-54), Instructions for continued airworthiness
e. Appendix H to Part 25, (Amendment 25-102), Instructions for continued airworthiness
f. § 91.403, Maintenance, Preventive Maintenance, and Alterations
g. §§ 91.410, 121.370, 125.248, and 129.32 (Operational rules)

2. Advisory Circulars (AC)

a. AC 25.981-1, "Fuel Tank Ignition Source Prevention Guidelines"
b. AC 121-22A, "Maintenance Review Board Procedures"
c. AC 120-16D, "Air Carrier Maintenance Programs"

3. Other Documents

a. ATA MSG-3 "Operator/Manufacturer Scheduled Maintenance Development"
b. Aging Transport Systems Rulemaking Advisory Committee (ATSRAC), Task #9, Final Report, Attachment 1, AC120-XX, July 15, 2002, submitted to the FAA, containing "Program to Enhance Aircraft Electrical Wiring Interconnection System Maintenance," EZAP guidance. (This report can be found on URL http://www.mitrecaasd.org/atsrac/final_reports.html)

POLICY

1. Applicability.

The guidance provided in this document is directed to design approval holders of type certificates and supplemental type certificates of certain large transport airplanes (see Section 2, Definitions). This material is neither mandatory nor regulatory in nature and does not constitute a regulation. It describes acceptable means, but not the only means, for demonstrating compliance with the applicable regulations. The FAA will consider other methods of demonstrating compliance that an applicant may elect to present.

This guidance is derived from extensive FAA and industry experience in determining compliance with the relevant regulations and information developed in the safety reviews required by SFAR 88. However, if we become aware of circumstances that convince us that following this guidance would not result in compliance with the applicable regulations, we would not be bound by the terms of this guidance, and we may require additional substantiation or changes as a basis for finding compliance.

This material does not change, authorize changes in, permit deviations from, or create any additional regulatory requirements.

The role of the foreign regulatory authority in applying this policy statement is the same as that of the FAA ACO, with the following exception. The foreign regulatory authority will need to coordinate the final compliance findings with the FAA Transport Airplane Directorate, because for SFAR 88 the FAA must make the final finding of compliance.

This guidance, including the definition of terms, applies only to the development of maintenance and inspection instructions for fuel tank systems in accordance with SFAR 88. This guidance was originally being developed as an Advisory Circular (AC). However, a policy statement can be issued more quickly than an AC and can be targeted by the FAA or by foreign authorities to the affected design approval holders. The FAA is developing separate policies for applicants for new type certificates or supplemental type certificates that have Amendment 25-102 as part of the certification basis.

2. Definitions.

Aircraft Maintenance Manual (AMM): A manual developed by the manufacturer of a particular airplane that contains information necessary for the continued airworthiness of that airplane.

Airworthiness Limitation Item (ALI): In terms of SFAR 88, mandatory maintenance of the fuel system that can include Critical Design Configuration Control Limitations (CDCCL), inspections, or other procedures determined necessary to ensure that unsafe conditions identified by the SFAR 88 Mandatory Action Advisory Board do not occur and are not introduced into the fuel system as a result of maintenance actions, repairs, or alterations throughout the operational life of the airplane.

Air Transport Association (ATA): A trade association that represents some of the principal U.S. airlines. In that role, among other items, ATA publishes airline industry manuals, such as Maintenance Steering Group-3 (MSG-3).

Aging Transport Systems Rulemaking Advisory Committee (ATSRAC): A committee established by the FAA to provide advice and recommendations to the FAA Administrator on airplane system safety issues, such as aging wiring systems.

Component Maintenance Manual (CMM): A manual developed by a manufacturer that contains information necessary for the continued airworthiness of a particular component.

Critical Design Configuration Control Limitations (CDCCL): In terms of SFAR 88, a CDCCL is a limitation requirement to preserve a critical ignition source prevention feature of the fuel system design that is necessary to prevent the occurrence of an unsafe condition identified by the SFAR 88 review using the process shown in Appendix B. The purpose of the CDCCL is to provide instructions to retain the critical ignition source prevention feature during configuration change that may be caused by alterations, repairs, or maintenance actions. A critical ignition source prevention feature may exist in the fuel system and its related installation or in systems that—if a failure condition were to develop—could interact with the fuel system in such a way that an unsafe condition would develop in the fuel system without this limitation.

Design Approval Holders: In the context of this policy statement, Type Certificate (TCs) and Supplemental Type Certificate (STC) holders for large transport airplanes—as defined below—are design approval holders.

Enhanced Zonal Analysis Procedure (EZAP): A logical process for developing maintenance and inspection instructions for Electrical Wiring Interconnection System (EWIS). ATSRAC submitted a final report from the Task 9 Working Group to the FAA that included the proposed AC, "Program to Enhance Aircraft Electrical Wiring Interconnection System Maintenance," containing the EZAP guidance. To the extent required by 14 CFR part 25, Appendix H–Instructions For Continued Airworthiness, applying EZAP will ensure that sufficient attention is given to the EWIS of the fuel tank system during development of maintenance and inspection instructions. The website where this document can be found is indicated earlier in this policy statement under Current Regulatory and Advisory Material, section 3.b.

Functional Failures: The failure of a component or subsystem to perform its intended function within specified limits. The failure of a function that is intended to prevent ignition, as identified by the safety review required by paragraph 2(a) of SFAR 88, must be considered in the development of maintenance and inspection instructions.

Hidden Functional Failure Safety Effect: A combination of a hidden functional (or latent) failure and one additional failure of a system-related or back-up function that will have an adverse effect on operational safety.

Instructions for Continued Airworthiness (ICA): Maintenance instructions required by 14 CFR 25.1529 and prepared to meet the specific requirements of 14 CFR part 25, Appendix H, for a design approval holder.

Large Transport Airplanes: The group of airplanes to which SFAR 88 applies. That group consists of turbine-powered transport category airplanes, provided that the type certificate for the airplane was issued after January 1, 1958, and that the airplane has either a maximum type certificated passenger capacity of 30 or more or a maximum payload capacity of 7,500 pounds or more, resulting from the original certification of the airplane.

Maintenance and inspection instructions: Scheduled maintenance or inspection tasks and intervals developed by the design approval holder and used by operators to create or revise their maintenance programs in accordance with SFAR 88. The information provided in the instructions should be sufficient for the development of job aids or task cards, used by operators for implementation of the instructions.

Maintenance Planning Data (MPD): Data developed by the manufacturer of a particular airplane which contain the information each operator of that airplane needs to develop a customized, scheduled maintenance program.

Maintenance Review Board (MRB): A FAA group that supports industry development of the Maintenance Review Board Report (MRMR) and approves the final MRBR.

Maintenance Review Board Report (MRBR): Intended for air carriers, a report which contains the initial minimum scheduled maintenance and inspection requirements for a particular transport category airplane and on-wing engine program. Air carriers may use those provisions—along with other maintenance information contained in the Instructions for Continued Airworthiness—in the development of their maintenance programs. (See Current Regulatory and Advisory Material, section 2.b.).

Maintenance Significant Item (MSI): Under MSG-3, items identified by the design approval holder whose failure could cause one of the following effects:

- It could affect safety on the ground or in flight,
- It could be undetectable during operations,
- It could have a significant impact on operations, or
- It could have a significant economic impact.

In terms of development of maintenance and inspection instructions, MSIs include systems, sub-systems, modules, components, accessories, units, or parts.

Maintenance Steering Group-3 (MSG-3): A voluntary structured process developed by the industry and maintained by ATA to make decisions used to develop maintenance and inspection tasks and intervals for an airplane. (See Current Regulatory and Advisory Material, section 3.b.).

Maintenance Working Group (MWG): A working group of maintenance specialists from participating operators, the prime manufacturer, and the regulatory authority whose function is to develop airplane maintenance programs. The MWG should have representatives knowledgeable about the fuel tank system under analysis and about the requirements of and lessons learned from SFAR 88, as documented in AC 25.981-1.

Mandatory Action Advisory Board: A committee composed of representatives from the cognizant Aircraft Certification Office and the Transport Airplane Directorate whose function is to review the findings from the SFAR 88 safety review for determination of an unsafe condition, as defined in the SFAR 88 unsafe condition policy statement in Appendix B.

Master Minimum Equipment List (MMEL): A document that the FAA develops with participation by industry. The document consists of a list of equipment that the FAA finds can be inoperative for a limited time, given the application of associated maintenance or operational procedures to maintain an acceptable level of safety.

