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Section 8. Powerplant Controls and Accessories

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Section 25.1141 Powerplant controls: General.

a. **Rule Text.**

Each powerplant control must be located, arranged, and designed under § 25.777 through § 25.781 and marked under § 25.1555. In addition, it must meet the following requirements:

(a) Each control must be located so that it cannot be inadvertently operated by persons entering, leaving, or moving normally in, the cockpit.

(b) Each flexible control must be approved or must be shown to be suitable for the particular application

(c) Each control must have sufficient strength and rigidity to withstand operating loads without failure and without excessive deflection.

(d) Each control must be able to maintain any set position without constant attention by flight crewmembers and without creep due to control loads or vibration.

(e) The portion of each powerplant control located in a designated fire zone that is required to be operated in the event of fire must be at least fire resistant.

(f) Powerplant valve controls located in the cockpit must have --

(1) For manual valves, positive stops or in the case of fuel valves suitable index provisions, in the open and closed position; and

(2) For power-assisted valves, a means to indicate to the flight crew when the valve --

(i) Is in the fully open or fully closed position; or

(ii) Is moving between the fully open and fully closed position.

(Doc. No. 5066, 29 FR 18291, Dec. 24, 1964, as amended by Amendment 25-40, 42 FR 15044, Mar. 17, 1977; Amendment 25-72, 55 FR 29785, Jul 20, 1990)

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

c. **Background.**

(1) The regulatory history shows that this rule originated from section 4b.434 (“Fuel Valves”) of the Civil Air Regulations (CAR) 4b, December 31, 1953. It contained the original requirement located in § 25.1141(f)(1), which was also located in § 25.995(a). Amendment 25-AD was published in the Federal Register on December 24, 1964 (29 FR 18289), which 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). Part 25 [New] was published as a Notice of Proposed Rulemaking in the Federal Register on June 2, 1964 (29 FR 7169), and given further distribution as Notice No. 64-28. It was recodified from CAR 4b.434 without any substantive changes.

(2) Amendment 25-11 (32 FR 6906, May 5, 1967), which followed Notice of Proposed Rulemaking 65-43 (31 FR 93, January 5, 1966) contained the following pertinent discussion in its preamble:

> [Notice 65-43] proposed to amend § 25.1141 to require that no probable failure or, combination of failures” in any powerplant control system may cause the failure of any function necessary for safety, and that compliance must be shown by fault analysis, component tests, and simulated environmental tests.”
>
> One commenter objects to the proposal because (1) “combination of failures” is contrary to the basic philosophy that the airplane need only be capable of continued safe flight and landing after a single failure; and (2) compliance with the requirement should not be required to be by fault analysis, component tests, and simulated environmental tests, since accepted practice is to use fault analysis alone, unless tests are necessary to substantiate the validity of a particular analytical result. The Administrator does not agree with the first statement. It is not the policy of the Administrator to ignore a probable combination of failures whose result would be hazardous. The Administrator does, however, agree with the second statement. A combination of means of showing compliance is therefore permitted under this amendment.
>
> In addition, two changes to the notice are made to more accurately express its intent. First, the prescribed failed “function” is limited to “powerplant function.” Secondly, the words “failures or combination of failures” in the system is changed to include “malfunctions. The notice did not intend to raise a technical or semantic distinction between a powerplant control system “failure’’ and “malfunction” where their common result is discontinuance of an essential powerplant function.

(3) Section 25.1141(f)(2) was introduced [and § 25.995(a) deleted] as a result of the 1974-75 Airworthiness Review Program by Amendment No. 4: Powerplant Amendments 25-40, published in the Federal Register on March 17, 1977 (42 FR 15034). The Joint Airworthiness Authority (JAA) of Europe proposed the introduction of § 25.1141(f)(2), based on the following justification:

> For valves operated other than by mechanical means, e.g., electrically, the control position is not a certain indication of the valve position since the control system could fail.

The preamble to the amendment disposed of comments that contended that this requirement should only apply to valves that were essential to the safe operation of the airplane. The FAA disagreed with this comment and responded:

> If any power assisted valve is used, the flight crew might rely on it and should have an indication of when the valve is in the fully open or fully closed position, or when it is moving between open and fully closed position.

d. **Policy/Compliance Methods.**

(1) The following excerpt from an FAA Generic Issue Paper provides guidance for providing an equivalent level of safety to this requirement for the engine fuel shutoff valve.

> **Statement Of Issue**: Section 25.1141 (f)(2) requires power-assisted valve controls located in the cockpit to have a means to indicate to the flight crew when the valve is in the fully open or fully closed position or is moving between the fully open or fully closed position. The airplane model does not strictly conform to § 25.1141(f)(2). Therefore, the airplane manufacturer is requesting an equivalent level of safety finding for the airplane model.
>
> **Background.** Traditionally, § 25.1141(f)(2) is complied with by providing valve position indicators or EICAS valve position disagreement indications. Fuel can be shut off by the condition lever which shuts off the engine fuel shutoff valve and by the fire handle which shuts off the airframe fuel shutoff valve. Normally the pilot shuts off engines by positioning the condition levers to off, which closes each engine shutoff valve. The pilot can confirm the valves are closed by looking at the engine valve position indications. However, for the [airplane model], there is no direct engine fuel shutoff valve position indications. The [applicant] has requested a finding of equivalent safety for the engine fuel shutoff valve position. A report has been submitted to support this request. The [applicant’s] position is summarized as follows:
>
>> The [engine] fuel shut-off valve is operated by the FADECs (either automatically or via the power management unit in response to input from the condition lever), or by the fire handle. The condition lever positions are OFF (engine off), START, and RUN (engine on). Each FADEC does have its own electrical interface and is being monitored by the maintenance system for electrical continuity. When operated, the valve is rapidly driven open or closed by an electrical torque motor.
>>
>> There is no direct indication of the valve position. However, if the position did not correspond with the position selected by the condition lever it would be the result of a FADEC commanded shutdown, or control system malfunction, and would be indicated by powerplant indications on EICAS. If the engine is running, i.e., the valve is open, the pilot can always command it to close by the condition lever via FADEC, or overriding FADEC by using the fire handle.

> The position of the fuel shut-off valve is evident. The condition lever design, with positive stops and position index provisions, is identical to the provisions required for manual valves. The actual position of the valve proper can be readily ascertained from other engine indications (fuel flow, Ng, Itt) and from engine behavior. The electrical interface for each FADEC is monitored by the maintenance system."

FAA position: The lack of indication of the position of the engine fuel shutoff valve, as the [airplane model] fuel shutoff control system is currently configured, could allow unannunciated leakage of fuel into the engine compartment (if there is no fire detected) during an engine shutdown in flight or on the ground.

The proposal to provide an inferred valve position by monitoring fuel flow indication, engine speed and engine operation does not address several failure modes. For example, a fuel line leak with significant leakage into the engine compartment may cause engine power fluctuation resulting in crew action to shutdown the engine. If the engine fuel shutoff valve failed partially open, uncontrolled fuel leakage into the engine compartment would be possible. If indication of the failed engine mounted shutoff valve was provided, the flight crew would have the opportunity to shut off fuel flow by closing the airframe valve via the fire handle.

Reliance on the flight crew to detect fluctuating fuel flow indication without a specific EICAS indication is not considered an adequate method to ensure shutdown. In addition, no indication of fuel flow would be provided if the fuel leak were upstream of the fuel flow meter.

As another example, during an engine rotor non-containment, rupture of the fuel line is possible. If the flight crew chose to shut down the engine using the normal shutdown procedure (without activating the fire handle) uncontrolled fuel leakage into the failed engine is possible.

