U. S. DEPARTMENT OF COMMERCE

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CIVIL AIR REGULATIONS

13.—AIRCRAFT ENGINE AIRWORTHINESS

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CIVIL AIR REGULATIONS

13.—AIRCRAFT ENGINE AIRWORTHINESS

13.0—GENERAL.

13.00—Provision for Rating.—Pursuant to the provisions of the Air Commerce Act requiring the Secretary of Commerce to provide for the rating of aircraft as to their airworthiness, the requirements hereinafter set forth shall be used as a minimum basis for establishing such rating for aircraft engines for use in certificated aircraft.

13.01—Scope.

13.010—AIRWORTHINESS REQUISITES.—To show eligibility of an engine for certification the engine shall meet the requirements herein as to design, construction and testing. The manufacturer shall comply with the requirements by the submission of technical data and by conducting tests with suitable test equipment. The applicable requirements are set forth in CAR 13.1 through 13.5.

13.011—TYPE CERTIFICATE.—The general requirements for the issuance of a type certificate are set forth in CAR 01. The procedure relative to type certification of engines is set forth in CAR 13.6.

13.012—PRODUCTION CERTIFICATE.—The requirements for the issuance of a production certificate are set forth in CAR 01.

13.013—DEVIATIONS.—When an engine embodies a feature of design or construction which deviates from the practice in conventional internal-combustion types, application shall be made to the Secretary for special rulings covering the feature in question.

13.02—Light Aircraft Engines.—An uncertificated engine for certificated light aircraft (See CAR 04.01 (b)) will be assigned a power rating as to maximum power and speed upon compliance with CAR 13.50.

13.03—Testing Facilities.—A manufacturer submitting an engine for certification or power rating shall conduct all of the tests and supply or arrange for the testing facilities necessary to show compliance with the requirements contained herein.

13.04—Military Engines.—An engine of a type which has passed the regular endurance tests of and is approved by the United States Army Air Corps or the Bureau of Aeronautics, Navy Department, may be certificated in accordance with CAR 13.51.

13.05—Engine Operation Limits.—A certificated engine or a power-rated engine shall not be operated at a manifold pressure, crankshaft speed or horsepower greater than assigned thereto by the Secretary.

13.06—Engine Identification Plate.—A plate shall be permanently attached to the engine in such location as to be readily accessible when the engine is installed in aircraft and shall contain the following information: manufacturer's name; name, model designation and serial number of the engine; certified manifold pressure, crankshaft speed and power limits; and minimum octane number of the fuel.

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13.07—Previously Approved Engines.—These regulations supersede the requirements for approval of engines set forth in previous regulations. However, engines rated as suitable for use in approved aircraft in accordance with previous requirements may be used in certificated aircraft at the discretion of the Secretary.

13.1—DESIGN REQUIREMENTS.

13.10—An engine of more than 100 horsepower shall be equipped with a dual ignition system having at least two spark plugs per cylinder.

13.11—An engine and its accessories shall be so designed and constructed as to reduce to a minimum the chances of failure to function in the air and of fire during flight or in the event of a crash.

13.12—Provision shall be made for the installation of a means for preventing the formation of ice in the carburetor.

13.13—An engine shall operate smoothly with no undue vibration at speeds which may be used for continuous operation.

13.14—The fuel system of an engine shall be of such design that it will continue to supply a satisfactory mixture when tilted to the various angles encountered in normal flight maneuvers.

13.2—COMMERCIAL SEA LEVEL ENGINE.

13.20—Data Required.—In the case of an engine of a type which has not been previously approved by the Army or Navy, and for which the manufacturer desires the certification of the Secretary, the following information shall be submitted:

13.200—(*a*) Application for type certificate on Form AC 13-1 which will be furnished for the purpose by the Secretary.

13.201—(*b*) A test report, satisfactory to the Secretary, including a log and an affidavit, describing in full detail the manufacturer's block test of an engine of the type for which certification is desired. The test shall be of at least 100 hours duration, of which 50 hours shall be at full throttle at an average speed within plus or minus 3 per cent of the proposed rated speed and 50 hours at 75 per cent of the proposed rated power at propeller load speed. The submission of this test report will not be deemed necessary by the Secretary for modified engines of a type previously tested which do not incorporate changes in the general arrangement, number of cylinders or displacement, or an appreciable increase in power or speed.

