SUBPART E - POWERPLANT

Section 3. Fuel System Components

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SUBPART E - POWERPLANT

Section 3. Fuel System Components

Section 25.991 Fuel pumps.

a. **Rule Text.**

(a) Main pumps. Each fuel pump required for proper engine operation, or required to meet the fuel system requirements of this subpart (other than those in paragraph (b) of this section, is a main pump. For each main pump, provision must be made to allow the bypass of each positive displacement fuel pump other than a fuel injection pump (a pump that supplies the proper flow and pressure for fuel injection when the injection is not accomplished in a carburetor) approved as part of the engine.

(b) Emergency pumps. There must be emergency pumps or another main pump to feed each engine immediately after failure of any main pump (other than a fuel injection pump approved as part of the engine).

b. **Intent of Rule.** Section 25.991, paragraphs (a) and (b), provide definitions of the main pump(s) and requires an “emergency pump(s).” The main aircraft pump(s) consists of whatever pump(s) is required for proper engine or fuel system operation throughout the range of ambient temperature, fuel temperature, fuel pressure, altitude, and fuel types intended for the airplane. If the main aircraft pump(s) is required to meet the above criteria, then an emergency pump(s) is required. As discussed within the original Civil Air Regulations 4b.430, Rule Text, it is intended that:

> . . . Emergency pumps shall be provided and immediately available to permit supplying all engines with fuel in case of failure of any one main fuel pump except fuel injection pumps approved as part of the engine. This requirement is not intended to prohibit the use of another main pump as an emergency pump after failure of one main pump.

c. **Background.** The regulatory history shows that this requirement originated from Section 430 of Civil Air Regulations (CAR) 4b, December 31, 1953. 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.430 without any substantive changes.

The following excerpt from the original CAR 4b regulatory text and interpretive material provides insight into the intent of this rule:

4b.430 Fuel pumps

(a) Main pumps

(1) [*Same as current wording*]

(2) "

(b) Emergency pumps

(1) Emergency pumps shall be provided and immediately available to permit supplying all engines with fuel in case of failure of any one main fuel pump except fuel injection pumps approved as part of the engine. This requirement is not intended to prohibit the use of another main pump as an emergency pump after failure of one main pump.

4b.430-1 Fuel injection pump
(*FAA interpretations that apply to Section 4b.430*). The phrase "fuel injection pump" means a pump that supplies the proper flow and pressure conditions for fuel injection when such injection is not accomplished in a carburetor.

d. **Policy/Compliance Methods.**

(1) Acceptable methods of compliance, and in certain cases "required compliance methods," include drawing and schematic review together with a compliance (mock-up) inspection, fuel flow tests and demonstrations in accordance with Sections 25.951 and 25.955. Consideration can be given to prior compliance by similarity, and service experience on applicants approved existing fuel tank designs, fuel system components and fuel system designs on other model aircraft.

(2) The following excerpt is from the guidance material contained in Advisory Circular 29-2B, "Certification of Transport Category Rotorcraft," which provides guidance on transport category rotorcraft and may also provide additional insight into compliance methods useful for transport category airplanes.

FUEL PUMPS.

Procedures.

(1) Each pump classified as a main aircraft pump, which is also a positive displacement pump, must have provisions for a fuel bypass. An exception is made for fuel injection pumps used on certain reciprocating engines and for the positive displacement, high pressure, and fuel pumps routinely used in turbine engines. The bypass may be accomplished via internal spring check valve and fuel passage, or by external plumbing and a check valve. High capacity positive displacement pumps with internal pressure relief and recirculation passages should be checked for overheating if they may be expected to operate continuously at or near 100 percent recirculation.

(2) Section 25.991, paragraph (b) specifies a requirement for "emergency" pumps to provide the necessary fuel after failure of any (one) main aircraft pump. (Injection pumps and high pressure pumps used on turbine engines are exempt.) As stated in this rule, the "emergency" pump must be operated continuously or started automatically to assure continued normal operation of the engine. For some multiengine aircraft, another main aircraft pump may possibly be used as the required "emergency" pump. In this case, the dual role of this pump requires it to have capacity to feed two engines at the critical pressure/flow condition. Availability of fuel flow from this backup pump must be automatic and this function should be verified in the preflight check procedure. A comprehensive fault analysis of the fuel system is mandatory to assure compliance with § 25.903, paragraph (b).

e. **<u>References.</u>**

(1) Civil Air Regulations 4b, December 31, 1953.

(2) Amendment 25-AD (29 FR 18289, December 24, 1964).

(3) Advisory Circular 29-2B, "Certification of Transport Category Rotorcraft," July 30, 1997.

Section 25.993 Fuel system lines and fittings.

a. **Rule Text.**

(a) Each fuel line must be installed and supported to prevent excessive vibration and to withstand loads due to fuel pressure and accelerated flight conditions.

(b) Each fuel line connected to components of the airplane between which relative motion could exist must have provisions for flexibility.

(c) Each flexible connection in fuel lines that may be under pressure and subjected to axial loading must use flexible hose assemblies.

(d) Flexible hose must be approved or must be shown to be suitable for the particular application.

(e) No flexible hose that might be adversely affected by exposure to high temperatures may be used where excessive temperatures will exist during operation or after engine shut-down.

(f) Each fuel line within the fuselage must be designed and installed to allow a reasonable degree of deformation and stretching without leakage.

(Doc. No. 5066, 29 FR 18291, Dec. 24, 1964, as amended by Amdt. 25-15, 32 FR 13266, Sept. 20, 1967)

b. **Intent of Rule.** This rule outlines design requirements for transport category airplane fuel system lines and fittings, including lines and fittings forming part of fuel vent, pressure fueling, and fuel jettison systems.

c. **Background.**

(1) Paragraphs (a), through (e) of this rule originated from Section 432 of Civil Air Regulations (CAR) 4b, December 31, 1953. 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.432 without substantive change.

(2) Notice of Proposed Rulemaking 66-26 (31 FR 11725, September 7, 1966) proposed to add a new § 25.993(f). The new paragraph would require that each fuel line within the fuselage must be designed and installed to allow a reasonable degree of deformation and stretching without failure or leakage, and must be enclosed in a shroud. The impetus for paragraph (f) can be found in a Civil Aeronautics

Board (CAB) accident report involving a landing accident at Salt Lake City, November 11, 1965.

Amendment 25-15 (32 FR 13255, September 20, 1967) followed Notice 66-26. In response to several comments received that were concerned about the requirement for a shroud, the FAA deleted the requirement from the final amendment, since

> . . . a shroud is a device that protects against the effects of leakage rather than a device that prevents leakage. Leakage prevention is the object of this amendment. The need for a shroud should be determined, in each case, under the flammable fluid fire protection requirements of § 25.967 and § 25.863.

