SUBPART F - EQUIPMENT

Section 4. Miscellaneous Equipment

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Section 25.1461 Equipment containing high-energy rotors.

a. **Rule Text.**

(a) Equipment containing high-energy rotors must meet paragraph (b), (c), or (d) of this section.

(b) High-energy rotors contained in equipment must be able to withstand damage caused by malfunctions, vibration, abnormal speeds, and abnormal temperatures. In addition-

(1) Auxiliary rotor cases must be able to contain damage caused by the failure of high energy rotor blades; and

(2) Equipment control devices, systems, and instrumentation must reasonably ensure that no operating limitations affecting the integrity of high-energy rotors will be exceeded in service.

(c) It must be shown by test that equipment containing high-energy rotors can contain any failure of a high-energy rotor that occurs at the highest speed obtainable with the normal speed control devices inoperative.

(d) Equipment containing high-energy rotors must be located where rotor failure will neither endanger the occupants nor adversely affect continued safe flight.

(Amdt. 25-41, 42 FR 36971, July 18, 1977)

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

c. **Background.** The regulatory history shows that this requirement originated from Amendment 25-41 (42 FR 36960, July 18, 1977), which followed two Notices of Proposed Rulemaking:

- Notice 75-10 (40 FR 10802, March 7, 1975) and
- Notice 75-23 (40 FR 23048, May 27, 1975).

The amendments based on Notice 75-10 were deferred to the series of amendments titled “Miscellaneous Amendments" so that they could be considered with the final disposition of certain proposals in Notice 75-23. The preamble to the amendment contained a discussion of the comments received for the proposals; the following is an excerpt from that discussion:

One commenter objects to proposed § 25.1461, contending that there is no need for it since current §§ 25.1309 and 25.901(c) provide adequate coverage for this item. The FAA does not agree. Sections 25.1309 and 25.901(c) list general requirements, the former for all classes of equipment and the latter for powerplant installations. These general requirements do not contain the detailed airworthiness standards specifically applicable to high energy rotors that the FAA believes are necessary for the reasons stated in the explanation of this proposal.

Another commenter suggests that the proposal be clarified as to whether § 25.1461(a) requires compliance with either paragraph (b), (c), or (d). The FAA believes that the proposed language is clear in this respect. The applicant is required to comply with one of those paragraphs, and he may select any one of them.

d. **Policy/Compliance Methods.**

(1) The following excerpt is from Advisory Circular 29-2B, "Certification of Transport Category Rotorcraft," and provides guidance for the application of this section to transport rotorcraft propulsion systems, including high energy rotors. It may also provide additional insight into compliance methods useful for transport category airplanes.

This section contains requirements for the installation of equipment containing high energy rotors. A high energy rotor is any rotor that has sufficient kinetic energy to cause damage to surrounding structure, wiring, and equipment if a failure occurs. In general, turboshaft engine and APU rotors are not covered by this paragraph. An APU does not have its own type certificate and has been considered "equipment" installed on an airplane. As such, the provisions of § 5.1461 have occasionally been used in the approval of APU installations, regardless of protection from high energy rotor disintegration. However, the more specific requirements of § 25.903(d)(1) and associated guidance described within AC 20-128A ("Design Considerations for Minimizing Hazards Caused by Uncontained Turbine Engine and Auxiliary Power Unit Rotor and Fan Blade
Failures") and additional guidance provided in this AC take precedence over the requirements of § 25.1461.)

Compliance Methods.

One of the following requirements of § 25.1461 must be met.

- Paragraph (b) deals with damage tolerance, containment, and control devices.
- Paragraph (c) deals with containment and inoperative speed controls.
- Paragraph (d) deals primarily with equipment location.

. . .

Procedures.

Compliance with § 25.1461(b) can be shown by a combination of analysis and test. A failure modes and effects and a stress analysis, together with a dynamic test, could be used to verify that the rotor would withstand the damage from environmental effects, and that the rotor case would contain any parts that may separate from the rotor shaft. The

analysis and test should include a demonstration of the control device's ability to prevent limitations from being exceeded.

If compliance with the requirements of § 25.1461(c) is chosen, a test must be conducted which demonstrates that all parts from any type failure of a high energy rotor will be contained when that rotor is operating at the highest speed obtainable, with all speed control devices inoperative. This containment must not damage any components, systems, or surrounding structures that are essential for continued safe flight.

If compliance with § 25.1461(d) is chosen, the location of the high energy rotor must be in an area where uncontained failed parts will not damage other components, systems, or surrounding structure which are essential for continued safe flight. It must also be shown that there is no possibility for failed, uncontained parts to enter the cabin area and endanger any occupant.

(2) The following excerpt is from an FAA letter dated February, 13, 1981, concerning engine starter containment testing, and may provide additional insight into compliance guidance.

The referenced meeting involved discussion of starter containment philosophy that has been found to be acceptable to the FAA on past certification projects. In general, these are as follows:

a. Start Valve Fails to Close - For this fault condition, it must be demonstrated by test that the hub and blades are contained at a starter speed associated with that of the engine running at stabilized idle speed, unless starter assist will be required for all or a significant part of air starts. "Contained" in this context means that no fragments are liberated with sufficient energy to cause damage to other components.

b. Start Valve Opens in Flight or Fails to Close - The maximum available pressure ratio to drive the starter must be analyzed and the associated starter maximum free run speed determined. For this fault, at least blade containment must be demonstrated within the context of containment described above.

c. Engine/Starter Clutch Lockup - Although the pawl-and-ratchet type starter clutch configuration proposed for this design has, to our knowledge, experienced no lockup failures during many years of service on several major aircraft models, it must be shown by analysis that the hub has a stress margin of at least 1.5 at "maximum free run speed" and an appropriate stress margin at the maximum driven speed. Blades must be assumed to be attached for these analyses unless it can be shown that features are incorporated such that "blade shedding" would occur at some lower speed.

d. Quality Control Spin Test - A "proof" spin test must be conducted on each unit produced to the maximum free run speed.

e. **References.**

(1) Amendment 25-41 (42 FR 36960, July 18, 1977).

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

(3) Advisory Circular 20-128A, “Design Considerations for Minimizing Hazards Caused by Uncontained Turbine Engine and Auxiliary Power Unit Rotor and Fan Blade Failures,” March 25, 1997.