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CIVIL AERONAUTICS MANUALS—Volume II

Federal Aviation Agency

Civil Aeronautics Manuals and supplements thereto are issued by the Bureau of Flight Standards, Federal Aviation Agency, for the guidance of the public and are published in the Federal Register and the Code of Federal Regulations.

Supplement No. 25 **January 15, 1959**

SUBJECT: Revisions to CAM 3 dated October 1956, CAM 4b dated January 1958, and CAM 6 dated November 1956.

This supplement is issued to provide revised pages for the subject manuals.

The revisions present FAA interpretation of the term "manufacturer" as applied to persons signing the statement of conformity under the Technical Standard Order system, and presents FAA policies for the approval of aeronautical products as a part of the airplane.

Effective January 1, 1959, the new Federal Aviation Agency (Administrator—E. R. Quesada) absorbed the Civil Aeronautics Administration and has assumed all of the functions and responsibilities of CAA. Technical information in the Civil Aeronautics Manuals has not been affected by FAA's assumption of CAA operational responsibilities.

New material is indicated by brackets with the exception of appendix I to CAM 4b. Since the appendix is entirely new, the usual brackets have been omitted.

Remove and destroy the following pages:	*Insert the following new pages:*
CAM 3—III and IV	CAM 3—III and IV
9 and 10	9 through 10–1
65 and 66	65 and 66
CAM 4b—III	CAM 4b—III
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Attachments.

Introductory Note

Civil Aeronautics Manual 3 contains in a consolidated form all manual material issued against Part 3 of the Civil Air Regulations to date.

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

CAA *policies* provide detailed technical information on recommended methods of complying with the Civil Air Regulations. Such policies are for the guidance of the public and are not mandatory in nature.

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.

The manual is arranged to show the number of each section of the regulation followed by the title of the particular section in italic letters. Any rules, policies, or interpretations follow the pertinent section of the regulation and are identified by consecutive dash numbers appended to the regulation section number.

This manual includes and supersedes supplements numbers 1 and 2 issued on September 19, 1955, and January 20, 1956. Moreover, the contents of this manual supersede any contradictory material found in any Flight Operations and Airworthiness Release or like publication outstanding on the issuance date of this manual.

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shall be deemed to have met the requirements for approval when it meets the pertinent specifications adopted by the Administrator, and the manufacturer so certifies in a manner prescribed by the Administrator.

3.18–1 *Approval of materials, parts, processes, and appliances (CAA rules which apply to sec. 3.18).* Aircraft materials, parts, processes, and appliances made the subject of Technical Standard Orders shall be approved upon the basis and in the manner prescribed in Part 514[6] of this title, Technical Standard Orders—C-Series—Aircraft Components.

(CAR, Supp. 14, 17 F. R. 9065, Oct. 11, 1952.)

3.18–2 *Application of the Technical Standard Orders (TSO) System; C Series (CAA policies which apply to sec. 3.18).*

(a) *Purpose of Technical Standard Orders.* Technical Standard Orders are a means by which the Administrator adopts and publishes the specifications for which authority is provided in section 3.18 (a).

(b) *Applicability of Technical Standard Order requirements.*

(1) The applicability of and effective dates for TSO items are set forth in each TSO.

(2) Each Technical Standard Order sets forth the conditions under which materials, parts, processes, and applicances approved by the Administrator prior to establishment of an applicable TSO, may continue to be used in aircraft.

(3) The establishment of a Technical Standard Order for any product does not preclude the possibility of establishing the acceptability of a similar product as part of an aircraft, engine, or propeller, under the type certification or modification procedures, if there is established a level of safety equivalent to that provided in the regulations in this subchapter as implemented by the appropriate Technical Standard Order and the product is identified as part of the airplane, engine, or propeller.

(c) *Administration of the Technical Standard Order (TSO) system.* The principles which apply in administering the Technical Standard Order system are as follows:

(1) Technical Standard Orders will reference performance provisions of recognized government specifications, or established industry specifications which have been found acceptable by the CAA. If no satisfactory specification exists, the Orders will include criteria prepared by the Administrator. In preparing criteria of this type, the Administrator will give consideration to recommendations made by the industry.

(2) Minimum performance requirements established by the Civil Aeronautics Administration and published in Technical Standard Orders will serve as a means by which materials, parts, processes, and appliances intended for use in certificated aircraft will be accepted.

(3) TSO's set forth the minimum requirements for safety. Every effort will be made by the CAA to keep the requirements at the minimum levels of safety and TSO's will not be used to set forth "desirable" standards.

(4) It will be the responsibility of the person submitting a statement of conformance to the CAA, certifying that his product meets the requirements of the TSO, to conduct the necessary tests demonstrating compliance therewith. This person will be held responsible for maintaining quality control adequate to assure that products which he guarantees to meet the requirements of a TSO do, in fact, meet these standards. The CAA will not formally approve such products as meeting the requirements of TSO's nor exercise direct inspection control over them. The statement of conformance with the provisions of a Technical Standard Order normally will be accepted by the CAA as sufficient indication that the applicable requirements have been fulfilled.

Any TSO item which is modified must continue to comply with the requirements of the TSO; and the person authorizing the modification will be responsible for such compliance.

(d) *Numbering of Technical Standard Orders.* Each Technical Standard Order will be assigned a designation consisting of the letters "TSO," a series code letter "C" indicating aircraft materials, parts, processes, and appliances, and a serial number to be assigned in sequence for each of the TSO's issued in the "C" series, e. g., TSO–C–1, "Smoke Detectors." Revisions

[6] Copies of individual TSO's contained in Part 514 of this title are available upon application to the Aeronautical Reference Division, Attn. W–126, Civil Aeronautics Administration, Washington 25, D. C.

are indicated by the addition of letters a, b, c, etc., after the number.

(CAR, Supp. 14, 17 F. R. 9065, Oct. 11, 1952.)

[3.18–3 *Manufacturer (CAA interpretations which apply to sec. 3.18 (b)).* For the purpose of accepting a statement of conformance for a Technical Standard Order Product, the word "manufacturer" is interpreted to mean a person who designs and fabricates by welding, cutting, drilling, forming, bolting, riveting, glueing, soldering, sewing, etc., a product. This includes products which are composed in whole or in part of components of TSO products. One who merely cleans products or appliances or repairs them by replacing standard parts and/or by replacing components with identical ones is not considered to be the manufacturer. Nor is the distributor of another person's completed product considered to be the manufacturer.]

(23 F. R. 10323, Dec. 25, 1958, effective Jan. 31, 1959.)

[3.18–4 *Products approved as a part of the airplane (CAA policies which apply to sec. 3.18).*

[(a) A material, part or appliance (hereinafter called product) may be approved as a part of the airplane type design under a type certificate or a supplemental type certificate.

[(1) If a Technical Standard Order covering the product is in effect, the applicant for approval should submit type design data showing that the product meets the performance standards of the Technical Standard Order except that:

[(i) Deviations from the performance standards may be allowed when the applicant for, or holder of, the type certificate or the supplemental type certificate substantiates that other performance standards are applicable for the product as installed in the airplane. Any deviation from standards prescribed in this part may be allowed only in accordance with section 3.10.

[(2) Where no TSO covering the product exists, the applicant for approval should submit type design data showing compliance with all the requirements of this part which are applicable to the product.

[(3) Products previously approved by the CAA by means of letters of approval, Repair and Alteration Form ACA–337, or listing on CAA Product and Process Specifications will continue to be eligible for installation in aircraft unless the eligibility is restricted by applicable regulations or airworthiness directives issued under section 1.24 of this subchapter.

[(b) Products approved as a part of the airplane type design under a type certificate should be identified by an airplane part number on the approved drawing list.

[(c) Products approved as a part of the airplane under a supplemental type certificate should be identified by a part or drawing number on such certificate.

[(d) Each TSO product that is approved as a part of the airplane should have the TSO identification removed and be identified as set forth in paragraph (b) or (c) of this section, whichever is applicable.]

(23 F. R. 10323, Dec. 25, 1958, effective Jan. 31, 1959.)

3.19 *Changes in type design.* (For requirements with regard to changes in type design and the designation of applicable regulations therefor, see secs. 3.11 (d) and (e) and Part 1 of this subchapter.)

3.19–1 *Changes of engines (CAA policies which apply to sec. 3.19).*

(a) There are currently available newly designed engines of approximately the same size and weight as previously designed engines, but with considerable variations in power. It is possible to interchange these engines with little or no installation changes, and although minor changes in engine weight may be involved, it will still be practical to operate the aircraft at the originally approved gross weight. Under section 3.185, the maneuvering load factor is not dependent upon engine power, and under section 3.184 the design airspeeds can be independent of engine power. Therefore, a change which involves or permits a practical power increase by exchange of engines shall be approved by the Administrator: *Provided,* That such exchange of engines is not accompanied by an increase in the gross weight of the aircraft, or an increase in placard speeds. Under those

conditions it will not be necessary to restrict the maximum continuous horsepower by a placard because of the airplane speed limitations since the latter are indicated on the speed placards.

(b) Aircraft alterations involving weight or speed changes beyond those set forth above will be approved by the Administrator, if the applicant shows compliance with the applicable airworthiness requirements.

(c) Under section 3.19, it will be necessary to require such investigations of local structure, weight and balance, power plant installations and flight tests as are normally involved in a change of engine type. However, every effort will be made by reference to data already on hand to minimize the amount of testing and structural analysis required of the applicant.

(CAR, Supp. 10, 16 F. R. 3281, Apr. 1951. Redesignated and amended by Supp. 14, 17 F. R. 9065, Oct. 11, 1952.)

Airplane Categories

3.20 *Airplane categories.*

(a) For the purpose of certification under this part, airplanes are divided upon the basis of their intended operation into the following categories:

(1) *Normal-suffix N.* Airplanes in this category are intended for nonacrobatic, nonscheduled passenger, and nonscheduled cargo operation.