The applicant's design relies on flight crew recognition that the fuel shutoff valve has moved to the commanded position based on engine indications which are not typically evaluated for this purpose. The reliance on flight crew procedures and training for this function is not considered equivalent. Failure of the flight crew to recognize valve failure and follow the procedures could result in substantial uncontrolled fuel leakage and resultant fire hazards.

The FAA does not agree that the proposed configuration provides equivalent safety to the regulation. A configuration that closed both the engine shutoff valve and the airframe shutoff valve during the normal shutoff procedure would be considered equivalent because indication of the shutoff of the fuel supply to the engine would be provided by the airframe shutoff valve.

Applicant Position*:* By letter, [the applicant] provided a copy of the compliance document. This document revision reflects design changes to meet the intent of the subject requirement Issue Paper as follows:

> *With the exception for the Fuel shut-off valve, the powerplant valves controlled from the flight deck are provided with direct means of indicating whether the valves are open or closed, and an appropriate message is provided on Primary EICAS Display if there is a fault or disagreement with the selected position. The engine Anti-ice, Pressure Regulator and HP bleed air valves also*

have illuminated switches which will give an amber indication if a fault or disagreement exists.

The open position of the Fuel shut-off valve is evident by proper engine operation. The Fuel, Fire SOV also being controlled by the condition lever and the fire handle, provides engine fuel shutoff indication on Primary EICAS Display if there is a fault or disagreement with the selected fuel on/off position.

Conclusion*:* The revised fuel system as described provides an equivalent level of safety to the requirement of § 25.1141 for indication of powerplant valve position. The FAA concurs with the position; therefore, this Issue Paper is closed.

e. **References.**

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

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

(3) Amendment 25-40 (42 FR 15044, March 17, 1977).

(4) Amendment 25-72 (55 FR 29785, July 20, 1990).

Section 25.1142 Auxiliary power unit controls.

a. **Rule Text.**

Means must be provided on the flight deck for starting, stopping, and emergency shutdown of each installed auxiliary power unit.

(Amendment 25-46, 43 FR 50598, Oct. 30, 1978)

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

c. **Background.**

(1) The regulatory history shows that this rule was first proposed in Notice of Proposed Rulemaking 75-31 (40 FR 29410, July 11, 1975), and made final as Amendment 25-46 (43 FR 50578, October 30, 1978). The preamble to the amendment contained the following discussion concerning the requirement that necessary auxiliary power unit controls be provided on the flight deck:

> Two commenters state that there is no need for starting control on the flight deck for APU's that are operable only on the ground. The FAA believes that any APU installed on the airplane, whether or not intended only for ground use, should be able to be operated by the flight crew, since its improper operation or malfunction could affect the safety of the aircraft. The commenters appear to have interpreted the proposal to apply to both the APU's that are installed in the airplane, and to those stationary, portable, or mobile units that are external to the airplane and are considered to be ground support equipment. [The amendment text was revised to clarify that it is applicable only to installed APU's.]
>
> One commenter states that APU and engine standards in Part 25 should be separated to ensure consistent administration. The FAA does not agree with this, and believes the suggested revision is unnecessary. The APU and engine standards in Part 25 have been administered without difficulty for years.
>
> Other commenters state that the proposal should be revised to differentiate between essential and non-essential APU's, and that those classed as "essential" only need to meet the applicable provisions of the subpart. The FAA does not agree with these comments and believes that appropriate requirements for safety must be applied to all APU installations. No justification has been shown for the operation of a non-essential or a ground operation only APU at a safety level that is different from that which is required for an essential APU.

d. Policy/Compliance Methods.

(1) The following represents recent FAA policy concerning the Auxiliary Power Unit (APU) that was invoked during recent certification efforts:

The latest revision of the TSO (TSO-C77a, dated July 20, 1981) is acceptable for inflight essential APU's; however, many recent essential APU's have been certified that do not meet the requirements of Section 6.16 of the TSO for auto shutdown by overspeed only. With the implementation of two crew cockpit design, the elimination of the flight engineer has resulted in a need to provide self monitoring and auto shutdown under certain conditions which could result in unsafe operation. Essential APU's installed on two crew configured aircraft must provide reliable operation and also a means to avoid unsafe operating conditions. Therefore, the APU self monitoring auto shutdown feature must be evaluated to assure that reliability of the APU is maintained at levels which assure availability of critical functions provided by the essential unit.

(2) APU Cockpit Displays: Information regarding current policy for APU cockpit displays is provided below.

The requirements for APU flight deck instrumentation have developed into a certification issue for APU installations that use an electronic control unit designed to automatically maintain certain parameters within normal ranges when operated within the approved flight and ground operating envelopes. FAA regulations require adequate APU flight deck instrumentation to assure safe operation within the APU's approved limitations.

Certain APU parameters are, by design, monitored by the APU electronic control unit, and in the event a monitored parameter reaches its operating limit, or a fault develops, an automatic APU shutdown is initiated. Depending on the integrated design in the airplane and the automatic protective features of the airplane electrical system, together with the protective features built into the APU control unit, an automatic fault shutdown can have a resulting action essentially the same as the flightcrew would take under the same fault or condition event. This kind of installation may delete the need for certain Federal Aviation Regulation (FAR) 25 required APU flight deck instruments. In general, however, some kind of APU status (off or operating), along with fire protection status has been found to be required.

If such a system is submitted to the FAA for approval, the FAA can make an equivalent safety finding in accordance with § 21.21(b)(1) where the compensating features provide the equivalent level of safety as that provided by the installation of the required flight deck instrumentation.

The criteria used previously for making equivalent safety findings relative to APU instruments have largely been dependent on the parameters being monitored, the automatic protective features of the airplane electrical system, the intended use of the APU (i.e. ground only, flight nonessential, or flight essential use with Minimum Equipment List (MEL) dispatch), crew compliment, APU faults that automatically shut down the APU, the fault display in the cockpit, along with the internal monitoring capability of the APU electronic control unit, and other safety related operating features. The equivalency finding must satisfy the basic tenet that the total automatic features and capability must perform the same action as the flight crew under the same normal and non-normal conditions prior to, during, and following APU operation.

As a general rule, each installation should be investigated for its unique features, and operational envelope. However, as noted above, the following minimum features and operating parameters should be investigated:

- Fire
- Overspeed
- Electronic Control Unit (ECU) failure
- Load Compressor Reverse Flow (if a separate load compressor is a feature)
- Overtemperature (Exhaust Gas Temperature (EGT))
- Low Oil Pressure
- Variable Inlet Geometry (APU inlet door position)
- High Oil Temperature
- Loss of Cooling System Capability
- Loss of DC Power
- Loss of Rotor(s) Speed Signals
- Self monitoring features that detect and make known to the flight crew failure of the APU control features noted herein.
- Loss of EGT signals
- Flammable fluid leakage
- Any features of the APU electrical generation system, the pneumatic bleed system, and the hydraulic system (if installed), that are unique, or interface with the APU ECU should be investigated relative to the requirement for automatic shutdown to prevent a potential hazard to the airplane and its associated systems.
- Any features of the APU which may be required as part of the Technical Standard Order to which the APU has been evaluated.

This policy is specifically directed only to that requirement for providing appropriate instrumentation, markings, and limitations for APU installation (Reference § 25.901(d)). Other regulations affecting the installation must be complied with over and above the equivalency finding for the APU flight deck instrumentation. Note that an APU installation must comply with the provisions of § 25.1461.

