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(Propulsion Considerations)

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Section 1. Fire Protection

Section 25.863 Flammable Fluid Fire Protection.

a. **Rule Text.**

(a) In each area where flammable fluids or vapors might escape by leakage of a fluid system, there must be means to minimize the probability of ignition of the fluids and vapors, and the resultant hazards if ignition does occur.

(b) Compliance with paragraph (a) of this section must be shown by analysis or tests, and the following factors must be considered:

(1) Possible sources and paths of fluid leakage, and means of detecting leakage.

(2) Flammability characteristics of fluids, including effects of any combustible or absorbing materials.

(3) Possible ignition sources, including electrical faults, overheating of equipment, and malfunctioning of protective devices.

(4) Means available for controlling or extinguishing a fire, such as stopping flow of fluids, shutting down equipment, fireproof containment, or use of extinguishing agents.

(5) Ability of airplane components that are critical to safety of flight to withstand fire and heat.

(c) If action by the flight crew is required to prevent or counteract a fluid fire (e.g., equipment shutdown or actuation of a fire extinguisher) quick acting means must be provided to alert the crew.

(d) Each area where flammable fluids or vapors might escape by leakage of a fluid system must be identified and defined.

(Amdt. 25-23, 35 FR 5676, April 8, 1970, as amended by Amdt. 25-46, 43 FR 50597, Oct. 30, 1978)

b. **Intent of Rule.** The intent of this rule is self-evident.

c. **Background**.

(1) The regulatory history shows that this requirement originated from Section 385 of the Civil Air Regulations (CAR) 4b, September 1962. Amendment 25-AD (29 FR 18289, December 24, 1964) added Part 25 [New] to the Federal Aviation Regulations and replaced Part 4b of the CAR. It was part of the Agency recodification program announced in Draft Release 61-25, published in the Federal Register on November 15, 1961 (26 FR 10698). This rule was recodified from CAR 4b.385 without substantive changes.

(2) Notice of Proposed Rulemaking 68-18 (33 FR 11913. August 22, 1968) proposed to revise this section by increasing the areas of the airplane covered by fire detection and extinguishing means. The following discussion from the preamble to the Notice provides insight into the intent of this regulation and indicates that this action was the result of a petition from the Airline Pilots Association (ALPA).

> **Explanation**: Inflight fire warning and extinguishing systems are required in powerplant and certain other compartments of transport category aircraft. By letter dated September 13, 1967, the Airline Pilots Association (ALPA) petitioned for rulemaking to extend the inflight fire warnings system and extinguishing means to include other sections of the airplane, and to require that Class D cargo compartments be provided with the same fire detection and fire extinguishing systems as are required in Class C cargo compartments.
>
> The FAA believes that the present inflight fire warning requirement, the broad requirements pertaining to flammable fluids, and other “fire safety” rules have, to a large extent, minimized the hazards associated with inflight fires. The amendments and additions to these requirements set forth in other proposals in this notice would further decrease the hazards of fire. Similarly, expanding the inflight fire warning and extinguishing system as requested by ALPA would further minimize the hazards associated with fire.
>
> However, as submitted, the ALPA proposal would have required means of fire detection and extinguishing in certain compartments, even though [those compartments] contained no combustible materials or source of flammable fluid leakage. Since this would be an unnecessary burden, the proposal herein is limited to areas having combustible materials or the possibility of flammable fluid leakage.
>
> It is also recognized that a relatively large number of fire detectors located throughout the airplane might increase the problem of false fire alarms, and comments on this term are especially solicited. The requirement for a means to extinguish any fire likely to occur in a particular compartment would not necessarily require a system employing an extinguishing agent. For example, it might be shown that in a certain region the quantity of combustible materials and fire resistance of the surrounding components are such that any fire occurring therein would extinguish itself without hazard. . .
>
> Section 25.863 provides that, where flammable fluids might be liberated by the leakage of fluid systems, there must be a means either to prevent ignition by any other equipment, or to control any fire resulting from ignition. Service experience has shown that either of these methods, by itself, can be rendered ineffective. The proposal would remove this alternative, and would require a means to prevent ignition by other equipment in all cases, backed up with provisions to

> minimize hazards in the event ignition does occur. In the areas specified in proposed § 25.863 (a), these backed-up provisions might be provided by the detection and extinguishing means required by that paragraph. In other areas, where detection and extinguishing means might be impractical, the back-up provisions might, for example, consist of a means to limit the fluid leakage, and fireproofing or isolation of critical parts.