(2) *Utility-suffix U.* Airplanes in this category are intended for normal operations and limited acrobatic maneuvers. These airplanes are not suited for use in snap or inverted maneuvers.

NOTE: The following interpretation of paragraph (a) (2) was issued May 15, 1947, 12 F. R. 3434: The phrase "limited acrobatic maneuvers" as used in section 3.6 (now sec. 3.20) is interpreted to include steep turns, spins, stalls (except whip stalls), lazy eights, and chandelles.

(3) *Acrobatic-suffix A.* Airplanes in this category will have no specific restrictions as to type of maneuver permitted unless the necessity therefor is disclosed by the required flight tests.

(b) An airplane may be certificated under the requirements of a particular category, or in more than one category, provided that all of the requirements of each such category are met. Sections of this part which apply to only one or more, but not all, categories are identified in this part by the appropriate suffixes added to the section number, as indicated in paragraph (a) of this section. All sections not identified by a suffix are applicable to all categories except as otherwise specified.

3.20–1 *Approved maneuvers for normal category aircraft (CAA interpretations which apply to sec. 3.20).* The phrase "nonacrobatic operation" as used in section 3.20 (a) (1) is interpreted to mean that type of operation in which the aircraft is limited to those maneuvers incidental to normal flying and including stalls (except whip stalls) and turns in which the angle of bank is not in excess of 60°.

(CAR, Supp. 10, 16 F. R. 3278, Apr. 14, 1951. Redesignated and amended by Supp. 14, 17 F. R. 9065, Oct. 11, 1952.)

3.20–2 *Approved limited acrobatic maneuvers for utility category aircraft (CAA interpretations which apply to sec. 3.20).* The phrase "limited

so as to facilitate egress without crowding in all probable attitudes resulting from a crash. The method of opening shall be simple and obvious, and the exits shall be so arranged and marked as to be readily located and operated even in darkness. Reasonable provisions shall be made against the jamming of exits as a result of fuselage deformation. The proper functioning of exits shall be demonstrated by tests.

(b) The number of emergency exits required is as follows:

(1) Airplanes with a total seating capacity of more than 5 persons, but not in excess of 15, shall be provided with at least one emergency exit or one suitable door in addition to the main door specified in section 3.389. This emergency exit, or second door, shall be on the opposite side of the cabin from the main door.

(2) Airplanes with a seating capacity of more than 15 persons shall be provided with emergency exits or doors in addition to those required in paragraph (b) (1) of this section. There shall be one such additional exit or door located either in the top or side of the cabin for every additional 7 persons or fraction thereof above 15, except that not more than four exits, including doors, will be required if the arrangement and dimensions are suitable for quick evacuation of all occupants.

(c) If the pilot compartment is separated from the cabin by a door which is likely to block escape in the event of a minor crash, it shall have its own exit, but such exit shall not be considered as an emergency exit for the passengers.

[(d) Category A airplanes shall be provided with exits which will permit all occupants to bail out quickly with parachutes at any speed between V_{s_0} and V_d.]

3.388 *Fire precautions.*

(a) *Cabin interiors.* Only materials which are flash-resistant shall be used. In compartments where smoking is to be permitted, the wall and ceiling linings, the covering of all upholstering, floors, and furnishings shall be flame-resistant. Such compartments shall be equipped with an adequate number of self-contained ash trays. All other compartments shall be placarded against smoking.

(b) *Combustion heaters.* If combustion heaters are installed, they shall be of an approved type. The installation shall comply with applicable parts of the powerplant installation requirements covering fire hazards and precautions. All applicable requirements concerning fuel tanks, lines, and exhaust systems shall be considered. In addition to the components provided for normal continuous control of air temperature, air flow, and fuel flow, means independent of such components shall be provided for each heater to automatically shut off and hold off the ignition and fuel supply to the heater at a point remote from the heater when the heat exchanger temperature or ventilating air temperature exceeds safe limits or when either the combustion air flow or the ventilating air flow becomes inadequate for safe operation.

3.388–1 *Heater isolation (CAA policies which apply to sec. 3.388 (b)).*

(a) Under sections 3.388 (b) and 3.623, heaters should be isolated from the remainder of the airplane by means of a fireproof shield. However, this need not necessarily mean a complete shield around the entire heater unit (although this would be satisfactory) since in many heater designs, a fireproof air jacket largely surrounds the flame chamber. Thus, the heater design itself practically provides a steel shield between the combustion unit and the remainder of the airplane. In such cases, it should suffice to provide isolation for the fuel system components mounted on the heater and for the heater exhaust and combustion chamber drains.

(b) The following schematic sketch shows an example of an installation which should be satisfactory.

The shut-off valve shown in the sketch should be provided if there are fuel system components within the ventilating air shroud which may be subject to leakage or failure. In such cases, that portion of the ventilating air duct up to the valve, as well as the valve itself, should be of fire-resistant construction and the valve should provide as flame-tight a seal as possible. If the fuel system is so arranged that there are no fittings or connections within the ventilating air shroud, the downstream air shut-off valve and fire-resistant duct between the heater and the valve may be dispensed with.

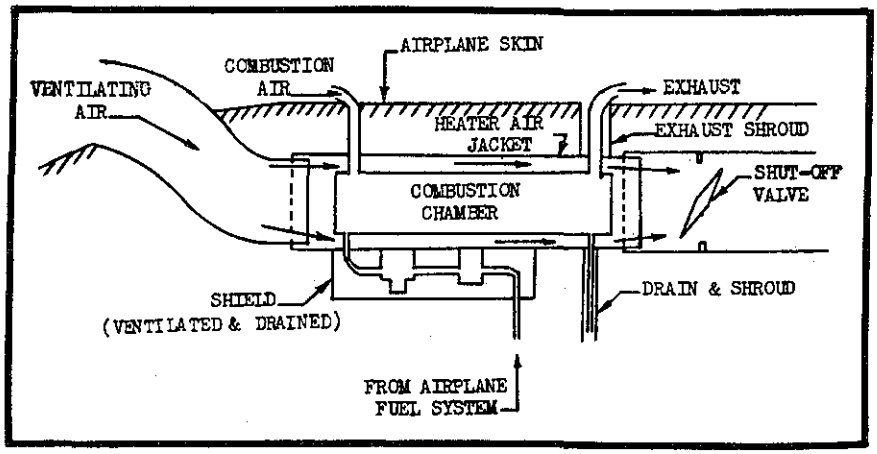


Figure 2.—Heater isolation.

(c) As regards shrouds for the combustion chamber drain lines, the necessity for these will generally depend upon the location of the drain in the heater. If the drain outlet from the combustion chamber is so located that products of combustion can issue through the drain line, it will no doubt become hot and require isolation. However, drains are sometimes connected in such a manner that they do not carry exhaust gases and remain relatively cool. In such cases, shrouds are not necessary.

(Supp. 10, 16 F. R. 3290, Apr. 14, 1951.)

3.388–2 *Fire-detector and extinguisher equipment (CAA policies which apply to sec. 3.388 (b)).*

(a) For nontransport category airplanes equipment of this type is not required. If such equipment is installed and it is shown to provide equivalent safety to the use of fireproof isolation, it may be considered a suitable alternative for fireproof isolation provisions discussed in section 3.388–1 (b). In such cases, the detection and extinguishing provisions should comply with the requirements for transport category airplanes; that is, detectors and extinguishers should be provided wherever potential sources of fuel leakage and sources of ignition are in close proximity.

(b) In the sketch in section 3.388–1 (b) the space within the shield would require such protection. In addition, detectors and extinguisher nozzles should be installed in the ventilating air passages of the heater if this chamber contains fuel system fittings or connections that may be subject to leakage.

(c) Hand fire extinguishers should be considered equivalent to a fixed fire extinguisher installation only when the heater is located in such a manner that it is readily accessible to the crew and when all fire zones in the installation can easily be reached with a hand extinguisher.

(d) All extinguishers may also be dispensed with when the heater is so shielded and located that a fire could be permitted to burn itself out without danger of damage to any important structural members or otherwise endangering the safety of the airplane.

(e) Detectors may be dispensed with as an alternative to fireproof isolation, only when the heater is so located that the occurrence of fire would immediately be noted by the crew.

3.388–3 *Heater fuel system (CAA policies which apply to sec. 3.388 (b)).*

(a) The heater fuel system should comply with airworthiness standards for the engine fuel system as regards fuel lines, fittings and accessories.

(b) Valves should be provided for shutting off in flight the flow of fuel at its source, unless equivalent provisions in the form of a separate heater fuel pump are available.

(c) All pressure lines should comply with the provisions of section 3.432 regarding pressure cross feed arrangements.

(Supp. 10, 16 F. R. 3291, Apr. 14, 1951.)

3.388–4 *Combustion heaters (CAA rules which apply to sec. 3.388 (b)).* The minimum safety requirements for combustion heaters which are intended for use in civil aircraft have been

Introductory Note

Civil Aeronautics Manuals are published by the Civil Aeronautics Administration to supplement the Civil Air Regulations of the Civil Aeronautics Board. This manual contains rules, policies, and interpretations of the Administrator of Civil Aeronautics which pertain to the current requirements of Part 4b of the Civil Air Regulations. The complete text of Part 4b is included in this manual to assist the public in understanding how the Administrator's rules, policies, and interpretations apply to the various sections of the Civil Air Regulations.

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 *policies* provide recommended methods of complying with the Civil Air Regulations. Such policies are for the guidance of the public and are not mandatory in nature.

CAA *interpretations* define 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.

The text of this manual is arranged to set forth in bold type each numbered section of Part 4b followed by related rules, policies, or interpretations of the Administrator. The Administrator's sections pertaining to a particular section of Part 4b are identified by consecutive dash numbers appended to the regulation section number. Thus, section 4b.10–2 means the second section of the Administrator's sections pertaining to section 4b.10 of the Civil Air Regulations.