Other comments received and relevant issues were discussed in the preamble to the Amendment as follows:

> One comment suggested that the proposal should be applied only to fuel lines within occupied and cargo compartments. Another comment suggested that the proposal should apply only to lines within the pressurized section of the fuselage. These comments are not accepted since fuel lines passing from the fuel tanks through any portion of the fuselage to the engines should be evaluated for leakage security.
>
> This amendment specifies only "leakage" rather than "failure or leakage." Failures other than those that cause leakage, such as those that cause fuel stoppage only, are not the subject of this amendment.

d. **Policy/Compliance Methods.**

(1) Acceptable methods of compliance, and in certain cases "required compliance methods," include a system description, drawing and schematic review together with a compliance (mock-up) inspection, stress analysis, failure analysis, ground impact deformation test, and TSO conditions compliance. Consideration can be given to prior compliance with an industry standard for fuel lines and fittings, and service experience, by similarity, on other model aircraft. The applicant must supply impact-deformations test proposal which address conditions related to compliance with Section 25.993(f).

(2) Current transport category airplane policy and compliance material for this section has been contained in Chapter 2, Paragraph 4 (a)(1) of Advisory Circular (AC) 25-8, "Auxiliary Fuel System Installations." That AC has been cancelled with issuance of the Propulsion Mega AC and its guidance incorporated in total into Section 25.952 of this Mega AC.

(3) In addition, the following excerpt from Advisory Circular 29-2B, "Certification of Transport Category Rotorcraft," provides guidance on transport category rotorcraft fuel system lines and fittings, and may also provide additional insight into compliance methods useful for transport category airplanes.

a. **Explanation**. This rule outlines design requirements for fuel system lines.

b. **Procedures**.

(1) Compliance is usually obtained by employing routing and clamping as described in Paragraph 709, Chapter 14, Section 2, of AC 43.13-1A and by monitoring the arrangement throughout the developmental and certification test period. Requirements for approved flexible lines be resolved by utilizing lines listed as TSO C53a approved for installation in either normal or high temperature areas as appropriate.

(2) Verify adequate clearance exists between lines and elements of the aircraft control system at extremes of control travel, including control deflections and, for flexible lines (hoses), possible variations in routing.

(3) Flexible lines inside fuel or oil tanks require special evaluation to assure that the external surfaces of these lines are compatible with the fluids involved and that fluid sloshing will not cause line failure. Lines inside tanks should be routed to avoid impingement by fuel or filler nozzles.

(4) Good design practice suggests that all flammable fluid lines should be routed to minimize the possibility of rupture in the event of a crash or from engine rotor disc failure.

e. **References.**

(1) Civil Air Regulations 4b, December 31, 1953.

(2) Amendment 25-AD (29 FR 18289, December 24, 1964).

(3) Amendment 25-15 (32 FR 13266, Sept. 20, 1967).

(4) Advisory Circular 25-8, “Auxiliary Fuel System Installations,” May 2, 1986 [Incorporated in total in this Propulsion Mega AC at Section 225.952].

(5) Advisory Circular 29-2B, “Certification of Transport Category Rotorcraft,” July 30, 1997.

Section 25.994 Fuel system components.

a. **Rule Text.**

Fuel system components in an engine nacelle or in the fuselage must be protected from damage which could result in spillage of enough fuel to constitute a fire hazard as a result of a wheels-up landing on a paved runway.

(Amdt. 25-57, 49 FR 6848, Feb. 23, 1984)

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

c. **Background.**

(1) This rule was first proposed in Notice of Proposed Rulemaking 68-18 (33 FR 11913, August 22, 1968). Amendment 25-23 (35 FR 5665, April 8, 1970) followed Notice 68-18 and adopted the proposal.

(2) Shortly after promulgation of Amendment 25-23, inquiries to the FAA made it obvious that a description of the wheels-up landing condition and the maximum loads to be used for fuel system components should have been established. Amendment 25-57 (49 FR 6832, February 23, 1984) was issued to clarify that the fuel system needed to be protected against fuel spillage in terms of that occurring after a wheels-up landing on a paved runway. The preamble to the Amendment also stated:

> The FAA recognizes that release of minute quantities of fuel would not be likely to present a fire hazard, and that complete avoidance of fuel spillage or approval of a specific amount would be very difficult.

d. **Policy/Compliance Methods.**

(1) Acceptable methods of compliance, and in certain cases "required compliance methods," include a system description, drawings and schematic review together with a compliance (mock-up) inspection, and gear-up airplane-nacelle geometry analysis. Consideration can be given to prior compliance by similarity, and service experience on applicants approved existing engine nacelle and fuselage fuel system routing design on other model aircraft.

(2) Policy and compliance material for this section has been contained in Advisory Circular 25-994-1, "Design Considerations to Protect Fuel Systems During a Wheels-Up Landing," dated July 24, 1986. However, AC 25-994-1 has now been cancelled with the issuance of this Propulsion Mega AC and its material incorporated in total below:

Advisory Circular 25-994-1

DESIGN CONSIDERATIONS TO PROTECT FUEL SYSTEMS DURING A WHEELS-UP LANDING

1. **PURPOSE.** This advisory circular (AC) presents guidelines and methods for complying with the requirements of Title 14, Code of Federal Regulations(CFR), commonly referred to as Federal Aviation Regulations (FAR). These guidelines pertain to section 25.994, relative to protecting fuel system components located in the engine nacelles and the fuselage from damage which could result in spillage of enough fuel to constitute a fire hazard as a consequence of a wheels-up landing on a paved runway. As with all AC's, this material is not mandatory and does not constitute a regulation.

2. **RELATED SECTIONS OF THE REGULATIONS**. The following are related sections that may help determine an acceptable design:

   § 25.561 Emergency Landing Conditions, General.
   § 25.721 Landing Gear, General.
   § 25.863 Flammable fluid fire protection.
   § 25.963(d) Fuel tanks: general.
   § 25.993(f) Fuel system lines and fittings.
   § 25.1189 Shutoff means.
   § 25.1359 Electrical system fire and smoke protection

3. **BACKGROUND.** This AC was developed from FAA Order 8110.19, Fuel System Components Affected by Wheels-Up Landing, dated August 24, 1976. Order 8110.19 has been cancelled and this AC takes its place. Section 25.994 was incorporated in the regulations by Amendment 25-23 dated April 8, 1970. Shortly after promulgation, inquiries made it obvious that a description of the wheels-up landing condition and the maximum loads to be used for the fuel system components should have been established. These additional clarifications to § 25.994 were incorporated in the regulations by Amendment 25-57, dated February 23, 1984.

