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TITLE 14 - AERONAUTICS AND SPACE

CHAPTER I - FEDERAL AVIATION AGENCY

[Regulatory Docket No. 1925; Amendment 13-6]

PART 13 - AIRCRAFT ENGINE AIRWORTHINESS

Two and One-Half Minute Power Rating For Helicopter Turbine Engines

There is hereby being adopted an amendment of Part 13 of the Civil Air Regulations, to establish a 2½-minute power rating and associated test requirements for type certification of turbine engines intended for use in multiengine helicopters. Manufacturers of engines, and manufacturers and operators of multiengine helicopters may be affected by this amendment. The contents of this amendment were published by the Federal Aviation Agency as a notice of proposed rule making (28 F.R. 9697) and circulated as Notice 63-35 dated August 28, 1963.

The currently effective provisions of Part 7 of the Civil Air Regulations require for Category A that the takeoff performance be determined and scheduled in such a manner that, in the event of one engine becoming inoperative at any instant after the start of takeoff, it be possible for the rotorcraft either to return to and stop safely on the takeoff area, or to continue the takeoff climbout. For the landing approach, performance must be determined and scheduled in such a manner that, in the event of one engine becoming inoperative at any point in the approach path, it be possible for the rotorcraft to land and stop safely or to climbout safely. Under the present schedule of engine power ratings, takeoff power is used to show compliance with these requirements.

The rule being issued establishes a rated power, greater than takeoff, but limited in use to 2½ minutes, to determine takeoff and approach

performance when one engine of a multiengine helicopter becomes inoperative. This rating will improve the economics of domestically-built multiengine helicopters, will enhance the position of the United States manufacturers in the foreign market, and will not result in a degradation of safety.

With respect to the effect of the 2½-minute rating upon engine reliability, the limitations on turbine engine power and performance are determined, in a physical sense, by considerations of the cumulative turbine blade creep, which is dependent principally upon the temperature and mechanical loads to which the blades are subjected. There has been no clear criterion for establishing the absolute power limit of a turbine engine. The power ratings that are established represent compromises intended to produce engines which have reasonable performance, a satisfactory service life, and are able to complete the endurance test program satisfactorily. When the basis for the established ratings is evaluated against the fundamental consideration of material creep, it is seen that higher temperatures and speeds than are associated with rated power levels may be attainable. To date, however, there has been no particular effort by manufacturers to exploit this capability.

To grant engine power ratings in excess of takeoff power would not be justifiable if engine reliability were adversely affected. It is recognized that there are temperatures and/or speeds for any particular engine that could result in immediate and catastrophic failure. It is also recognized that continued operation of a particular engine at temperatures and/or speeds slightly higher than its established limits would probably cause an appreciable reduction in service life. It is

seen, however, that a 2½-minute power rating would be needed only in the event of an engine failure during takeoff or approach to landing. Service experience so far gathered with respect to multiengine helicopters indicates that this situation occurs relatively infrequently, hence, it would be expected that an engine would rarely be called upon to deliver 2½-minute power. On this basis, establishment of 2½-minute power would not adversely affect engine reliability by subjecting turbine blades to prolonged operations at elevated temperatures or speeds. A definition of the power is adopted as a new § 13.1(b)(5). The format of the definition differs from that in the currently effective regulations. It is consistent with that of a rated power and properly does not include limitations.

To establish that the introduction of 2½-minute power will not involve temperatures or speeds that would immediately impair engine reliability, and otherwise to establish that a satisfactory level of overall reliability exists when the selected 2½-minute rating is used, it is necessary that the endurance test schedule be modified for engines to be granted this rating. The endurance test schedule of § 13.254 is amended, therefore, to require that during the 150-hour endurance test the engine be operated at 2½-minute power during 50 periods of 2½-minutes duration. It is considered that this procedure will establish the reliability of the engine with a 2½-minute rating when operated in service under the conditions proposed for this rating.

Several comments were received on the notice of proposed rule making (28 F.R. 9697), and are discussed in the following numbered paragraphs.