Civil Aeronautics Manuals and their supplements are published in the Federal Register which is incorporated yearly in the Code of Federal Regulations. The Federal Register is cited by volume, page number, and date. Thus, the citation 21 F. R. 988, February 11, 1956, means Vol. 21 of the Federal Register, page 988, published on February 11, 1956.

Once the material is picked up in the Code of Federal Regulations, only the the code is referenced. Code references are by title and part number. Thus, 14 CFR 4b indicates Title 14 of the Code of Federal Regulations, Part 4b. The Federal Register citations and effective dates are given as a matter of information following their pertinent sections.

This manual will be revised from time to time as a result of amendments to Part 4b, and as new manual material is found necessary to keep the public informed on acceptable means of showing compliance with the requirements of Part 4b. New and revised material is indicated by brackets.

(Rev. 1/15/59)

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[4b.18–3 *Manufacturer (CAA interpretations which apply to sec. 4b.18 (b)).* For the purpose of accepting a statement of conformance for a Technical Standard Order Product, the word "manufacturer" is interpreted to mean a person who designs and fabricates by welding, cutting, drilling, forming, bolting, riveting, glueing, soldering, sewing, etc., a product. This includes products which are composed in whole or in part of components of TSO products. One who merely cleans products or appliances or repairs them by replacing standard parts and/or by replacing components with identical ones is not considered to be the manufacturer. Nor is the distributor of another person's completed product considered to be the manufacturer.

(23 F. R. 10325, Dec. 25, 1958, effective Jan. 31, 1959.)

[4b.18–4 *Products approved as a part of the airplane (CAA policies which apply to sec. 4b.18).* (a) A material, part or appliance (hereinafter called product) may be approved as a part of the airplane type design under a type certificate or a supplemental type certificate.

[(1) If a Technical Standard Order covering the product is in effect, the applicant for approval should submit type design data showing that the product meets the performance standards of the Technical Standard Order except that:

[(i) Deviations from the performance standards may be allowed when the applicant for, or holder of, the type certificate or the supplemental type certificate substantiates that other performance standards are applicable for the product as installed in the airplane. Any deviation from standards prescribed in this part may be allowed only in accordance with section 4b.10.

[(2) Where no TSO covering the product exists, the applicant for approval should submit type design data showing compliance with all the requirements of this part which are applicable to the product.

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[(3) Products previously approved by the CAA by means of letters of approval, Repair and Alteration Form ACA–337, or listing on CAA Product and Process Specifications will continue to be eligible for installation in aircraft unless the eligibility is restricted by applicable regulations or airworthiness directives issued under section 1.24 of this subchapter.

[(b) Products approved as a part of the airplane type design under a type certificate should be identified by an airplane part number on the approved drawing list.

[(c) Products approved as a part of the airplane under a supplemental type certificate should be identified by a part or drawing number on such certificate.

[(d) Each TSO product that is approved as a part of the airplane should have the TSO identification removed and be identified as set forth in paragraph (b) or (c) of this section, whichever is applicable.]

(23 F. R. 10325, Dec. 25, 1958, effective Jan. 31, 1959.)

4b.19 *Changes in type design.* (For requirements with regard to changes in type design and the designation of applicable regulations therefor, see sec. 4b.11 (d) and (e), and Part 1 of this subchapter.)

Flight

General

4b.100 *Proof of compliance.*

(a) Compliance with the requirements prescribed in this subpart shall be established by flight or other tests conducted upon an airplane of the type for which a certificate of airworthiness is sought or by calculations based on such tests, provided that the results obtained by calculations are equivalent in accuracy to the results of direct testing.

(b) Compliance with each requirement shall be established at all appropriate combinations of airplane weight and center of gravity position within the range of loading conditions for which certification is sought by systematic investigation of all these combinations, except where compliance can be inferred reasonably from those combinations which are investigated.

(c) The controllability, stability, trim, and stalling characteristics of the airplane shall be established at all altitudes up to the maximum anticipated operating altitude.

(d) The applicant shall provide a person holding an appropriate pilot certificate to make the flight tests, but a designated representative of the Administrator shall pilot the airplane when it is found necessary for the determination of compliance with the airworthiness requirements.

(e) Official type tests shall be discontinued until corrective measures have been taken by the applicant when either:

(1) The applicant's test pilot is unable or unwilling to conduct any of the required flight tests, or

(2) It is found that requirements which have not been met are so substantial as to render additional test data meaningless or are of such a nature as to make further testing unduly hazardous.

(f) Adequate provision shall be made for emergency egress and for the use of parachutes by members of the crew during the flight tests.

(g) The applicant shall submit to the Administrator's representative a report covering all computations and tests required in connection with calibration of instruments used for test purposes and correction of test results to standard atmospheric conditions. The Administrator's representative shall conduct any flight tests which he finds necessary to check the calibration and correction report.

(17 F. R. 10101, Nov. 7, 1952, effective Dec. 1, 1952.)

4b.100–1 *Procedure for demonstrating compliance with the flight requirements (CAA policies which apply to sec. 4b.100 (a)).*

(a) *Responsibility.* The burden of showing or implementing compliance with the requirements for an airworthiness or a type certificate rests with the applicant. The applicant should at his own expense and risk, conduct such official flight tests as determined by the CAA to demonstrate compliance with the minimum requirements. During the type inspection the applicant should make available the airplane for that purpose as well as all of the personnel and equipment necessary to obtain the required data.

(b) *Tolerances permitted for flight tests.*

(1) *General.* The tolerances in (b) (2) of this section are the allowable deviation from specified flight conditions for a particular test. They are not allowable tolerances on specific requirements, nor are they to be considered as allowable inaccuracy of measurement or of the method of determination. As an example, when demonstrating stability with specified trim speed of 1.4 V_{s_1}, the trim speed may be 1.4 $V_{s_1} \pm 3$ m. p. h. or 3 percent; however, no positive tolerance is permitted when demonstrating the minimum prescribed trim speed of 1.4 V_{s_1}.

(i) Where variation in the parameter on which a tolerance is allowed will have an appreciable effect on the test, the result should be corrected to the standard value of the parameter; otherwise, no correction is necessary. The applicant may adhere to closer tolerances if he so desires.

(ii) The following list indicates the cases in which correction for tolerances should be made:

Test	Weight	C. G.	Air speed	Power	Wind
Airspeed calibration					
Stall speeds	X				
All climbs	X			X	
Landings	X		X		X
Takeoff	X		X	X	X
Accelerate	X		X	X	X
Decelerate	X		X		X
Stability and control.					
Minimum control speed.				X	

(2) *Individual tolerances.* The following are general tolerances from specified values permitted during CAA testing. These tolerances apply unless, for a particular test, other tolerances are set forth in the testing procedure.

These tolerances are plus or minus variations unless otherwise noted in the particular test:

Item	*Tolerance*
Weight	+5%−10%
Critical items affected by weight	+5%−1%
C. G.	7% total travel
Air speed	3 m. p. h. or ±3% whichever is greater
Power	5%
Wind (takeoff and landing tests)	As low as possible but not to exceed approximately 12% V_{s_1} or 12 m. p. h. whichever is lower, along the runway—measured at a height of 6 feet above the runway surface.

(c) *Type Inspection Report.*

(1) All information and data obtained as a result of the type inspection investigation and tests should be reported in Form ACA 283–4b, Type Inspection Report.

(2) Upon completion of the type inspection, the applicant should prepare the information necessary to show compliance with the requirements. This material together with the Airplane Flight Manual required by section 4b.740 should be completed as promptly as possible and forwarded to the CAA.

(19 F. R. 4448, July 20, 1954, effective Sept. 1, 1954.)

4b.100–2 *Selection of weight, altitudes, speeds and wing flap positions (CAA policies which apply to sec. 4b.100 (b)).* Before starting official flight tests, certain data should be obtained by the applicant in order that the options prescribed in (a) through (e) of this section can be executed:

(a) *The selection of the range of weight and altitude to be covered by the flight testing required for certification.* This selection should be based upon the extent to which the applicant for certification is concerned with the operating limitations which will be imposed upon the airplane. If the applicant is not concerned with this point, he may elect to conduct only the flight tests required to demonstrate compliance with the minimum performance requirements contained in section 4b.110 together with those required to demonstrate compliance with the flying qualities and other requirements specified in sections 4b.130 through 4b.190. If it is practicable to limit the operation of the airplane by a scheduled air carrier to sea level airports containing runways of ample length and to terrain altitude not in excess of 4,000 feet, this procedure appears satisfactory. It should be noted that this case could apply to a seaplane in scheduled operation. If the applicant wishes to provide for the greatest possible flexibility in the matter of compliance with the operating limitations contained in section 40.70 of this subchapter, considerably more performance tests will be necessary. It may be entirely practicable, for example, for operation over routes involving appreciable differences in the altitude of airports, to take advantage of the improvement in performance which is possible by means of reducing the weight at which the airplane is operated. It may also be desirable to alter the various flap settings in order to improve the climbing performance at a given weight. In cases such as these, it will be necessary to determine by flight testing and calculation, the effect of weight, altitude, and flap setting, throughout the range of each for which it is desired to provide, upon the takeoff, landing, and climbing performance and to include this information in the CAA Approved Airplane Flight Manual. This selection will be left to the applicant since, even though he may find it difficult to anticipate the uses to

performance prescribed in this subpart shall be determined, and compliance shall be shown, for standard atmospheric conditions and still air, except that the performance as affected by engine power, instead of being based on dry air, shall be based on 80 percent relative humidity.

(b) Each set of performance data required for a particular flight condition shall be determined with the powerplant accessories absorbing the normal amount of power appropriate to that flight condition. (See also sec. 4b.117.)

4b.110–1 *Engine power corrections (CAA policies which apply to sec. 4b.110).*

(a) *Engine power corrections for vapor pressure.* The following standard vapor pressures, specific humidities, and densities versus altitude have been established for the purpose of correcting airplane performance data in accordance with section 4b.110.