4. **DISCUSSION.**

   a. Section 25.994 requires that the fuel system components in an engine nacelle or in-the fuselage be protected from damage which could result in the spillage of enough fuel to constitute a fire hazard. Fuel is the most likely cause of a fire following a wheels-up landing if the fuel system components in the engine nacelles and the fuselage are damaged to the extent that fuel is released. Therefore, the location and routing of fuel system components in the engine nacelle and fuselage should be evaluated with respect to the runway scraping action that may be encountered and the resultant structural distortion that may occur. The components which cannot be located to protect them from likely damage in a wheels-up landing should be designed to minimize fuel spillage and leakage into zones of possible or likely ignition sources. The probable migration of fuel should be evaluated and those zones where fuel is likely to enter should not have potential ignition sources. Equipment in such areas should be explosion-proof, hermetically sealed, or otherwise qualified to operate in a flammable fluid leakage zone.

   b. Fuel system components and likely ignition sources [electrical arcing and high temperature surfaces (above 400° F.)] that should be investigated for protection include fuel shutoff valves, couplings, fittings, lines, electrical wiring, electric power cables, electric motors, electric motor-driven pumps, hot air conditioning ducts and engine bleed air ducts. Many of these components are installed in, or routed through areas susceptible to damage resulting from a wheels-up landing.

c. For purposes of this AC, a wheels-up landing is defined as a landing on a paved runway under a controlled emergency landing condition as described in § 25.561. The damage that may be sustained in a full gear-up landing or other failure configurations, such as one or two gears extended or all gears collapsed, cannot be precisely determined. However, a reasonable design effort to protect fuel system components for the all-wheels-up landing should minimize the extent of component damage for the other gear failure configurations.

5. **ACCEPTABLE MEANS OF COMPLIANCE.**

a. The airplane fuel system should be designed to minimize the spilling or leaking of fuel from damaged components during and following a wheels-up landing. The unpreventable release of fuel, such as from severed or punctured fuel lines downstream from shutoff valves, should be diverted or excluded to the maximum extent practicable from spreading to likely ignition sources.

b. Fuel lines and fuel system components should be located and routed as far as practicable from likely impact areas and from areas where structural deformation may cause crushing, severing, punctures or high tensile loads in the lines.

c. Fuel lines should be constructed to protect their integrity during and after a wheels-up landing. Flexible and stretchable hoses should be used or the fuel line should be designed to allow stretching or movement with the deformed structure up to an amount likely to be required to prevent failure under high tensile or shear loading. Flexible hoses should also be designed and qualified to absorb the energy that would likely be imparted to the component or fuel line from direct impact resulting from structural failure.

d. Fuel lines and fuel system components within the engine nacelle should be arranged and protected to the maximum extent possible so that spilled fuel caused by damage to lines or components from a wheels-up landing is not likely to contact hot engine surfaces (over 400° F.).

e. In areas of the engine nacelles, pylons, and airplane fuselage that are susceptible to being damaged by a wheels-up landing, fuel lines and electrical wiring should be isolated, separated and routed to the maximum extent practicable, to minimize the hazards of spilled fuel flowing into an area containing a potential ignition source. In addition, electrical components should be acceptable for operation in flammable leakage zones identified in accordance with § 25.863.

f. Shielding and drainage may be used wherever it is considered appropriate to prevent spilled fuel from spreading to potential ignition sources or occupied areas. Drip fences and drainage troughs can be used to divert flow of spilled fuel from potential ignition sources such as hot engine cases, electrical accessories, and component compartments. Nonconductive material should be used to shroud electrical wiring that might be damaged by deforming structure.

g. Fuel shutoff valves should not be located within the engine nacelles, pylon areas or adjacent to engine air intakes and exhausts where they may be subjected to damage from impact and scraping action during a wheels-up landing. Fuel shutoff valve mountings should, as a minimum, be designed for the inertial loads listed in § 25.561 unless the location and estimated loads in the area impose a greater strength requirement to maintain the shutoff valve mounting integrity.

h. Installation of auxiliary fuel tanks and systems in the fuselage should be based on the guidance and information in AC 25-8, Auxiliary Fuel System Installations, incorporated into guidance for Section 25.952 of this Propulsion Mega AC .

■■

END OF ADVISORY CIRCULAR 25-994-1

e. **References.**

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

(2) Amendment 25-57 (49 FR 6832, February 23, 1984).

(3) Advisory Circular 25-994-1, "Design Considerations to Protect Fuel Systems During a Wheels-Up Landing," July 24, 1986 [incorporated in total into this Propulsion Mega AC].

Section 25.995 Fuel valves.

a. **Rule Text.**

In addition to the requirements of § 25.1189 for shutoff means, each fuel valve must --

(a) (Reserved)

(b) Be supported so that no loads resulting from their operation or from accelerated flight conditions are transmitted to the lines attached to the valve.

(Doc. No. 5066, 29 FR 18291, Dec. 24, 1964, as amended by Amdt. 25-40, 42 FR 15043, March 17, 1977)

b. **Intent of Rule.** This rule requires that fuel valves be supported so that no loads resulting from their operation or from accelerated flight conditions are transmitted to the lines attached to the valve.

c. **Background.**

(1) Paragraph (b) of this rule originated in Section 430 of the Civil Air Regulations (CAR) Part 4b, December 31, 1953. 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.430 without substantive change.

(2) Revision of this rule was proposed by two Notices of Proposed Rulemaking:

- Notice 75-10 (40 FR 10802, March 7, 1975) and
- Notice 75-19 (40 FR 21866, May 19, 1975).

Amendment 25-40 (42 FR 15043, March 17, 1977) followed Notice 75-19 and revised this rule by deleting the design requirements of § 25.995(a) and transferring them to § 25.1141 ("Powerplant controls, general"). However, the design requirement for *"positive stops or suitable index provisions in the 'on' and 'off' "positions,"* as originally published in CAR Part 4b, Section 4b.434, was directed at the valve design and its physical fuel valve installation; it was not directed at the fuel valve installation, and not directed at the fuel valve control located in the cockpit. That design requirement is still implied so that the position of the cockpit control is in agreement with the physical position of the valve.

d. **Policy/Compliance Methods.**

(1) Acceptable methods of compliance, and in certain cases "required compliance methods," include a system description, drawings and schematic review together with a compliance (mock-up) inspection, loads criteria, stress analysis and structural fail-safe analysis. Consideration can be given to prior compliance with an industry standard for fuel valve installation and fuel lines and fittings. Service experience and compliance by similarity on applicants approved existing fuel valve installation and fuel lines and fittings may also be considered.

(2) FAA policy on this topic has been limited. Policy governing this part is predicated on mutual acceptance of these requirements and those governing fuel shutoff (§ 25.1189). The compliance method chosen for this rule is usually accomplished by designing the installation of the fuel valve so that the valve is supported by either primary or secondary airframe structure.

e. **References.**

(1) Civil Air Regulations 4b, December 31, 1953.

