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CIVIL AERONAUTICS MANUAL 13



Aircraft Engine Airworthiness



December 1954

U. S. DEPARTMENT OF COMMERCE
Sinclair Weeks, Secretary
CIVIL AERONAUTICS ADMINISTRATION
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Aircraft Engine Airworthiness



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Introductory Note

Civil Aeronautics manuals are published by the Civil Aeronautics Administration to supplement and explain the Civil Air Regulations. This manual contains the first of a series of policies, interpretations, and rules which pertain to the current requirements of Part 13 of the Regulations of the Civil Aeronautics Board. Additional manual material on other sections will be issued from time to time to inform the public on acceptable means of showing compliance with the requirements of Part 13.

CAA *rules* are issued pursuant to authority conferred upon the Administrator in the Civil Air Regulations. Such rules are mandatory and must be complied with.

CAA *interpretations* define or explain words and phrases of the Civil Air Regulations. Such interpretations are for the guidance of the public and will be followed by the Administration in determining compliance with the regulations.

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The Administrator's rules, interpretations, and policies set forth acceptable procedures and practices for the guidance of the public in complying with the regulations. Other methods or practices which provide equivalent safety to those specified by the Administrator will also be acceptable. Any provisions which are shown to be inapplicable in a particular case may be modified upon request.

Part 13 of the Civil Air Regulations, available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., should be inserted in front of the table of contents and should also be consulted when using this manual. The table of contents is arranged to show the title and number of each section of the regulations. Any rules, policies, or interpretations follow the pertinent section of the regulations and are identified by consecutive dash numbers appended to the regulation section number. The text contains only the rules, policies, and interpretations which have been issued.

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Aircraft Engine Airworthiness

§ 13.18-1 *Approval of spark plugs for reciprocating engines (CAA policies which apply to § 13.18)*—(a) *General*. Spark plugs are considered to be an integral part of an aircraft engine and therefore should be tested with the engine to determine that the spark plug-engine combination will operate and perform satisfactorily. Upon successful completion of the applicable tests specified in this section the spark plugs will be approved and listed on the pertinent Aircraft Engine Specification.¹ This approval may be extended to other approved models of the same series of engines having equal or lower BMEP ratings or different series of engines of the same manufacture having similar combustion chamber characteristics and equal or lower BMEP ratings.

(1) *Facilities for testing*: The applicant requesting approval for the spark plug should provide the necessary facilities, equipment, personnel, etc., for conducting the tests. If the applicant does not possess such facilities, he may arrange for the tests to be conducted by qualified personnel at any appropriate agency which is available to undertake the work. Such agencies might include engine manufacturers, airlines, schools, universities, etc.

(b) *Nomenclature*. (1) *Spark plugs of new design*: Spark plugs of a type that has not been previously approved for use in any aircraft engine model.

¹ The aircraft engine specifications are contained in the Aircraft Engine Listing which may be obtained from the Civil Aeronautics Administration, Washington 25, D. C.

(2) *Spark plugs of an approved type*: Spark plugs of a type that has been approved for use in one or more specific aircraft engine models.

(3) *Spark plugs of a design similar to an approved type*: Spark plugs of a given manufacturer which are similar to an approved type spark plug previously designed by that manufacturer. This classification does not include spark plugs of one manufacturer that may appear to be similar to approved spark plugs designed by another manufacturer.

(4) *New engine models*: Engines scheduled for, or undergoing type certification testing prior to approval.

(5) *Active engines*: Engines which are currently being produced under a Type and/or Production certificate.

(6) *Obsolescent engines*: Engines not in production; somewhat inactive in service, but the type certificates for which have not been canceled.

(7) *Obsolete 150-hour engines*: Engines certificated under 150-hour endurance test, but the type certificates for which have been canceled.

(8) *Obsolete 50-hour engines*: Engines certificated under 50-hour endurance test, but the type certificates for which have been canceled.

(c) *Tests*²—(1) *General*. For engines with 6 cylinders or less, a full set of spark plugs of one type should be installed. For engines with 7 cylinders or

² Table 1 provides a ready reference to spark plug testing requirements for various types of engines.

more, either a full set of one type or two half-sets of different types of spark plugs may be installed. During the block or ground tests it should be determined that the spark plugs do not have an adverse effect in connection with the following:

Starting.
Acceleration.
Preignition.
Detonation.
Fouling.
Idling.
R. P. M. drop.
F/A ratio variations.
Distribution—F/A—leaded fuel.
T. O. M. C.: cruising powers and speeds.
Gap erosion rate.
Mechanical breakdown.
Ease of installation in engine.

(2) *Replacements.* Normal replacement of spark plugs is permissible during any test, i. e., up to 20 percent of the spark plugs may be replaced during any test provided related engine conditions are satisfactory.

(3) *Spark plug inspection.* At the completion of all block tests and at the intervals specified in each of the flight service tests the spark plugs should be inspected for any unsatisfactory conditions such as mechanical breakdown, gap erosion rate, fouling, etc.

(d) *Spark plugs for new engines.* All types of spark plugs proposed for use in new engines should be tested with the engine during the type certification tests.