(3) Amendment 25-23 (35 FR 5665, April 8, 1970) followed Notice 68-18. The preamble to that amendment stated that the prescriptive requirements proposed in Notice 68-18 were withdrawn, and a more general regulation was adopted. The following excerpt from the preamble to Amendment 25-23 provides further insight into this rule:

> In response to numerous comments, the proposed amendment to § 25.863 has been substantially revised.
>
> A number of commenters object to the proposed paragraph (a) that would require fire or overheat detectors and fire extinguishing means in specified areas of the airplane. A study of the research conducted on this matter and subsequent service experience has shown that other methods of fire protection may be equally or more effective, and that each area should be carefully examined with respect to the potential sources of combustion materials and ignition and appropriate fire protection means provided to prevent the occurrence of a catastrophic fire. Therefore, the proposal has been relaxed by withdrawing paragraph (a).
>
> However, proposed paragraph (b) of the Notice has been retained as the new paragraph (a), stating the basic objectives of
>
> - preventing the ignition of flammable fluids, and
> - minimizing the hazards in the event an ignition does occur.
>
> In addition, a new paragraph has been added which lists those factors (among others) that the applicant must consider in showing compliance with these objectives. A requirement for a means to alert the crew when an action by the crew is necessary to counteract or prevent a fire has been incorporated in a new paragraph (c) in view of the withdrawal of the proposed paragraph (a).

(4) ***FAA/Industry Activity:*** In 1991, an airplane accident resulted from retracting a burning tire into the wheel well of the airplane. Installation of fire detection or overheat warnings was not required when this airplane type was certificated. Many airplane manufacturers have now incorporated wheel well overheat or fire detectors to indicate to the flight crew if overheat of the landing gear or a fire is present. Flight crew procedures include extension of the landing gear to extinguish the fire or eliminate the overheat condition. The FAA has requested the Aviation Rulemaking Advisory Committee (ARAC) to assist in developing new standards that would be applicable to newly-certificated transport category airplanes.

> **Background:** In service accidents have occurred due to uncontrolled fire within the wheel well. In 1991 an airplane crashed due to a burning tire that was retracted into the wheel well. This accident report recommended that all transport aircraft be equipped with wheel well overheat and fire detectors, wheel

> well fire protection, brake temperature sensors tire pressure sensors and corresponding indicators in the cockpit. Also recommended was training of flight and ground crews on tire performance and vulnerability to ensure safety. In June 1986, the Flight Safety Digest reported an accident on an airplane model following a tire explosion within the wheel well. The crew disregarded a fire warning and did not extend the gear prior to the explosion. It should be noted that systems providing tire/brake data to the cockpit have been retrofitted to aircraft in the past. For example, a low-pressure tire detection system was installed on an airplane model after several blown tire incidents were experienced in the late 1970's and early 1980's. In another application, a fire warning system was installed on a USAF airplane model following a wheel-well fire on takeoff that resulted in the loss of an aircraft. Many current transport airplanes incorporate wheel well overheat/fire detectors and procedures to extend the landing gear however, these features are not currently required.

d. **Policy/Compliance Methods.** Section 25.1435(c) ("Hydraulic systems") requires that each hydraulic system using flammable hydraulic fluid must meet the applicable requirements of §§25.863, 25.1183, 25.1185, and 25.1189. Section 25.1189 ("Shutoff means") requires that each engine installation and fire zone have a means to shut off or to prevent hazardous quantities of flammable fluids from flowing into, within, or through the fire zone or by installation of a hydraulic shutoff valve.

(1) The following excerpts are from an internal FAA letter dated January 9, 1980. They provide additional guidance on FAA policy and acceptable means of compliance with § 25.863, "Flammable Fluid Fire Protection":

> Two recent type certification programs have required compliance with current § 25.863 (per Amendment 25-46). Because this rule has changed significantly since it was last administered for certification, a detail review of the development and intent of the rule was made and guidelines were established for acceptable means of compliance.
>
> The purpose of this letter is to inform all regions of this certification experience, and to promote uniformity of compliance with this rule
>
> Compliance with paragraph (a) of § 25.863 must be shown by analysis or tests, and the following factors must be considered:
>
> - Possible sources and paths of fluid leakage, and means of detecting leakage.
> - Flammability characteristics of fluids, including effects of any combustible or absorbing materials.
> - Possible ignition sources, including electrical faults, overheating of equipment, and malfunctioning of protective devices.
> - Means available for controlling or extinguishing a fire, such as stopping flow of fluids, shutting down equipment, fireproof containment, or use of extinguishing agents.
> - Ability of airplane components that are critical to safety of flight to withstand fire and heat.