(2) Amendment 25-AD (29 FR 18289, December 24, 1964).

(3) Notice of Proposed Rulemaking 75-10 (40 FR 10802, March 7, 1975).

(4) Notice of Proposed Rulemaking 75-19 (40 FR 21866, May 19, 1975).

(5) Amendment 25-40(42 FR 15043, March 17, 1977).

Section 25.997 Fuel strainer or filter.

a. **Rule Text.**

There must be a fuel strainer or filter between the fuel tank outlet and the inlet of either the fuel metering device or an engine driven positive displacement pump, whichever is nearer the fuel tank outlet. This fuel strainer or filter must --

(a) Be accessible for draining and cleaning and must incorporate a screen or element which is easily removable;

(b) Have a sediment trap and drain except that it need not have a drain if the strainer or filter is easily removable for drain purposes;

(c) Be mounted so that its weight is not supported by the connecting lines or by the inlet or outlet connections of the strainer or filter itself, unless adequate strength margins under all loading conditions are provided in the lines and connections; and

(d) Have the capacity (with respect to operating limitations established for the engine) to ensure that engine fuel system functioning is not impaired, with the fuel contaminated to a degree (with respect to particle size and density) that is greater than that established for the engine in Part 33 of this chapter.

(Amdt. No. 25-36, 39 FR 35460, Oct. 1, 1974, as amended by Amdt. 25-57, 49 FR 6848, Feb. 23, 1984)

b. **Intent of Rule.** This rule requires that a main in-line fuel filter be installed to collect all fuel impurities which could adversely affect fuel system and engine components downstream of the filter. The rule also requires a sediment bowl and drain (or that the bowl be removable for drain purposes) to facilitate separation of contamination, both solid and liquid, from the fuel.

c. **Background.**

(1) The fuel filter capability and indication requirements within Part 23, Part 25, Part 29, and Part 33 of the regulations were first proposed in Notice of Proposed Rulemaking 71-12 (36 FR 8383, May 5, 1971). That Notice contained numerous proposals, and therefore the discussion of what was intended by each proposal is brief. However, review of the Notice and other materials shows that the FAA intended that an indicator be required to indicate fuel filter clogging from foreign particles.

(2) Amendments 23-15, 25-36, and 33-6,(39 FR 35452, October 1, 1971) followed Notice 71-12 and contained the following excerpt in the preamble:

> Section 25.1305(c) has been amended so that it is substantively the same as the parallel provision of § 23.1305. The related Part 23 preamble discussion is

> applicable. The proposed new subparagraph 25.1305(d), concerning an indicator to indicate rotor system unbalance, has already been adopted by separate rulemaking action (Amdt. 25-35, 39 FR 1831).
>
> One commenter questions whether the fuel strainer or filter indicator referred to in § 25.1305 (t) were required on all filters, even last-chance filters. Consistent with the requirements applicable to strainers or filters themselves § 25.1305(t) has been revised to make clear that the indicator required is for a fuel strainer or filter required under § 23.997. Similarly, § 23.1305(t) and (u) have been reworded in order to be consistent with §§ 23.997 (fuel filter) and 23.1019 (oil filter), respectively, in regard to the degree of contamination that must be indicated. In response to a further comment, § 23.1305(t) has been reworded to clarify that the desired indication is of the occurrence of contamination rather than the more stringent requirements to the degree of contamination as suggested in the notice. This change achieves consistency between paragraphs (t) *(fuel filter)* and (u) *(Oil filter)*.

d. **Policy/Compliance Methods.**

(1) In the explanation provided in Notice 71-12 and Amendment 25-36, the FAA apparently intended that an indicator be required to indicate fuel filter clogging from foreign particles. It is also clear that the FAA intended that a filter be installed, either as part of the engine (for newly certificated engines) or as part of the airplane (for previously certificated engines). In addition, the docket file information for Amendment 25-36 supports the FAA position that the fuel filter indication required by § 25.1305 was intended to be a cockpit indicator for indication of particulate contamination of the fuel filter. The FAA policy published in Advisory Circular 33-7, which requires the fuel filter capacity to be only one-half that required to complete the flight, assumes that a cockpit indicator would be provided so that crew action would preclude loss of all engine power.

Section 25.997 requires that the engine fuel system "must have a capacity and mesh to ensure that the engine fuel system functioning is not impaired with fuel contaminated to a degree that is greater than that established for the engine in Part 33." The intent of this wording was to allow margin between the engine type-certificated value and when the actual engine function would be impaired.

Part 33 certification fuel filter capacity is based on a fuel contamination level defined within Military Specification MIL-E-5007E(AS), "Engines, Aircraft, Turbojet and Turbofan, General Specification For," dated September 1, 1983. This specification defines a given concentration of Arizona Road dust (particle size and density is defined by specification). Within Advisory Circular 33-2B, "Aircraft Engine Type Certification Handbook," the FAA has specified that:

> . . . an acceptable means of compliance with § 33.67(b)(5) can be that the applicant show that the engine will continue to operate satisfactorily, for at least one-half of the maximum flight time (of the intended aircraft applications), beginning at first indication of impending filter blockage. Actual, or rig-simulation of, test engine operation should be at the most critical mission fuel flows expected to be used in service. Table X of the reference provides an example of

typical fuel contaminants, particle sizes, and quantities; and an evaluation of the mission requirement for the airplane.

The FAA policy regarding Part 33 is interesting in that, for the airplane to complete the flight safely, one would have to assume that the flight crew was made aware of the impending bypass and acted accordingly. All current large transport category airplanes incorporate fuel filters with capacities well in excess of the minimum requirement noted above. The contamination level assumed within the Mil. Spec. is arbitrary, and higher levels have been seen in service that have resulted in engine shutdowns.

(2) Additional guidance on this subject is provided below. Although it is based upon material in Advisory Circular 29-2B, "Certification of Transport Category Rotorcraft, dated July 30, 1997, it may also provide insight into additional compliance methods for transport airplanes.

Procedures.

(1) Section 25.997(d) sets forth a requirement for filter capacity and for filter mesh. The capacity requirement may be substantiated by showing that the filter, when partially blocked by fuel contaminates (to a degree corresponding to the indicator marking or setting required by § 25.1305(c)(6)), does not impair the ability of the fuel system to deliver fuel at pressure and flow values established as minimum limitations for the engine. The filter mesh must be sized to prevent passage of particulates that cannot be tolerated by the engine. Part 33 requires that the degree and type of filtration be established and demonstrated during the engine certification. This information should be evaluated by the installer and may be used in developing the compliance plan for the engine installation for this section. Note that when the filter capacity is reached, continued flow of contaminated fuel may result in engine failure.