1. One comment stated that the 2½-minute rating, as proposed in the notice, would result in a derated engine with only a small amount of extra power available for emergency use. This comment suggested a new "X-minute emergency rating" which would make available more power than the proposed 2½-minute rating, but which would be more restricted in use by requiring the engine to be inspected or overhauled after the emergency rating is used a specified number of times (preferably one time) and by requiring a device to prevent the engine from being started after such use. This comment also suggested that the engine testing for the X-minute emergency rating consist of 5 cycles at this power for each time the emergency power is to be made available without inspection or overhaul, and that this testing take place after the normal 150-hour test. The suggestion to establish a higher power emergency rating, based on fewer test cycles but having special inspection and overhaul requirements, represents a major substantive change from the proposal and is not within the framework of this regulatory action; consequently, the suggestion has not been incorporated in the amendment.

2. Another comment considered the proposed testing as reasonable to establish a 2½-minute rating, but expressed concern about the variety of power ratings and stated a belief that the 2½-minute rating should be a fully tested takeoff rating. The comment also indicated concern that the 2½-minute power rating would be abused in operations if it is an emergency rating which must be reported and must not be utilized more than once before overhaul. However, the 2½-minute rating is not one which requires such special reporting and engine overhaul after each use.

As explained previously, the 50 cycles of testing at 2½-minute power are considered adequate to assure safe operation of the remaining engines at this power on the relatively few occasions when a multiengine helicopter is operated with one engine inoperative during takeoff or landing. On the other hand, the 2½-minute rating is not a normal takeoff rating, since the total endurance testing at this power would be approximately 2 hours whereas the testing at takeoff power is approximately 18 hours. For this reason, the rotorcraft takeoff performance with all engines operating is determined with takeoff power under the provisions of Part 7. An engine which meets the present takeoff power testing would be expected to meet the 2½-minute power testing at a power somewhat higher than the takeoff rating. If the duration of the 2½-minute power testing were made comparable to the takeoff power testing, as suggested by the comment, the resulting engine rating would probably be about the same as present takeoff power, and no economic benefit would be obtained under the one-engine-inoperative performance requirements. In view of the foregoing, and since no specific justification was presented in support of this comment, it has not been incorporated in the amendment.

3. A comment was made that the words "or thrust" should be added after "horsepower" in the definition of 2½-minute power; otherwise, the rating would be restricted to shaft engines. Since the proposed rating and corresponding tests were developed expressly for helicopter engines, and the comment presented no reason or explanation for including thrust in the definition, it has not been incorporated in the amendment.

4. Another comment on the proposed definition of 2½-minute power noted that it referred to the horsepower developed at a single altitude, and stated that if the word altitude is needed in the definition, it should be plural. Although this power may be developed at various altitudes and the available power may vary with altitude, a specific condition is desirable for the purpose of establishing an engine "rating" under Part 13; consequently, the comment has not been incorporated in the amendment.

5. A comment concerning the paragraph on gas and oil temperatures in the proposed test requirements recommended that the following clause be added at the end of § 13.254(c)(7): ". . . except where the test periods are not longer than 5 minutes and do not permit stabilization." Since this addition is needed to allow for the problem of stabilizing temperatures during short test periods and is consistent with the current requirements of § 13.254(b)(7), it has been incorporated in the amendment.

Although this amendment to Part 13 establishes a 2½-minute power rating for the type certification of helicopter turbine engines, it should be noted that certain related provisions of Part 7 for the

certification of rotorcraft do not yet provide for this power rating. This is the case, for example, with respect to rotor drive mechanism endurance tests, engine cooling, and determination of the height-velocity diagram with one engine inoperative. A notice proposing appropriate amendments to Part 7 will, therefore, be issued in the near future.

Interested persons have been afforded an opportunity to participate in the making of this amendment (28 F.R. 9697), and due consideration has been given to all relevant matter presented. Since this amendment imposes no additional burden on any person, good cause exists for making it effective on less than 30 days' notice.

This amendment is subject to the FAA Recodification Program announced in Draft Release No. 61-25(26 F.R. 10698). This recodification, however, will not result in any substantive change in the rules as adopted herein.

This amendment is issued under the authority of sections 313(a), 601, and 603 of the Federal Aviation Act of 1958 (49 U.S.C. 1354, 1421, 1423).