Altitude H (Ft.)	Vapor Pressure e (In. Hg.)	Specific Humidity w (Lb. moisture per lb. dry air)	Density Ratio $\sigma = \frac{\rho}{0.0023769}$
0	0. 403	0. 00849	0. 99508
1, 000	. 354	. 00773	. 96672
2, 000	. 311	. 00703	. 93895
3, 000	. 272	. 00638	. 91178
4, 000	. 238	. 00578	. 88514
5, 000	. 207	. 00523	. 85910
6, 000	. 1805	. 00472	. 83361
7, 000	. 1566	. 00425	. 80870
8, 000	. 1356	. 00382	. 78434
9, 000	. 1172	. 00343	. 76053
10, 000	. 1010	. 00307	. 73722
15, 000	. 0463	. 001710	. 62868
20, 000	. 01978	. 000896	. 53263
25, 000	. 00778	. 000436	. 44806

(b) *Engine power corrections for cylinder head temperatures.* Official flight tests should be discontinued whenever engine limitations are exceeded. This procedure automatically makes corrections of this type unnecessary.

(c) *Engine power corrections for fuel flow.* Official flight tests should not be conducted when the metering characteristics of the carburetor are outside the range of acceptable tolerances. This procedure automatically makes corrections for fuel-air mixture ratio in performance evaluation unnecessary.

(19 F. R. 1817, Apr. 2, 1954, effective Apr. 2, 1954; amended in 23 F. R. 7482, Sept. 26, 1958, effective Oct. 20, 1958.)

4b.110–2 *Engine power calibration (CAA policies which apply to sec. 4b.110).* The performance of an airplane established in accordance with the requirements of sections 4b.110 through 4b.125 and shown in the performance section of the Airplane Flight Manual should be reproducible by any airplane of a similar model having engines that deliver no more than 100 percent certificated rated power. This means that the power used to drive all accessories, other than those necessary to the functioning of the engine, should be deducted from the certificated rated or installed engine power, whichever is less. To assist in meeting these objectives, the engine power of all new type airplanes as defined by section 4b.11 (e) should be calibrated in accordance with paragraphs (a) through (c) of this section.

(a) *Corrections to the calibrated power for engines producing power above the certificated ratings.* The applicant should provide engine power output data obtained from dynamometer tests, or the equivalent thereof, for all engines that are installed in the airplane which will be used in the power calibration flight tests. The data should be sufficiently complete to allow a direct comparison with the approved certificated ratings of the engines.

If the dynamometer calibration data for any engine selected for the inflight power calibration in accordance with the provisions of paragraph (b) of this section indicate that the power (based on standard atmospheric conditions for the engine) is higher than the certificated rating for the engine model, the calibrated power curve established as a result of flight tests in paragraphs (b) and (c) of this section should be corrected by applying the following power reduction: 100 percent of the power increment between the dynamometer calibration and the certificated engine rating at sea level, and 47 percent of the sea level power increment applied at an altitude of 20,000 feet with a lineal variation between these two points throughout the operating altitude range of the airplane. If the calibrated power curve established as a result of the flight tests represents an average power for more than one engine, it should be corrected by applying a power reduction equivalent to the average power difference between the dynamometer and the rated power for all engines used

in the flight calibration tests. The application of other correction methods and values that will adjust the power data on the basis of the certificated rating of the engine throughout the operating altitude range of the airplane are acceptable if they can be substantiated.

(b) *Selection of engines for power calibration in flight.* With the exception of the critical inoperative engine, the number of engines which will be used as a basis for power calibration is left to the option of the applicant. However, the procedure specified in this paragraph should be followed to determine which engine(s) should be selected for establishing the basic calibrated power curve.

(1) The installed power of all engines should be compared in flight by means of calibrated torquemeters or other equivalent methods. If a calibrated power curve is to be established on the basis that all engine driven accessories will be in operation during flight, the comparison should be made under full accessory load conditions. If a separate calibrated power curve is to be established for application to those test configurations where certain accessories will not be in operation, the power of all engines may be compared when these accessories are in the appropriate idling or off position. In this case it will be necessary to provide data, indicating accessory load requirements for those flight configurations and the particular engine(s) from which the power is obtained.

(2) For two-engine aircraft it is only necessary to calibrate the engine which produces the lesser power determined by comparing the results of the torquemeter indications in accordance with subparagraph (1) of this paragraph for the most critical accessory load condition and taking into consideration the appropriate power reduction when the engine dynamometer test output is above the rated power for the engine. All performance data scheduled in the Airplane Flight Manual should be based on the calibrated power curve established for this engine. If the applicant desires to calibrate the power of both engines, only the all-engine-operating performance data should be based on a curve representing the average power for the two engines.

(3) When the applicant desires to calibrate the power of one engine for aircraft having more than two engines, the engine selected should be that which delivers the lowest power, determined by comparing the results similarly as in the case of the two-engine aircraft in subparagraph (2) of this paragraph. All performance data scheduled in the Airplane Flight Manual should be based on the calibrated power curve established for this engine. If the applicant desires to calibrate the power of two engines, the calibrated power curve should be based on values representing an average of the two engines delivering the lowest power.

(4) The procedure in subparagraph (3) of this paragraph should be followed if the applicant desires to calibrate the power of more than two engines, however, the Airplane Flight Manual performance data should be based upon an average calibrated power curve which has been derived from not more than the actual number of engines in operation corresponding to the test configuration for which performance is established. This procedure is not necessary, for example, in the case where the average power curve for two and three engines is substantially equal. However, the third engine may be calibrated to obtain additional data which will permit a more accurate fairing of the calibrated power curve.

(5) If the results of the flight tests indicate that the power of any engine selected in accordance with the provisions of this paragraph exceeds rated power after the application of the dynamometer correction specified in paragraph (a) of this section, the calibrated power curve for application to performance testing should be based upon not more than certificated rated power of the engine with the power to drive the accessories deducted.

(c) *Flight test procedure for calibrating engine power.* The engine calibration flight tests should be conducted in accordance with the provisions specified in this paragraph.

(1) The critical altitudes of the engine should be established for takeoff power and maximum continuous power providing these critical altitudes lie below the highest operating altitude desired for certification. Critical altitudes need not be determined above the maximum operating altitude of the airplane.

(2) For engine installations specifically designed to indicate power by means of torquemeters, the engine power calibration tests as well as all performance tests which are

tested to assure conformance to the following reliability criteria:

(a) *Failure of propulsion engines or other prime movers.* The generating system performance (after failure of one or more propulsion engines or other prime movers) should be that specified in section 4b.606 (c).

(b) *Generating system malfunctions.* No probable malfunction [37] in the generating system, or in the generator drive system,[38] should result in the permanent loss of service to electric utilization systems [39] which are necessary to maintain controlled flight and to effect a safe landing,[40] unless the aircraft is equipped with an independent source of electric power capable of supplying continuous emergency service to these utilization systems.

(c) *Corrective action.* Where corrective action is necessary to comply with (a) and (b) above,

(1) Adequate warning should be provided for any malfunction or failure requiring such corrective action.

(2) Controls should be so located as to permit such corrective action during any probable flight situation.

(3) If corrective action must be taken within a specified time interval for continued safe operation of the generating system, it should be demonstrated that such corrective action can be accomplished within the specified time interval during any probable flight situation.

(4) The procedure to be followed by the crew should be detailed in the Operating Procedures Section of the Airplane Flight Manual (see sec. 4b.740).

[37] A probable malfunction is any single electrical or mechanical malfunction or failure which is considered probable on the basis of past service experience with similar components in aircraft applications. This definition should be extended to multiple malfunctions when: (1) the first malfunction would not be detected during normal operation of the system, including periodic checks established at intervals which are consistent with the degree of hazard involved, or (2) the first malfunction would inevitably lead to other malfunctions.

[38] The generator drive system includes the prime movers (propulsion engines or other) and coupling devices such as gear-boxes or constant-speed drives.

[39] An electric utilization system is a system of electric equipment, devices and connected wiring which utilizes electric energy to perform a specific aircraft function.

[40] The specific electric utilization systems which are necessary to maintain controlled flight and effect a safe landing will vary with the type of aircraft and with the nature of the operation in which the aircraft is utilized. Examples of systems which may be in this category are as follows: basic flight instruments, minimum navigation equipment, minimum two-way radio communications, control system boost.

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(d) *Electric system smoke and fire procedures (see sec. 4b.371 (c)).* To cope with electrical smoke or fire of undetermined origin, generating system controls should be designed to permit electrical disconnection of overheated equipment in flight without hazardous interruption of service to electric utilization systems. Procedures for this purpose should be contained in the Operating Procedures Section of the Airplane Flight Manual (see sec. 4b.740).

(22 F. R. 6885, Aug. 27, 1957, effective Sept. 15, 1957.)

4b.623 *Distribution system.*

(a) The distribution system shall be considered to include all distribution busses, their associated feeders, and control and protective devices.

(b) Individual distribution systems shall be designed to insure that essential load circuits can be supplied in the event of reasonably probable faults or open circuits.

(c) Where two independent sources of electrical power for particular equipment or systems are required by the Civil Air Regulations, their electrical energy supply shall be assured.

NOTE: Various means may be used to assure a supply, such as duplicate electrical equipment, throw-over switching, and multi-channel or loop circuits separately routed.

4b.624 *Electrical protection.*

(a) Automatic protective devices shall be provided to minimize distress to the electrical system and hazard to the airplane in the event of wiring faults or serious malfunctioning of the system or connected equipment.

(b) In the generating system the protective and control devices shall be such as to de-energize and disconnect faulty power sources and power transmission equipment from their associated busses with sufficient rapidity to provide protection against hazardous over-voltage and other malfunctioning.

(c) All resettable type circuit protective devices shall be so designed that when an overload or circuit fault exists, they will open the circuit irrespective of the position of the operating control.

