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UNITED STATES OF AMERICA
CIVIL AERONAUTICS BOARD
WASHINGTON, D. C.

Civil Air Regulations Amendment 13-1
Effective: August 12, 1957
Adopted: July 8, 1957

AIRCRAFT ENGINE AIRWORTHINESS

MISCELLANEOUS AMENDMENTS RESULTING FROM THE 1956 ANNUAL AIRWORTHINESS REVIEW

There are contained herein amendments with respect to various issues stemming from the 1956 Annual Airworthiness Review.

There exist certain differences in detail between the Civil Air Regulations effective heretofore and military specifications with respect to the endurance testing of turbine engines. These differences have caused some difficulty in the approval for civil use of engines developed for the military services. Accordingly, informal discussions were held between engine manufacturers and interested government agencies as a result of which a proposal for the amendment of Part 13 was submitted to the Board. The changes being made reflect in substance the proposal submitted differing, however, in that no provision is made to permit deducting the time in changing power settings from the endurance times specified for the various power and/or thrust conditions. Also, the changes herein require consideration of the augmented take-off rating in connection with the tests specified in paragraphs (b), (e), and (g) of § 13.254.

In addition, a change is being made to § 13.210 to require that a turbine engine be demonstrated to be capable of operation without serious power loss under icing conditions as specified in Part 4b of the Civil Air Regulations. Concurrently with this amendment, changes are being made in Part 4b relative to the intermittent maximum icing conditions to cover conditions more critical to turbine engine operation.

Important substantive provisions are being included in new §§ 13.116 and 13.216 relative to the structural integrity of turbine rotors under abnormal operating conditions and relative to the reliability and safety of systems, devices, and instruments affecting turbine rotor structural integrity. To this end, these new provisions are intended to require taking into account in the design of the turbine rotor, and its associated systems, all practicable safeguards.

There is also being included a provision in §§13.104 and 13.204 which requires turbine engine rotor cases to be designed so as to contain damage resulting from rotor blade failure.

The definitions in § 13.1 (b) are being changed to incorporate appropriate definitions with respect to turbine engine power and thrust. These new definitions are formulated to be generally applicable to the power and thrust of turbine engines under specified conditions of altitude, atmosphere, and flight speeds. It is not anticipated that these new definitions will affect the past procedure of rating engines under standard atmospheric conditions.

Several other changes of comparatively less substantive importance are also included.

Interested persons have been afforded an opportunity to participate in the making of this amendment (21 F.R. 9217), and due consideration has been given to all relevant matter presented.

In consideration of the foregoing, the Civil Aeronautics Board hereby amends Part 13 of the Civil Air Regulations (14 CFR Part 13, as amended) effective August 12, 1957.

1. By amending § 13.1 (b) (1) by inserting between the words "atmosphere" and "defined" the following: "(see NACA Technical Note 3182)".

2. By amending § 13.1 (b) (1) (iv) by deleting the expression "-67° F." and inserting in lieu thereof the expression "-69.7° F."

3. By amending § 13.1 (b) (1) (v) by deleting the numerals "0.002378" and inserting in lieu thereof the numerals "0.002377".

4. By amending § 13.1 (b) by amending subparagraphs (3) and (4); by redesignating subparagraphs (5) and (6) as subparagraphs (6) and (7), respectively; and by adding a new subparagraph (5) to read as follows:

13.1 Definitions. * * *

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(b) General design. * * *

(3) Take-off power or thrust.

(i) Take-off power for reciprocating engines is the brake horsepower developed under standard sea level conditions and under the maximum conditions of crankshaft rotational speed and engine manifold pressure approved for the normal take-off, and limited in use to a maximum continuous period as indicated in the approved engine specification.

(ii) Take-off power for turbine engines is the brake horsepower developed under static conditions at specified altitudes and atmospheric temperatures and under the maximum conditions of rotor shaft rotational speed and gas temperature approved for the normal take-off, and limited in use to a maximum continuous period as indicated in the approved engine specifications.

(iii) Take-off thrust for turbine engines is the jet thrust developed under static conditions at specified altitudes and atmospheric temperatures and under the maximum conditions of rotor shaft rotational speed and gas temperature approved for the normal take-off, and limited in use to a maximum continuous period as indicated in the approved engine specification.