Section 25.1305 requires an indicator for the fuel strainer or filter required by this section to indicate the occurrence of contamination of the strainer or filter before it reaches the capacity established in accordance with paragraph (d) of this section. Appropriate cockpit annunciation and flight crew procedures are addressed in the guidance for § 25.1305 of this advisory circular.

(2) Part 33 (through Amendment 33-6) has an identical requirement for a fuel filter for the engine fuel system. Both the Part 25 and the Part 33 requirements may be satisfied with a single filter that meets the engine and airplane installation requirements.''

e. **References.**

(1) Civil Air Regulations 4b, December 31, 1953.

(2) Amendment 25-AD (29 FR 18289, December 24, 1964).

(3) Notice of Proposed Rulemaking 71-12 (36 FR 8383 May 5, 1971).

(4) Amendment 25-35 (39 FR 1831, January 1, 1974).

(5) Amendment 25-36 (39 FR 35460, October 1, 1974).

(6) Amendment 25-38 (41 FR 55467, December 20, 1976).

(7) Amendment 25-57 (49 FR 6848, February 23, 1984).

(8) Advisory Circular 29-2B, “Certification of Transport Category Rotorcraft,” July 30, 1997.

(9) Advisory Circular 33-2B, “Aircraft Engine Type Certification Handbook,” June 30, 1993.

Section 25.999 Fuel system drains.

a. **Rule Text.**

(a) Drainage of the fuel system must be accomplished by the use of fuel strainer and fuel tank sump drains.

(b) Each drain required by paragraph (a) of this section must --

(1) Discharge clear of all parts of the airplane;

(2) Have manual or automatic means for positive locking in the closed position; and

(3) Have a drain valve --

(i) That is readily accessible and which can be easily opened and closed; and

(ii) That is either located or protected to prevent fuel spillage in the event of a landing with landing gear retracted.

(Doc. No. 5066, 29 FR 18291, Dec. 24, 1964, as amended by Amdt. 25-38, 41 FR 55467, Dec. 20, 1976)

b. **Intent of Rule.** The intent of this rule is to require fuel system drain valves and to define requirements relating to the valves.

c. **Background.**

(1) Notice of Proposed Rulemaking 75-10 (40 FR 10802, March 7, 1975) proposed adding a requirement for consideration of sludge. The explanation given was as follows:

> Current § 25.999 does not require quick actuation type drain valves and does not provide adequate standards for such valves, if installed. The absence of quick actuation type valves has been suggested as a contributing factor in accidents caused by water contamination of fuel. The proposal would require the installation of quick actuation type drain valves and would provide standards relating to such installations.

(2) Amendment 25-38 (41 FR 55454 December 20, 1976) followed Notice 75-10 and adopted the proposal, with some clarification. The preamble to the Amendment provides additional insight into the intent of this regulation, as indicated in the following excerpts:

> Several commenters question the meaning of the term “quick actuation drain valve” in proposed § 25.999(b)(3). The FAA agrees that the term may be subject to misinterpretation and that the provision is complete without the words “quick actuation.”

One commenter asserts that the proposed requirement in § 25.999(b)(3), to require that drain valve not be damaged in the event of a landing with the landing gear retracted, was not a proper design specification since damage was beyond the control of the manufacturer. The FAA agrees that the language "so that it will not be damaged" is not proper for this requirement; but the FAA believes that the valve, the location of the valve, or both, can be designed to prevent fuel spillage, assuming that a landing is made with the landing gear retracted. The section as adopted has been revised to clarify this intent.

d. **Policy/Compliance Methods.**

(1) Acceptable methods of compliance, and in certain cases "required compliance methods," include a system description, drawings and schematic review together with a compliance (mock-up) inspection, fuel system drain functional demonstration, and gear-up airplane-fuel drain geometry analysis. Consideration can be given to prior compliance by similarity, and service experience on an applicants previously approved fuel system drain configurations on other model aircraft. The applicant must supply system functioning and test proposals which address each system design requirement and condition cited in Sections 25.971 (c) and 25.999.

(2) The following excerpt is from FAA Advisory Circular 20-119, "Fuel Drain Valves," dated February 7, 1983, and provides additional insight into current policy and compliance methods for this rule.

1. **PURPOSE.** This advisory circular provides an acceptable means, but not the only means, of compliance with the requirements of Title 14, Code of Federal Regulations (CFR), commonly referred to as the Federal Aviation Regulations (FAR), for positive locking of fuel drain valves in the closed position.

2. **BACKGROUND.** Sections 23.999(b), 25.999(b), 27.999(b), and 29.999(b) require, in part: *"Each drain . . . must have manual or automatic means for positive locking in the closed position . . . ."* This requirement refers to the required drain valves. The purpose of this advisory circular is to respond to the question as to whether a spring loaded valve in the closed position could be considered a "positive locking valve."

3. **GUIDANCE.** Spring loaded fuel drain valves conforming to MIL-V-25023B or TSO-C76 or equivalent way be approved for those installations where the person operating the valve can visually confirm that the valve is closed, provided the applicant has shown that the valve will not open inadvertently under any foreseeable operating condition.

(3) The following excerpt is from FAA Advisory Circular 29-2B, "Certification of Transport Category Rotorcraft," dated July 30, 1997, which provides compliance guidance for transport rotorcraft, and which may also provide insight into compliance for transport aircraft.

Section 29.901(b)

. . .

(iii) Accessibility. Accessibility for maintenance should be reviewed. Typically, some maintenance activities must involve disassembly or removal of adjacent components. This should be avoided if repetitive activity can jeopardize the performance of critical or safety-related equipment. Verify that easy access exists to items such as oil system sight gauges or dip sticks, filler ports and drain valves for engines, auxiliary propulsion units, transmissions, fuel tanks and filters, etc.

(4) Advisory Circular 20-119 provides an acceptable means, but not the only means, of compliance with the requirement for positive locking of fuel drain valves in the closed position.

(5) The fuel drain installation on aircraft with retractable landing gear will be satisfactory if recessed within the outside surface of the aircraft.

e. **References.**

(1) Notice of Proposed Rulemaking 75-10 (40 FR 10802, March 7, 1975).

(2) Amendment 25-38 (41 FR 55467, December 20, 1976).

(3) Advisory Circular 20-119, "Fuel Drain Valves," February 7, 1983.

(4) Advisory Circular 29-2B, "Certification of Transport Category Rotorcraft," July 30, 1997.

Section 25.1001 Fuel jettisoning system.

a. **Rule Text.**

(a) A fuel jettisoning system must be installed on each airplane unless it is shown that the airplane meets the climb requirements of § 25.119 and § 25.121(d) at maximum takeoff weight, less the actual or computed weight of fuel necessary for a 15-minute flight comprised of a takeoff, go-around, and landing at the airport of departure with the airplane configuration, speed, power, and thrust the same as that used in meeting the applicable takeoff, approach, and landing climb performance requirements of this part.