3. Maintenance of Fuel Tank Systems: Background

The accident history that prompted the rulemaking effort known as SFAR 88 is contained in the preamble to the final rule (66 FR 23086, May 7, 2001). Advisory Circular (AC) 25.981-1 also provides a wealth of background information useful in the conduct of the safety review required by paragraph 2(a) of SFAR 88. These documents provide information for determining the existence of ignition sources inside a fuel tank. These ignition sources may result from deficiencies in the design or maintenance of the fuel tank system.

A. Historical Approach to Fuel Tank System Maintenance

Historically, manufacturers have been required to provide operators with information regarding maintenance of the airplane's fuel tank system. Before 1970, most manufacturers provided manuals containing such information to operators of large transport category airplanes. However, there were no certification standards for the content or the distribution of the manuals.

Section 25.1529, as amended by Amendment 25-21 in 1970, required applicants for a type certificate to provide Airplane Maintenance Manuals to owners of the airplanes. Amendment 25-54 amended this regulation in 1980. That amendment required applicants for a type certificate or a supplemental type certificate to provide Instructions for Continued Airworthiness (ICA), prepared in accordance with part 25, Appendix H.

In developing the Instructions for Continued Airworthiness, the applicant for a type certificate was to include information—such as a description of the airplane and its systems; servicing information; and maintenance and inspection instructions, including the extent and frequency of inspections—necessary to provide for the continued airworthiness of all systems of the airplane.

The FAA has examined the service history of transport airplanes and analyzed fuel tank fires and explosions on those airplanes. During the 1960's and 1970's, there were a significant number of fuel tank fires and explosions. The FAA found that, in most cases, a fire or explosion could be associated with faulty design or production, improper maintenance, or improper operation. As a result, the FAA conducted extensive design reviews to identify possible ignition sources and took actions to prevent similar accidents. But accidents caused by fuel tank systems occurred despite these efforts.

B. Review of Maintenance Practices

Besides reviewing ignition source prevention features and service histories of airplanes in the transport airplane fleet, the FAA has reviewed current practices of fuel tank system maintenance. In the past, the industry practice was to assume that typical fuel tank systems in transport category airplanes were designed with redundancy and fault-indication features, so that the failure of a single component would not result in a significant decrease in safety. Therefore, historically there have not been life-limited components of fuel tank systems or standardized maintenance tasks and inspection requirements, other than those mandated by airworthiness directives.

Historically, most fuel tank system maintenance involves zonal inspections to determine the condition of units, or systems, with regard to continued serviceability. Corrective action is taken only when indicated by the condition of a particular unit or system. The most common type of zonal inspection for certain components of fuel tank systems was a general visual inspection, that is, an examination of an interior or exterior area, installation, or assembly to detect obvious damage, failure or irregularity. Typically, operators conducted these general visual inspections as part of other zonal inspections of the fuel tanks.

A serious limitation of a general visual inspection of the fuel tank system is that often the inspection does not provide sufficient information to determine continued airworthiness of internal or hidden system components. This is because certain degraded conditions or failures are difficult or even impossible to detect without extensive, detailed inspection or functional checks. Examples of such degraded conditions or failures are worn wiring routed through conduit to fuel pumps, accumulated debris inside fuel pumps, corrosion of bonding wire interfaces, and broken or missing bonding straps.

C. Requirements of SFAR 88

Paragraph 2(a) of SFAR 88 required the design approval holders to conduct a safety review of the fuel tank systems. The purpose of the safety review is to identify features of the design that may either cause or prevent development of ignition sources in the fuel tank system of the airplane.

Paragraph 2(b) of SFAR 88 requires design approval holders to develop all necessary maintenance and inspection instructions to maintain the design features required to preclude the existence or development of an ignition source within the fuel tank system throughout the operational life of the airplane. These maintenance and inspection instructions should be derived from the safety review required by paragraph 2(a) of SFAR 88. The instructions should specify the maintenance and inspection task, the task intervals, and the pass/fail criteria associated with each task. Paragraph 2(c)(2) of SFAR 88 requires that the responsible design approval holder submit the instructions in a report to the FAA office responsible for oversight of the relevant type certificate or supplemental type certificate—which is either the cognizant ACO or the Transport Airplane Directorate.

These FAA-approved instructions will form the basis for changes to operators' maintenance programs, as required by certain operational rules that were amended as part of the SFAR 88 safety initiative. These operating rules specify that, after a certain date, no person may operate an airplane, unless instructions for maintenance and inspection of the fuel tank system are incorporated into the operator's maintenance program. Based upon a review of these instructions, operators are to propose any changes in their maintenance programs for review and approval by their Principal Inspectors. Upon approval, operator maintenance programs—which have been revised in accordance with instructions issued by either of the two processes described in the following sections—are considered to comply with any applicable requirement of the operating rules amended under the provisions of SFAR 88.

D. Maintenance and Inspection Instructions—Two Processes
Compliance with SFAR 88 results in the following types of maintenance and inspection instructions:

1. Those that are directly related to an unsafe condition and require mandatory action, and

2. Those that do not have a direct adverse effect on operational safety, but for which developing maintenance inspections, certain standard practices, or procedural warnings can reduce the potential for an ignition source.

To ensure the proper categorization of these two types of instructions, the design approval holder developing the maintenance and inspections instructions should use the two processes described in this policy statement as follows:

1. Safety critical actions that are needed to address unsafe conditions will be ALIs and will be adopted using the airworthiness directive process. That process, as used for SFAR 88, is described in part 5 of this policy statement.

2. The remaining actions—that do not address unsafe conditions but are necessary to maintain the continued airworthiness of the ignition source prevention features of the design—will be evaluated using a process based on the principles of MSG-3. That process is described in part 6 of this policy statement.

Considering the complexity of the process of developing necessary maintenance and inspection instructions, it is important for design approval holders to work with the cognizant FAA office to ensure a common understanding of the means of compliance. Therefore, design approval holders should provide a compliance plan as part of the process of developing the instructions required by SFAR 88. The plan should allow sufficient time for an operator to implement the instructions and gain the approval of its Principal Inspector for the revised maintenance program. The maintenance instructions must be approved and made available to the affected operators within the compliance period of the applicable operating rule associated with SFAR 88.

4. Determination of Whether an Unsafe Condition Exists

As described in Appendix A, the FAA convenes a Mandatory Action Advisory Board to determine which findings from the safety review required by paragraph 2(a) of SFAR 88 represent unsafe conditions. The paragraph 2(a) safety review was required to be submitted to the FAA by December 6, 2002. Before the board meeting, the design approval holder makes a presentation to the board regarding the findings of its safety review. The FAA board then uses the four-element criteria—presented in Appendix B—to make its determination as to whether there is an unsafe condition.

If the safety review indicates that an unsafe condition may exist in the fuel tank system and the FAA Mandatory Action Advisory Board makes a finding of unsafe condition, the design approval holder must develop a mandatory corrective action. That corrective action may be any of the following:

(1) A design modification (including interim action, as appropriate),

(2) An operational procedure,

(3) An Airworthiness Limitation Item (ALI), or

(4) A combination of the three.

One of the actions a Mandatory Action Advisory Board may identify is a maintenance action to mitigate certain unsafe conditions. If a maintenance action is mandated, the design approval holder is required to develop an ALI that ensures that an unsafe condition does not occur or is not introduced into the fuel tank system by configuration changes, repairs, alterations, or deficiencies in the maintenance program throughout the operational life of the airplane. The FAA will issue an airworthiness directive (AD) to mandate any ALI.

5. Development of Airworthiness Limitation Items for the Fuel Tank System

An SFAR 88 ALI for fuel tank systems may be one of the following:

(1) Maintenance and Inspection Instructions,

(2) Critical Design Configuration Control Limitations (CDCCL's), or

(3) A combination of the two.

A. Development of Maintenance and Inspection Instruction

The FAA expects that the design approval holder will use existing processes for addressing unsafe conditions. Under these existing processes, the development of service information should be coordinated with the cognizant FAA office to ensure that the maintenance action proposed is an acceptable means of correcting the unsafe condition.

During the process of developing service information, the design approval holder should evaluate the various types of maintenance actions (inspecting, testing, repairing, replacing, or overhauling) to ensure that the most effective and practical means has been selected. The practicality of the maintenance action should also be validated through processes, such as the lead airline process, to ensure that it effectively addresses the safety concern.