(4) Maximum continuous power or thrust.

(i) Maximum continuous power for reciprocating engines is the brake horsepower developed in standard atmosphere at a specified altitude and under the maximum conditions of crankshaft rotational speed and engine manifold pressure, and approved for use during periods of unrestricted duration.

(ii) Maximum continuous power for turbine engines is the brake horsepower developed at specified altitudes, atmospheric temperatures, and flight speeds and under the maximum conditions of rotor shaft rotational speed and gas temperature, and approved for use during periods of unrestricted duration.

(iii) Maximum continuous thrust for turbine engines is the jet thrust developed at specified altitudes, atmospheric temperatures, and flight speeds and under the maximum conditions of rotor shaft rotational speed and gas temperature, and approved for use during periods of unrestricted duration.

(5) Gas temperature. Gas temperature for turbine engines is the temperature of the gas stream obtained as indicated in the approved engine specification.

5. By amending § 13.102 by designating the introductory paragraph as paragraph (a) and by adding a new paragraph (b) to read as follows:

13.102 Fire prevention. * * *

(b) External lines and fittings which convey flammable fluids shall be at least fire-resistant. The possibility of flammable fluid carrying lines deteriorating from heat, vibration, or fluid pressure so as to cause a fire hazard shall be minimized by appropriate design, shielding, or routing. The fire-resistant standards of § 4b.1 (g) (2) of this subchapter shall be applicable.

6. By amending § 13.104 by adding a new sentence at the end thereof to read as follows: "Compressor and turbine rotor cases shall be designed to provide for containment of damage from rotor blade failure."

7. By adding a new § 13.116 to read as follows:

13.116 Turbine rotors. To minimize the probability of failure of turbine rotors, the provisions of paragraphs (a) and (b) of this section shall be complied with.

(a) Turbine rotors shall be demonstrated to provide sufficient strength to withstand damage inducing factors such as those which might result from abnormal rotor speeds, temperatures, or vibration.

(b) The design and functioning of engine control devices, systems, and instrumentation shall be such as to give reasonable assurance that those engine operating limitations which affect turbine rotor structural integrity will not be exceeded in service.

8. By redesignating §§ 13.156 and 13.157 as §§ 13.157 and 13.158, respectively, and by adding a new § 13.156 to read as follows:

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13.156 Engine component tests.

(a) For those systems which cannot be adequately substantiated by endurance testing in accordance with the provisions of § 13.154, additional tests shall be conducted to establish that components are capable of functioning reliably in all normally anticipated flight and atmospheric conditions.

(b) Temperature limits shall be established for those components which require temperature controlling provisions in the aircraft installation to assure satisfactory functioning, reliability, and durability.

9. By amending § 13.202 by designating the introductory paragraph as paragraph (a) and by adding a new paragraph (b) to read as follows:

13.202 Fire prevention. * * *

(b) External lines and fittings which convey flammable fluids shall be at least fire resistant. The possibility of flammable fluid carrying lines deteriorating from heat, vibration, or fluid pressure so as to cause a fire hazard shall be minimized by appropriate design, shielding, or routing. The fire-resistant standards of § 4b.1 (g) (2) of this subchapter shall be applicable.

10. By amending § 13.204 by adding a new sentence at the end thereof to read as follows: "Compressor and turbine rotor cases shall be designed to provide for containment of damage from rotor blade failure."

11. By amending § 13.210 by adding a new paragraph (c) to read as follows:

13.210 Fuel and induction system. * * *

(c) The engine, with icing protection systems operating if provided, shall be capable of operation throughout the flight power range without accumulation of ice on the engine components such as to adversely affect engine operation or cause a serious loss of power and/or thrust, in continuous maximum and intermittent maximum icing conditions as defined in § 4b.1 (b) (7) and (8) of this subchapter.

12. By adding a new § 13.216 to read as follows:

13.216 Turbine rotors. To minimize the probability of failure of turbine rotors, the provisions of paragraphs (a) and (b) of this section shall be complied with.