(d) Protective devices or their controls used in essential load circuits shall be accessible for resetting in flight.

(e) Circuits for essential loads shall have individual circuit protection.

NOTE: This provision does not necessarily require individual protection for each circuit in an essential load system (e. g., each position light in the system).

(f) If fuses are used, there shall be provided spare fuses for use in flight equal to at least 50 percent of the number of fuses of each rating required for complete circuit protection.

4b.624–1 *Automatic reset circuit breaker (CAA policies which apply to sec. 4b.624).* Automatic reset circuit breakers (which automatically reset themselves periodically) should not be applied as circuit protective devices.[41] They may be used as integral protectors for electrical equipment (e. g., thermal cut-outs) provided that circuit protection is also installed to protect the cable to the equipment.

(20 F. R. 2280, Apr. 8, 1955, effective Apr. 30, 1955.)

4b.625 *Electrical equipment and installations.*

(a) In showing compliance with section 4b.606 (a) and (b) with respect to the electrical system, equipment, and installation, consideration shall be given to critical environmental conditions.

NOTE: Critical environmental conditions may include temperature, pressure, humidity, ventilation, position, acceleration, vibration, and presence of detrimental substances.

(b) All electrical equipment, controls, and wiring shall be so installed that operation of any one unit or system of units will not affect adversely the simultaneous operation of any other electrical unit or system of units essential to the safe operation of the airplane.

(c) Cables shall be grouped, routed, and spaced so that damage to essential circuits will be minimized in the event of faults in heavy current-carrying cables.

(d) Batteries and their installations shall provide for ventilation, drainage of fluids, venting of gases, and protection of other parts of the airplane from corrosive battery fluids.

[4b.625–1 *Environmental tests for electrical equipment*[42] *(CAA policies which apply to sec. 4b.625 (a)).* The ability of electrical equipment to provide continuous safe service under foreseeable environmental conditions may be demonstrated by means of environmental tests, design analyses, or reference to previous comparable service experience on other aircraft. For environmental testing, the test procedures contained in appendix I of this manual are acceptable, subject to the following objective criteria:

[(a) The extremes of climatic and environmental conditions given in appendix I may be reduced in specific aircraft applications when it can be shown that these extremes would not be reached in normal service. Conversely, these extremes should be extended when individual applications indicate the need, such as may occur when electrical equipment is exposed to high intensity acoustic noise generated by turbo-jet engines.

[(b) In all cases the ability of the equipment to safely withstand exposure to temperature extremes, temperature shock, humidity, altitude, vibration, flight and normal landing impact shocks, and acceleration should be demonstrated. Tests for each of these conditions are set forth in appendix I. Tests in environments such as sand and dust, fungus and saltspray may be limited to equipment likely to be exposed to these conditions.

[(c) Electrical equipment altitude testing should be conducted at an altitude 15 percent above the maximum altitude to which the equipment would be exposed in normal service. However, testing of certain equipment installed in pressurized areas should be under conditions of altitude and time which will assure that, in case of rapid decompression:

[41] Circuit protective devices are normally installed to limit the hazardous consequences of overloaded or faulted circuits. These devices are resettable (circuit breakers) or replaceable (fuses) to permit the crew to restore service when nuisance trips occur or when the abnormal circuit condition can be corrected in flight. If the abnormal circuit condition can *not* be corrected in flight, the decision to restore power to the circuit involves a careful analysis of the flight situation. It is necessary to weigh the essentiality of the circuit for continued safe flight against the hazards of resetting on a possibly faulted circuit. Such evaluation is properly an aircraft crew function which can not be performed by automatic reset circuit breakers. To assure crew supervision over the reset operation, circuit protective devices should be of such design that a manual operation is required to restore service after tripping.

[42] This policy applies to all electrical generation, distribution, and utilization equipment required by or utilized in complying with the applicable Civil Air Regulations, except those items covered by Technical Standard Orders containing environmental test procedures.]

[(1) Equipment necessary for the execution of an emergency descent would remain operative for the probable period required for such descent.

[(2) Other equipment is not rendered permanently inoperative if the operation of the equipment is necessary to maintain controlled flight or effect a safe landing.

[(3) No equipment will constitute a hazard due to arcing, fire, or smoke. However, altitude testing for hazard from arcing, fire, or smoke is not required where any hazard is satisfactorily minimized independently of altitude by design and installation features.]

(23 F. R. 10325, Dec. 25, 1958, effective Jan. 31, 1959.)

4b.626 *Electrical system fire and smoke protection.* The design and installation of all components of the electrical system shall be in compliance with pertinent fire and smoke protection provisions of sections 4b.371 (c), 4b.385, and 4b.490. In addition, all electrical cables, terminals, and equipment which are necessary in emergency procedures and which are located in designated fire zones shall be fire-resistant.

4b.626–1 *Fire-resistant electrical equipment* [43] *(CAA policies which apply to sec. 4b.626).* When applied to the electrical equipment and components defined in the last sentence of section 4b.626, an accepted criterion for "fire resistant" is that such equipment and components, as installed in the aircraft, should withstand a 2000° F. oxidizing flame impinging on their surfaces for at least 5 minutes without adverse effect on their circuit function.[44] The 2000° F. oxidizing flame should envelop the equipment under test, using a test setup simulating the actual aircraft installation.[44a] Thermocouples for measurement of flame temperature should be located within one-fourth inch of the surface exposed to the flame.

(22 F. R. 6885, Aug. 27, 1957, effective Sept. 15, 1957; amended in 23 F. R. 2790, Apr. 26, 1958, effective May 5, 1958.)

4b.627 *Electrical system tests and analyses.* It shall be demonstrated by tests and analyses that the electrical system functions properly and without electrical or thermal distress.

[43] This policy establishes a basic test standard for fire-resistant electrical equipment. However, installation approval may be granted for equipment which does not conform to this standard, if it can be shown that such equipment would provide equivalent safety when exposed to the probable fire conditions at its particular location.

[44] Excessive temperature may affect electrical equipment and components by causing such malfunctions as short circuit, open circuit, and changes in circuit parameters (for example, reduced insulation resistance and dielectric strength).

[44a] In the case of electric cable, only a representative length, not less than 12 inches, need be enveloped in the flame.

Appendix I

ENVIRONMENTAL TEST PROCEDURES: ELECTRICAL EQUIPMENT

(Refer to CAM 4b.625–1)

A. TEST EQUIPMENT STANDARDS

1. *Test facilities.*—The apparatus used in conducting the tests described in this Appendix should be capable of producing the specified environmental conditions. The equipment under test should not occupy more than 50 percent of the volume of the test chamber. Heat sources should be disposed so that radiant heat does not fall directly on the equipment under test.

2. *Measurement tolerances.*—Allowable tolerances on test condition measurements are as follows:

(*a*) *Temperature.*—Plus or minus 4° F.
(*b*) *Altitude.*—Plus or minus 5 percent.
(*c*) *Humidity.*—Plus or minus 5 percent relative.
(*d*) *Vibration amplitude.*—Plus or minus 5 percent.
(*e*) *Vibration frequency.*—Plus or minus 2 percent.

3. *Standard room conditions.*—Room conditions for conducting the equipment functional performance check (specified in par. B1) should be as follows:

(*a*) *Temperature.*—77° plus or minus 18° F.
(*b*) *Relative humidity.*—90 percent or less.
(*c*) *Barometric pressure.*—28 to 32 inches of mercury.

4. *Temperature stabilization.* — Temperature stabilization may be checked by a temperature sensing device in good thermal contact with the largest centrally-located internal mass in the equipment under test.

B. BASIS FOR EVALUATION OF ENVIRONMENTAL TEST RESULTS

1. *Functional performance.*—Before conducting any of the tests described in Section C, the equipment should be operated under standard room conditions (refer to par. A3) and a record made of all data necessary to demonstrate satisfactory functional performance in all respects affecting safety. This record constitutes the reference performance level for equipment undergoing the environmental tests in Section C. Failure to achieve this reference performance, in any respect significant to safety, denotes failure to meet the environmental test to which the equipment was subjected.

2. *Deterioration.*—Deterioration or corrosion of any internal or external components which could in any manner prevent the continued safe operation of the equipment during its service life would constitute failure to meet the environmental test to which the equipment was subjected.

C. TEST PROCEDURES

1. *High temperature test.* The equipment should be placed within the test chamber and the internal temperature of the chamber raised to 160° F. with an internal relative humidity of not more than 5 percent. The item of equipment should be maintained at 160° F. for a period of 50 hours. While still at this temperature, the equipment should be operated and the results checked against the data obtained in paragraph B1. The temperature should then be reduced to prevailing room conditions and a visual examination conducted in accordance with paragraph B2.

2. *Low temperature tests.*—

(*a*) *Method I.*—The item of equipment should be placed within the test chamber and the chamber cooled to and maintained at a temperature of −65° F. until temperature stabilization (see par. A4) of the equipment is reached. While at this temperature,

the equipment should be operated and the results checked against the data obtained in paragraph B1.

(*b*) *Method II (alternate to Method I).*—The equipment should be placed within the test chamber and the chamber cooled to and maintained at a temperature of −80° F. for a period of 48 hours, at which time the equipment should be examined in accordance with paragraph B2. The temperature of the chamber should then be raised to −65° F. and maintained for an additional 24-hour period, or until temperature stabilization is reached (see par. A4), whichever is the longer. At the conclusion of this exposure period and while at this temperature, the equipment should be operated and the results checked against the data obtained in paragraph B1 and visually examined in accordance with paragraph B2.