13.202—(*c*) Data suitably describing the status of the engine to be used for the endurance test prescribed in CAR 13.23. The manufacturer may use any engine of the type for which certification is desired, regardless of its previous history, provided all defects which became apparent in the 100-hour manufacturer's test have been explained or corrected to the satisfaction of the Secretary. Such data shall include the permissible maximum and normal cylinder head temperatures determined by the manufacturer for the engine.

13.203—(*d*) A complete set of drawings descriptive of the engine, which drawings shall be numbered and dated, and shall include change letters for each revision. Drawings of small standard commercial parts need not be submitted, but all other drawings applying to the engine, including those of the assembly and installation, shall be included. The materials shall be specified on the drawings by reference to specification numbers of the Army, Navy, S. A. E., or other such recognized standard whenever possible. If the manufacturer refers to his own specification numbers, details of such specifications shall be furnished the Secretary. All drawings shall be folded to a size approximately 9 by 12 inches, with title showing. In order to eliminate a possible source of controversy, the Secretary will not accept drawings which can be

altered after approval. Blueprints, photostats or the equivalent are acceptable. If certain of the drawings required for a particular engine are identical with drawings previously submitted and approved in connection with a prior type of engine made by the same manufacturer, such drawings need not be again submitted.

13.204—(*e*) A complete parts list in duplicate, showing the drawing number, change letter, if any, and name of each component part of the engine. The drawing numbers shall be listed in numerical order.

13.205—(*f*) A detailed report, supported by affidavit, of a 10-hour flight test of the engine. This test shall include a climb at full throttle to 15,000 feet or to the service ceiling of the airplane. The report shall completely describe the test and the results thereof and shall include dates, the names of persons involved and particulars of the airplane. The engine used for this test may be the same engine as submitted for the endurance test or may be another engine of the same type.

13.21—Procedure for Submitting Data and Conducting Tests.—Upon receipt of satisfactory data in accordance with CAR 13.200 through 13.202, the Bureau of Air Commerce will authorize an inspector to examine the manufacturer's testing facilities. If the facilities conform to CAR 13.22, the inspector will witness the official tests and tear-down inspection outlined in CAR 13.23 through 13.27. Certification of the engine is then contingent upon the submission by the manufacturer of a satisfactory report signed by the inspector in accordance with CAR 13.4, and the data described in CAR 13.203 through 13.205.

13.22—Testing Equipment.—Equipment satisfactory to the Secretary shall be provided by the manufacturer and shall include personnel necessary to conduct the tests outlined in CAR 13.23, 13.24 and 13.25. The following equipment represents a minimum for this purpose:

(*a*) Electric cradle dynamometer (may be used in conjunction with a water brake absorbing up to to 80 per cent of the total horsepower) or torque stand (requires air straightening grid when used for calibration runs). A fixed stand may be used for the endurance test outlined in CAR 13.23.

(*b*) Propellers suitable for maintaining the speeds and power outputs required.

(*c*) Tachometer or other accurate means of indicating crankshaft speed. (Counter and stop watch required for frequent checks.)

(*d*) Manometer for measuring maifold pressure.

(*e*) Means for measuring engine air intake pressure and temperature.

(*f*) Oil pressure gauge.

(*g*) Suitable thermometers to measure oil inlet and outlet temperatures.

(*h*) Manometer to measure bubble pressure or air speed indicator to measure air velocity over the cylinder head of an air-cooled engine. (Shall be measured at a position approximately half-way between the cylinders and in line with the valve heads when practical.)

(*i*) Thermocouples for all cylinder heads and barrels of an air-cooled engine. (Shall be located at rear spark plug gasket and near rear cylinder hold-down nut on thrust side.)

(*j*) Suitable thermometers to measure liquid inlet and outlet temperatures in the case of liquid-cooled engines.