Design approval holders should provide at least the following information for the ALIs that are Maintenance and Inspection Instructions:

- The location of the fuel tank system components to be maintained or inspected and any access requirements.
- Any unique procedures required, such as special detailed inspections or a dual sign-off maintenance record of requirements.
- Specific task information, such as inspections defined by pictures or schematics.
- Intervals for any repetitive task.
- Methods, techniques and practices required to perform a task and the pass/fail criteria for any inspection.
- Special equipment or test apparatus required.

To ensure that ALIs are consistent with other documents, in developing the Maintenance and Inspection Instructions design approval holders should review at least the following:

- Current Instructions for Continued Airworthiness (if any) that parallel the Maintenance and Inspection Instructions proposed.
- Current instructions for ground operation (e.g., fuel pump ground operation or passenger air conditioning units on the ground).
- Changes to the Master Minimum Equipment List and associated maintenance or operational procedures.
- Changes to flight crew procedures in the Airplane Flight Manual.

B. Development of Critical Design Configuration Control Limitations

SFAR 88 requires the design approval holders to perform the following tasks:

1. Identify those features of the fuel tank system design that are critical to ignition source prevention for airplane safety, and
2. Develop maintenance and inspection instructions to ensure the continued airworthiness and effectiveness of those features in performing their ignition source prevention functions.

In section 25.981(b), as amended by Amendment 25-102, this type of instruction is referred to as a Critical Design Configuration Control Limitation (CDCCL). While the term is not used in SFAR 88, for ease of reference this type of instruction is referred to in this policy statement as a CDCCL.

Airworthiness Limitation Items may include Critical Design Configuration Control Limitations—the primary means of managing and controlling the configuration of the ignition source prevention features of the airplane's fuel tank system. CDCCLs will provide limitation requirements for configuration management to preserve the integrity of certain critical ignition source prevention features of the fuel tank system design. These critical ignition source prevention features are essential to ensure that unsafe conditions identified in accordance with SFAR88 do not develop from configuration changes caused by maintenance action, repair, or alteration of those critical ignition source prevention features. While inspections may be necessary to ensure that a CDCCL has not been violated by some action, CDCCLs in themselves are not inspections or life-limited items, as are most existing Airworthiness Limitation Items.

The design approval holder may determine that the Critical Design Configuration Control Limitations are applicable at the individual part level (e.g., a pump impeller) or at the component level (e.g., a pump). In the context of this policy statement, components are assembled from parts. Design approval holders as well as operators may elect to list the parts or components in which the Critical Design Configuration Control Limitation are applicable at the component level for the purposes of reducing tracking of ALIs. If the component level is used, the design approval holder is responsible for revising the Component Maintenance Manual (CMM) instructions to identify all of the critical ignition source prevention features of the component design—as determined by the safety assessment required by SFAR 88—and to provide special instructions for those critical design features in order to comply with the Critical Design Configuration Control Limitations.

To identify the parts or components in which the Critical Design Configuration Control Limitations are applicable, the design approval holder must first conduct a configuration assessment of the fuel tank system design. The purpose is to identify any foreseeable maintenance or inspection actions that could compromise the configuration of a critical ignition source prevention feature of the fuel tank system. In the context of this policy statement, foreseeable actions are those that have occurred in service in the past or those that engineering judgment predicts could compromise the critical ignition source prevention feature of a part or component of a fuel tank system. In performing this assessment, design approval holders should apply the lessons learned from SFAR 88 that are presented in AC25.981-1. The design approval holder must then develop maintenance and inspection instructions to prevent those foreseeable changes to the design configuration of the critical ignition source prevention features.

A list of parts or components to which the Critical Design Configuration Control Limitations are applicable should be developed by the design approval holder. The list should contain the following:

- The Limitation Statements shown below,

- A brief description of the critical ignition source prevention features,

- The safety issue associated with inadvertent changes to the configuration of each of those design features, and

- A list and description of the maintenance instructions (such as manuals, placards, task cards, and standard practices) to be revised or created to advise maintenance personnel of the CDCCLs.

The Critical Design Configuration Control Limitation statements are as follows:

LIMITATIONS:

1. The critical ignition source prevention features of the parts or components identified in this list as CDCCLs must be maintained in a configuration identical to an approved type design for the airplane.

2. Any repairs or overhauls to the critical ignition source prevention features of the parts or components that are identified in this list must be in accordance with the design approval holder's maintenance manual or with other acceptable repair or overhaul specifications and parts approved by the FAA Aircraft Certification Office specifically for that part or component.

3. Any alterations to the critical ignition source prevention features of the parts or components identified in this list are considered major alterations and require approval by the FAA Aircraft Certification Office.

4. In cases where the critical ignition source prevention features of a component are designated, any test equipment or tooling utilized to repair or overhaul the component must be in accordance with the CMM or otherwise comply with 14 CFR part 43.13(a) and be substantiated and documented as equivalent.

Situations that indicate the need for a Critical Design Configuration Control Limitation include the following:

Example 1: An operator replaces a fuel tank system component that has a critical design feature. Assume that the lack of a bonding strap would disable an ignition source prevention feature and, thus, would contribute to an unsafe condition. Typical instructions to comply with the CDCCLs would be the means to ensure reattachment of the bonding strap on the fuel pump whenever an operator changes the pump or does any maintenance that affects the bond strap. Only the proper reattachment (including validation of bond integrity) of the bonding strap is essential to prevent the unsafe condition. Therefore, the instruction to comply with the CDCCL is a requirement that provides information to ensure proper reattachment of the bonding strap—not installing or re-installing the entire pump.

Example 2. A specific configuration of the fuel tank system is identified as necessary to prevent development of an unsafe condition. Assume that separation of external wires of the fuel gauging system has been determined to be a way to keep unsafe energies out of the fuel tank. An instruction is required to comply with the CDCCLs to ensure that the wiring for the fuel gauging system remains separated from other wiring. This step ensures that—in combination with another failure—unsafe ignition energies cannot be produced in the fuel system.

Example 3. A specific feature of the fuel tank system creates an unsafe condition in the event of certain failures. Assume that a fuel pump is repaired or overhauled, but certain critical ignition source prevention features within the pump are not installed or are not overhauled in accordance with the CMM. An instruction is required to comply with the CDCCLs to ensure that certain critical ignition source prevention features of the fuel pump will be properly maintained in accordance with the CMM or with other acceptable procedures approved by the FAA Aircraft Certification Office.

C. Identification and Awareness of Critical Design Configuration Control Limitations

Design approval holders will normally list the parts or components for which the Critical Design Configuration Control Limitations are applicable for a particular airplane in the service information provided for the airworthiness directive that mandates the ALI. This is the mechanism for identifying critical ignition source prevention features and requiring their control under SFAR 88. To ensure that the operator introducing a modification or the mechanic is aware of the need to consider these critical ignition source prevention features, it will be necessary to insert cross-references in certain documents to comply with the CDCCLs.

1. For situations like those in Example 1, the design approval holder should identify the task with WARNING or CAUTION notes for the component or part that has a critical design feature in the Airplane Maintenance Manual (AMM). The operator should incorporate acceptable procedures to ensure compliance with the CDCCLs.

2. For situations like those in Example 2, the design approval holder should include information in standard practices manuals, such as the standard wiring practices manual for the type design to ensure compliance with the CDCCLs.

3. For situations like those in Example 3, the design approval holder should identify the appropriate Component Maintenance Manual. In addition, the design approval holder should ensure that a statement is inserted into both the Component Maintenance Manual and the Airplane Maintenance Manual that the component is controlled by the CDCCL and, therefore, that it may be repaired or overhauled only in accordance with the Component Maintenance Manual or other acceptable maintenance procedures and parts approved by the FAA Aircraft Certification Office.

As may be specified in the airworthiness directive that mandates the ALI, operators need to identify their means of compliance to their cognizant FAA Principal Inspector. The Airworthiness Directive will require documentation, per existing AD recording procedures (see Current Regulatory and Advisory Material, section 3.c.), that the CDCCLs are implemented in the operators' maintenance program.

6. Development of Instructions for Continued Airworthiness

In addition to developing ALIs to address unsafe conditions, the design approval holder must develop maintenance and inspection instructions for those features of fuel tank system design that, while not requiring ALIs, contribute to preventing an ignition source from occurring or developing. The safety review of the fuel tank system required by paragraph 2(a) of SFAR 88 will identify all ignition source prevention features of the fuel tank system design. For any ignition source prevention features that has not been directly addressed as an unsafe condition per Appendix B, the design approval holder must develop Instructions for Continued Airworthiness (ICA), as required by paragraph 2(b) of SFAR 88. Examples of these Instructions for Continuing Airworthiness are instructions pertaining to maintenance of wires, explosion-proof features of fuel pumps, or fuel pump circuit protection devices.