3. *Temperature shock tests.*—

(*a*) *Method I.*—The equipment should be placed within a test chamber wherein a temperature of 185° F. is maintained. The equipment should be subjected to this temperature for a period of 4 hours, at the conclusion of which, and within 5 minutes, the equipment should be transferred to a chamber having an internal temperature of −40° F. The equipment should be subjected to this temperature for a period of 4 hours. This completes one cycle. The equipment may be restored to room temperature before starting the next cycle. The number of complete cycles should be three. At the conclusion of the third cycle, the equipment should be removed from the test chamber and within a period of 1 hour operated and the results checked against the data obtained in paragraph B1. A visual examination should then be completed in accordance with paragraph B2.

(*b*) *Method II (alternate to Method I).*—The equipment should be placed within the test chamber and maintained for a period of at least 1 hour or until the equipment performance stabilizes at a temperature of 77°±27° F. The chamber temperature should then be reduced to − 67° F. and maintained at this condition for at least 1 hour or until the equipment performance stabilizes. The internal temperature of the chamber should then be increased to 160° F. and maintained at this condition for at least 1 hour or until the equipment performance stabilizes. The internal temperature should then be returned to 77°±27° F. and the performance of the equipment checked against data obtained in paragraph B1.

4. *Humidity tests.*—

(*a*) *Method I.*—The equipment should be placed in the test chamber and set up to simulate installed conditions. The chamber temperature should be between 68° F. and 100° F. with uncontrolled humidity. During the first 2-hour period the temperature should be gradually raised to 160° F. The 160° F. temperature should be maintained during the next 6-hour period. During the following 16-hour period, the temperature in the chamber should be gradually reduced to between 68° F. and 100° F., which constitutes one cycle. The relative humidity throughout the cycle should be 95 percent. The cycle should be repeated a sufficient number of times to extend the total time of the test to 240 hours (10 cycles). At the conclusion of the 240-hour period, the equipment should be operated and the data checked against that obtained in paragraph B1, and a visual examination made in accordance with paragraph B2. Distilled or demineralized water having a pH value of between 6.5 and 7.5 at 77° F. should be used to obtain the desired humidity. The velocity of the air throughout the test area should not exceed 150 feet per minute.

(*b*) *Method II (alternate to Method I).*—The equipment should be placed in the

test chamber and set up to simulate installed conditions. The temperature and relative humidity in the chamber should be 120° F. and 95 percent respectively. The test conditions should be maintained for 360 hours. At the conclusion of this period, the equipment should be operated and the results checked against those obtained in paragraph B1. An examination in accordance with paragraph B2 should then be made.

5. *Altitude test.*—The equipment should be placed within the test chamber and the internal pressure of the chamber reduced to correspond to an altitude exceeding by 15 percent the maximum altitude to which the equipment would be exposed in normal service. The ambient temperature in the chamber (irrespective of test altitude) should be −65° F. The equipment should be maintained at this condition until temperature stabilized (see par. A4). While at this condition, the equipment should be operated and the results checked against those obtained in paragraph B1.

6. *Vibration tests.*—

(a) *Method I (Apply to items of equipment which mount directly on the structure of aircraft powered by reciprocating, turbojet or turbo-propeller engines and to items of equipment which mount directly on gas turbine engines).*—The test specimen should be mounted on the apparatus in a manner which is dynamically similar to the most severe condition likely to be encountered in service. The test specimen should be performing its function during the entire test period whenever practicable. At the end of the test period, the test specimen should be inspected thoroughly for damage or defects resulting from the vibration tests. The amplitude or acceleration for the frequency cycling test should be within ±10 percent of the specified values. Vibration tests should be conducted under both resonant and cycling conditions according to the following vibration test schedule (table 1):

Table 1.—VIBRATION TEST SCHEDULE

Type	Vibration at—		
	Room temp.	160° F.	−65° F.
	(*Minutes*)	(*Minutes*)	(*Minutes*)
Resonance	60	15	15
Cycling	60	15	15

NOTE: Times shown refer to one axis of vibration.

(i) *Resonance.*—Resonant frequencies of the test specimen should be determined by varying the frequency of applied vibration slowly through the specified range of frequencies at vibratory accelerations not exceeding those shown in figure 1. Individual resonant frequency surveys should be conducted with vibration applied along each of any set of three mutually perpendicular axes of the test specimen. Whenever practicable, functioning of the test specimen should be checked (against the data obtained in par. B1) concurrently with the operation of scanning the frequency range for resonant frequencies. The test specimen should be vibrated at the indicated resonant conditions for the periods shown in the vibration test schedule (table 1) and with the applied double amplitude or vibratory acceleration specified in figure 1. These periods of vibration should be accomplished with vibration applied along each of three mutually perpendicular axes of vibration. When more than one resonant frequency is encountered with vibration applied along any one axis, the test period may be accomplished at the most severe resonance or the period may be divided among

the resonant frequencies, whichever is considered most likely to produce failure. However, in no instance should the specimen be vibrated on any resonant mode for periods less than half as long as those shown for resonance in the vibration test schedule. When resonant frequencies are not apparent within the specified frequency range, the specimen should be vibrated for periods twice as long as those shown for resonance in the vibration test schedule (table 1) at a frequency of 55 cps. and an applied double amplitude of 0.060 inch.

(ii) *Cycling.*—For test specimens mounted on vibration isolators, a vibration test should be conducted with a constant applied double amplitude of 0.060 inch and the frequency cycling between 10 and 55 cps. in 1-minute cycles. Vibration should be applied along each of three mutually perpendicular axes according to the vibration test schedule (table 1). For specimens which are to be installed in aircraft without vibration isolators, a vibration test should be conducted with the frequency cycling between 10 and 500 cps. in 15-minute cycles at an applied double amplitude of 0.036 inch or an applied acceleration of ± 10g, whichever is the limiting value. Vibration should be applied along each of three mutually perpendicular axes according to the vibration test schedule (table 1).

(*b*) *Method II (Apply to items of equipment which mount directly to reciprocating engines).*—The test specimen should be mounted on the apparatus in a position dynamically similar to the most severe mounting likely to be used in service. Resonant frequencies of the test specimen should be determined by varying the frequency of applied vibration slowly through the specified frequency range at vibratory accelerations not exceeding those shown in figure 1. Individual resonant frequency surveys should be conducted with vibration applied along each of any set of three perpendicular axes of the test specimen. Whenever practicable, the functioning of the test specimen should be checked (against the data obtained in par. B1) concurrently with the operation of scanning the frequency range for resonant frequencies. If resonant frequencies are encountered, the test specimen should be vibrated successively along each of three mutually perpendicular axes for 4 hours at the resonant conditions with the applied double amplitude or vibratory acceleration shown in figure 1. When more than one resonant frequency is encountered with vibration applied along any one axis, the test period may be carried out at the most severe resonance, or the period may be divided uniformly among the resonant frequencies, whichever procedure is considered most likely to produce failure. When clearly defined resonant frequencies are not encountered within the specified frequency range, the test specimen should be vibrated for 12 hours along each of its mutually perpendicular axes at an applied double amplitude of 0.018 inch and a frequency of 150 cycles per second. The test specimen should be performing its function during the entire test period whenever practicable. At the end of the test period the test specimen should be inspected thoroughly for damage or defects resulting from the vibration tests.

(Rev. 1/15/59)

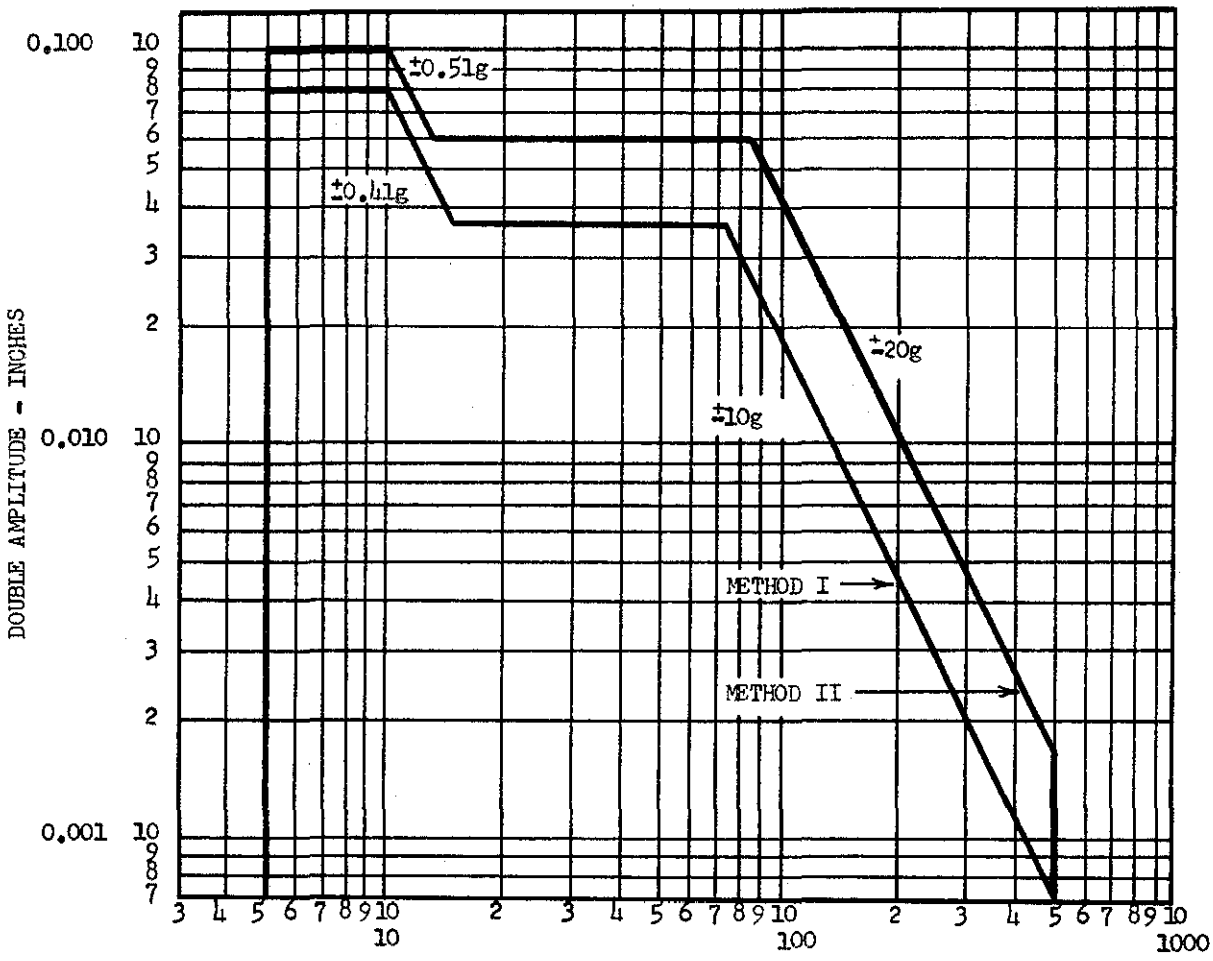


Figure 1.—Range curves for vibration tests.