(*k*) Apparatus for measuring fuel consumption by weight or volume.

(*l*) Apparatus for measuring oil consumption by weight.

(*m*) Barometer.

(*n*) Dry and wet bulb thermometers.

13.23—Endurance Test.—A 50-hour full throttle endurance test of the engine described in accordance with CAR 13.202 shall be run in periods of at least 5 hours each on consecutive working days except that interruptions to such schedule are permissible if explained to the satisfaction of the Secretary. The test shall be witnessed by an authorized Bureau inspector.

13.230—The engine shall be run at a speed approximately equal to the proposed rated speed and with the manufacturer's recommended setting of the ignition timing, mixture control and intake heat control. The grade of fuel used during the test will be the lowest approved for

use in the engine when certificated. Excessive adjustment to the engine or dependence upon excessive fuel or oil consumption for proper cooling during the test will be considered cause for denial of certification by the Secretary.

13.231—Not more than three forced stops caused by the engine shall be allowed during the endurance test. A run of 5 hours shall be added to the test for each forced stop made. Failure of accessories shall not necessarily be considered a forced stop. If the power in a dynamometer run drops as much as 10 per cent, due allowance being made for atmospheric conditions, this shall constitute a forced stop. If a propeller is used to absorb the power during the endurance test, variations in speed of plus or minus 3 per cent are permissible. A variation in speed in excess of this amount due to atmospheric conditions will not be considered a forced stop but the propeller shall be changed to correct for the conditions. Excessive water, fuel or oil leaks developing at the engine shall constitute forced stops. In all cases the Secretary shall be the judge as to what constitutes a forced stop. An engine failure of a type which could cause an immediate forced landing in flight or require the replacement of a major part of the engine shall terminate the test.

13.232—Complete readings of the performance of the engine shall be recorded at least every half-hour throughout the endurance test. The following readings are essential:

(*a*) Crankshaft speed in revolutions per minute.
(*b*) Manifold pressure.
(*c*) Temperatures of the two hottest cylinder heads and barrels if air-cooled, or of the inlet and outlet liquid if liquid-cooled.
(*d*) Fuel consumption.
(*e*) Oil consumption.
(*f*) Oil inlet and outlet temperatures.
(*g*) Oil pressure.
(*h*) Air velocity or pressure difference over the cylinder heads if air-cooled.
(*i*) Barometric pressure.
(*j*) Temperature (dry and wet bulb).
(*k*) Engine air inlet temperature and pressure.

13.24—**Take-Off Rating.**—If a take-off rating in excess of the endurance test rating is desired, the engine shall be run 10 hours at the take-off power and crankshaft speed. This test may be run as the last 10 hours of the 50-hour endurance test required by CAR 13.23 or as a separate test. The take-off output may be maintained continuously for 5-hour periods or may be maintained for 5 minutes and the engine idled for 5 minutes, consecutively, in which case the duration of the take-off testing shall total 20 hours. Take-off ratings of more than 10 per cent in power or in speed in excess of the endurance test output will require additional tests and a special ruling by the Secretary.

13.25—**Calibration Test.**—A full throttle power versus speed calibration of the engine shall be made before or after the endurance test outlined in CAR 13.23 and shall be witnessed by an authorized Bureau inspector.

13.250—Full throttle runs shall be made at crankshaft speed intervals of approximately 100 revolutions per minute from 75 to 110 per cent of the proposed rated speed by varying the load. Each speed shall be maintained for at least 2 minutes, or until operating conditions have stabilized, before a reading is taken.

13.251—The engine shall be operated during the calibration test at the manufacturer's recommended setting of the ignition timing, mixture control and intake heat control. The power rating assigned to the engine by the Secretary will correspond to the corrected horsepower obtained during the calibration test at a crankshaft speed within 25 revolutions per minute of the average speed maintained during the endurance test. This corrected horsepower

shall be the observed horsepower corrected to standard conditions for the pressure, temperature and humidity existing in the air intake of the carburetor just ahead of the venturi. Standard conditions are a barometric pressure of 29.92 inches of mercury, an air temperature of 60° F., and a water vapor pressure of 0.39 inch of mercury. It is recommended that a suitable correction, satisfactory to the Secretary, be further applied to the horsepower when the calibration test is conducted with cooling air of a temperature and velocity which differ materially from 60° F. and the velocity normally to be encountered in flight, respectively.