(e) *Spark plugs for active engines—*
(1) *Spark plugs of new design or of a type that has been approved for use with other engine models.* Either of the procedures outlined below may be used to substantiate the airworthiness of spark plugs of these categories.

(i) *Block test.* This test should be conducted in accordance with the requirements of §§ 13.151 through 13.155.

(ii) *Ground and flight service test.*

(a) A 50-hour engine block test should be conducted in accordance with the requirements of § 13.154. The total time of each test run should be one-third of the time specified in that section; however, the time may be varied to meet special conditions. The vibration, cali-

bration and detonation tests prescribed in §§ 13.151 through 13.153 should be conducted during this test.

(b) The flight portion of the test should be conducted under normal operating conditions for 200 hours on an experimental (NX) basis. The spark plugs should be inspected in accordance with (c) (3) of this section at 30- to 50-hour intervals.

(2) *Spark plugs of a design similar to an approved type.* The manufacturer of a spark plug that is approved for a lower rated engine of a series of engines may modify the basic spark plug by changing its characteristics to accommodate the higher IMEP of other engines of the same series with higher hp ratings. The modified spark plugs will be granted approval for use with all engines of the particular model involved upon satisfactory completion of either of the procedures in (1) of this paragraph or the following ground and flight service test:

(i) *Ground test.* A 50-hour engine block test should be conducted in accordance with the requirements of § 13.154. The total time of each test run should be one-third of the time specified in that section; however, the time may be varied to meet special conditions. The vibration, calibration and detonation tests prescribed in §§ 13.151 through 13.153 should be conducted during this test. Upon satisfactory completion of this test, approval will be granted for limited use of the spark plug in aircraft for the purpose of flight service testing in not more than two aircraft as follows:

(ii) *Flight service test.* (a) When installed in engines of aircraft being operated under Parts 40, 41 or 42 of this subchapter, 250 hours of flight under normal operating conditions should be conducted and the spark plugs inspected in accordance with (c) (3) of this section at 30- to 50-hour intervals.

(b) When installed in engines of aircraft being operated under Part 43 of this subchapter, 100 hours of flight under normal operating conditions should be conducted and the spark plugs inspected in accordance with (c) (3) of this section at 20- to 25-hour intervals.

(f) *Spark plugs for obsolescent engines*—(1) *Spark plugs of a new design or of a type that has been approved for use with other engine models.* The test procedures outlined in (e) (1) apply.

(2) *Spark plugs of a design similar to an approved type.* It sometimes happens that the spark plug manufacturer may wish to tailor or redesign a type of spark plug previously approved for use in certain engines in order that the redesigned spark plug will be suitable for use in an obsolescent engine of a different series of engines. Upon satisfactory completion of the block test and the applicable flight service test specified below the redesigned spark plug will be granted approval for use in all engines of the particular model involved.

(i) *Block test.* This test should be conducted using the procedure of (e) (2) (i). Upon satisfactory completion of this block test approval will be granted for limited use of the spark plug in aircraft for the purpose of flight service testing in not more than two aircraft as follows:

(ii) *Flight service test.* (a) When installed in engines of aircraft being operated under Parts 40, 41 or 42 of this subchapter, 150 hours of flight under normal operating conditions should be conducted and the spark plugs inspected in accordance with (c) (3) of this section at 25- to 30-hour intervals.

(b) When installed in engines of aircraft being operated under Part 43 of this subchapter, 50 hours of flight under normal operating conditions should be conducted and the spark plugs inspected in accordance with (c) (3) of this section at 10- to 15-hour intervals.

(g) *Spark plugs for obsolete 150-hour engines*—(1) *Spark plugs of new design.* The test procedures outlined in (e) (1) apply.

(2) *Spark plugs of a design similar to an approved type.* Upon satisfactory completion of the preignition test and the applicable flight service test specified below, spark plugs of a type, or similar to a type which has been previously approved for use in one or more specific engine models, will be granted approval for use with all obsolete engine models

for which the approved spark plug used in the preignition rating test has been granted approval.

(i) *Comparative single cylinder preignition test.* This test should be conducted on a single cylinder engine acceptable to the CAA and should consist of the following: six approved spark plugs of a type currently considered acceptable for use in the obsolete engine and six test spark plugs of the type for which approval is desired should be tested to establish comparative preignition ratings. If the average IMEP rating of the test spark plugs falls within the range of plus or minus ten percent ($\pm 10\%$) of the average rating established for the approved type spark plugs, the test plug will be approved for limited use in an aircraft for the specific purpose of accomplishing one of the following flight service tests:

(a) When installed in not more than one-half of the engines of not more than two aircraft being operated under Parts 40, 41 or 42 of this subchapter, 150 hours of flight under normal operating conditions should be conducted and the spark plugs inspected in accordance with (c) (3) of this section at 25- to 30-hour intervals.

(b) When installed in engine(s) of not more than one aircraft being operated under Part 43 of this subchapter, 100 hours of flight under normal operating conditions should be conducted and the spark plugs inspected in accordance with (c) (3) of this section at 20- to 25-hour intervals.