7. *Fungus resistance test.*—Five groups of fungi are listed below, and one species of fungus from each group should be used. In the preparation of the spore suspension, distilled water having a pH value between 5.8 and 7.2 at temperatures between 72° F. and 89° F. should be used. Approximately 10 ml. of distilled water should then be introduced directly into a tube culture of the fungus and the spores brought into suspension by vigorous shaking or by gentle rubbing of the spore layer with an inoculating loop without disturbing the agar surface. This process is repeated for each species of fungus. The separate spore suspensions from the five species of fungi should be mixed together to provide a composite suspension. Actively sporulating cultures between 7 and 21 days old after initial inoculation should be used for the preparation of the spore suspension. After preparation the spore suspension should not be kept for more than a 24-hour period at temperatures between 72° F. and 89° F. and not more than 48 hours at refrigerator temperatures of 35° F. to 45° F. The equipment, including applicable external connections, should be placed in a chamber maintaining an internal temperature of 86° ± 3.6° F. and a relative humidity of 95±5 percent, and sprayed with the suspension of mixed spores. The test period should be 28 days. At

the end of the test period the test item should be examined visually in accordance with paragraph B2.

(*a*) *Organisms.*—

Group I— *Chaetomium globosum* USDA 1042.4 or *Myrothecium verrucaria* USDA 1334.2

Group II— *Rhizopus nigricans* S. N. 32 or *Aspergillus niger* USDA Tc215–4247

Group III—*Aspergillus flavus* WADC No. 26 or *Aspergillus terreus* PQMD 82J

Group IV—*Penicillium luteum* USDA 1336.1, *Penicillium sp.* USDA 1336.2, or *Penicillium citrinum* ATCC 9849

Group V— *Memnoniella echinata* WADC No. 37 or *Fusarium moniliforme* USDA 1004.1

(*b*) *Stock culture designations and sources.*—

Symbols	*Source*
USDA	U. S. Dept. of Agriculture, Beltsville, Md.
ATCC	American Type Culture Collection, 2029 M Street, NW., Washington 6, D. C.
PQMD	Philadelphia Q. M. Depot, 2800 South 20th Street, Philadelphia, Pa.
WADC	Wright Air Development Center, Materials Laboratory, Wright-Patterson Air Force Base, Ohio.
S.N.	Dr. W. B. Weston, Biological Laboratories, Harvard University, Cambridge, Mass.

8. *Salt spray test.*—

(*a*) *Apparatus.*—Apparatus used in the salt spray test should include the following:

(i) Exposure chamber with racks for supporting specimens.

(ii) Salt solution reservoir.

(iii) Means for atomizing salt solution, including suitable nozzles and compressed air supply.

(iv) Chamber heating means and control.

(v) Means for humidifying the compressed air at a temperature above the chamber temperature.

(*b*) *Chamber.*—The chamber and all accessories should be made of material which will not affect the corrosiveness of the fog, such as glass, hard rubber, plastic, or wood other than plywood. In addition, all parts which come in contact with test items should be of materials that will not cause electrolytic corrosion. The chamber and accessories should be so constructed and arranged that there is no direct impinging of the spray or dripping of the condensate on the test items, that the spray circulates freely about all items to the same degree and that no liquid which has come in contact with the test specimens returns to the salt solution reservoir. The chamber should be properly vented.

(*c*) *Atomizers.*—The atomizers used should be of such design and construction as to produce a finely divided, wet, dense fog.

(*d*) *Air supply.*—The compressed air entering the atomizers should be free from all impurities such as oil and dirt. Means should be provided to humidify and warm the compressed air as required to meet the operating conditions. The air pressure should be suitable to produce a finely divided dense fog with the atomizer or atomizers used. To insure against clogging the atomizers by salt deposition, the air should have a relative humidity of

at least 85 percent at the point of release from the nozzle. A satisfactory method is to pass the air in very fine bubbles through a tower containing heated water. The temperature of the water should be 95° F. and often higher. The permissible temperature increases with increasing volume of air and with decreasing heat insulation of the chamber and temperature of its surroundings. It should not exceed a value above which an excess of moisture is introduced into the chamber (for example, 109° F. at an air pressure of 12 psi) or a value which makes it impossible to meet the requirement for operating temperature.

(e) *Salt solution.* The salt used should be sodium chloride containing on the dry basis not more than 0.1 percent of sodium iodide and not more than 0.2 percent of total impurities. The solution should be prepared by dissolving 20 ± 2 parts by weight of salt in 80 parts by weight of distilled or other water containing not more than 200 parts per million of total solids. The solution should be kept free from solids by filtration or decantation. The solution should be adjusted to and maintained at a specific gravity of from 1.126 to 1.157 and at a pH of between 6.5 to 7.2 when measured at a temperature between 92° F. and 97° F. Only C. P. hydrochloric acid or C. P. sodium hydroxide should be used to adjust the pH. The pH measurement should be made electrometrically using a glass electrode with a saturated potassium chloride bridge or by a colorimetric method such as bromothynol blue provided the results are equivalent to those obtained with the electrometric method.

(f) *Operating conditions.*—

(i) *Temperature.*—The test should be conducted with a temperature in the exposure zone maintained at 95° F. Satisfactory methods for controlling the temperature accurately are by housing the apparatus in a properly controlled constant-temperature room, by thoroughly insulating the apparatus and preheating the air to the proper temperature prior to atomization and by jacketing the apparatus and controlling the temperature of the water or of the air used. Immersion heaters should not be used to maintain the temperature within the chamber.

(ii) *Atomization.*—The conditions maintained in all parts of the exposure zone should be such that a suitable receptacle placed at any point in the exposure zone will collect from 0.5 to 3 ml. of solution per hour for each 30 sq. cm. of horizontal collecting area (10 cm. diameter) based on an average of at least 16 hours. The solution thus collected shall have a sodium chloride content of from 18 to 22 percent (specific gravity of from 1.126 to 1.157 when measured at a temperature between 91.4 and 96.8° F.). At least two clean fog collecting receptacles should be used, one placed nearest to any nozzle and one farthest from all nozzles. Receptacles should be fastened so that they are not shielded by specimens and so that no drops of solution from specimens or other sources will be collected. When using nozzles made of material nonreactive to the salt solution, suitable atomization has been obtained in boxes having a volume of less than 12 cubic feet with the following conditions: Nozzle pressure between 12 and 18 pounds per square inch; orifices between 0.02 and 0.03

inch in diameter; atomization of approximately 3 quarts of the salt solution per 10 cubic feet of box volume per 24 hours. When using large size boxes having a volume considerably in excess of 12 cubic feet, these conditions may have to be modified to meet the requirements for operating conditions.

(iii) *Preparation of equipment.*—The equipment should be mounted in the chamber and electrical and mechanical connections completed where operation is required during the test period. Access covers and inspection plates should be in place except when such covers would normally be removed for service use. When operation is not required, external connections may be plugged to simulate actual service conditions.

(*g*) *Conclusion.*—The length of the salt spray test should be not less than 50 hours. At the end of the test period, the equipment should be operated and the results checked against the data obtained in paragraph B1. Salt deposits resulting from the test conditions may be removed prior to operation. A visual examination should be conducted in accordance with paragraph B2.

9. *Sand and dust tests.*—The equipment should be placed within the test chamber and the sand and dust density raised and maintained at 0.1 to 0.5 grams per cubic foot within the test space. The relative humidity should not exceed 30 percent at any time during the test. Sand and dust used in the test should be of angular structure and should have characteristics as follows:

(*a*) 100 percent of the sand and dust should pass through a 100-mesh screen, U. S. Standard Sieve Series.

(*b*) 98 ± 2 percent of the sand and dust should pass through a 140-mesh screen, U. S. Standard Sieve Series.

(*c*) 90 ± 2 percent of the sand and dust should pass through a 200-mesh screen, U. S. Standard Sieve Series.

(*d*) 75 ± 2 percent of the sand and dust should pass through a 325-mesh screen, U. S. Standard Sieve Series.

(*e*) Chemical analysis of the dust should be as follows:

Substance	*Percent by Weight*
SiO_2	97 to 99
Fe_2O_3	0 to 2
Al_2O_3	0 to 1
TiO_2	0 to 2
MgO	0 to 1
Ign Losses	0 to 2

The internal temperature of the test chamber should be maintained at 77° F. for a period of 6 hours with sand and dust velocity through the test chamber between 100 and 500 feet per minute. After 6 hours at these conditions, the temperature should be raised to and maintained at 160° F. These conditions should be maintained for 6 hours. At the end of this test period, the equipment should be removed and allowed to cool to room temperature. When cooled to room temperature, the equipment should be operated and the results checked against those obtained in paragraph B1. An examination in accordance with paragraph B2 should be conducted.

10. *Shock test.*—The equipment should be subjected to the shock conditions as normally used in service, including any shock mount assembly. A shock testing machine conforming to Military Specification MIL–S–4456 is suitable for this test.