13.252—Essential readings for each run during the calibration test shall be the same as listed in CAR 13.232 except that torque, observed horsepower and corrected horsepower shall be recorded and the oil consumption need not be.

13.26—Operation Test.—At the conclusion of the endurance or the calibration test the engine shall be operated in the presence of the Bureau inspector at various speeds throughout its operating range to demonstrate the idling, acceleration and running characteristics, which shall be satisfactory to the Secretary.

13.27—Tear-Down Inspection.—After completion of the endurance and calibration tests a complete tear-down and detailed inspection of engine parts shall be made, particular attention being paid to excessive wear or signs of failure. The Bureau inspector will check the conformity of the engine parts with the set of drawings to be submitted by the manufacturer. As a result of the inspection the Secretary may require, prior to certification, such revisions and additional tests as appear necessary to establish the airworthiness of the engine, or he may deny certification notwithstanding the completion of the tests described in CAR 13.23 and 13.24.

13.28—Geared Engines.—Complete tests as outlined herein are required for the certification of geared engines. Unless the horsepower loss due to reduction gears is appreciable, a geared engine may, at the option of the engine manufacturer, retain the same power rating as a previously approved identical engine with direct drive.

13.3—COMMERCIAL ALTITUDE ENGINES.

13.30—Tests.—An engine which is not designed for full throttle continuous operation at sea level shall be tested and rated as an altitude engine. The requirements for certification of such an engine are identical with those outlined in CAR 13.2 with the following exceptions.

13.300—The manufacturer's test outlined in CAR 13.2 may be conducted at proposed rated power instead of at full throttle.

13.301—The flight test shall be in accordance with CAR 13.205 (f) except that the engine need not be operated at full throttle below the rated altitude.

13.302—The endurance test shall be conducted at a power and speed of at least that at which the manufacturer desires the engine to be rated. In lieu thereof, when the engine is highly supercharged, the test may be conducted at at least the manifold pressure and rated speed which the engine will develop at the proposed rated altitude. In such a case an engine identical except for the supercharger drive shall also be tested at the power and speed at which the manufacturer desires the engine to be rated. When the engine is highly supercharged and is endurance tested at less than rated power, it will be limited for take-off operation to the power developed during this endurance test unless a take-off test in accordance with CAR 13.24 is made to establish the airworthiness of the engine for take-off at higher power.

13.303—The calibration test shall consist of the following:

(*a*) A full throttle calibration at sea level in accordance with CAR 13.25 except that outputs above the proposed rated power need not be maintained 2 minutes before a reading is taken. This calibration may be omitted if the engine is highly supercharged.

(*b*) Constant speed runs made by varying the load and the throttle to determine curves of horsepower versus manifold pressure. Curves shall be obtained at crankshaft speed intervals of 100 revolutions per minute from 100 revolutions per minute in excess of the proposed rated speed down to the manufacturer's recommended cruising speed of the engine. For each speed, such curves shall extend from approximately 75 per cent of the average manifold pressure of the engine during the endurance test to 110 per cent of such manifold pressure.

13.31—Altitude Rating.—The rated altitude shall be that altitude at which the engine develops the rated power and speed at full throttle under standard altitude conditions with the grade of fuel used during the endurance test. When equipment is available, calibration tests simulating altitude conditions shall be made to determine the rated altitude and the characteristics of the engine between the rated altitude and sea level. In lieu of such testing the Secretary will accept such empirical methods of determining the altitude performance of the engine as are substantiated by simulated altitude tests of similar engines or by extensive flight tests. The manufacturer shall in each case submit for the consideration of the Secretary all references, test data and curves upon which the manufacturer's estimate of the altitude performance is based.