(a) Turbine rotors shall be demonstrated to provide sufficient strength to withstand damage inducing factors such as those which might result from abnormal speeds, temperatures, or vibration.

(b) The design and functioning of engine control devices, systems, and instrumentation shall be such as to give reasonable assurance that those engine operating limitations which affect turbine rotor structural integrity will not be exceeded in service.

13. By amending § 13.250 by deleting from the second sentence the words "chosen by the applicant" and inserting in lieu thereof the word "applicable".

14. By amending § 13.251 by deleting the note thereunder.

15. By amending § 13.254 to read as follows:

13.254 Endurance test. The endurance test of an engine with a representative propeller (if applicable) shall include a total of 150 hours of operation consisting of 25 periods of 6 hours each as specified in this section. The runs shall be performed in such order as is found appropriate by the Administrator for the specific engine. During the endurance test the engine power and/or thrust and the engine rotational speed shall be controlled within ± 3 percent of the specified values. Each period of the 150-hour endurance test shall be conducted as follows:

(a) Take-off and idling. One hour of alternate 5-minute periods shall be conducted at take-off power and/or thrust and at idling power and/or thrust. The developed powers and/or thrusts at take-off 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/or thrust

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while taking data to check performance. For engines with augmented take-off ratings which involve increases in turbine inlet temperature, rotor speed, or shaft power, this period of running at take-off shall be at the augmented rating . For engines with augmented take-off ratings which do not materially increase operating severity, the amount of running conducted at the augmented rating shall be established by the Administrator. In changing the power setting after each period, the power-control lever shall be moved in the manner prescribed in paragraph (e) of this section.

(b) Maximum continuous and take-off. Fifteen periods each of 30 minutes' duration shall be conducted at maximum continuous power and/or thrust, and 10 periods each of 30 minutes' duration shall be conducted at take-off power and/or thrust.

(c) Maximum continuous power and/or thrust. One hour and 30 minutes shall be conducted at the maximum continuous power and/or thrust.

(d) Incremental cruise power and/or thrust. Two hours and 30 minutes shall be conducted at the successive power lever positions corresponding to at least 15 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, the thrust and/or power may be varied in lieu of speed. In the event significant peak vibrations exist anywhere between ground idle and maximum continuous conditions, the number of increments chosen may be altered to increase the amount of running conducted while being subjected to the peak vibrations up to an amount not to exceed 50 percent of the total time spent in incremental running. (See also § 13.251.)

(e) Acceleration and deceleration runs. Thirty minutes shall be conducted of accelerations and decelerations consisting of 6 cycles from idling power and/or thrust to take-off power and/or thrust and maintained at the take-off power lever position for 30 seconds and at the idling power lever position for approximately $4\frac{1}{2}$ minutes. In complying with the provisions of this paragraph, the power-control lever shall be moved from one extreme position to the other in not more than one second, except 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.

(f) 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 with not longer than 15 minutes since engine shutdown. It shall be acceptable to make the remaining starts after completion of the 150 hours of endurance testing.

(g) Maximum temperatures. The limiting maximum hot gas and, when practicable, oil inlet temperatures shall be substantiated by operation at these limits during all the take-off and maximum continuous running of the endurance test except where the test periods are of 5 minutes or shorter duration and do not always permit stabilization.

16. By redesignating §§ 13.256 and 13.257 as §§ 13.257 and 13.258, respectively, and by adding a new § 13.256 to read as follows:

13.256 Engine component tests.

(a) For those systems which cannot be adequately substantiated by endurance testing in accordance with the provisions of § 13.254, additional tests shall be conducted to establish that components are capable of functioning reliably in all normally anticipated flight and atmospheric conditions.

(b) Temperature limits shall be established for those components which require temperature controlling provisions in the aircraft installation to assure satisfactory functioning, reliability, and durability.

(Sec. 205(a), 52 Stat. 984; 49 U.S.C. 425(a). Interpret or apply secs. 601, 603, 52 Stat. 1007, 1009, as amended; 49 U.S.C. 551, 553)

By the Civil Aeronautics Board:

/s/ M. C. Mulligan

M. C. Mulligan
Secretary

(SEAL)

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