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CIVIL AERONAUTICS AUTHORITY
WASHINGTON

C. A. R. 04.503

RADIO SPECIFICATIONS

July 1, 1939

Aircraft Radio Equipment Specifications

1. In accordance with the terms of Section 04.503 of the Civil Air Regulations the following procedures, specifications and tests for type certification of air carrier aircraft radio equipment are issued.

2. These specifications shall apply to all items of radio equipment which may be required by the Civil Air Regulations to be installed aboard certificated aircraft engaged in scheduled air carrier operations.

3. For the purpose of these specifications, a unit of radio equipment is considered important if, by malfunctioning, it may endanger the safety of the aircraft, or the cargo or passengers in the aircraft or persons or property on the ground.

4. Due to the fact that the development of aircraft radio equipment is constantly increasing in scope and variety, there will be developed from time to time important items of radio equipment for which specific provisions are not made in these specifications. In such cases, the general procedure for type certification will be in accordance with these specifications, and the applicant shall apply to the Authority for special ruling particularly applicable to that product.

5. All units of radio equipment falling within the meaning of these specifications, irrespective of their classification, and installed in certificated aircraft engaged in scheduled air commerce shall:

   (a) Satisfactorily fulfill the purpose for which they are intended.

   (b) Be free from undue hazard both in themselves and in their method of operation and

   (c) Be constructed of suitable and dependable materials.

Procedure to be followed in making application for type certificate:

6. Interested persons or corporations desiring type certificate for air carrier aircraft radio equipment may make application to the Civil Aeronautics Authority setting forth the following information:

(a) List of equipment to be certificated.

(b) Date that equipment will be ready for inspection.

(c) Address of place where equipment is to be inspected.

This application should be in the form of a letter addressed to the Authority in which will be incorporated the information as set forth immediately above. Upon receipt of this application the Authority will detail an Inspector to the address set forth in the application for the purpose of inspecting the equipment and witnessing the test hereinafter prescribed.

Procedure to amend type certificates:

7. In order to permit desirable changes in aircraft radio equipment, the Authority may consider application for approval of modifications upon any unit of equipment to which a type certificate has been issued. The application for approval of modifications may be initiated by the manufacturer or by interested air carriers. Applications for such modifications shall be made to the local Air Carrier Inspector (Radio) or to the Washington Office of the Authority. The application may take the form of a letter containing the following information:

(a) Name and address of applicant.

(b) Model name or model number of unit affected and type certificate number assigned to such unit.

(c) Purpose and extent of proposed modification.

(d) Date and place where the equipment may be inspected.

Upon receipt of this information, the local Inspector will inspect the equipment to determine whether or not the changes or modifications are desirable in the interest of increased performance or efficiency, and if any degradation of reliability will be caused by the proposed modification. Upon completion of this inspection, the applicant shall furnish the Inspector with two copies of detailed drawings, test data, and other factual data necessary to fully describe the changes involved. This information, together with the Inspector's recommendations, shall be forwarded to the

This information shall be displayed in a conspicuous place on the unit in such manner that it may not be easily erased, disfigured or obscured. Additional information may be added by the applicant at his discretion.

Test Equipment:

10. The applicant shall provide all apparatus and facilities necessary to conduct the test outlined herein.

Definitions:

11. The term "unit" as used herein shall mean any assembly of radio parts and material eligible for type certification.

12. Where the term "operate" is used in conjunction with a time period, it shall be interpreted as meaning operation during the period stated according to a predetermined cycle. In general, for receivers and receiving equipment, this duty cycle shall be continuous operation for the period indicated. For transmitters and transmitting power apparatus, the duty cycle shall be five minutes on and five minutes off.

Safety Requirements:

13. All units of equipment shall be designed to afford the maximum protection to maintenance and operating personnel. The design of all equipment shall be such as to preclude the possibility of operating personnel receiving an electrical shock or burn.

Inspections:

14. An inspection shall be made to determine if the unit submitted for type certification complies with the requirements outlined herein. Measurements shallbe made prior to submission of the unit to any or all of the tests outlined herein and, during the test or at the conclusion of the test, additional measurements shall be made to determine if any, or to what extent, degradation of performance or reliability has resulted due to the conditions imposed during the test.

Minimum Requirements:

15. Insofar as test and ratings are concerned, in all cases not specifically covered herein the unit shall, as a minimum requirement, conform with the standards of Radio Manufacturer's Association or, where these do not apply, with the standards of the American

Institute of Electrical Engineers, and deviations below these standards shall be made only where an undeniable gain in reliability and/or performance results therefrom.

Mechanical construction and design:

16. All units of radio equipment submitted for type certification shall meet the minimum requirements with respect to mechanical and electrical design as outlined in paragraph 17 to 44 inclusive, unless the applicant can demonstrate an undeniable gain in reliability by deviations therefrom.

17. The dimensions of all units shall be held to a tolerance that will assure accurate and true alignment insofar as interchangeability of units is concerned.