13.32—Limitations Applied to Altitude Engines.—The manufacturer shall submit to the Secretary suitable curves descriptive of the performance of the engine for take-off, climb, cruising, and high speed at all altitudes between sea level and the rated altitude. It is recommended that these curves be plotted on a single sheet with horsepower versus crankshaft speed or manifold pressure at sea level, and with horsepower versus altitude above sea level. Full speed lines shall be indicated. The manufacturer shall also indicate on these curves the limitations desired. The Secretary will issue limiting instructions for the operation of the engine, a copy of which the manufacturer shall supply with each engine delivered for use in certificated aircraft. CAR 04 outlines the operating limitations applied to altitude engines.

13.4—TEST REPORT.—The manufacturer of an engine which is tested in accordance with CAR 13.2 or 13.3 shall prepare a suitable report describing the test equipment, testing and tear-down inspection. The report shall be completely descriptive of the test and shall include all essential details. The report shall be signed and sworn to by the responsible representative of the engine manufacturer and shall include the following information:

13.40—(*a*) A description and photographs of the testing equipment. (This description need not be included if a previously submitted report adequately describes the equipment used, in which case reference shall be made to such report.)

13.41—(*b*) A chronological description of the endurance testing, covering the events of each period of running. All irregularities, failures and forced stops shall be fully discussed. A table or chart showing all readings recorded during the test shall be included.

13.42—(*c*) A description of the calibration testing, and a table of all readings and corrections. The results shall be plotted as curves of brake-mean-effective pressure, corrected horsepower, manifold pressure, cylinder head or cooling liquid temperatures and fuel consumption versus crankshaft speed.

13.43—(*d*) A description of the condition of the engine parts as determined from the complete tear-down and detailed inspection of the engine after testing. Photographs of all failures or excessively worn parts shall be included.

13.44—(*e*) Photographs of the engine (front, side, and two three-quarter rear views).

13.5—SPECIAL ENGINES.

13.50—Power-Rated Engines for Light Aircraft.—In the case of engines which are to be installed in light aircraft as defined in CAR 04, and for which the manufacturer desires the Secretary to assign a maximum power and speed rating only, the data submitted shall include the following:

(*a*) An application for power rating, submitted on the same form as is furnished by the Secretary to applicants for a type certificate. When used for this purpose the form shall be altered by the applicant by crossing out the words "Type Certificate" in the heading and substituting the words "Power Rating".

(*b*) One set of general assembly drawings sufficiently well-dimensioned to show the general specifications of the engine.

(*c*) A complete report of a power rating test which shall consist of a 5-hour run on a test stand with the throttle wide open, and at the speed at which a rating is desired. If the corrected horsepower cannot be determined satisfactorily from this test, a calibration test may be made after the 5-hour run. The report shall include a detailed log of the 5-hour test and a description of the test stand and instruments used. Details of the equipment and of the calculations used to determine the corrected horsepower shall also be included.

13.51—Military Engines.—In the case of an engine of a type which has previously been approved by the Army or Navy and for which the manufacturer desires certification by the Secretary, the following data shall be submitted:

(*a*) An application as described in CAR 13.200.

(*b*) A copy of the official Army or Navy endurance test report which was the basis for the military approval, signed by the Army or Navy representative who witnessed the test. It is not necessary for the manufacturer to submit this report when such report has previously been forwarded to the Secretary through official channels. When the report is being prepared by the military agency the Secretary, to expedite approval, may in the interim accept a copy of the official letter of approval of the engine, which letter shall include the military rating and calibration curves.

(*c*) Drawings as described in CAR 13.203.

(*d*) A parts list as described in CAR 13.204.

(*e*) A report of a flight test as described in CAR 13.205, or a statement from the Army or Navy to the effect that such flight tests have been satisfactorily conducted in the Army or Navy service.

13.52—Modified Engines.—When a manufacturer desires certification by the Secretary of an engine which embodies a modification of a certificated engine of the same manufacturer, data shall be submitted and tests conducted as follows:

13.520—(*a*) If the manufacturer desires to increase the rated power or rated speed, or if the modification is of such extent (in the opinion of the Secretary) as to require endurance testing, the modified engine shall be considered a new design which will be eligible for certification upon compliance with CAR 13.2, 13.3 or 13.51, whichever may apply.