Those maintenance and inspection instructions should be developed using the guidance in this policy statement and existing maintenance development processes. The policy statement is written using MSG-3 as the preferred existing maintenance development process, but the process that was used in the development of the original maintenance instructions for the airplane may be acceptable. The instructions should be added to the existing Instructions for Continued Airworthiness for the airplane. The purpose of these instructions is to ensure the preservation of those features of the design intended to preclude ignition sources in the fuel tank system during the operational life of the airplane. These instructions will form the basis for changes to the operators' maintenance programs for the fuel tank system, in accordance with the operating rules associated with SFAR88.

A. Background

Maintenance of ignition source prevention features is necessary for the continued operational safety of an airplane's fuel tank system. One of the primary functions of the fuel tank system is to deliver fuel in a safe manner. Within the fuel tank system are fail-safe features required to preclude ignition sources. Preventing ignition sources is as important a function of the fuel system as delivery and gauging of fuel. The failure of any of these ignition source prevention features may not immediately result in an ignition event, but the failure warrants maintenance for continued airworthiness, because the subsequent failure of another feature could have a direct adverse effect on operational safety.

In the course of normal operation, the operating crew would usually not be made aware of the failure of any of these ignition source prevention features. (Normal operating procedures are those defined in the operator's flight crew operating manual.) In certain combinations, the failures of these ignition source prevention features could prevent the continued safe flight and landing of the airplane or cause serious or fatal injury to the occupants. Therefore, maintenance and inspection instructions will be needed to ensure that these kinds of failures of the fuel tank system are identified and corrected for the continued airworthiness of the airplane.

B. Identification of Maintenance Significant Items Design Features

Before design approval holders can develop fuel tank system maintenance and inspection instructions that incorporate the lessons learned from SFAR 88, they must determine whether the ignition source prevention features identified by the safety review performed to comply with paragraph 2(a) of SFAR 88 are part of the existing fuel tank system Maintenance Significant Items (MSIs).

A common industry standard applies the following questions to each item (such as systems, components, or features) that is part of the MSI:

- Could the failure of this item be undetectable or not likely to be detected by the operating crew during normal duties?
- Could the failure affect safety on the ground or in flight, including emergency systems or equipment?
- Could the failure or combination of failures have a significant effect on operations?
- Could the failure or combination of failures have a significant economic impact?

Based on the answers to these questions, the design approval holder will identify the design features of the Maintenance Significant Items for the fuel tank or any adjacent affected system. The ignition source prevention design features could be new to a MSI in the sense that they were not specifically identified in the original maintenance analysis of that airplane. If an identified ignition source prevention feature is not contained in any existing fuel tank system MSI, then a new MSI may need to be created. For example, fuel system bonding should be identified as a system and a new MSI should be created, if one does not already exist.

The original maintenance analysis used to develop maintenance and inspection instructions for many existing airplanes considered only functional failures of the fuel tank system. Those functional failures typically did not include failures of ignition source prevention means. Therefore, that analysis did not identify the need to develop maintenance and inspection instructions for the continued airworthiness of ignition source prevention means. The safety review of the ignition-prevention features that is required by SFAR 88 will identify these ignition source prevention features as safety-significant for the fuel tank system. It will be necessary to review these features in relation to existing maintenance and inspection instructions and Maintenance Significant Items to address the need for new or revised maintenance and inspection instructions for the continued airworthiness of the fuel tanks system.

C. Analysis of Function and Failure of Maintenance Significant Items

After the design approval holder has identified the ignition source prevention features associated with Maintenance Significant Items for the fuel tank system, the next step is to determine the function, functional failure, failure effect, and failure cause of each ignition source prevention feature.

- Function is the ignition source prevention function of the item.
- Functional failure is the failure of an item to perform its intended function.
- Failure effect is the result of the functional failure.
- Failure cause is the reason for the functional failure.

A detailed understanding of the fuel tank system and the safety review required by SFAR 88 is necessary to formulate the functional failures and develop the maintenance and inspection instructions. The lessons learned which are identified in AC 25.981-1B should also be considered.

Some examples of the functions of design features that prevent ignition are the following:

- The ignition-prevention function of the bonding system of the fuel tank system is to carry the electrical current generated in the event of lightning.
- The ignition-prevention function of the wire harness of the fuel tank system is to prevent electrical shorts and sparks from forming in and around the fuel tank, if wires external to the fuel tank chafe against a power wire. The wire harness includes the features that keep it separated from other objects in the fuel system that would cause contact and chafing.

Design approval holders should document the process of identifying the ignition source prevention features of Maintenance Significant Items and their associated functional failures, effects, and causes. Such documentation will allow them to demonstrate that they have properly considered all of the ignition source prevention features that are not addressed as ALIs. The cognizant FAA office will review and approve the results of that process before that data is used in the development of maintenance and inspection instructions.

D. Development of Maintenance and Inspection Instructions

Once the design approval holder has identified the functions and functional failures of the ignition source prevention features, the next step is to ask a series of questions to determine what instruction is needed to prevent the failure of an ignition source prevention feature. Instructions considered would include those for inspecting, restoring, discarding, or—as a last resort—redesigning an item, if an instruction could not be determined for a feature that has hidden functional safety effects.

Such an application of questions is usually conducted with the guidance of MSG-3. The maintenance and inspection instructions developed in accordance with SFAR 88 should be based on the following:

- Application of a structured logical process (MSG-3),
- Engineering judgment, based on the anticipated consequences of the failures identified by the safety review, and
- Lessons learned from in-service experience (e.g., ineffective inspections, inadequate fuel tank cleaning procedures, improper clamping of wiring, and unattended transferring of fuel).

Application of Enhanced Zonal Analysis Procedure (EZAP) logic should also be used in the process of developing maintenance and inspection instructions (See Current Regulatory and Advisory Material, item 3.b., ATSRAC Report for EZAP Guidance). Design approval holders should coordinate their proposals for how to apply EZAP with the cognizant ACO and AEG.

The maintenance task descriptions and interval requirements produced by this analysis may result in changes to maintenance and inspection instructions and to standard practices documents developed by design approval holders. Such changes should be published as amendments to the Instructions for Continuing Airworthiness of the design approval holder. When identified by the design approval holder, documents such as the following are part of the Instructions for Continuing Airworthiness.

- Airplane Maintenance Manual
- Component Maintenance Manual
- Maintenance Planning Data
- Maintenance Review Board Report

If the processes described above are properly applied, the resulting maintenance tasks and intervals should be fully effective to address hidden functional failure safety effects, as required by paragraph 2(b) of SFAR 88. To minimize any potential for confusion regarding other changes in these documents for systems other than the fuel tank system, the design approval holder should develop the report required by paragraph 2(c)(2) of SFAR 88 that clearly identifies those changes applicable to the fuel tank system that show compliance with paragraph 2(b). The design approval holder should submit the report required by paragraph 2(c)(2) for approval to the FAA office responsible for the oversight of the relevant type certificate or supplemental type certificate). That office is either the cognizant ACO or the TAD.

Operators should incorporate the changes in that report into their maintenance program, in accordance with the applicable operational rules. Maintenance programs revised in accordance with instructions developed by the process described in this policy statement, upon approval by the Principal Inspector, are considered to have met any applicable requirement of the operating rules of SFAR 88.

7. Training Considerations.

SFAR 88 safety reviews conducted by design approval holders will identify maintenance and inspection procedures and parts or components for which the Critical Design Configuration Control Limitations are applicable which have unique requirements for implementation. For example, there may be new inspection devices, graphical information showing required tasks, changes in tasks such as wire splicing, or heightened awareness of the criticality of certain design features. In some of these cases, additional training in maintenance procedures will need to be developed.

Operators may prevent adverse effects associated with wiring changes by standardizing maintenance practices through training. Training is needed to end indiscriminant routing and splicing of wire and to provide comprehensive knowledge of critical design features of fuel tank systems that would be controlled by a Critical Design Configuration Control Limitation.

If you have further questions, the person on my staff most familiar with this issue is Mr. Dennis Kammers (425-227-2956).