(h) *Spark plugs for obsolete 50-hour engines*—(1) *Spark plugs of new design.* Either of the following procedures may be used to substantiate the airworthiness of spark plugs in this category:

(i) *Block test.* A 50-hour block test under conditions similar to those specified for the original type certification tests of the engine.

(ii) *Ground and flight service test.* (a) The ground test should be a 10-hour endurance test under conditions similar to those specified for the original type certification of the engine.

(b) The flight portion of the test should be conducted under normal operating conditions for 90 hours on an experimental (NX) basis. The spark plugs should be inspected in accordance with (c) (3) of this section at 25- to 30-hour intervals.

(2) *Spark plugs of a design similar to an approved type.* Upon satisfactory completion of the preignition test and the flight service test specified below, spark plugs of a type, or similar to a type which has been previously approved for use in one or more specific engine models, will be granted approval for use with all obsolete 50-hour engine models for which the approved spark plug used in the preignition rating test has been granted approval.

(i) *Comparative single cylinder pre-ignition test.* The test procedures outlined in (g) (2) (i) should be followed.

(ii) *Flight service test.* Upon satisfactory completion of the preignition test a 50-hour flight service test should be conducted under normal operating conditions in one airplane only. The spark plugs should be inspected in accordance with (c) (3) of this section at 20- to 30-hour intervals.

(i) *Alteration to approved spark plugs—(1) Major changes.* Any major change to an approved type spark plug requires substantiation normally by engine testing. A description of the change and substantiating data should be submitted to the CAA for evaluation and/or approval to determine whether testing is necessary before installing the modified spark plug in a certificated engine. Major changes include:

(i) Any alteration or modification which will appreciably change the IMEP rating of the spark plug.

(ii) The substitution of nonequivalent materials for the fabrication of major parts and assemblies of the spark plug.

(iii) Any other change which may adversely affect the operating characteristics and the airworthiness of the spark plug.

(2) *Minor changes.* Minor changes do not require CAA approval prior to in-

corporation in certificated engines, but should be included in the semi-annual drawing submittal for subsequent CAA approval. Minor changes include:

(i) Slight variations in tolerances and clearances.

(ii) Change to equivalent or improved material in minor parts.

(iii) Improvements in surface treatment of external areas.

(iv) Any other minor change which does not adversely affect the operating characteristics and the airworthiness of the spark plug.

(3) *Spark plugs tested by engine manufacturers.* The spark plug manufacturer supplies detailed information (usually on blue prints) to the engine manufacturer with respect to changes or alterations to approved type spark plugs. The engine manufacturer should include these changes in engine parts drawing submittals to the CAA.

(4) *Spark plugs tested by others than engine manufacturers.* Spark plug manufacturers and others who have obtained approval of a spark plug without testing by an engine manufacturer should submit all changes or alterations to the spark plug direct to the CAA.

(j) *Spark plugs for military engines—(1) Military approved spark plugs.* (i) Spark plugs approved by the military services for use in military engines whose commercial counterpart has been type certificated in accordance with CAR will be granted approval upon request for use in the civil counterpart of the military engine, providing their service experience in military operations has been satisfactory.

(ii) Spark plugs approved by the military services for use in a surplus military engine model which has subsequently been certificated under Group 5-E Specifications of the Aircraft Engine Listing,³ may be granted automatic approval for use in the engine, provided the military service experience of the spark plug has been satisfactory.

³ See footnote 1.

(2) *Replacement spark plugs for military engines.* (i) The test procedures outlined in (e), except (e) (2) (ii) (b) will apply to new or replacement spark plugs proposed for use in surplus military engines installed in aircraft being operated under Parts 40, 41 or 42 of this subchapter.

(ii) The test procedures outlined in (f), except (f) (2) (ii) (a) will apply to new or replacement spark plugs proposed for use in surplus military engines installed in aircraft being operated under Part 43 of this subchapter.

TABLE I—SPARK PLUG TEST SCHEDULE

Engine classification	New type spark plug		Approved spark plugs modified	
	Block test (hours)	Flight test (hours)	Block test (hours)	Flight test (hours)
New engines.....	150.....	0.....		
Active engines:				
(a) Air carrier aircraft.....	}		50 plus.....	250 NC
(b) Nonair carrier aircraft.....			50 plus.....	100 NC
Obsolescent engines:				
(a) Air carrier aircraft.....	150.....	0.....	50 plus.....	150 NC
(b) Nonair carrier aircraft.....	50 plus.....	200 NX.....	50 plus.....	50 NC
Obsolete engines:				
(a) 150-hour engines:				
(1) Air carrier aircraft.....	}		Preignition test plus.....	150 NC
(2) Nonair carrier aircraft.....			Preignition test plus.....	100 NC
(b) 50-hour engines:				
(1) Air carrier aircraft.....	}	No engines used 50 or 100 NX	No engines used	
(2) Nonair carrier aircraft.....			Preignition test plus.....	50 NC

CAVIATION
INFORMATION