If action by the flightcrew is required to prevent or counteract a fluid fire (e.g., equipment shutdown or actuation of a fire extinguisher), a quick acting means must be provided to alert the crew.

Each area where flammable fluids or vapors might escape by leakage of a fluid system must be identified and defined.

Means of Compliance. The intent of the rule is to require for areas containing potential ignition sources and systems which might be subject to flammable fluid or vapor leakage -- that there be means to minimize the probability of ignition backed up by means to minimize the resultant hazard if ignition does occur. The rule does not go so far as to require the entire airplane to be a "designated fire zone." The concept of requiring fire detectors and extinguishers throughout the airplane was originally proposed in 1968 in Notice 68-18, and was subsequently dropped in favor of the current objective rule. The notice explains that in areas where fire detection and extinguishing means might be impracticable, the back-up provisions might, for example, consist of means to limit fluid leakage and fireproofing or isolation of critical parts. Therefore, compliance with § 25.863 could be accomplished with means to limit fluid leakage and minimize the probability of ignition and fireproofing or isolation of critical parts.

If a finding is made that flammable fluids or vapors cannot escape into an area containing a potential ignition source, or if the fluids involved are nonflammable, the rule would not apply to that area. Several design measures could support such a finding. One might be by appropriate shrouding (sealing off) of all potential ignition sources and effectively excluding them from the area. Similarly, another might be the shrouding or sealing off of fluid/vapor sources and excluding these from the area. In either case, it should be ascertained that the shrouding or sealing means will continue to serve its function following any single failure of the system or component it is isolating from the area, subject to appropriate maintenance.

While the rule addresses the occurrence of ignition, it does not imply that an intense fire necessarily must be assumed to occur. The actual fire hazard would depend largely on quantity and flammability characteristics of fluids and vapors, ability of the environment to sustain fire once ignition has occurred, and ability of critical aircraft components (shielded, if necessary) to withstand the fire.

The rule does not require or prohibit any specific design feature. If a single unisolated fluid line is the sole means of preventing the escape of fluids or vapors into an area, it should be substantiated that the line can continue to serve this function under all conditions expected in service. (Note that the FAA has not seen a proposed program for substantiating the integrity of a single line system without back-up isolation.)

(2) In addition, current FAA policy for maximum allowable bleed duct temperatures within flammable fluid leakage zones to preclude auto ignition of flammable fluid vapors is defined in the Advisory Circular (AC) AC 25-8 [which has been incorporated in total into this Propulsion Mega AC at Section 25.952]. The following excerpt from AC 25-8 states:

h). <u>Maximum Surface Temperatures</u>

> There is a general industry/FAA practice that a temperature providing a safe margin under all normal or failure conditions is at least 50°F below the lowest expected auto ignition temperature of the fuel. The auto ignition temperature of fuels will vary because of a variety of factors (ambient pressure, dwell time, fuel type, etc.) but the value generally accepted without further substantiation for kerosene type fuels, under static sea level conditions, is 450° F. This results in a maximum surface temperature of approximately 400° F. for an affected component.

(3) The following excerpt from Advisory Circular 25-1187, "Minimization of Flammable Fluid Fire Hazards (Flammable Fluid Fire Protection)," provides additional guidance on compliance methods:

> The FAA has historically approved installations, which may experience bleed duct temperatures in excess of 400° F. Manufacturers have substantiated that the conditions (ambient pressure, dwell time, fuel type, etc.) within certain flammable fluid leakage zones are such that a higher value may be used. For example, one large manufacturer uses a 450°F maximum allowable bleed duct temperature with excursions up to 500°F for a maximum value of two minutes. The excursion above 450°F occurs only during failure conditions such as an engine pneumatic high stage bleed valve failure. Approval of these elevated temperatures has been based on compensating design features such as automatic over temperature shutoff of the pneumatic system so that the temperature cannot exceed the accepted 450°F value for more than two minutes.

(4) ***FAA/Industry Activity:*** In 1991, an airplane accident resulted from retracting a burning tire into the wheel well of the airplane. Installation of fire detection or overheat warnings was not required when this airplane type was certificated. Many airplane manufacturers have now incorporated wheel well overheat or fire detectors to indicate to the flight crew if overheat of the landing gear or a fire is present. Flight crew procedures include extension of the landing gear to extinguish the fire or eliminate the overheat condition. The FAA has requested the Aviation Rulemaking Advisory Committee (ARAC) to assist in developing new standards that would be applicable to newly-certificated transport category airplanes.