/s/ Kalene C. Yanamura for
Ali Bahrami

cc: ANM-111, ANM-112, ANM-113, ANM-115, ANM-116, ANM-117

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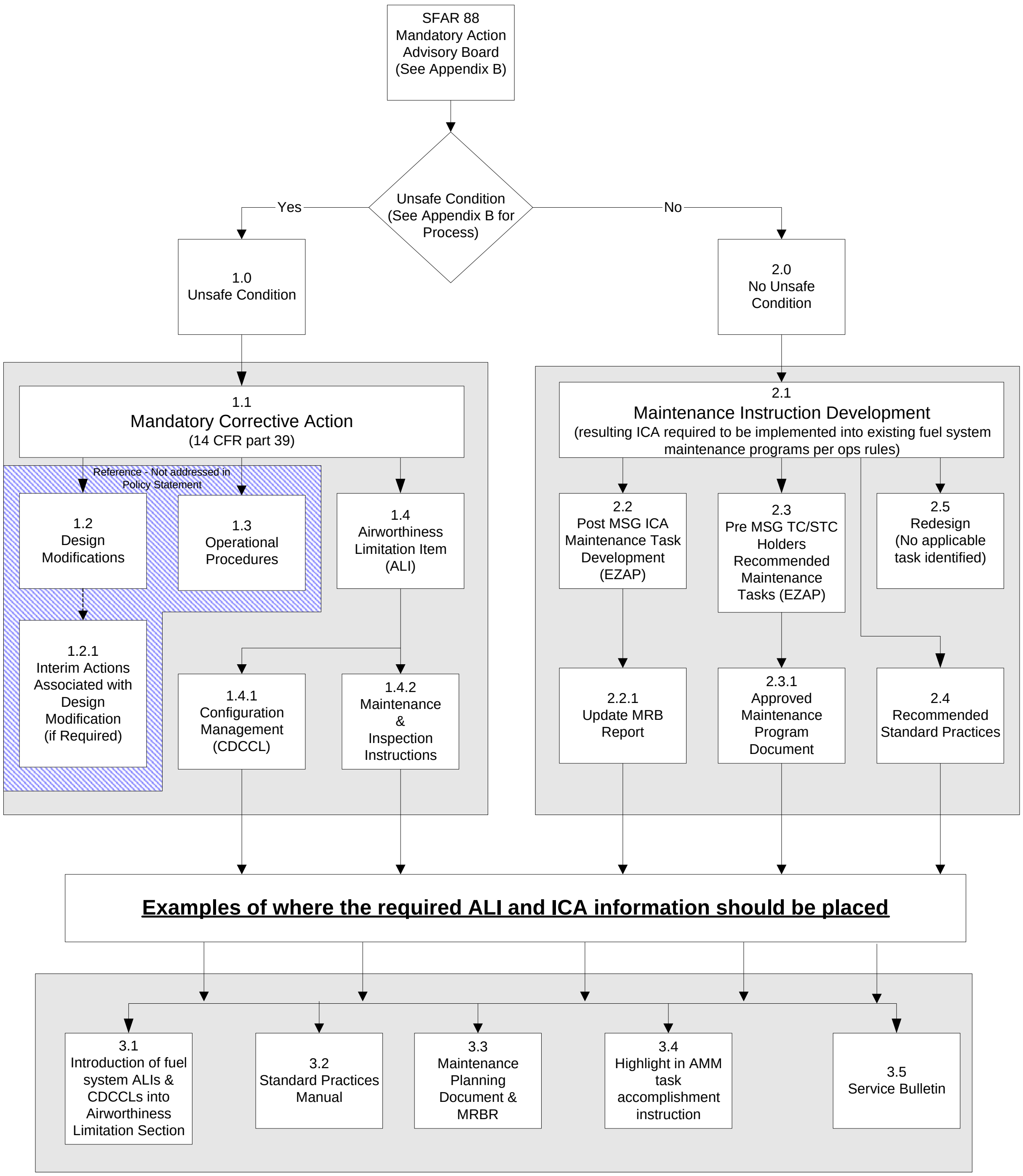
Appendix A: Fuel Tank Safety – SFAR 88 Implementation Process Flow Chart



Appendix A: **The following information explains the flow process chart.**

Safety Assessment Items Identified:

In accordance with the requirements of paragraph 2(a) of SFAR 88, certain design approval holders are required to conduct a safety review of their fuel tank system or components. Paragraphs 2(b) and 2(c)(2) of SFAR 88 require that these design approval holders prepare instructions for maintenance and inspection of the fuel tank system.

Process 1.0 Unsafe Condition Determination

Transport Standards staff engineers of the Transport Airplane Directorate hosted Mandatory Action Advisory Boards to identify any unsafe condition from the findings of the SFAR 88 fuel tank safety reviews for all applicable airplane models. To make their determinations, the boards use the four-element criteria presented in Appendix B.

Process 1.1 Mandated Corrective Actions

Each unsafe condition is required [by the four-element unsafe condition criteria in Appendix B to have a mandated corrective action. The mandated corrective action may consist of a design modification, a maintenance or inspection task, an operational procedure or a CDCCL. The corrective actions will be mandated through the issuance of an Airworthiness Directive.

Process 1.2 Design Modifications

In the event that the corrective action is a design change, the 14 CFR part 39 process will be followed. This process allows for consideration of the risk associated with the unsafe condition as well as the availability of parts, effort required for incorporating the design change on the airplane, and any associated inspection requirements.

Process 1.2.1 Interim Action

In some cases, associated with the incorporation of the design change, interim actions (maintenance or operational) may be required by the Airworthiness Directive to provide an acceptable level of safety until the design change can be incorporated. Normally, the incorporation of the design change will terminate the interim action.

Process 1.3 Operational Procedures

Operational procedures may be identified as an action to mitigate the unsafe condition. That action would require a flight crew action and AFM revision. Examples of such actions could include mandatory shutting off of fuel pumps in a particular fuel tank at a pre-determined level to keep pump inlets covered or prohibition of wide cut fuel, such as JP-4, except for ferry flight provisions.

Process 1.4 Airworthiness Limitation Items for the Fuel System

Airworthiness Limitations Items (ALI) are maintenance and inspection tasks or CDCCLs required to preclude the development of unsafe conditions identified from the SFAR 88 review within the fuel system. The maintenance and inspection tasks and CDCCLs should be properly documented within the airworthiness limitations section of the ICA and approved by the FAA. The approved documents will be referenced in applicable Airworthiness Directives.

Process 1.4.1 Configuration Management

Operators will be expected to demonstrate to their FAA Principal Inspector that the required control systems are in place to ensure that CDCCL items are properly identified and managed.

Process 1.4.2 Maintenance and Inspection Instructions

Each limitation will describe the specific maintenance and inspection instructions, frequency and any other special requirements. It will be the responsibility of the manufacturer or operators to develop specific work instructions (e.g., job/task cards) for accomplishment of the maintenance and inspection instructions.

Process 2.0 No Unsafe Condition

All ignition source prevention features identified by the safety review required by paragraph 2(a) of SFAR 88, but determined not to be unsafe should be itemized and subjected to a review as described by this guidance.

Process 2.1 Maintenance and inspection instructions Development

At the completion of the review described in this guidance, the safety significant items identified should be subjected to the standard maintenance program development methods, e.g., MSG (including EZAP guidance), for developing scheduled maintenance and inspection instructions. It will be necessary to track these maintenance and inspection instructions in order to demonstrate proper disposition. These instructions will result in changes within the existing maintenance and inspection programs, as provided by the applicable operating rules.

Considering the complexity of the process of developing necessary maintenance and inspection instructions, it is important for design approval holders to work with the cognizant FAA office to ensure a common understanding of the means of compliance. Therefore, design approval holders should provide a compliance plan as part of the process of developing the instructions required by SFAR 88.

Process 2.2 Post MSG ICA - Maintenance Task Development

The cognizant ACO or TAD office will review and approve the results of the process of categorizing the ignition source prevention features under the fuel tank system MSIs. That review will include the functional failures, effects and causes identified by the safety analysis conducted by the design approval holder, as required by paragraph 2(a) of SFAR 88. That data will then be presented to an ad hoc Maintenance Working Group (if there is a functioning MWG) that includes representatives from industry and the cognizant AEG and ACO which will determine new or revised fuel tank maintenance and inspection instructions, using existing maintenance processes. In addition, EZAP (See Current Regulatory and Advisory Material, item 3.b.) should be applied.

Process 2.2.1 MRB Reports

If revision to an existing MRB Report using a current version of MSG-3 is contemplated, AC 121-22A, "Maintenance Review Boards," should be used to establish an ad hoc MWG and the appropriate AEG should be contacted. MSG-3, Revision 2003, includes the enhanced zonal analysis procedure (EZAP).