(3) Additional FAA policy on powerplant instrument displays is provided in Advisory Circular (AC) 20-88A, "Guidelines on the Marking of Aircraft Powerplant Instruments (Displays)," dated September 30, 1985.

e. **References.**

(1) Amendment 25-46 (43 FR 50598, October 30, 1978).

(2) Advisory Circular 20-88A, "Guidelines on the Marking of Aircraft Powerplant Instruments (Displays)," September 30, 1985

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

Section 25.1143 Engine controls.

a. **Rule Text.**

(a) There must be a separate power or thrust control for each engine.

(b) Power and thrust controls must be arranged to allow --

(1) Separate control of each engine; and

(2) Simultaneous control of all engines.

(c) Each power and thrust control must provide a positive and immediately responsive means of controlling its engine.

(d) For each fluid injection (other than fuel) system and its controls not provided and approved as part of the engine, the applicant must show that the flow of the injection fluid is adequately controlled.

(e) If a power or thrust control incorporates a fuel shutoff feature, the control must have a means to prevent the inadvertent movement of the control into the shutoff position. The means must --

(1) Have a positive lock or stop at the idle position; and

(2) Require a separate and distinct operation to place the control in the shutoff position.

(Amendment 25-23, 35 FR 5677, April 8, 1970, as amended by Amendment 25-38, 41 FR 55467, Dec. 20, 1976; Amendment 25-57, 49 FR 6849, Feb. 23, 1984)

b. **Intent of Rule.** The intent of this rule is directed at the prevention of inadvertent operation of engine controls.

c. **Background.**

(1) The regulatory history shows that this requirement originated from section 4b.471 of the Civil Air Regulations (CAR) 4b, December 31, 1953. Amendment 25-AD was published in the Federal Register on December 24, 1964 (29 FR 18289), which 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). Part 25 [New] was published as a Notice of Proposed Rulemaking in the Federal Register on June 2, 1964 (29 FR 7169), and given further distribution as Notice No. 64-28. It was recodified from CAR 4b.471 without any substantive changes.

(2) Notice of Proposed Rulemaking 68-18 (33 FR 11913, August 22, 1968) proposed the addition of § 25.1143(e) to read:

> (e) Each power or thrust control must have means to prevent inadvertent movement of the power or thrust control into any position that will reduce the fuel flow necessary for normal flight idle operation. The means must have a positive lock or stop at the flight idle position and must require a separate and distinct operation by the crew to displace the control from the flight idle position."

(3) Amendment 25-23 (35 FR 5665, April 8, 1970) followed Notice 68-18. Following is an excerpt from the preamble to the amendment:

> Several commenters object to the use of the words "flight idle" and contend that they are improper in that they could lead persons to believe that any position below the flight idle position results in a fuel cut-off. The FAA agrees. The intent of the proposal is to preclude inadvertent movement of the control into the cutoff position and to require a separate and distinct motion on the part of the crew to shut down the engine, which may be accomplished by means of shutoff levers. The proposal has been revised accordingly.

(4) Amendment 25-38 (41 FR 55454, December 20, 1976) revised the rule to withdraw the original § 25.1143(d). The preamble to the amendment stated the following:

> A commenter states that the phrase "automatically controlled with relation to the amount of power produced by the engine" in proposed § 25.1143(d) is not appropriate for all fluid injection systems. The FAA agrees that the phrase is not appropriate for certain turbine engine-powered airplanes and that further revision of § 25.1143(d) should be considered. Proposed § 25.1143(d) has therefore been withdrawn for further study.
>
> No unfavorable comment was received concerning proposed § 25.1143(e) and this paragraph has been adopted without substantive change.
>
> Several commenters suggest that the proposed change to § 25.1305 be revised to except anti-detonant injection (ADI) systems from the powerplant instrument proposal for fluid augmentation systems. The commenters expressed the opinion that the proposal for § 25.1143(d) concerning automatic controls for fluid injection systems (other than fuel) eliminated the need for a powerplant instrument for the ADI system. The FAA believes that the flight crew should be able to monitor the proper functioning of any fluid system that is used for thrust or power augmentation and the section as adopted is applicable to ADI systems. However, the section has been clarified to ensure application only to fluids systems that are used for thrust or power augmentation.

(5) Amendment 25-54, October 14, 1980 (45 FR 60154, September 11, 1980) contained the following discussion in its preamble:

> The addition of new §§ 25.101(i) and (j) would set forth requirements for automatic systems that affect performance, including automatic takeoff thrust control systems (ATTCS). In view of the evolving technology of

> automatic systems, the special features and functions of each design, and the complex interrelationships with other systems, the FAA has concluded that specific regulations are premature and that safety considerations can be more advantageously addressed in special conditions for specific systems. Accordingly, Proposal 8-26 and related Proposals 8-34, 8-48, and the § 25.1305(c)(9) portion of 8-50 are withdrawn.

(6) Amendment 25-57 (49 FR 6832, February 23, 1984) contained the following discussion in its preamble:

> Proposal 13. This proposed change would add a new § 23.1143(e) to: (1) state engine control requirements not only for antidetonant injection (ADI) systems, but for other fluid injection systems (other than fuel) as well; (2) make it clear that any fluid injection system and its controls provided and approved as part of the engine need not be duplicated by the aircraft manufacturer; and (3) specify a separate control for fluid injection pumps.
>
> Five commenters object to proposed § 23.1143(e)(1) on the grounds that it restricts design of fluid control to one of a number of satisfactory types. It is their view that fluid injection requirements are influenced by other factors which may not relate to the amount of power produced by an engine in service. In some cases, the engine installations have fluid systems that do not vary the fluid flow with power. Fluid is injected in a fixed amount, and power is varied by the engine fuel control via the power lever. The proposed paragraph is rephrased to permit more flexibility in design.
>
> One commenter requests that the regulations be clarified so that separate control for fluid injection pumps is required regardless of whether or not the injection system is approved as part of the engine. Another suggests deletion of this paragraph as some current systems do not use pumps. The FAA agrees with the commenters, and the proposed regulation is revised accordingly.
>
> The portion of the proposed rule exempting engine-supplied devices from the requirements of this section is withdrawn for the reason given for § 23.997.
>
> Proposal 33. For a discussion of comments and disposition of the proposed amendment to § 25.1143(d), see the proposal for § 23.1143(e).
>
> Proposals 45 and 55. These amendments add new §§ 27.1143(d) and 29.1143(d) and (e) specifying that fluid injection (other than fuel) controls be in the throttle controls and eliminating duplicate certification requirements, as in §§ 23.1143 and 25.1143. However, the term “throttles” is a misnomer for modern turbine engines installed in rotorcraft. Changes needed to rectify the terminology would be beyond the scope of this review. The proposals to amend §§ 27.1143 and 29.1143 are withdrawn and will be referred to the Rotorcraft Regulatory Review Program for consideration.

d. **Policy/Compliance Methods.** The following guidance concerning engine controls has been extracted from material published in Advisory Circular (AC) 29-2B, dated July 30, 1997. (Although that AC provides guidance for transport rotorcraft, it may provide insight into acceptable compliance methodology useful for other category aircraft.)

(1) Certification data submitted by the applicant should be reviewed to ensure that all the design features stated in § 25.1143 exist.

(2) Proper engine control functioning (to verify the design features of § 25.1143) should be verified as part of the type inspection authorization (TIA) for the certification project.

(3) Compliance with § 25.1143(e)(1) has been shown successfully in the past by use of idle detents (mechanical or electrical/mechanical such as a solenoid).