(b) If a fuel jettisoning system is required it must be capable of jettisoning enough fuel within 15 minutes, starting with the weight given in paragraph (a) of this section, to enable the airplane to meet the climb requirements of § 25.119 and § 25.121(d), assuming that the fuel is jettisoned under the conditions, except weight, found least favorable during the flight tests prescribed in paragraph (c) of this section.

(c) Fuel jettisoning must be demonstrated beginning at maximum takeoff weight with flaps and landing gear up and in --

(1) A power-off glide at 1.4 Vs 1 ;

(2) A climb at the one-engine inoperative best rate-of-climb speed, with the critical engine inoperative and the remaining engines at maximum continuous power; and

(3) Level flight at 1.4 Vs 1 ; if the results of the tests in the conditions specified in paragraphs (c) (1) and (2) of this section show that this condition could be critical.

(d) During the flight tests prescribed in paragraph (c) of this section, it must be shown that --

(1) The fuel jettisoning system and its operation are free from fire hazard;

(2) The fuel discharges clear of any part of the airplane;

(3) Fuel or fumes do not enter any parts of the airplane; and

(4) The jettisoning operation does not adversely affect the controllability of the airplane.

(e) For reciprocating engine powered airplanes, means must be provided to prevent jettisoning the fuel in the tanks used for takeoff and landing below the level allowing 45 minutes flight at 75 percent maximum continuous power. However, if there is an auxiliary control independent

of the main jettisoning control, the system may be designed to jettison the remaining fuel by means of the auxiliary jettisoning control.

(f) For turbine engine powered airplanes, means must be provided to prevent jettisoning the fuel in the tanks used for takeoff and landing below the level allowing climb from sea level to 10,000 feet and thereafter allowing 45 minutes cruise at a speed for maximum range. However, if there is an auxiliary control independent of the main jettisoning control, the system may be designed to jettison the remaining fuel by means of the auxiliary jettisoning control.

(g) The fuel jettisoning valve must be designed to allow flight personnel to close the valve during any part of the jettisoning operation.

(h) Unless it is shown that using any means (including flaps, slots, and slats) for changing the airflow across or around the wings does not adversely affect fuel jettisoning, there must be a placard, adjacent to the jettisoning control, to warn flight crewmembers against jettisoning fuel while the means that change the airflow are being used.

(i) The fuel jettisoning system must be designed so that any reasonably probable single malfunction in the system will not result in a hazardous condition due to unsymmetrical jettisoning of, or inability to jettison, fuel.

(Doc. No. 5066, 29 FR 18291, Dec. 24, 1964, as amended by Amdt. 25-18, 33 FR 12226, Aug. 30, 1968; Amdt. 25-57, 49 FR 6848, Feb. 23, 1984)

b. **Intent of Rule.** The intent of this rule is to assure adequate airplane performance is provided for obstacle clearance, and return landing during failure conditions.

c. **Background.**

(1) This rule originated in the Civil Air Regulations (CAR) Part 4b, December 31, 1953. The original jettison requirements developed for reciprocating engine powered airplanes were based on the need for a jettison system on a ratio between the landing weight and the takeoff weight of the airplane. With the advent of turbine powered airplanes, the FAA and industry recognized that it was not reasonable to apply this standard to turbine powered airplanes in view of the relatively rapid fuel burn-off rate associated with turbine engines.

(2) 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). Part 25 [New] was published as a notice of proposed rule making in the Federal Register on June 2, 1964 (29 FR 7169), and given further distribution as Notice 64-28. The following excerpt is from the discussion of this proposal within the preamble to the Notice.

> Section 25.1001 (§ 25.733)(CAR 4b.437) has been revised by changing the requirement for a placard to warn flight crewmembers against jettisoning fuel with flaps lowered (if it has not been shown that it is safe to do so with them lowered). It now reads “means (including flaps, slots, and slats) for changing the airflow across or around the wing” instead of the word flaps. This was done to update the language as these other devices (slats and slots) take the place of the flaps in some airplanes and are referred to in other regulations (particularly in AD’s).

(3) Notice 67-51 (32 FR 1748, December 6, 1967) proposed revisions to this rule, the reasons for which were explained as follows:

> Service experience with airplanes certificated under the current regulations and under the various exemptions to those regulations has shown that the structural design requirements applicable to transport category airplanes provide sufficient structural strength for landings at weights up to the maximum takeoff weight established for those airplanes. However, at takeoff weights exceeding 105 percent of the landing weight, the weight of the airplane that could exist during the approach and landing stages following a rapid go-around would substantially affect the climb performance of the airplane. Thus, rather than premise the installation of a fuel jettisoning system on an arbitrary weight ratio between the takeoff and landing weights of an airplane, it is considered more reasonable to relate the need for a fuel jettisoning system to the climb performance of the airplane. The relevant climb requirements for the landing condition are the all engine operating landing climb and the one engine inoperative approach climb prescribed in §§ 25.65(b) and 25.67(e) for reciprocating engine-powered airplanes, and in §§ 25.119 and 25.121(d) for turbine engine-powered airplanes. Safety, therefore, dictates that an airplane must be at that weight during the approach and landing at which it cam meet the applicable climb requirements. Assuming the most unfavorable situation involving a rapid go-around and a landing at the airport of departure, an airplane without a jettison system would have to meet the climb requirements at the maximum takeoff weight less the weight of the fuel that would be consumed by the engines during the go-around operation. Considering airport traffic condition the FAA believes that a pilot should be able to complete a rapid go-around procedure in not more that 15 minutes.

Amendment 25-18 (33 FR 12224, August 30, 1968) followed Notice 67-51 and adopted the proposal. It is interesting to note that within the preamble to Amendment 25-18, the FAA discussed comments submitted in response to the notice, which indicated that, under certain conditions, maximum brake energy capacity may be more limiting than the landing approach climb requirements. The commenter also stated that the proposed rule should include language to the effect that the aircraft must be capable of stopping within the confines of the available runway at the airport of departure. The FAA did not consider the commenter’s suggestion to be necessary due to no adverse service experience, and further stated:

> Moreover the accelerate-stop demonstration used in showing compliance with the takeoff performance requirements at takeoff weight also provides assurance of the ability to stop an airplane with takeoff weight within the confines of the available runway at the airport of departure.

Since the issuance of Amendment 25-18, however, service experience has shown instances where brake performance has been an issue during certain failure conditions, such a flap asymmetry, engine thrust reverser deployment, engine out, etc.. More recent twin engine airplanes have had landing speeds which exceed tire speed and brake energy limits. The FAA has, therefore, required that this potentially unsafe condition be addressed by application of Issue Papers, which are described below.

(4) Notice of proposed rulemaking 80-21 (45 FR 76872, November 20, 1980) proposed further amendment of the rule and contained the following explanation in its preamble:

> Proposed § 25.1001 eliminated specific references to reciprocating and turbine engine powered airplanes and to §§ 25.65 and 25.67, as explained for the proposed for § 33(a)(2). Other editorial changes are proposed which eliminate redundancies and clarify the text.

Amendment 25-57 (49 FR 6832, February 23, 1984) followed Notice 80-21 and adopted the proposal. The preamble to this Amendment contained a discussion of the comments submitted in response to the Notice, as follows.

> The proposed revision of § 25.1001 removes the distinction between fuel jettisoning systems for reciprocating and turbine engine-powered airplanes, deletes obsolete sections, and corrects references to climb performance sections. Other changes are editorial in nature, eliminate redundancies, and clarify the text.
>
> No unfavorable comments on the proposed change of § 25.1001 were received. However, two commenters recommend rephrasing the requirement of paragraph (d)(3) to specify that fuel or fumes do not enter any part of the airplane in sufficient quantity to constitute a fire or explosion hazard, maintaining that not all fuel or fumes necessarily constitute a fire or explosion hazard. A third commenter recommends revising paragraph (b) to rectify a condition in which the intended reduction in airplane weight cannot be achieved when jettisoning is initiated with the fuel quantity and distribution associated with takeoff at maximum zero fuel weight (that is, for short range with high cabin load).
>
> Fuel or fumes should not be allowed to reenter any part of the airplane during an emergency condition such as jettisoning. It would be difficult to establish the amount of fuel or fumes that does constitute a hazard. Regarding the wording in paragraph (b), the FAA agrees that the comment has merit; however, it is outside the scope of the proposed change.
>
> The rule is adopted as proposed.

d. **<u>Policy/Compliance Methods.</u>**

(1) Acceptable methods of compliance, and in certain cases "required compliance methods," include a system description, drawing and schematic review together with a compliance (mock-up) inspection, loads criteria, stress analysis, flight test jettison discharge patterns, jettison flow rate determination, unjettisonable fuel quantity

determination, asymmetric fuel distribution structural limitation and airplane handling qualities demonstration.

Paragraph (i) requires that the jettison system be designed so that any reasonable probable single malfunction in the system will not result in a hazardous condition due to unsymmetrical jettisoning of, or inability to jettison, fuel. This requirement originated from Civil Air Regulations (CAR) 4b, and therefore the meaning of the term "reasonable probable" was not defined in the context later definitions used in compliance with § 25.1309. Although the rule text clearly allows systems where a single failure could affect jettison operation, typical single component failures have not been accepted as meeting this requirement. In practice, fuel jettison systems have been required to have redundant, fail safe features, such as outlet valves, pumps, switches, sensors, etc,. to allow jettison (sometimes at reduced rates) during single failure conditions.

The failure analysis should carefully consider the consequences of failures in other systems that could affect jettison system operation. In one case on a transport airplane, engine failure caused loss of power to one of the three main power buses. Loss of power to the bus normally would have resulted in automatic switching of power from the remaining sources. Failure of the electrical power switching system resulted in the one bus being unpowered. The jettison system automatic shutoff system required power from the upowered bus, therefore jettison of fuel below the desired level occurred. This resulted in a potentially unsafe condition. In this case, a single failure in the power switching system caused loss of critical jettison system function, which would not comply.

(2) ***Compliance Demonstration Flight Test:*** The following excerpts are from Advisory Circular (AC) 25-7, "Flight Test Certification Guide for Transport Category Airplanes," original and Change 1, dated June 6, 1995, and provide a description of compliance demonstration.

(a) From AC 25-7, Original:

FUEL JETTISONING SYSTEM - § 25.1001.

a. **Explanation**.

(1) Sections 25.1001(a) and (b) permit airplanes without a fuel jettison system to have a weight reduction allowance equal to the weight of fuel that would be consumed during a fifteen minute period in order that the airplanes may meet the climb requirements of §§ 25.119 and 25.121(d) at the weight specified in § 25.1001(c). With a jettisoning system installed, fuel jettisoning would normally be performed during the same fifteen minute period in order that the requirements of §§ 25.1001(a) or (b) are satisfied. Credit is allowed for both fuel burnoff and fuel jettisoning during the fifteen minute period.

(2) The basic purpose of these tests is to establish the minimum jettison rate and to determine that the required amount of fuel may be safely jettisoned under reasonably anticipated operating conditions within the

prescribed time limit without danger from fire, explosion or adverse effects on the flying qualities.

b. **Procedures.**

(1) Jettison Rate

(i) In determining the minimum jettison rate, the tanks, tank combinations or fuel feed configurations which are critical should be selected for demonstrating the flow rate.

(ii) It should be determined if aircraft attitude or configuration has an affect on the jettison rate.

(iii) It should be demonstrated that the means to prevent jettisoning of the fuel in the tanks used for takeoff and landing, below the level to meet the requirements of §§ 25.1001(h) and (i), are effective.

(2) Fire Hazard

(i) Fuel jettisoning flow pattern should be demonstrated from all normally used tank or tank combinations on both sides of the airplane whether or not both sides are symmetrical.

(ii) The fuel jettison flow pattern should be demonstrated for the flight conditions specified in §§ 25.1001(f)(1), and (2) and (3). Steady state sideslips anticipated during operation should be conducted during flight conditions.

(iii) Fuel in liquid or vapor form should not impinge upon any external surface of the airplane during or after jettisoning. Colored fuel, or surface treatment that liquid or vaporous fuel changes the appearance of, may be used on airplane surfaces for detection purposes (See AC 25.1187 for information regarding methods of testing for impingement of flammable fluid). Other equivalent methods for detection may be acceptable.

(iv) Fuel in liquid or vapor form should not enter any portion of the airplane during or after jettisoning. The fuel may be detected by its scent, a combustible mixture detector, or by visual inspection. In pressurized airplanes, the check for the presence of liquid or vaporous fuel should be accomplished with the airplane unpressurized.

(v) There should be no evidence of leakage after the fuel jettison valve is closed.

(vi) Testing should be conducted with the wing flaps in all available positions and during transition from each position to the next. If there is any evidence that wing control surface (flaps, slats, etc.) positions may adversely affect the flow pattern, and allow fuel to impinge on the airplane, the airplane should be placarded and a limitation noted in the Airplane Flight Manual.

(3) Control.

(i) Changes in the airplane control qualities during the fuel jettisoning tests should be investigated including asymmetrical jettisoning.

(ii) Discontinuance of fuel jettisoning should be demonstrated in flight.

(4) Residual Fuel. The unjettisonable usable fuel should be determined by draining the tanks from which fuel was jettisoned inflight to establish if there is sufficient reserve fuel after jettisoning to meet the requirements of §§ 25.1001(h) and (i).