The deliverables (new or revised tasks) from either of the above processes should be included within or by reference in the ICA by the design approval holder. In some cases, the maintenance evaluation of the fuel tank system may include elements of the electrical wire interconnection system (EWIS). Where electrical elements are common to both the fuel tank system and EWIS, resulting tasks and interval should be compatible. Because there is a plan to separately address EWIS in future operational rules, care should be taken to properly identify an EWIS consideration verses the fuel tank system maintenance consequence from compliance with SFAR 88 paragraphs 2(b) and 2(c)(2).

Process 2.3 Pre-MSG Design Approval Holders Recommended Scheduled Tasks

For those airplane models and modifications where the maintenance programs were developed prior to the MSG process (or without the MSG process), the design approval holders should apply the process that was originally used in the development of the maintenance instructions for the airplane. Using that process and the ignition source prevention features—identified by the safety review conducted in accordance with paragraph 2(a) of SFAR 88—the design approval holder will develop the maintenance instructions that are necessary for continued airworthiness. Scheduled or unscheduled maintenance tasks and maintenance practices should be developed to address those ignition source prevention features that are identified. The cognizant ACO and AEG will participate in the review process and approve the out come of that process to ensure that maintenance instructions are developed for the identified ignition source prevention features. These instructions should be included in the design approval holder's Instructions for Continued Airworthiness. The application of EZAP should be accomplished as a stand-alone analytical activity following the procedures found in Current Regulatory and Advisory Material, section 3.b.

Process 2.3.1 Maintenance Program Document

The affected operators should develop changes to their maintenance program, based on the ICA that have been developed for a specific model airplane. In accordance with the operational rules, the operator is then required to propose changes to its program for review and approval by its Principal Inspector.

Process 2.4 Standard Practices

The design approval holders may identify standard practices which will address the MSIs identified. The practices may be associated with the original design, alteration, or maintenance. The design approval holders will need to ensure that the appropriate ICA are revised as necessary and sent to the affected operators. The operator will need to ensure that its affected documents and procedures incorporate the standard practices and that organizations responsible for alterations have access to such practices. Some examples of practices that may change are clean tank procedures, wire clamping practices, bonding standards, routing of power supplies to pumps and switches, wire separation, wire splice repairs in fuel tank systems, and fuel tank and component storage procedures (e.g., as applicable to auxiliary fuel tanks). These examples may also result in revision to 'Design Standard Practices Manuals.'

Process 2.5 Redesign Required if no applicable task can be identified

An ignition source prevention feature identified by the SFAR 88 design review may be determined to have a hidden safety effect. (See section 6 of this policy statement.) It may be further determined by existing maintenance development processes, e.g., MSG, that there is no applicable maintenance or inspection action for such an ignition source prevention feature. In this case, the feature should be identified for proposed redesign and brought back to the SFAR 88 Mandatory Action Advisory Board for determination whether part 39 action should be taken to mandate that redesign.

Appendix B: "SFAR 88 – Mandatory Action Decision Criteria," Memo Number 2003-112-15, dated February 25, 2003.

Memorandum

U.S. Department of Transportation

Federal Aviation Administration

Subject:	INFORMATION: SFAR 88 – Mandatory Action Decision Criteria	Date:	February 25, 2003
From:	Manager, Transport Standards Directorate, Aircraft Certification Service, ANM-100	Reply to Attn. of:	**2003-112-15**
To:	See Distribution	Regulatory Reference:	SFAR 88

Summary/Background:

The purpose of this memorandum is to provide standardized policy for determining the need for mandatory action relative to the findings from the fuel system safety review required by Special Federal Aviation Regulation Number 88 (SFAR 88). SFAR 88 requires certain Type Certificate (TC) and Supplemental Type Certificate (STC) holders to conduct a system safety review of fuel tank systems on transport category airplanes using the provisions of 14 CFR 25.981 (a) and (b) (Amendment 25-102) and 25.901 and to submit a report to the FAA. The compliance dates for TC holders and STC holders are December 6, 2002, and June 6, 2003, respectively. These reviews are a "re-evaluation" of previously approved fuel systems using the current ignition source prevention standards (Amendment 25-102). Note that the SFAR 88 process is not a re-certification effort.

SFAR 88 is a process for determining what design and/or maintenance improvements would be required to bring each existing transport category airplane into compliance with 14 CFR 25.981 (a) and (b) (Amendment 25-102) and 25.901. Some of these improvements may warrant airworthiness directives implemented under Part 39; others may not. A "Spot Amendment" to SFAR 88, Amendment 21-82, was issued to add an equivalent safety finding provision and to clarify that fuel tank system designs not meeting the new standards will be further reviewed under part 39, Airworthiness Directives, to determine if design changes or other actions are required to resolve unsafe conditions. SFAR 88 was also revised to allow additional time for STC holders and operators to comply.

Recently several applicants have requested to use the equivalent safety provision of the Spot amendment and have proposed use of inerting systems, or polyurethane foam in combination with certain design changes and maintenance actions to address ignition sources. These proposals have introduced the concept of flammability reduction as a factor in determining unsafe conditions on in-service airplanes. In order to determine which fuel tank system design feature will require mandatory action, the FAA has established a 4-element unsafe condition evaluation criteria that was presented in the November 19, 2002, Fuel Tank Safety Workshop held in Washington, D.C.

This memorandum will expand on the guidance that was presented at that workshop. The Federal Aviation Administration (FAA) and Joint Aviation Authorities (JAA) have developed these harmonized criteria for determination of an unsafe condition based upon the findings from the SFAR 88 fuel tank system safety review.

One of the elements used in these evaluation criteria involves a determination of whether the fuel tank is classified as having a relatively high flammability exposure time or a relatively low flammability exposure time. Except for the case where an ignition source is continuously present, a relatively low fuel vapor flammability exposure time substantially decreases the probability of tank explosions. Similarly, a higher flammability exposure time has been associated with higher risk, given a similar intermittent exposure to ignition sources. In general, unheated aluminum wing tanks and unheated center wing tanks fueled with Jet A have exhibited an acceptable level of safety. Wing and body tanks fueled with JP-4 (or a mixtures of Jet A and JP-4) and heated center wing tanks fueled with Jet A have not had an acceptable level of safety on many airplanes.

The consideration of flammability exposure time in the unsafe condition determination process is not intended to imply that ignition source prevention is unimportant for tanks with low flammability exposure time. The fundamental method for preventing fuel tank explosions involves establishing that the fuel tank system designs do not develop a condition that would result in an ignition within the fuel tank ullage space and fluid leakage zones (i.e. ignition source prevention). Ignition source prevention measures will still be the principal line of safety in the fuel tank system. However, the unsafe condition determination will take into consideration the tank flammability exposure time in determining the extent of ignition source reduction needed.

This memorandum provides guidance to be used for determining unsafe conditions due to ignition sources, based upon results from the one-time design review conducted to evaluate compliance with §§ 25.981 (a) and (b) (Amendment 25-102) and 25.901, in accordance with SFAR 88. The TC and STC holder’s system safety assessment provided in their fuel tank system design reviews and flammability exposure time determination of each fuel tank is the basis for the determination of the unsafe condition. The method to determine flammability exposure time of a given fuel tank is provided in Element 4 and attachment 2 of this memo.

Current Regulatory and Advisory Material

- SFAR 88 latest amendment, effective 12/9/02
- Sections 25.901, and 25.981 (a) and (b) as amended by Amendment 25-102
- AC 25.981-1B or C (draft)

Definitions*:*

The following definitions apply only to this policy memorandum.

a) *Extremely Improbable*: An event is considered to be extremely improbable if it is so unlikely that it is not anticipated to occur during the entire operational life of all airplanes of one type. In quantitative terms, a failure or condition that can be anticipated to occur at a rate in the order of 10^{-9} events per flight hour or less. (Based on JAA ACJ 25.1309 & draft FAA AC 25.1309.)

b) *Extremely Remote*: An event is considered to be extremely remote if it is unlikely to occur during the entire operational life of all airplanes of one type, but nevertheless has to be considered as being possible. In quantitative terms, a failure or condition that can be anticipated to occur at a rate between 10^{-7} and 10^{-9} events per flight hour. (Based on JAA ACJ 25.1309 & draft FAA AC 25.1309.)

c) *Flammable*: Flammable with respect to a fluid or gas, means readily susceptible to ignition or to exploding. (14 CFR part 1, Definitions)

d) *Flammability Exposure Time*: The percent of operational time that the fuel tank ullage is flammable over the expected range of operational conditions during many different mission simulations. The simulations use the approved fuel types for the airplane model. It is calculated using the FAA Monte-Carlo method.

e) *Flammable fluid leakage zones:* Any area where flammable liquids or vapors are not intended to be present, but where they might exist due to leakage from flammable fluid carrying components (e.g. leakage from tanks, lines). Examples of these areas include:
    - The wing leading (including any adjacent compartment such as the strut) and trailing edges,
    - Farings located below the fuel tanks,
    - Wheel wells,
    - Fuel pump enclosures,
    - Unpressurized areas of the fuselage surrounding fuel tanks, and
    - Areas containing flammable fluid lines or tanks.

f) *Foreseeable*: An event or condition is foreseeable if the physics of the failure can be defined and the occurrence of the failure during the exposure period in question cannot be acceptably ruled out. The level of probability where an event is no longer considered “foreseeable” lies somewhere between "extremely improbable" and “impossible.” Any event that is “impossible” is clearly not “foreseeable.” All events that are not “extremely improbable” are considered “foreseeable.” However, for those events whose probability lie between “extremely improbable” and “impossible”, the determination as to whether or not they are to be considered “foreseeable” has less to do with their "probability" and more to do with the confidence we have in the provisions made to actively preclude their occurrence (e.g. design margins, quality assurance, conservative maintenance provisions, etc.). The bottom line is, if we don't have confidence the event will not occur, then it should be considered “foreseeable.”

g) *Hazardous Energy*: Energy into the fuel tanks greater than 200 micro-joules and surface temperatures in the fuel tank greater than 400 deg F.

h) *Known*: Those conditions which have occurred in-service and are likely to occur on other products of the same or similar type design, and conditions which have been subject to mandatory corrective actions, following in-service findings, on products with a similar design of fuel system.

i) *Low and High Flammability Exposure Time:* In determining whether a fuel tank is classified as either a tank with low or high flammability exposure time for the mission profile:
   - Fuel tanks with low flammability exposure time are defined as those tanks that have a fleet average flammability exposure time no more than 7% using the FAA Monte-Carlo Model method.
   - Fuel tanks with high flammability exposure time are those tanks that have a fleet Average Flammability exposure time of greater than 7% using the FAA Monte-Carlo Model method.

j) *Monte-Carlo Method*: The Monte-Carlo method was agreed to during both the 1998 and 2000 ARAC fuel tank harmonization working groups as the preferred method of analysis for determining flammability exposure time of a fuel tank. Monte-Carlo analysis is a simulation that calculates values for the parameter of interest by randomly selecting values for each of the uncertain variables from predetermined distribution tables. This calculation is conducted over and over to simulate a process where the variables are random within defined distributions. The results of a large number of calculations can be used to approximate the results of real world conditions. The Monte-Carlo Model should be run for at least 1,000 flights to generate a representative average percent flammability exposure time. The FAA approved model is available on FAA web site: http://qps.airweb.faa.gov/sfar88flamex

k) *Unheated Aluminum Wing Tank*: A conventional aluminum structure, integral tank of a subsonic transport wing, with minimum heat input from aircraft systems or other fuel tanks that are heated.

l) *Ullage or Ullage Space:* The volume within the tank not occupied by liquid fuel at the time interval under evaluation.

Policy:

SFAR 88 design reviews relative to the design standards of §§ 25.981 (a) and (b) and 25.901 may show that some fuel systems or components do not meet these design standards using AC 25.981-1 for guidance. The items identified by that review will be evaluated using the criteria herein to determine if an airworthiness directive is warranted. These criteria require identification of any unsafe conditions that would require corrective action regardless of tank flammability exposure time (e.g. single failures such as an electrical arc through a conduit). The criteria allow for flammability exposure time to be considered when evaluating the need for corrective action for certain combinations of failures.

The applicant may choose to make a determination of high or low flammability exposure time using FAA approved methods that are discussed in Element 4. If the applicant chooses not to make a determination, the FAA will assume high flammability exposure time for the fuel tanks under consideration. The method described in Element 4 includes an initial evaluation of tank cooling characteristics to determine if a tank is considered as having a high or low flammability exposure time. In general, unheated wing tanks would be found to meet the low flammability exposure time criteria upon inspection. If the initial evaluation shows that a tank does not meet the low flammability exposure time criteria, a further evaluation using the FAA Monte-Carlo analysis is required.

These criteria do not provide the entire basis for the decision on the actual implementation of mandatory corrective action (e.g. compliance time determination) on the aircraft type under consideration. Experienced engineering judgment is critical in determining assumptions, expected failure rates, and relationships between failures. The final decision will be made under the normal processes for issuing Airworthiness Directives (part 39) with the addition of a mandatory action advisory board whose function is to ensure standardization in the decision making process. A summary of the SFAR 88 AD determination criteria is presented in the attached Table 1, "SFAR 88 Unsafe Condition Determination Criteria."

Four-Element Unsafe Condition Evaluation Criteria

<u>Element 1. Single Failures – all tanks</u>
For any tank (with a high or low flammability exposure time), any foreseeable single failure condition, regardless of probability and service experience, that may result in a potential ignition source within the fuel tank system is considered an unsafe condition and may be addressed by corrective action (i.e. AD).

In general, the FAA does not accept a probabilistic determination that a single failure is extremely improbable. However, experienced engineering judgment may enable an assessment that such a failure is not foreseeable. The assessment logic and rationale should be readily obvious, so that a knowledgeable, experienced person would unequivocally conclude that the failure condition simply would not occur. When making such an assessment, all possible and relevant considerations should be taken into account, including all relevant attributes of the design. Extensive service experience alone showing that the failure condition has not yet occurred is not sufficient reason to indicate that a single failure condition cannot exist.

Element 2. Combination of failures

1. Fuel tanks with low flammability exposure time

For fuel tanks with low flammability exposure time, known combinations of failures are considered an unsafe condition and may be addressed by corrective action (i.e. by Airworthiness Directive).

Known combinations of failures include combinations of failures which have occurred in-service and are likely to occur on other products of similar type design (i.e. products with a similar design of the fuel system) and combinations of failures which have been subject to mandatory corrective actions, following in-service findings on products with a similar fuel system design.

2. Fuel tanks with high flammability exposure time

For fuel tanks with high flammability exposure time, non-compliant design features and associated maintenance action— identified by the system safety analysis that was conducted for the one time SFAR 88 design review—will be used for establishing unsafe condition. These will be considered as unsafe conditions (i.e. strict compliance to §§ 25.981 (a) and (b) (Amendment 25-102) and 25.901 using guidance in AC 25.981-1 may be found) and may be addressed by corrective action (i.e. by Airworthiness Directive).

3. Unacceptable service experience – all tanks

For any tank (either high or low flammability exposure time), all failures identified in service that result in thermal or electrical energy dissipation into the fuel tank system which could create an ignition hazard or that make fuel tank safety protection devices inoperative (e.g. fuel pump canister, wire sleeving, bonding lead), are considered unsafe conditions and may be addressed by corrective action (i.e, an AD). Those failures may result from equipment or component failures, aging, production or maintenance errors, or inappropriate flight deck actions (such as, leaving fuel pumps "ON" beyond their design usage).

4. Determination of the flammability exposure time of each fuel tank

Typically, aluminum wing tanks without any heating source are considered to have a low flammability exposure time. However, several parameters, including tank volume, geometry, amount of fuel remaining from the previous flight, ambient temperature, temperature of loaded fuel, or time on the ground may influence flammability exposure time. Determination of flammability exposure time of each fuel tank is required. In the absence of any substantiating analysis, all tanks should be considered as a "high flammability exposure time" fuel tanks. Table 2, "Flammability Exposure Time Determination," attached at the end of this memorandum, summarizes the following discussion on determining fuel tank flammability exposure time.

Acceptable method of analysis

In the absence of another method agreed to by the FAA, the following guidance is considered an acceptable means of establishing the flammability exposure time of each fuel tank. Other methods may be proposed, but should be approved by the FAA. For the purpose of the assessment of in-service aircraft, this three-step approach has been harmonized between FAA and JAA.

Low Flammability Exposure Time Tank Determination:

Step 1.
Does the tank have characteristics of a Low Flammability Exposure Time tank, as defined below, by inspection and qualitative design review?

If Yes, tank is a Low Flammability Exposure Time Tank; if No, go to Step 2

Step 2.
Can the tank meet the abbreviated quantitative criteria for a Low Flammability Exposure Time Tank?

If Yes, tank is a Low Flammability Exposure Time Tank; if No, go to Step 3

Step 3.
Can the tank meet the Low Flammability Exposure Time Tank Criteria using the FAA Monte-Carlo analysis and ground fuel temperature limit?

If Yes, tank is a Low Flammability Exposure Time Tank; If No, tank is a High Flammability Exposure Time Tank.

Characteristics of a Low Flammability Exposure Time Tank

For Step 1:
The qualitative design review criteria for a low flammability exposure time tank are the following:

1. During 4 hour operation on the ground on a 100 deg F day, a fuel temperature rise of less than 10 deg F above ambient with an 80% full fuel load. Heat inputs to be addressed are any airplane-based heat sources, both internal and external to the tank, including heat transfer from an adjacent tank that could heat the subject tank.
   And
2. The ability of the tank to reject heat quickly to outside air. A conventional aluminum skin stringer construction, with a high percentage (80 to 90%) of the tank surface exposed to free stream air will satisfy this criterion.

For Step 2:

The abbreviated quantitative criteria for a low flammability exposure time tank are:

1. During 4 hour operation on the ground on a 100 deg F day, a fuel temperature rise of less than 10 deg F above ambient with an 80% full fuel load. Heat inputs to be addressed are any airplane-based heat sources, both internal and external to the tank, including heat transfer from an adjacent tank that could heat the subject tank.

And

2. Initial cruise fuel cooling rates of 20 deg F per hour, with tank 80% full, and 35 deg F per hour with tank empty, starting from a fuel temperature of 60 deg F and TAT of –20 deg F.

And

3. The fuel temperature at the end of a maximum range cruise should be within 10 deg F of TAT.

For Step 3:

The criteria for a low flammability exposure time tank are:

1. Has a Fleet Average Flammability exposure time of no more than 7%, using the FAA Monte-Carlo Model method.

And

2. A fuel temperature rise of less than 20 deg F on the ground, starting with a 100 deg F ambient temperature and minimum operational fuel loaded in the tank, considering a ground operation period of at least four hours. Heat inputs to be addressed are any airplane-based heat sources, both internal and external to the tank, including heat transfer from an adjacent tank anticipated to occur during the 4 hour period that could heat the subject tank.

Discussion

This approach would provide an evaluation of the thermal characteristics of the tank in question, and if it met the criteria above, the tank would be considered a low flammability exposure time tank. If a tank does not meet the above criteria, it will be classified as a high flammability exposure time tank for the purpose of making unsafe condition findings. The Monte-Carlo model uses a flammability envelope that is based on a one joule spark, as being a relatively large spark, and in the lack of any real data on the distribution of spark sizes in a fuel tank, a conservative approach seemed appropriate. The model is an excel spreadsheet, and is downloadable from the FAA web site, http://qps.airweb.faa.gov/sfar88flamex . It is required to use version 5a or later of the Monte-Carlo model and provide documentation of how the analysis was performed.

Flammability Reduction or Effects of Ignition Mitigating Devices

A suitable flammability reduction system, such as inerting, or an ignition mitigating device, such as foam, may be used for ignition source mitigation. High flammability exposure time fuel tanks can be treated as low flammability exposure time fuel tanks for the purpose of SFAR 88 AD determination, if the mitigation of these devices is found acceptable by the Aircraft Certification Office (ACO) or the office of the Transport Airplane Directorate having cognizance over the type certificate.

Systems & Areas Adjacent to the Fuel Tank

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 in accordance with § 25.863(a). This has typically been accomplished by using various standards of explosion-proof components and good design practice.

The existence of an unsafe condition should be determined, based on the probability of a leak (taking into account in-service experience and mitigating factors, such as using double walls or protective coating.), and considering the potential ignition sources and the design precautions taken in the area (such as component qualification, drainage, and ventilation). Unsafe conditions may be addressed by corrective action (i.e. AD).

Maintenance Considerations

Results of safety assessments may define mandatory maintenance actions needed to prevent an unsafe condition. These maintenance actions may be included in the limitation section of the Instructions for Continued Airworthiness. Some manufacturers have developed airworthiness limitations (referred to as “Fuel System Limitations” by some manufactures) to differentiate these limitations from structural limitations. The limitations and Critical Design Configuration Control Limitations may be addressed in accordance with the standards of § 25.981(b) (Amendment 25-102) to ensure that fuel tank system protective features are maintained or controlled.

Effect of Policy

The general policy stated in this document does not constitute a new regulation or create a new norm, but is for the purpose of clarifies the considerations to determine an unsafe condition, using the findings from the on- time fuel tank safety review conducted for SFAR 88. These criteria are intended to complement the associated SFAR 88 advisory material and help determine which corrective action should or should not be introduced on in-service airplanes. The office that implements policy should follow this policy when applicable to the specific SFAR 88 project. Whenever an applicant's proposed method of compliance is outside this established policy, it may be coordinated with the policy-issuing office, e.g., through the issue paper process or the equivalent.

Applicants should expect that the certification officials will consider this information when making determination of unsafe conditions for the fuel system design features identified from the system safety analysis conducted for the one time SFAR 88 design review.

If you have further questions, the person on my staff most familiar with this issue is Mr. Dennis Kammers (425-227-2956).

s/ MJK

for Vi L. Lipski

cc: ANM-111, ANM-112, ANM-113, ANM-115, ANM-116, ANM-117

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I. TABLE 1

SFAR 88 Unsafe Condition Determination Criteria

<table>
<tr><td></td><td colspan="3">ELEMENT 4: Flammability Exposure Time</td></tr>
<tr><td></td><td>A
High Flammability Exposure Time tanks
>7%
(Boeing-Seattle, Airbus CWT)</td><td>B
High Flammability Exposure Time tanks driven to Low Flammability Exposure Time tanks through inerting or other means</td><td>C
Low Flammability Exposure Time tanks</td></tr>
<tr><td>ELEMENT 1:
Evaluation for Single Failures</td><td colspan="3">Unsafe if: Foreseeable Single Failures Jeopardize Safe Operation
Required Action: All identified single failure conditions must be addressed by corrective action (i.e. AD)</td></tr>
<tr><td>ELEMENT 2:
Evaluation for Combinations of Failures</td><td>“Compliance”
Unsafe if: Any noncompliance to §§ 25.981 (a) or (b) (Amendment 25-102) or 25.901 using guidance in AC 25.981-1
Required Action: It is expected that any noncompliance finding will be considered as an unsafe conditions and addressed by corrective actions (i.e. AD)</td><td colspan="2">Unsafe if: Known Combinations of Failures Jeopardize Safe Operation
Required Action: All known combinations of failures must be addressed by corrective action (i.e. AD).</td></tr>
<tr><td>ELEMENT 3:
Evaluation for In-Service Experience</td><td colspan="3">Unsafe if: In-service failures exist that either a) dissipate energy into tank/create ignition sources, or b) compromise fuel tank safety protection devices
Required Action: All of the in-service failures must be addressed by corrective action (i.e. AD)</td></tr>
</table>

Attachment 1

Table 2
Flammability Exposure Time Determination

Step	Characteristics of a Low Flammability Exposure Time Tank
Step 1 Can the tank satisfy the Low Flammability exposure time characteristics by qualitative inspection and design review? If Yes, tank is a Low Flammability exposure time tank, if No, go to Step 2	Low Heat Input: Step 1: Qualitative Inspection &Design Review: No or very small airplane based heat sources (A fuel temp rise of less that 10 deg F above ambient on the ground, for a 100 deg F day with an 80% full fuel load) internal/external to the tank, including heat transfer from an adjacent tank that could heat the tank, and Ability to reject heat quickly to outside air. A conventional Aluminum skin stringer construction, high percentage (80 to 90%) of surfaces exposed to free stream air
Step 2 Can the tank meet the Quantitative criteria for a Low Flammability exposure time tank? If Yes, Tank is a Low Flammability exposure time tank, if No, go to Step 3	Step 2: Quantitative Determination: Less than 10 Deg F above ambient temperature rise on the ground over many hours with an 80% full fuel load, and Initial cruise cooling rates of 20 Deg F per hour, with tank 80% Full, and 35 Deg F per hour with tank empty, starting from 60 Deg F and a TAT of –20 Deg F, and End of long cruise tank temperature within 10 Deg F of TAT
Step 3 Can the tank meet the Low Flammability exposure time tank Criteria using the FAA Monte-Carlo analysis? If Yes, Tank is a Low Flammability exposure time Tank, If No, Tank is a High Flammability exposure time tank	Step 3: Monte-Carlo Method: Has a Fleet Average Flammability exposure time of no greater than 7% using the FAA Monte-Carlo Model, and A fuel temperature rise of less than 20 deg F on the ground starting with a 100 deg F day

Attachment 2