> **Background:** In service accidents have occurred due to uncontrolled fire within the wheel well. In 1991 an airplane crashed due to a burning tire that was retracted into the wheel well. This accident report recommended that all transport aircraft be equipped with wheel well overheat and fire detectors, wheel well fire protection, brake temperature sensors tire pressure sensors and corresponding indicators in the cockpit. Also recommended was training of flight and ground crews on tire performance and vulnerability to ensure safety. In June 1986, the Flight Safety Digest reported an accident on an airplane model following a tire explosion within the wheel well. The crew disregarded a fire warning and did not extend the gear prior to the explosion. It should be noted that systems providing tire/brake data to the cockpit have been retrofitted to aircraft in the past. For example, a low-pressure tire detection system was installed on an airplane model after several blown tire incidents were experienced in the late 1970's and early 1980's. In another application, a fire warning system was installed on a USAF airplane model following a wheel-well fire on takeoff that resulted in the loss of an aircraft. Many current transport

airplanes incorporate wheel well overheat/fire detectors and procedures to extend the landing gear however, these features are not currently required.

e. **References.**

(1) Civil Air Regulations (CAR) 4b, September 1962.

(2) Notice of Proposed Rulemaking 68-18 (33 FR 11913, August 22, 1968).

(3) Amendment 25-23 (35 FR 5665, April 8, 1970).

(4) Advisory Circular 25-8, "Auxiliary Fuel System Installations," May 2, 1986 [Incorporated in total in this Propulsion Mega AC at Section 25.952].

(5) Advisory Circular 25-1187, "Minimization of Flammable Fluid Fire Hazards (Flammable fluid Fire Protection)."

Section 25.865 Fire protection of flight controls, engine mounts, and other flight structure.

a. **Rule Text.**

Essential flight controls, engine mounts, and other flight structures located in designated fire zones or in adjacent areas which would be subjected to the effects of fire in the fire zone must be constructed of fireproof material or shielded so that they are capable of withstanding the effects of fire.

(Amdt. 25-23, 35 FR 5676, April 8, 1970)

b. **Intent of Rule.** The intent of this rule is to ensure that critical components of the flight control and engine mounting system, located within or adjacent to a fire zone, maintain the capability needed to complete safe flight and landing following a fire within the zone.

c. **Background.**

(1) The regulatory history shows that this requirement originated in Notice of Proposed Rulemaking 68-18 (33 FR 11913, August 22, 1968). The following excerpt from the preamble to the Notice provides guidance on the intent of this rule.

> The current regulations do not require protection of engine mounts, or control systems from the effects of fire. The need for this protection was recently highlighted when control problems were experienced on a jet transport airplane after aluminum aileron rods located outside of the fire zone became distorted due to heat from an engine fire. Engine mounts and flight structures can also be affected by fire and a failure resulting from the heat of a fire could cause a serious safety hazard.

(2) Amendment 25-23 (35 FR 5665, April 8, 1970) followed Notice 68-18, and incorporated the proposed change. The following excerpt from the preamble to the Amendment provides further guidance on the intent of this rule.

> In response to comments received, the proposed requirement of § 25.865 has been changed to make it clear that it is only those flight controls, engine mounts, and other flight structures which would be damaged by the "effects of fire" that need be constructed of fireproof material or shielded. In response to another comment, § 25.865 has been changed to make it clear that it is the "essential" flight controls with which the regulation is concerned.

d. **Policy/Compliance Methods.**

(1) Advisory Circular 20-135, "Powerplant Installation and Propulsion System Component Fire Protection Test Methods, Standards, and Criteria," provides guidance on compliance methodology and defines criteria for conducting tests to

substantiate that materials used in construction of, or shielding installed to protect, components defined within the rule meet this requirement.

Some manufacturers have incorporated engine mounting structure utilizing titanium or incorporate vibration dampening materials that may be damaged or burned away during a fire. Standardized definitions of fireproof and fire resistant materials from §1.1 are as follows:

> **Fireproof.** With respect to materials and parts used to confine fire in a designated fire zone, this term means the capacity to withstand at least as well as steel in dimensions appropriate for the purpose for which they are used, the heat produced when there is a severe fire of extended duration in that zone. In addition, with respect to other materials and parts, this term means the capacity to withstand the heat associated with fire at least as well as steel in dimensions appropriate for the purpose for which they are used.
>
> **Fire resistant.** With respect to sheet or structural members, this term means the capacity to withstand the heat associated with fire at least as well as aluminum alloy in dimensions appropriate for the purpose for which they are used. In addition, with respect to fluid-carrying lines, fluid system parts, wiring, air ducts, fittings, and powerplant controls, this term means the capacity to perform the intended functions under the heat and other conditions likely to occur when there is a fire at the place concerned.