In consideration of the foregoing, Part 13 of the Civil Air Regulations (14 CFR Part 13, as amended) is hereby amended as follows, effective April 22, 1964 :

1. By amending § 13.1(b) by redesignating subparagraphs (5), (6), (7), and (8) as (6), (7), (8), and (9), and by adding a new subparagraph (5) to read as follows:

13.1 Definitions.

* * * * *

(b) General design.

* * * * *

(5) 2½-minute power for helicopter turbine engines. 2½-minute power for helicopter turbine engines is the brake horsepower developed statically in standard atmosphere at sea level, or at a specified altitude, for one-engine-out operation of multiengine helicopters for 2½ minutes at rotor shaft rotational speed and gas temperature established for this rating.

2. By amending § 13.254 by deleting "or (b)" from the first sentence and inserting ", (b), or (c)" in lieu thereof, and by adding a new paragraph (c) to read as follows:

13.254 Endurance test. * * *

(c) Helicopter engines for which 2½-minute and 30-minute power ratings are desired.

(1) Takeoff, 2½-minute power, and idling. One hour of alternate 5-minute periods of engine operation shall be conducted at

takeoff power and thrust and at idling power and thrust except that, during the third and sixth takeoff power periods, only 2½ minutes will be conducted at takeoff power and the remaining 2½ minutes will be conducted at 2½-minute power. The developed powers and thrusts at takeoff, 2½-minute, and idling conditions and their corresponding rotor speed and gas temperature conditions shall be as established by the power control(s) in accordance with the schedule established by the manufacturer. It shall be permissible to control manually during any one period the rotor speed and power and thrust while taking data to check performance. For engines with augmented takeoff ratings which involve increases in turbine inlet temperature, rotor speed, or shaft power, this period of running at rated takeoff power shall be at the augmented rating. In changing the power setting after or during each period, the power control lever shall be moved in the manner prescribed in subparagraph (5) of this paragraph.

(2) 30-minute power. Thirty minutes of engine operation shall be conducted at 30-minute power, or thrust, or both.

(3) Maximum continuous power and thrust. Two hours of engine operation shall be conducted at the maximum continuous power and thrust.

(4) Incremental cruise power and thrust. Two hours of engine operation shall be conducted at the successive power lever positions corresponding with not less than 12 approximately equal speed and time increments between maximum continuous engine rotational speed and ground or minimum idle rotational speed. For engines operating at constant

speed, it shall be permissible to vary the thrust and power in lieu of speed. In the event significant peak vibrations exist anywhere between ground idle and maximum continuous conditions, the number of increments chosen shall be altered to increase the amount of running conducted while being subjected to the peak vibrations up to an amount not exceeding 50 percent of the total time spent in incremental running. (See also § 13.254)

(5) Acceleration and deceleration runs. Thirty minutes of engine operation shall be conducted of accelerations and decelerations consisting of 6 cycles from idling power and thrust to takeoff power and thrust and maintaining at the takeoff power lever position for 30 seconds and at the idling power lever position for approximately 4½ minutes. In complying with the provisions of this subparagraph, the power-control lever shall be moved from one extreme position to the other in not more than one second except that, where different regimes of control operations are incorporated necessitating scheduling of the power-control lever motion in going from one extreme position to the other, a longer period of time shall be acceptable but in no case shall this time exceed 2 seconds.

(6) Starts. One hundred starts shall be made, of which 25 starts shall be preceded by at least a 2-hour engine shutdown. Ten starts shall be false engine starts pausing for the applicant's specified minimum fuel drainage time before attempting a normal start. Ten starts shall be normal restarts, each performed not more than 15

minutes after engine shutdown. It shall be acceptable to make the remaining starts after completion of the 150 hours of endurance testing.

(7) Maximum temperatures. The limiting maximum hot gas and oil inlet temperatures shall be substantiated by operation at these limits during all the takeoff, 2½-minute power, 30-minute power, and maximum continuous running of the endurance test, except where the test periods are not longer than 5 minutes and do not permit stabilization.

Administrator

Issued in Washington, D.C., on April 17, 1964.