13.521—(*b*) If no increase in rated power or rated speed is involved and the modified engine embodies only a minor modification of the certificated engine, and if technical data are submitted to the Secretary which demonstrate conclusively that the airworthiness of the modified engine is at least equal to that of the certificated engine, data shall be submitted in accordance with CAR 13.200, 13.203 and 13.204, and a report of calibration testing shall be submitted in accordance with CAR 13.25, 13.303, 13.31 or 13.42, whichever may apply.

13.6—PROCEDURE RELATIVE TO TYPE CERTIFICATION.

13.60—General.—The procedure and general requirements for the issuance of a type certificate shall be as prescribed in CAR 01.

13.61—Sealed Drawing List.—When a type certificate is granted, a drawing list representative of the certificated engine is impressed with the seal of the Bureau of Air Commerce and is returned to the manufacturer. Bureau inspectors may call for, and must have access to, the sealed drawing list and the pertinent drawings when making an inspection at the manufacturer's plant to determine whether the engines as built conform to the approved data.

13.62—Major Changes.—Any major change from the approved drawings must be approved in advance by the Secretary. A change shall be considered major within the meaning of these regulations if it adversely affects the reliability or increases the power output of the engine. In all doubtful cases the decision of the Secretary will establish the category within which a specific change shall be included.

13.620—Information accompanying a request for approval of a major change to a certificated engine shall include sufficient technical data and reports of tests (when necessary) to demonstrate to the satisfaction of the Secretary that the changed engine is airworthy. Reports shall be signed and sworn to by the responsible representative of the manufacturer. When it is deemed necessary by the Secretary, an endurance test witnessed by an authorized Bureau inspector will be required to substantiate the airworthiness of specific changes, and particularly when a change is such as to increase materially the power output of the engine.

13.63—Minor Changes.—On January 1 and July 1 of each year the holder of an engine type certificate shall submit, for approval and file, drawings pertaining to all the minor changes made to the engine during the preceding 6-month period.

13.7—ENGINE PARTS.—Only structural engine parts which are approved by the Secretary may be used to modify, maintain or repair certificated engines. Replacement parts will be approved provided the airworthiness of the replacement part is proven to the satisfaction of the Secretary at least equal to that of the original part by technical data or tests, or both; or provided an engine of the specific type has been equipped with the part and has satisfactorily completed an endurance test as prescribed in CAR 13.23; or provided the manufacturer submits an official Army or Navy report approving the part for the engine. Drawings of the part shall be submitted and the factory of the manufacturer shall be inspected for its suitability to produce the part. If the part supplied constitutes a major modification of the engine when installed, the engine shall be considered a new design and as such will be eligible for certification only on compliance with all of the regulations pertaining thereto.

13.8—ENGINE ACCESSORIES.—An engine will be tested and certificated as a complete powerplant including all engine accessories that are attached to the engine and are essential for its proper operation in the air. Cowling, exhaust manifolding and mufflers need not be included, as these items are subject to inspection and approval in each type installation on certificated aircraft. Propellers, propeller hubs and propeller blades are also subject to separate certification under the requirements outlined in CAR 14.

13.80—Tests.—At the time of the endurance tests the Secretary will require such additional tests as may be necessary to determine the airworthiness of the engine with the attached accessories. It is recommended that the manufacturer install on the engine, at the time of the test, the accessories with which he may desire the engine to be certificated. Engines may be certificated with other accessories provided the airworthiness of the engine with such other accessories is demonstrated by sufficient technical data, including certified reports of tests when necessary. Additional endurance tests of the engine as described in CAR 13.3 or 13.4 may be necessary if the accessory change constitutes a major modification of the engine.

13.81—Certification.—Engine accessories as described in CAR 13.8 are not eligible for separate certification.

Any and all rules or regulations made, established, and issued by the Secretary of Commerce pursuant to law as are inconsistent with the provisions of the above specified civil air regulations are hereby repealed.