(4) In the past, compliance with § 25.1143(e)(ii) has been achieved by use of a switch or button to displace the stop or by use of distinct offsets in throttle motion to allow movement from the idle stop to shutoff.

e. **References.**

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

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

(3) Amendment 25-23 (35 FR 5677, April 8, 1970).

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

(5) Amendment 25-57 (49 FR 6849, February 23, 1984).

(6) Advisory Circular 25.939-1, "Evaluating Turbine Engine Operating Characteristics," March 19, 1986.

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

Section 25.1145 Ignition switches.

a. **Rule Text.**

(a) Ignition switches must control each engine ignition circuit on each engine.

(b) There must be means to quickly shut off all ignition by the grouping of switches or by a master ignition control.

(c) Each group of ignition switches, except ignition switches for turbine engines for which continuous ignition is not required, and each master ignition control must have a means to prevent its inadvertent operation.

(Doc. No. 5066, 29 FR 18291, Dec. 24, 1964, as amended by Amendment 25-40, 42 FR 15044 Mar. 17, 1977)

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

c. **Background.**

(1) The regulatory history shows that the requirement was originated from section 4b.472 of the Civil Air Regulations (CAR) 4b, December 31, 1953. Amendment 25-AD was published in the Federal Register on December 24, 1964 (29 FR 18289), which 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). Part 25 [New] was published as a Notice of Proposed Rulemaking in the Federal Register on June 2, 1964 (29 FR 7169), and given further distribution as Notice No. 64-28. It was recodified from CAR 4b.472 without any substantive changes.

(2) Amendment 25-40 (42 FR 15034, March 17, 1977), concerning § 25.1145(c), was directed at preventing the inadvertent shutdown of engines. The proposal that preceded this amendment contained text that would have made the rule applicable to all engine types. Commenters to the proposal stated that this new requirement was not necessary for turbine engines that do not require continuous ignition, since inadvertent movement of the ignition switch would not affect the operation of such an engine once that engine had been started. As a result of the comments, the proposed change was revised to exempt turbine engines from the requirement to have a means to prevent inadvertent operation of the group of ignition switches.

Of special note is a qualifying statement provided in the preamble to Amendment 25-40 as follows:

> In response to a comment, a cross reference to § 25.1145(b) has been added to § 25.1307 (§ 25.947)(§ 4b.605) to make it clear that a ganged ignition switch may be used to satisfy the subject requirement.

d. **Policy/Compliance Methods.** The following guidance was developed in 1986 for § 23.1145 (small airplanes) and was coordinated with other FAA Directorates to ensure consistency between the requirements of part 23, 25, 27 and 29 of the Federal Aviation Regulations (14 CFR parts 23, 25, 27, and 29).

Subject*:* Ignition switch requirements for turbine engine installation per § 23.1145 (“”Ignition switches”) of the Federal Aviation Regulations.

Issue: Does § 23.1145 require an ignition switch with shutoff provisions for turbine powered airplanes?

Background. A question has been asked whether all the provisions of § 23.1145 apply to turbine engine installations and whether an ignition switch must have shutoff provisions. A manufacturer has recently developed an automatic ignition system (auto-relight) for their turboprop engines. This modification was developed to correct an engine flameout problem that has developed in service. It has been proposed that an automatic ignition system allow the pilot to select automatic or continuous, but without having any ignition shutoff provisions.

Discussion: Civil Air Regulation (CAR) 3.629 requires that ignition switches shall provide control for each ignition circuit on each engine. Also, it shall be possible to shut off quickly all ignition on multi-engine airplanes, either by grouping of individual switches or by providing a master ignition control. If a master control is provided, suitable means shall be incorporated to prevent inadvertent operation. These requirements were for reciprocating type engines. CAR 3.629 was recodified as § 23.1145 with no change to the requirements. When turbine engines were introduced in Part 23 by Amendment 23-7, no changes were proposed or adopted for § 23.1145, thereby making the requirements of § 23.1145 applicable to turbine engines. Section 23.1145 was amended by Amendment 23-18 to exempt turbine engines, for which continuous ignition is not required, from the requirement that each group of ignition switches must have means to prevent inadvertent operation. Further, when the Special Conditions were developed for the first turbine engine installation for the Lear Model 23, no changes to CAR 3.629 were proposed.

The regulations require that ignition switches shall provide control for each ignition circuit. This has always required that each ignition switch incorporate an “off” position. Control is not truly accomplished without an “off” position. This requirement should apply to both reciprocating and turbine engine installations.

It is recognized that a turbine engine may not require continuous ignition or shut the engine off by turning the ignition off. However, it appears that if continuous or automatic ignition can be selected by the pilot, the ignition should also be capable of being shut off. Unwanted ignition during an engine malfunction could result in an unairworthy condition.

Conclusion: § 23.1145 of the Federal Aviation Regulations requires the following:

1. § 23.1145 (a), (b), and (c) all apply to turbine engine installations.

2. § 23.1145(b) does require shutoff provisions on all ignition switches.

3. An ignition switch is required and may be used to select any position such as continuous, automatic, or on.

Since § 23.1145 is similar to Parts 25, 27, and 29, the above position is being coordinated with all [FAA] Directorates. . .

Transport Directorate Response: The provisions of § 25.1145 do pertain to turbine engine installations. The Transport Directorate does not completely agree with your conclusion No. 2, which states that an ignition switch must have a shutoff provision. Section 25.1145(b) states that "there must be means to quickly shut off all ignition. . . " and we believe there are means other than an ignition switch "off" position. Some aircraft have an ignition cutoff feature linked to the power lever whereby selection of "idle cutoff" not only interrupts fuel flow to the engine but also turns off the ignition system. While an ignition switch "off" position may seem desirable, we believe there are other design features that also provide a satisfactory means to quickly shut off the ignition systems.

e. **References.**

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

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

(3) Amendment 25-40 (42 FR 15044 Mar. 17, 1977).

Section 25.1147 Mixture controls.

a. **Rule Text.**

(a) If there are mixture controls, each engine must have a separate control. The controls must be grouped and arranged to allow --

(1) Separate control of each engine; and

(2) Simultaneous control of all engines.

(b) Each intermediate position of the mixture controls that corresponds to a normal operating setting must be identifiable by feel and sight.

(c) The mixture controls must be accessible to both pilots. However, if there is a separate flight engineer station with a control panel, the controls need be accessible only to the flight engineer.

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

c. **Background.** The regulatory history shows that this requirement originated from section 4b.473 of the Civil Air Regulations (CAR) 4b, December 31, 1953 (29 FR 18289). Amendment 25-AD was published in the Federal Register on December 24, 1964, which 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). Part 25 [New] was published as a Notice of Proposed Rulemaking in the Federal Register on June 2, 1964 (29 FR 7169), and given further distribution as Notice No. 64-28. It was recodified from CAR 4b.473 without any substantive changes.

d. **Policy/Compliance Methods.** The following guidance is based upon guidance from Advisory Circular (AC) 29-2B, dated July 30, 1997. (Although that AC provides guidance for transport rotorcraft, it may provide insight into acceptable compliance methodology useful for other category aircraft.)

(1) **Mixture Controls:** This section addresses the arrangement of fuel mixture controls, if installed. Major manual adjustment of the fuel mixture to optimize performance is not normally allowed due to the possibility of engine failure or detonation if significant misadjustment occurs. If "best-power" with respect to fuel mixture is desired, normal practice is to utilize engines with automatic mixture controls, in which case the lever in the cockpit reverts to merely an engine shutdown device. In any case, manual adjustment of the mixture, except for intentional shutdown, should not be prescribed without positive means of ascertaining that the resulting fuel-air mixture is within the range associated with safe engine operation. Some manual mixture adjustment may be acceptable for more efficient engine operation if suitable stops or automatic means are provided to prevent inadvertent engine shutdown with mixture movement or engine malfunction with flight condition changes.

(a) Section 25.1147(a) requires (if mixture controls exist) that controls be arranged to allow:

(i) Separate control of each engine.

(ii) Simultaneous control of all engines.

(b) Section 25.1147(b) requires that each intermediate position of the mixture controls corresponding to a normal operating setting be identifiable by both feel and sight.

(c) Procedures:

(i) Certification data submitted by the applicant should be reviewed to ensure that the design features stated in § 25.1147 exist.

(ii) Proper mixture control functioning (to verify the design features of § 25.1147) should be verified as part of the TIA for the certification project.

(iii) Compliance is typically shown by use of a side-by-side arrangement of the controls, provided that the arrangement is compatible with other controls and considering that crew attention to the primary flight controls may be a full-time, “hands-on” operation.

e. **References.**

(1) Civil Air Regulations (CAR) 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 25.1149 Propeller speed and pitch controls.

a. **Rule Text.**

(a) There must be a separate propeller speed and pitch control for each propeller.

(b) The controls must be grouped and arranged to allow-

(1) Separate control of each propeller; and

(2) Simultaneous control of all propellers.

(c) The controls must allow synchronization of all propellers.

(d) The propeller speed and pitch controls must be to the right of, and at least one inch below, the pilot's throttle controls.

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

c. **Background.** The regulatory history shows that this requirement originated from section 4b.474(a) of the Civil Air Regulations (CAR) 4b, December 31, 1953. Amendment 25-AD was published in the Federal Register on December 24, 1964 (29 FR 18289), which 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). Part 25 [New] was published as a Notice of Proposed Rulemaking in the Federal Register on June 2, 1964 (29 FR 7169), and given further distribution as Notice No. 64-28. It was recodified from CAR 4b.474(a) without any substantive changes.

d. **Policy/Compliance Methods.** The following excerpt from Advisory Circular (AC) 23-8A C1, August 30, 1993, provides current FAA guidance. (Although that AC provides guidance for small airplanes, it may provide insight into acceptable compliance methodology useful for other category aircraft.)

PROPELLER SPEED AND PITCH LIMITS.

Procedures. Assuming that both the tachometer and the airspeed indicator system of the test airplane have been calibrated within the past 30 days and that the best rate of climb speed is known, the following appropriate tests should be conducted:

(a) **Controllable Pitch Propellers Without Constant Speed Controls.**

(1) *Climb revolutions per minute (R.P.M.).* With the propeller in full low pitch, determine that the maximum R.P.M. during a climb using maximum power at the best rate of climb speed does not exceed the rated takeoff R.P.M. of the engine.

(2) *Dive R.P.M.* With the propeller in full high pitch, determine that the closed throttle R.P.M. in a dive at the never-exceed speed is

not greater than 110% of the rated maximum continuous R.P.M. of the engine.

(b) **Controllable Pitch Propellers With Constant Speed Controls.**

(1) <u>*Climb R.P.M.*</u> With the propeller governor operative and prop control in full high R.P.M. position, determine that the maximum power R.P.M. does not exceed the rated takeoff R.P.M. of the engine during takeoff and climb at the best rate of climb speed.

(2) <u>*Static R.P.M.*</u> With the propeller governor made inoperative by mechanical means, obtain a no-wind static R.P.M. Determine that the maximum power static R.P.M., with the propeller blade operating against the low pitch stop, does not exceed 103% of the rated takeoff R.P.M. of the engine. Although this rule references manifold pressure, it has been considered to be applicable to turbopropeller installations. Propellers that go to feather when the governor is made inoperative need not be tested.

(aa) *Reciprocating Engines*. Determine that the maximum power static R.P.M., with the propeller blade operating against the low pitch stop, does not exceed 103% of the rated takeoff R.P.M. of the engine.

(bb) *Turbopropeller Engines*. Although this rule references manifold pressure, it has been considered to be applicable to turbopropeller installations. With the governor inoperative, the propeller blades at the lowest possible pitch, with takeoff power, the airplane stationary, and no wind, ensure that the propeller speed does not exceed the maximum approved engine and propeller R.P.M. limits. Propellers that go to feather when the governor is made inoperative need not be tested.

(3) <u>*Safe Operation Under Normal Operating Conditions*</u>.

(aa) *Reciprocating Engines.* Descent at VNE or VMO with full power, although within the normal operating range, is not a normal operating procedure. Engine R.P.M., with propeller on the high pitch blade stops, that can be controlled by retarding the throttle may be considered as acceptable in showing compliance with the requirement.

(bb) *Turbopropeller Engines.* Perform a maximum R.P.M. at maximum torque (or power) descent at VMO to ensure that normal operating limits for the propeller are not exceed.

(c) **Data Acquisition and Reduction.** The observed R.P.M. data in each case must be corrected for tachometer error. The airspeed system error must also be taken into consideration to determine the proper calibrated airspeed. True airspeed may also need to be considered because propeller angle of attack is a function of true airspeed.

e. **References.**

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

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

(3) Advisory Circular 23-8A C1, "Flight Test Guide for Certification of Part 23 Airplanes," August 30, 1993.

Section 25.1153 Propeller feathering controls.

a. **Rule Text.**

(a) There must be a separate propeller feathering control for each propeller. The control must have means to prevent its inadvertent operation.

(b) If feathering is accomplished by movement of the propeller pitch or speed control lever, there must be means to prevent the inadvertent movement of this lever to the feathering position during normal operation.

(Doc. No. 5066, 29 FR 18291, Dec. 24, 1964, as amended by Amendment 25-11, 32 FR 6913, May 5, 1967)

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 4b.474(b) of the Civil Air Regulations (CAR) 4b, December 31, 1953. Amendment 25-AD was published in the Federal Register on December 24, 1964 (29 FR 18289), which 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). Part 25 [New] was published as a Notice of Proposed Rulemaking in the Federal Register on June 2, 1964 (29 FR 7169), and given further distribution as Notice No. 64-28. It was recodified from CAR 4b.474(b) without any substantive changes.

(2) Notice 65-43 (31 FR 93, January 6, 1966) proposed to amend § 25.1153(b) to require only that "inadvertent" movement of the propeller control to the feathering position be prevented (rather than positive prevention of such movement, as the rule currently required). One commenter to this proposal objected to this change as an undesirable relaxation. The FAA did not agree, however, citing that the current rules for propeller feathering controls generally (in § 25.1153(a)) and for reverse thrust controls (in § 25.1155) cover only "inadvertent" control operation; no higher standard has been shown to be necessary for propeller pitch or speed controls used for feathering. The final rule was adopted as proposed in Amendment 25-11 (32 FR 6913, May 5, 1967).

d. **Policy/Compliance Methods.** No dedicated guidance is currently available.

e. **References.**

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

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

(3) Notice of Proposed Rulemaking 63-43 (31 FR 93, January 6, 1966).

(4) Amendment 25-11 (32 FR 6906, May 5, 1967).

Section 25.1155 Reverse thrust and propeller pitch settings below the flight regime.

a. **Rule Text.**

Each control for reverse thrust and for propeller pitch settings below the flight regime must have means to prevent its inadvertent operation. The means must have a positive lock or stop at the flight idle position and must require a separate and distinct operation by the crew to displace the control from the flight regime (forward thrust regime for turbojet powered airplanes).

(Amendment 25-11, 32 FR 6913, May 5, 1967)

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

c. **Background.**

(1) The requirements listed in § 25.1155 can be traced back to Part 25's parent document, Part 4b of the Civil Air Regulations (CAR). Sections 4b.474(a) and (b) stated criteria for "propeller reverse thrust controls" and for "turbo-jet reverse thrust controls," respectively. When Part 25 of the FAR replaced CAR 4b on February 1, 1965, the turbojet and propeller control criteria of CAR 4b were consolidated into one paragraph, § 25.1155, which was labeled "Reverse Thrust Controls." Amendment 25-AD was published in the Federal Register on December 24, 1964 (29 FR 18289), which 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). Part 25 [New] was published as a Notice of Proposed Rulemaking in the Federal Register on June 2, 1964 (29 FR 7169), and given further distribution as Notice No. 64-28. It was recodified from CAR 4b without any substantive changes.

(2) This rule was carried over until June 4, 1967, when § 25.1155 was revised by Amendment 25-11 (32 FR 6906, May 5, 1967). Amendment 25-11 broadened § 25.1155 by covering controls for any propeller pitch setting below the flight regime, and not just reverse pitch settings. The justification for this rule change was that propeller pitch control systems that caused drag through the use of pitch settings lower than the flight low pitch limit (but not into the reverse or beta range of pitch settings) were beginning to be widely used. Experience had shown that the high discing drag induced by these systems could have the same effect as reverse thrust; thus, their controls should be designed to the same standards as the controls for turbojet thrust reversers. In short, the propeller controller system should be prevented from being inadvertently selected in flight to any propeller setting below the inflight pitch limit (i.e. ground idle pitch setting). Section 25.1155 has not been changed since Amendment 25-11. The disposition of comments received in response to the proposal for this amendment were discussed in the preamble to the amendment as follows:

The notice proposed to amend § 25.1153(b) to require only that "inadvertent" movement of the propeller control to the feathering position be prevented (rather than positive prevention of such movement as the rule currently required). One commenter objects to this change as an undesirable relaxation. *[FAA's response:]* The Administrator disagrees. The present rules for propeller feathering controls generally [in § 25.1153(a)] and for reverse thrust controls (in § 25.1155) cover only "inadvertent" control operation. No higher standard has been shown to be necessary for propeller pitch or speed controls used for feathering. This amendment is issued as proposed.

The notice proposed to broaden § 25.1155 to cover controls for propeller pitch settings below the flight regime, not just reverse thrust controls. One commenter states that the degree of complexity of such controls in a certain currently operational aircraft should not be exceeded in the administration of this amendment. *[FAA's response:]* This amendment is not intended to dictate any specific degree of complexity. Another comment objects, stating that this amendment relaxes the present rule by using the word "inadvertent." *[FAA's response:]* No relaxation results. The word "inadvertent" is used in the present rule. This amendment, in fact, increases the burden by extending § 25.1155 to cover controls heretofore not covered by the regulations.

Section 25.1155 currently requires that each control for reverse thrust and propeller pitch settings below the flight regime must have a means to prevent its inadvertent operation. Additionally, the means must have a positive lock or stop at the flight idle position and must require a separate and distinct operation by the crew to displace the control from the flight regime (forward thrust regime for turbojet powered airplanes). Although the current rule does address engine controls for both turbojet and propeller powered transport category airplanes, the intent of this amendment is to revise only the propeller control requirements.

For propeller powered airplanes, pitch settings below the flight regime (flight idle) are commonly referred to as "beta mode." Operation of the power levers below the flight regime usually results initially in ground idle propeller pitch settings. If the power levers are further displaced, reverse or Beta propeller pitch settings may be obtained.

d. **Policy/Compliance Methods.** Current transport category airplane policy is reflected in the following material:

(1) ***Beta Lock Out System Criteria***. The following guidance is based on an FAA Issue Paper applied to airplanes without a method of preventing inadvertent or intentional operation within the propeller Beta range.

The propeller reverse system is intended for ground use only. Section 25.1155 requires that for propeller reversing systems intended for ground use, that a positive means to prevent inadvertent reverse or beta operation be provided. Unsatisfactory service experience that resulted in several accidents on Part 25 turbopropeller airplanes has shown that this requirement does not provide protection from intentional operation in the beta mode. As a result of this service experience and under the no unsafe feature or characteristic provisions of § 21.21(b)(2), the airplane design must prevent intentional or inadvertent inflight selection of propeller pitch settings below flight idle (beta).

In-service experience of some turbopropeller powered transport category airplanes has shown that intentional or inadvertent in-flight operation of the propeller control systems below flight idle can, and has, produced two types of unsafe conditions:

- Permanent engine damage and total loss of thrust on all engines when the propellers that were operating in the beta range drove the engines to overspeed, and;
- Loss of airplane control because at least one propeller operated in the beta range during flight creating asymmetric control conditions.

In-flight protection against inadvertent operation of the cockpit mounted propeller control lever(s), below the flight regime, is required by § 25.1155. This regulation requires the propeller control system to incorporate positive locks or stops at the flight idle position, and specifies that the control means must require a separate and distinct operation by the crew in order to displace the propeller control from the flight regime. Intentional operation in beta mode/reverse in flight for rapid aircraft deceleration is not specifically addressed by this regulation. Also, § 25.933(a) has been interpreted as not requiring, for turbopropeller aircraft, an interlock or other automatic device to prohibit movement of the power lever by the flight crew below the flight idle stop when the aircraft is in flight.

Consequently, initial FAA certification of transport category turbopropeller aircraft has not required an inflight beta lock-out device to prevent intentional operation in the beta mode/reverse in flight. However, inflight beta lock-out systems have been retroactively required (via Airworthiness Directives) on multiple transport category turboprop airplanes because of unsatisfactory service experience. These beta lock-out systems were required only after it was determined that increased crew training, installation cockpit placards warning crews not to use beta inflight, and stronger wording in AFM warnings and limitations did not preclude additional inflight beta events.

Therefore, in an attempt to achieve the safety level originally intended for transport category turbopropeller powered airplanes, a proposed amendment to § 25.1155, to prevent inadvertent or intentional beta mode/reverse operation during flight is currently in the rulemaking process. Until the rule changes noted above are complete, the FAA is using the no unsafe feature or characteristic provisions of 21.21(b)(2) to require installation of beta lock-out systems on new transport category turbopropeller powered airplanes.

(2) ***Beta Lockout System Design Objectives***. The following design objectives and associated comments were developed after review of the oral and written comments presented in response to the public meeting on this subject that was held June 11 - 12, 1996, in Seattle, Washington [ref. Public Meeting Notice (61 FR16521, April 15, 1996.)] While this guidance is not mandatory, it offers a design objectives that, if followed, should avoid the deficiencies of previous systems that were installed to prevent or deter access to the propeller beta range in flight. These design objectives are provided to be in addition to a quadrant design that includes a gate/latch or detent mechanism typically accepted as compliance with § 25.1155. These objectives were based on "lessons learned" from less than satisfactory experience on existing beta lockout systems.

The beta lockout systems designed for commuter (SFAR 23/41) and transport category airplanes should comply with all applicable subparagraphs of Parts 23 and Part 25, respectively. This is a reminder that the design objectives are in addition to the FAR requirements.

Definitions - For the purposes of this document the following definitions apply:

- *Beta:* "Beta" is the range of propeller operation intended for use during taxi, ground idle and reverse operations, as controlled by the power lever settings aft of the flight idle stop.
- *Deter:* To discourage the flight crew from acting.
- *Intentional:* Deliberate and planned flight crew action.
- *Inadvertent:* Flight crew action which was not clearly deliberate and planned, i.e. unintentional, accidental, reflexive flight crew action.
- *Prevent:* To make flight crew action impossible.
- *Fail-safe:* The FAA considers a beta lockout system to be" fail-safe" when predominant failure modes (such as loss of power) of the system would continue to preclude flight crews from positioning the power levers aft of the flight idle stop in flight.
- *Primary:* If the airplane throttle quadrant has a service history similar to the designs for which the FAA required the addition of a beta lockout system, then the beta lockout system is considered primary.

Beta Lockout General Design Objectives. The beta lockout system design should include:

1. A means to prevent the flightcrew from inadvertently or deter the flight crew from intentionally selecting the propeller beta range during flight.
2. Automatic arming.
3. System circuit breakers (separate breakers for the indication systems) installed in such a manner as to deter the flightcrew from using the circuit breakers as a lockout override.
4. A caution/warning system that shows when the beta lockout system lock is not in the appropriate position for all phases of operation.
5. A means to ensure that the beta indication system does not flash messages from the time of the takeoff power setting speed until the airplane reaches a minimum reasonable altitude (approximately 400 feet above ground level), unless immediate crew action is required to prevent an unsafe condition.

Beta Lockout System and Indication System Reliability Design Objectives. The beta lockout system should be designed such that:

6. Beta lockout system failure resulting in loss of protection from inadvertent access to beta in flight is improbable (a failure rate of 1×10^{-5} or less per operating hour).

7. A single failure does not disable both the lockout system and the indication system.

8. The probability of the failure of both the beta lockout system and the beta lockout indication is extremely remote (a failure rate of 1 x 10^{-7} or less per operating hour).

9. For systems that do not have a beta override (mechanism or switch), any failure or combination of failures that will lock out the flightcrew's ability to obtain the propeller beta range during landing (provided it is not detectable prior to landing is improbable (a failure rate of 1 x 10^{-5} or less per operating hour).

10. The probability of failure of the beta lockout system (with independent locks), which prevents one engine from obtaining reverse pitch while allowing the other engine(s) to go into reverse pitch (beta), is 1 x 10^{-7} or less.

> *Note: It is not the FAA's intent to allow the use of probability of pilots inadvertent access to beta in flight when assessing the reliability of the beta lockout system design. Thus, relative to the above and § 25.1309 assessments, the probability of the pilot's action to access beta in flight should be assumed to be one.*

Beta Lockout System Override Design Objectives. If the applicant chooses to design a beta lockout override that enables access to the beta range following rare beta lockout system failures or in other emergency situations, once the override has been used, the beta lockout system should be designed such that:

11. Indication is provided to the flightcrew the override was used. The indication system should include an independent annunciation or should be connected to the master caution system.

12. The flightcrew should not able to reset the override mechanism or switch.

13. The override system prevents subsequent takeoffs until the override mechanism or switch has been reset by maintenance action. As an example, include the override activation in the takeoff configuration warning system (or similar warning system).

Airplane Flight Manual (AFM) Information. The AFM should include:

14. An AFM limitation that prohibits use of beta during flight and a consequence statement similar to the following: *"Positioning of power levers below the flight idle stop in flight is prohibited. Such positioning may lead to loss of airplane control or may result in an engine overspeed condition and consequent loss of engine power."*

15. Abnormal/emergency procedures for failure indications of the Beta Lockout System (ref. objective 6 and 9).

Dispatch

16. If flight with an inoperative beta lockout system is permitted for a specific installation, limitations specifying terms and conditions of dispatch relief

shall be defined in an FAA approved document such as an AD, AFM, or Maintenance Manual.

Continued Airworthiness. Make aware the cognizant FAA Aircraft Evaluation Group any required system maintenance, inspections, or functional checks that are required to achieve the reliability of beta lockout systems specified above.

Training. Training emphasis is appropriate. However, using training techniques and tools currently available doesn't offer total solution to the problem. History of enhanced training efforts on problematic aircraft have been unsuccessful in preventing follow on inflight beta events. Some of the manufacturers which have voluntarily installed beta lockout systems have reached the same conclusion.

e. **References.**

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

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

(2) Amendment 25-11 (32 FR 6913, May 5, 1967).

Section 25.1157 Carburetor air temperature controls.

a. **Rule Text.**

There must be a separate carburetor air temperature control for each engine.

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

c. **Background.** The regulatory history shows that this requirement originated from section 4b.476 of the Civil Air Regulations (CAR) 4b, December 31, 1953. Amendment 25-AD was published in the Federal Register on December 24, 1964 (29 FR 18289), which 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). Part 25 [New] was published as a Notice of Proposed Rulemaking in the Federal Register on June 2, 1964 (29 FR 7169), and given further distribution as Notice No. 64-28. It was recodified from CAR 4b.476 without any substantive changes.

d. **Policy/Compliance Methods.** No dedicated policy material on transport category airplanes is currently available.

e. **References.**

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

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

Section 25.1159 Supercharger controls.

a. **Rule Text.**

Each supercharger control must be accessible to the pilots or, if there is a separate flight engineer station with a control panel, to the flight engineer.

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

c. **Background.** The regulatory history shows that this requirement originated from section 4b.476a of the Civil Air Regulations (CAR) 4b, December 31, 1953. Amendment 25-AD was published in the Federal Register on December 24, 1964 (29 FR 18289), which 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). Part 25 [New] was published as a Notice of Proposed Rulemaking in the Federal Register on June 2, 1964 (29 FR 7169), and given further distribution as Notice No. 64-28. It was recodified from CAR 4b.476a without any substantive changes.

d. **Policy/Compliance Methods.** The following excerpt from Advisory Circular 29-2B, July 30, 1997, contains current FAA guidance. (Although that AC provides guidance for transport rotorcraft, it may provide insight into acceptable compliance methodology useful for other category aircraft.)

(1) The location and shape of the controls should be conveniently accessible and sufficiently unique to preclude inadvertent actuation of the wrong control.

(2) Compliance is typically shown by a cockpit evaluation.

e. **References.**

(1) Civil Air Regulations (CAR) 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 25.1161 Fuel jettisoning system controls.

a. **Rule Text.**

Each fuel jettisoning system control must have guards to prevent inadvertent operation. No control may be near any fire extinguisher control or other control used to combat fire.

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

c. **Background.** The regulatory history shows that this requirement originated from section 4b.475 of the Civil Air Regulations (CAR) 4b, December 31, 1953. Amendment 25-AD was published in the Federal Register on December 24, 1964 (29 FR 18289), which 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). Part 25 [New] was published as a Notice of Proposed Rulemaking in the Federal Register on June 2, 1964 (29 FR 7169), and given further distribution as Notice No. 64-28. It was recodified from CAR 4b.475 without any substantive changes.

d. **Policy/Compliance Methods.** Compliance has been demonstrated by review of the cockpit design with adherence to FAA guidelines reflected in § 25.1001, “Fuel jettisoning system.”

e. **References.**

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

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

Section 25.1163 Powerplant accessories.

a. **Rule Text.**

(a) Each engine mounted accessory must-

(1) Be approved for mounting on the engine involved;

(2) Use the provisions on the engine for mounting; and

(3) Be sealed to prevent contamination of the engine oil system and the accessory system.

(b) Electrical equipment subject to arcing or sparking must be installed to minimize the probability of contact with any flammable fluids or vapors that might be present in a free state.

(c) If continued rotation of an engine-driven cabin supercharger or of any remote accessory driven by the engine is hazardous if malfunctioning occurs, there must be means to prevent rotation without interfering with the continued operation of the engine.