The test specimen should be subjected to 18 impact shocks of 10g, each shock impulse having a time duration of 11 ± 1 milliseconds. The intensity should be within ± 10 percent when measured with a filter having a band width of 5 to 100 cycles per second. The maximum g should be reached in approximately 5½ milliseconds. The shock should be applied in the following directions:

(*a*) Vertically, 3 shocks in each direction.
(*b*) Parallel to the major horizontal axis, 3 shocks in each direction.
(*c*) Parallel to the minor horizontal axis, 3 shocks in each direction.

The test specimen should not suffer damage.

The equipment should be operated and the results checked against those obtained in paragraph B1. An examination in accordance with paragraph B2 should be conducted.

11. *Acceleration test.*—The test specimen should be mounted on the apparatus (centrifuge) successively in three positions so that each of the three major axes of the test specimen in turn extend in a radial direction with respect to the centrifuge center of rotation. A 15g acceleration should be attained, stabilized, and maintained for a period of not less than one minute for each position. Functional tests should be conducted during application of the acceleration to assure that safe performance (refer to par. B1) of the equipment is obtained. There should be no mechanical failures or malfunctions due to the applied acceleration.

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(e) If changes listed in subparagraphs (1) through (3) of this paragraph are made, the airplane shall be considered as a new type, in which case a new application for type certificate shall be required and the regulations together with all amendments thereto effective on the date of the new application shall be made applicable in accordance with paragraphs (a), (b), (c), and (d) of this section.

(1) A change in the number of engines or rotors;

(2) A change to engines or rotors employing different principles of operation or propulsion;

(3) A change in design, configuration, power, or weight, which the Administrator finds is so extensive as to require a substantially complete investigation of compliance with the regulations.

6.12 *Recording of applicable regulations.* The Administrator, upon the issuance of a type certificate, shall record the applicable regulations with which compliance was demonstrated. Thereafter, the Administrator shall record the applicable regulations for each change in the type certificate which is accomplished in accordance with regulations other than those recorded at the time of issuance of the type certificate. (See sec. 6.11.)

6.13 *Type certificate.*

(a) An applicant shall be issued a type certificate when he demonstrates the eligibility of the rotorcraft by complying with the requirements of this part in addition to the applicable requirements in Part 1 of the Civil Air Regulations.

(b) The type certificate shall be deemed to include the type design (see sec. 6.14 (b)), the operating limitations for the rotorcraft (see sec. 6.700), and any other conditions or limitations prescribed by the Civil Air Regulations.

(c) The applicable provisions of this part recorded by the Administrator in accordance with section 6.12 shall be considered as incorporated in the type certificate as though set forth in full.

6.14 *Data required.*

(a) The applicant for a type certificate shall submit to the Administrator such descriptive data, test reports, and computations as are necessary to demonstrate that the rotorcraft complies with the requirements of this part.

(b) The descriptive data required in paragraph (a) of this section shall be known as the type design and shall consist of such drawings and specifications as are necessary to disclose the configuration of the rotorcraft and all the design features covered in the requirements of this part, such information on dimensions, materials, and processes as is necessary to define the structural strength of the rotorcraft, and such other data as are necessary to permit by comparison the determination of the airworthiness of subsequent rotorcraft of the same type.

6.15 *Inspections and tests.* Inspections and tests shall include all those found necessary by the Administrator to insure that the rotorcraft complies with the applicable airworthiness requirements and conforms to the following:

(a) All materials and products are in accordance with the specifications in the type design.

(b) All parts of the rotorcraft are constructed in accordance with the drawings in the type design.

(c) All manufacturing processes, construction, and assembly are as specified in the type design.

6.16 *Flight tests.* After proof of compliance with the structural requirements contained in this part, and upon completion of all necessary inspections and testing on the ground, and proof of the conformity of the rotorcraft with the type design, and upon receipt from the applicant of a report of flight tests performed by him, the following shall be conducted:

(a) Such official flight tests as the Administrator finds necessary to determine compliance with the requirements of this part.

(b) After the conclusion of flight tests specified in paragraph (a) of this section, such additional flight tests as the Administrator finds necessary to ascertain whether there is reasonable assurance that the rotorcraft, its components, and equipment are reliable and function properly. The extent of such additional flight tests shall depend upon the complexity of the rotorcraft, the number and nature of new design features, and the record of previous tests and experience for the particular rotorcraft type, its components, and equipment. If practicable, these flight tests shall be conducted on the same rotorcraft used in the flight tests specified in paragraph (a) of this section and in the rotor drive endurance tests specified in section 6.412.

6.17 *Airworthiness, experimental, and production certificates.* (For requirements with regard to these certificates see Part 1 of the Civil Air Regulations.)

6.18 *Approval of materials, parts, processes, and appliances.*

(a) Materials, parts, processes, and appliances shall be approved upon a basis and in a manner found necessary by the Administrator to implement the pertinent provisions of the Civil Air Regulations. The Administrator may adopt and publish such specifications as he *finds necessary to administer this regulation*, and shall incorporate therein such portions of the aviation industry, Federal, and military specifications respecting such materials, parts, processes, and appliances as he finds appropriate.

(b) Any material, part, process, or appliance shall be deemed to have met the requirements for approval when it meets the pertinent specifications adopted by the Administrator, and the manufacturer so certifies in a manner prescribed by the Administrator.

NOTE: The provisions of this paragraph are intended to allow approval of materials, parts, processes, and appliances under the system of Technical Standard Orders, or in conjunction with type certification procedures for a rotorcraft, or by any other form of approval by the Administrator.

6.18–1 *Approval of aircraft components (CAA rules which apply to sec. 6.18).* Aircraft components made the subject of technical standards orders shall be approved upon the basis and in the manner provided in Part 514 of this title (Regulation of the Administrator).

(16 F. R. 672, Jan. 25, 1951, effective Jan. 25, 1951.)

[6.18–2 *Manufacturer (CAA interpretation which applies to sec. 6.18 (b)).* For the purpose of accepting a statement of conformance for a Technical Standard Order Product, the word "manufacturer" is interpreted to mean a person who designs and fabricates by welding, cutting, drilling, forming, bolting, riveting, glueing, soldering, sewing, etc., a product. This includes products which are composed in whole or in part of components of TSO products. One who merely cleans products or appliances or repairs them by replacing standard parts and/or by replacing components with identical ones is not considered to be the manufacturer. Nor is the distributor of another person's completed product considered to be the manufacturer.

(23 F. R. 10326, Dec. 25, 1958, effective Jan. 31, 1959.)

[6.18–3 *Products approved as a part of the rotorcraft (CAA policies which apply to sec. 6.18).*

[(a) A material, part or appliance (hereinafter called product) may be approved as a part of the rotorcraft type design under a type certificate or a supplemental type certificate.

[(1) If a Technical Standard Order covering the product is in effect, the applicant for approval should submit type design data showing that the product meets the performance standards of the Technical Standard Order except that:

[(i) Deviations from the performance standards may be allowed when the applicant for, or holder of, the type certificate or the supplemental type certificate substantiates that other performance standards are applicable for the product as installed in the rotorcraft. Any deviation from standards prescribed in this part may be allowed only in accordance with section 6.10.

[(2) Where no TSO covering the product exists, the applicant for approval should submit type design data showing compliance with all the requirements of this part which are applicable to the product.

[(3) Products previously approved by the CAA by means of letters of approval, Repair and Alteration Form ACA–337, or listing on CAA Product and Process Specifications will continue to be eligible for installation in aircraft unless the eligibility is restricted by applicable regulations or airworthiness directives issued under section 1.24 of this subchapter.

[(b) Products approved as a part of the rotorcraft type design under a type certificate should be identified by a rotorcraft part number on the approved drawing list.

[(c) Products approved as a part of the rotorcraft under a supplemental type certificate should be identified by a part or drawing number on such certificate.

[(d) Each TSO product that is approved as a part of the rotorcraft should have the TSO identification removed and be identified as set

forth in paragraph (b) or (c) of this section, whichever is applicable.]

(23 F. R. 10326, Dec. 25, 1958, effective Jan. 31, 1959.)

6.19 *Changes in type design.* (For requirements with regard to changes in type design and the designation of applicable regulations therefor, see sec. 6.11 (d) and (e), and Part 1 of this subchapter.)

Flight

General

6.100 *Proof of compliance.*

(a) Compliance with the requirements prescribed in this subpart shall be established by flight or other tests conducted upon a rotorcraft of the type for which a certificate of airworthiness is sought or by calculations based on such tests, provided that the results obtained by calculations are equivalent in accuracy to the results of direct testing.

(b) Compliance with each requirement shall be established at all appropriate combinations of rotorcraft weight and center of gravity position within the range of loading conditions for which certification is sought by systematic investigation of all these combinations, except where compliance can be inferred reasonably from those combinations which are investigated.

(c) The controllability, stability, and trim of the rotorcraft shall be established at all altitudes up to the maximum anticipated operating altitude.

(d) The applicant shall provide a person holding an appropriate pilot certificate to make the flight tests, but a designated representative of the Administrator shall pilot the rotorcraft when it is found necessary for the determination of compliance with the airworthiness requirements.

(e) Official type tests shall be discontinued until corrective measures have been taken by the applicant when either:

(1) The applicant's test pilot is unable or unwilling to conduct any of the required flight tests, or

(2) It is found that requirements which have not been met are so substantial as to render additional test data meaningless or are of such a nature as to make further testing unduly hazardous.

(f) Adequate provision shall be made for emergency egress and for the use of parachutes by members of the crew during the flight tests.

(g) The applicant shall submit to the Administrator's representative a report covering all computations and tests required in connection with calibration of instruments used for test purposes and correction of test results to standard atmospheric conditions. The Administrator's representative shall conduct any flight tests which he finds necessary to check the calibration and correction report.

6.101 *Weight limitations.* The maximum and minimum weights at which the rotorcraft will be suitable for operation shall be established as follows: