U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

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

Date: 7/24/86
Initiated by: ANM-110

AC No: 25.994-1
Change:

1. PURPOSE. This advisory circular (AC) presents guidelines and methods for complying with the requirements of § 25.994 of the Federal Aviation Regulations (FAR). These guidelines pertain 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 FAR SECTIONS. 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 Order 8110.19, Fuel System Components Affected by Wheels-Up Landing, dated 8/24/76. 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.). Fuel lines and components should be shrouded and drained to accomplish this protection.

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.

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