(Doc. No. 5066, 29 FR 18291, Dec. 24, 1964, as amended by Amendment 25-57, 49 FR 6849, Feb. 23, 1984)

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 4b.477 of the Civil Air Regulations (CAR) 4b, December 31, 1953. Amendment 25-AD was published in the Federal Register on December 24, 1964 (29 FR 18289), which 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). Part 25 [New] was published as a Notice of Proposed Rulemaking in the Federal Register on June 2, 1964 (29 FR 7169), and given further distribution as Notice No. 64-28. It was recodified from CAR 4b.477 without any substantive changes.

(2) Notice of Proposed Rulemaking 80-21 (45 FR 76872, November 20, 1980), proposed to amend § 25.1163(a) to make it clear that it is the ultimate responsibility of the aircraft manufacturer who installs an engine to assure proper sealing of engine oil lubricated accessories. Amendment 25-57 (49 FR 6832, February 23, 1984), which followed Notice 80-21, contained a discussion of comments in its preamble: Three commenters requested clarification of added paragraph (a)(3) to define what is to be sealed. The FAA concurred that the intent was unclear and paragraph (a)(3) was changed in the amendment to define the extent of sealing.

d. **Policy/Compliance Methods.** There is no policy or guidance material currently available.

e. **References.**

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

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

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

(4) Amendment 25-57 (49 FR 6849, February 23, 1984).

Section 25.1165 Engine ignition systems.

a. **Rule Text.**

(a) Each battery ignition system must be supplemented by a generator that is automatically available as an alternate source of electrical energy to allow continued engine operation if any battery becomes depleted.

(b) The capacity of batteries and generators must be large enough to meet the simultaneous demands of the engine ignition system and the greatest demands of any electrical system components that draw electrical energy from the same source.

(c) The design of the engine ignition system must account for --

(1) The condition of an inoperative generator;

(2) The condition of a completely depleted battery with the generator running at its normal operating speed; and

(3) The condition of a completely depleted battery with the generator operating at idling speed, if there is only one battery.

(d) Magneto ground wiring (for separate ignition circuits) that lies on the engine side of the fire wall, must be installed, located, or protected, to minimize the probability of simultaneous failure of two or more wires as a result of mechanical damage, electrical faults, or other cause.

(e) No ground wire for any engine may be routed through a fire zone of another engine unless each part of that wire within that zone is fireproof.

(f) Each ignition system must be independent of any electrical circuit, not used for assisting, controlling, or analyzing the operation of that system.

(g) There must be means to warn appropriate flight crewmembers if the malfunctioning of any part of the electrical system is causing the continuous discharge of any battery necessary for engine ignition.

(h) Each engine ignition system of a turbine powered airplane must be considered an essential electrical load.

(Doc. No. 5066, 29 FR 18291, Dec. 24, 1964, as amended by Amendment 25-23, 35 FR 5677, Apr. 8, 1970; Amendment 25-72, 55 FR 29785, Jul 20, 1990)

b. **Intent of Rule.** The intent of this rule is to provide proper design requirements for engine ignition systems to permit continued engine operation which could be jeopardized without proper consideration in the electrical system design.

c. **Background.**

(1) The regulatory history shows that this requirement originated from section 4b.445 of the Civil Air Regulations (CAR) 4b, December 31, 1953. Amendment 25-AD was published in the Federal Register on December 24, 1964 (29 FR 18289), which 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). Part 25 [New] was published as a Notice of Proposed Rulemaking in the Federal Register on June 2, 1964 (29 FR 7169), and given further distribution as Notice No. 64-28. It was recodified from CAR 4b.445 without any substantive changes.

(2) Notice of Proposed Rulemaking 68-18 (33 FR 11913, August 22, 1968) proposed a change to § 25.1165(f) which would require each ignition system to be independent of any electrical circuit not used for analyzing the operation of that system. The proposal relaxed the original rule to permit greater freedom of design in order to encourage the incorporation of desirable features in the system. The addition of the words “assisting” and “controlling” to the rule provided for the addition of automatic features to the system, and updated the rule in keeping with the then current state-of-the-art.

(3) Notice of Proposed Rulemaking 84-12 (49 FR 47358, December 3, 1984) proposed the addition of § 25.1165(h) to require that each engine ignition system of a turbine-powered airplane must be considered an essential electrical load. Compliance with § 25.1309(e) required such ignition systems to be considered essential electrical loads. This change would ensure that the requirement is not overlooked. One commenter to the proposal suggested that, since each engine has dual ignition systems, the wording should be changed to, “At least one ignition system per engine of a . . .”. The FAA did not concur with this commenter, since most ignition system designs either require or allow selection of both igniter systems (which would normally be the selection for certain flight conditions, such as icing); the complete ignition system should be considered an essential electrical load.

d. **Policy/Compliance Methods.** The following guidance is based upon material contained in Advisory Circular (AC) 29-2B, July 30, 1997**.** (Although that AC provides guidance for transport rotorcraft, it may provide insight into acceptable compliance methodology useful for other category aircraft.)

(1) Engine ignition systems. This section defines the design requirements for battery, generator, and magneto ignition systems installed in either reciprocating or turbine engine powered airplanes. The requirements specify common failure modes of batteries, generators, and installed wiring which must be considered in the design process and provides for crew warning of malfunctions.

(a) In a battery ignition system, a generator should be available to supply current to the engine ignition system if the battery fails. The generator power should be switched over automatically with an appropriate warning to the crew. The automatic switchover can be accomplished by a low voltage sensor which activates a relay that simultaneously activates a caution light in the cockpit.

(b) An electrical load analysis should be conducted to ensure that the capacity of the batteries and generator is large enough to meet the worst-case demands in the system. If there are other electrical system components installed which draw from the same source, the analysis should show that there is sufficient electrical power available from either the battery or the generator to operate all components simultaneously.

(c) The requirements of § 25.1165(c)(1) through (3), should be demonstrated by test. A proposed test plan should be coordinated with the FAA prior to conducting the testing.

(d) Compliance with the requirements of § 25.1165(d) can be shown by a failure mode and effect analysis.

(e) The requirements of § 25.1165(e) and (f) are self-explanatory.

e. **References.**

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

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

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

(4) Notice of Proposed Rulemaking 84-12 (49 FR 47358, December 3, 1984).

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

Section 25.1167 Accessory gearboxes.

a. **Rule Text.**

For airplanes equipped with an accessory gearbox that is not certificated as part of an engine-

(a) The engine with gearbox and connecting transmissions and shafts attached must be subjected to the tests specified in § 33.49 or § 33.87 of this chapter, as applicable;

(b) The accessory gearbox must meet the requirements of § 33.25 and § 33.53 or § 33.91 of this chapter, as applicable; and

(c) Possible misalignments and torsional loadings of the gearbox, transmission, and shaft system, expected to result under normal operating conditions must be evaluated.

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

b. **Intent of Rule.** The intent of this rule is to require substantiation of the accessory gearbox as part of the airframe comparable to that used in the substantiation of the gearbox when approved as part of the engine.

c. **Background.** Notice of Proposed Rulemaking 75-10 (40 FR 10802, on March 7, 1975), added § 25.1167 to 14 CFR Part 25 . No unfavorable comments were received on the proposal and it appeared in present form as Amendment 25-38 (41 FR 55467, December 20, 1976).

d. **Policy/Compliance Methods.** Guidance provided within Advisory Circular 33-2B, "Aircraft Engine Type Certification Handbook," dated June 30, 1993, for showing compliance to the referenced Part 33 requirements, is acceptable for showing compliance to this Part 25 section.

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 33-2B, "Aircraft Engine Type Certification Handbook," June 30, 1993.