(b) From AC 25-7, Change 1:

(2) Fuel jettisoning (§ 25.1001).

(i) If the applicant uses a trade-off between auxiliary fuel system weight at maximum fuel capacity and payload weight (and thus there is no change in the airplane maximum takeoff and landing weights} the fuel jettisoning requirements of the airplane will be the same as for the original, unmodified airplane. There will therefore be no need to jettison auxiliary tank fuel. Addition of fuel capacity which increases the maximum take-off weight of the airplane would require recertification efforts which are beyond the scope of this AC. One of these efforts would, however, be to evaluate the need of auxiliary fuel jettisoning.

(ii) Regardless of the need for auxiliary fuel jettisoning, the applicant should ensure by failure mode analysis or demonstration, that main tank fuel jettisoning can still be accomplished without hazard to the modified airplane (see also the discussion in Chapter 1, paragraph 3b)

(3) ***FAA Issue Paper Regarding Brake Energy and Tire Speed Considerations:*** The following excerpt is from an FAA Issue Paper that has been applied to many recent twin engine high gross weight airplanes where tire speeds and/or brake energy limits would be exceeded during conditions such as asymmetric flaps immediate return landing etc.

Statement of Issue. Current airworthiness requirements (§ 25.1301) require that airplane equipment (including that of the brakes, tires, and control surfaces) be of a type and design appropriate for its function. In addition, § 25.1309(a) requires that *"the equipment, systems and installations whose functioning is required by this subchapter, must be designed to ensure that they perform their intended functions under any foreseeable operating conditions."* The specific requirements for airplane tires under § 25.733 (3)(c) require that *"each wheel must be fitted with a suitable tire of proper fit with a speed rating approved by the Administrator that is not exceeded under critical conditions."*

Recent development of airplanes with exceptional takeoff performance, particularly large two-engine airplanes, has resulted in an unsafe condition under many foreseeable conditions where the airplane is not capable of a return landing without exceeding equipment capabilities. Compliance with § 25.1301 and § 25.1309 require the airplane systems to perform their intended functions during foreseeable abnormal operating conditions. On previous generation airplanes, the return landing was not the critical design case for the brakes and the tires, etc., because these aircraft incorporated jettison systems. The [*Applicant*] has proposed that the [*model*] airplane not be required to incorporate a jettison system. This Issue Paper clarifies the FAA policy regarding compliance with the existing regulations. Compliance with the regulations listed above may be demonstrated by a combination of failure analysis, equipment qualification testing, or the installation of a jettison which would reduce airplane gross weight and, hence, the airplane landing speed during foreseeable abnormal conditions.

The FAA's position is that airplane designs that do not provide for adequate return landing capabilities are unsafe and, under the provisions of § 21.21(b)(2), may not receive type approval.

Discussion. Development of new airplanes without consideration of return landing capabilities could result in an unsafe condition. The majority of large high gross weight airplanes have not been required to incorporate fuel jettison systems to meet the airplane climb performance requirements of § 25.1001. [The Issue Paper identifies specific airplane models which were required to incorporate fuel jettison systems to meet the requirements of § 25.1001 and, therefore, inherently meet the return landing requirements.]

Examination of takeoff performance capabilities of current and proposed large transport aircraft indicates that requirements other than climb performance (current § 25.1001 per Amendment 25-57, March 26,1984) should be addressed when establishing the need for a fuel jettison system. Since the adoption of the current rule, airplane aerodynamics (in particular, wing design) and propulsion technology have advanced to the state that current large transports are capable of lifting very heavy weights, with attendant high airplane energies when considering an immediate return landing. While climb performance per the existing rule may not dictate installation of a jettison system, an airplane may still be faced with a return landing in configurations, or at gross weights, which will cause exceedance of the limitations on which the prior takeoff was based. For example, maximum certificated brake energy and tire speed limits may be exceeded and the required approach speed may be above placards for the higher flap settings, or encroach on flap load relief, resulting in lesser flap settings, a less stable approach, and higher approach and landing speeds.

Current airworthiness requirements of § 25.1001 alone are not the only regulation that should be addressed when determining the need for a jettison system. Accordingly, for airplanes currently receiving certification scrutiny, the applicant must consider factors beyond airplane climb performance when addressing safe return operations and the advisability of the need to incorporate a fuel jettisoning system to meet the return landing performance requirements.

A survey of recent Service Difficulty Reports reveals a large number of immediate return or diversion landings for a wide variety of reasons. Several incident reports have shown an airplane skidding off the runway during the landing roll. In some incidents, the immediate return was necessitated by a failure, resulting in collateral damage to other parts (and/or systems) of the airplane and loss of hydraulic systems, flap lockout, and high landing speeds associated with the failure procedures. In cases for airplanes so equipped, the fuel jettison system was undoubtedly of significant value, and may have prevented the occurrence of more serious incidents. One incident involving jettison had two of three engines shut down.

FAA Position. The FAA has identified a potential unsafe condition per § 25.21(b)(2) for those airplanes where the limits identified below are exceeded following foreseeable abnormal operating conditions. Accordingly, the applicant must address the safety issues for potential return landings due to typical in-service causes. This may require incorporation of a fuel jettison system.

Subjects addressed should include, but may not be limited to:

- Exceedance of certificated maximum brake energies;
- Exceedance of tire speed limits;
- Controllability (e.g., hydraulic or flight control system failures);
- Margins to flap placard, or load relief operation speeds in turbulent air;
- Climb capability, engine-inoperative procedure; and
- Landing Distances (including wet runway, anti skid off, spoiler failures, etc.).

The information provided should address typical single failures, and multiple or collateral damage failure conditions, which have been shown to be foreseeable events, and can necessitate landing at non-normal speeds and flap settings.

For airplanes that use a fuel jettison system, the jettison rate should be such as to obviate all of the above issues in a 30-minute flight with 15 minutes of active fuel jettisoning. If this cannot be accomplished, or for airplanes without fuel jettison systems, the applicant must address how the above issues will be resolved by design or operation.

e. **References.**

(1) Civil Air Regulations 4b, December 31, 1953.

(2) Amendment 25-AD (29 FR 18289, December 24, 1964).

(3) Notice of Proposed Rulemaking 67-51 (32 FR 17487, December 6, 1967).

(4) Amendment 25-18 (33 FR 12224, August 30, 1968).

(5) Notice of Proposed Rulemaking 80-21 (45 FR 76872, November 20, 1980).

(6) Amendment 25-57 (49 FR 6832, February 23, 1984).

(7) Advisory Circular 25-7, "Flight Test Certification Guide for Transport Category Airplanes," dated June 6, 1995.

(8) Advisory Circular 25-7, Flight Test Certification Guide for Transport Category Airplanes, Change 1, dated June 6, 1995.