(2) Further guidance regarding demonstrating compliance with this section is provided in the following excerpt from an FAA generic Issue Paper developed for this purpose, as provided below:

> **FAA Position.** The titanium and elastomeric structures must be able to sustain the appropriate loads with a positive margin of safety for any foreseeable powerplant fire condition. A test should be performed in which the structures are subjected to a test flame of 2000 ± 50 degrees Fahrenheit for a period of 15 minutes. The heat flux should be as described in AC 20-135 and loads appropriate to the fire condition should be imposed during the test.
>
> In the absence of a more rational determination of the expected flight loads, the structure should be able to support limit flight loads without failure for at least five minutes. After 5 minutes and until the end of 15 minutes, the engine may be assumed to be shut down and structure must be able to support the discrete source damage loads described in AC 25.571-1A ["Damage Tolerance and Fatigue Evaluation of Structure"]. Freedom from flutter and whirlmode should also established.
>
> The failsafe features of the design may be taken into account if it can be shown that a foreseeable fire conditions could not affect the integrity of the alternate load paths.
>
> Validated analyses may be used to represent the transient temperature conditions and strength under the applied loads.

e. **References.**

(1) Notice of Proposed Rulemaking 68-18 (33 FR 11913, August 22, 1968).

(2) Amendment 25-23 (35 FR 5665, April 8, 1970).

(3) Advisory Circular 20-135, “Powerplant Installation and Propulsion System Component Fire Protection Test Methods, Standards, and Criteria,” May 6, 1990.

Section 25.867 Fire protection: other components.

a. **Rule Text.**

(a) Surfaces to the rear of the nacelles, within one nacelle diameter of the nacelle centerline, must be at least fire-resistant.

(b) Paragraph (a) of this section does not apply to tail surfaces to the rear of the nacelles that could not be readily affected by heat, flames, or sparks coming from a designated fire zone or engine compartment of any nacelle.

(Amdt. 25-23, 35 FR 5676, April 8, 1970)

b. **Intent of Rule.** Service experience has shown that fires adjacent to the engine nacelle may result in a hazard to the airplane if surfaces adjacent to the engine are not fire resistant. For example, fuel tank access panels and aerodynamic surfaces have been damaged by fire near the engine nacelle. The intent of this rule is to ensure that a fire adjacent to the engine will not be hazardous to the airplane.

c. **Background.**

(1) This regulation, along with several other powerplant fire protection requirements, originated from Amendment 4b-2 of the Civil Air Regulations (CAR), effective August 25, 1955. These new requirements were described as "several new provisions designed mainly for the protection against fire in turbine powerplant installations." It became section 4b.490 in the CAR, September 1962.

(2) Section 4b.490 was recodified from CAR 4b without any substantive changes via Amendment 25-AD, which was published in the Federal Register on December 24, 1964 (29 FR 18289). That amendment added Part 25 [New] to the Federal Aviation Regulations and replaced Part 4b of the Civil Air Regulations. It was part of the Agency recodification program announced in Draft Release 61-25, published in the Federal Register on November 15, 1961 (26 FR 10698). It was designated §25.1205 when Part 25 as part of the recodification.

(3) Notice of Proposed Rulemaking 68-18 (33 FR 11913, August 22, 1968) proposed relocating this requirement into a new section § 25.867 as follows:

> The proposal would require fire protection requirements for other components now specified in §25.1205 to a new §25.867 in order that the requirements would be in logical sequence.

This proposal was adopted by Amendment 25-23 (35 FR 5665, April 8, 1970) and has remained without further modification.

d. **Policy/Compliance Methods.** Compliance with this regulation may be shown by analysis and/or tests that show surfaces within one nacelle diameter of the engine center line are fire resistant. Conditions that must be addressed include in-flight and ground operations. The nacelle diameter should be measured from the outside surface of the outermost portion of the engine that contains flammable fluids. For example, an engine that has fan case mounted accessories, the outside of the fan cowl would be used; or for an engine with core-mounted accessories, the outside core diameter would be used.

Advisory Circular AC 20-135, "Powerplant Installation and Propulsion System Component Fire Protection Test Methods, Standards, and Criteria," provides detailed guidance for compliance demonstration.

e. **References.**

(1) Civil Air Regulations (CAR), Amendment 4b-2, effective August 25, 1955.

(2) Notice of Proposed Rulemaking 68-18 (33 FR 11913, August 22, 1968).

(3) Amendment 25-23 (35 FR 5665, April 8, 1970).

(4) Advisory Circular 20-135, "Powerplant Installation and Propulsion System Component Fire Protection Test Methods, Standards, and Criteria," February 15, 1990.