18. The dimensional tolerance and design location of component parts and structures shall be held to a value that will preclude the possibility of failures due to misalignment of such parts and structures.

19. Component parts shall, insofar as possible, be so located and disposed with respect to each other and to other material that they can be inspected, removed, and replaced without unduly disturbing or damaging other parts. In general, parts should not be stacked one upon the other nor should common mounting screws or devices be used unless such design can be justified by gains in reliability or other equally desirable characteristics. In particular, parts which require periodic cleaning and inspections shall be located in a manner which will permit visual inspection without disturbing other component parts.

20. The method of securing parts or structures to each other shall be such that any loosening which occurs can be immediately and effectively corrected. In this connection self-threading screws shall be restricted to those places where the design features are consistent with such use.

21. Wherever machine screws engage threads tapped in sheet material the threaded material shall be of ample thickness to assure the permanence and strength of the threads. This requirement is particularly applicable where the screw in question will be frequently removed and replaced for purpose of routine servicing and inspection.

22. The mounting of fragile parts shall be such as to preclude the existence of destructive strains.

23. All wire shall be of sufficient cross section, of correct temper, and of proper construction to provide ample current carrying capacity and mechanical strength.

24. All wires and cables shall be secured and supported in such a manner as to prevent breakage of the conductor and/or abrasion of the insulation.

25. Conductors which carry sufficient current to heat to incandesence in the event of short circuits, irrespective of whether such circuits are protected by fuses or not, shall utilize flameproof insulation.

26. Insulation used on conductors shall be of sufficient thickness and quality of material to provide protection throughout the length of the conductor. Where such insulation has been removed in order to make connections, adequate means shall be taken to prevent misplacement of the insulation.

27. Where the electrical design permits, all wiring used on the radio unit shall be color-coded.

28. Metallic shielding used on conductors shall be terminated at a suitable distance from the exposed conductor and in such a manner as to insure a satisfactory and permanent termination.

29. Conductors utilizing metallic shielding which are not protected by means of an insulation sleeve shall be secured in a manner which will prevent the shielding from coming into contact with exposed terminals or conductors.

30. Any process of soldering, welding, etc., which uses materials subject to the slightest degree of corrosiveness shall include means for the removal of the corrosive substance.

31. Mechanical strength of soldered connection shall not depend on the solder alone but shall be assured by suitable mechanical support in addition to the soldering process.

32. Plugs and receptacle used to connect the circuits of the unit to outside circuits or to connect circuits of the various parts of the unit to each other shall be suitable from the standpoint of:

(a) Mechanical ruggedness

(b) Method of locking

(c) Voltage insulation

(d) Current carrying capacity

(e) Method of connecting terminal conductors

(f) Method of terminating shielding (if used).

(g) Method of mechanically supporting terminating conductors.

33. All movable controls shall be so designed and constructed that displacement shall not result under service conditions.

34. Insofar as possible all controls, switches and levers which are manipulated during operation of the equipment shall be of rugged design and construction to permit their operation without damage and by unskilled personnel under the most adverse aservice conditions.

Electrical Design:

35. The electrical characteristics - input, output, frequency range, etc., of the unit shall be in accordance with the published ratings.

36. Component parts including vacuum tubes assembled in the unit shall not be operated at voltage or current levels beyond the recommendations of the manufacturer of these component parts.

37. Performance of the unit shall not vary beyond the operating limits upon replacement of any or all of the tubes used, by good tubes of the particular type incorporated in the design of the unit. An exception to this requirement may be made, however, where the unit in question is designed for some highly specialized use, in which case selected tubes may be used, provided the manufacturer so states (with due emphasis) on some placard or plate affixed to the unit and in the instruction bulletins pertaining to the unit.

38. The electrical design of the unit shall be such that operation must not be critical with respect to replacement of plug-in component, i.e, vibrators, crystals, etc.

39. In any receiver intended for the reception of radio range signals where the directive properties of these signals or the field strength intensity are used as an aid to navigation, the (sensitivity) volume control shall function in such a manner that for signal field strengths within the ranges encountered under service conditions, the output signal shall increase with increasing signal input, the control being always adjusted to prevent overloading of the receiver. The circuit shall be such that improper operation of the control shall not result in a reversal of radio range quadrant signals,

provided the output level of the receiver shall not be required to be greater than 300 milliwatts per audio output channel.

40. The control by means of which the sensitivity and/or volume of a receiver used for the reception of radio range signals is adjusted shall be so designed as to produce smooth operation through its entire range and the design shall be such that the minimum perceptible difference in output can be obtained, within the operating limits of the receiver, for any signal input up to one volt.

Material and workmanship:

41. Material which will ignite or explode from electrical spark or from any degree of heat encountered in service conditions will not be used and, in general, the use of combustion sustaining materials shall be held to a minimum.

42. Insulating materials used for structural parts shall have such characteristics that no permanent deformation shall result from temperature changes and other climatic conditions.

43. All bolts, studs, screws and nuts wherever practical, shall conform to the National Screw Thread Commission fine or coarse thread series.

44. All units shall be assembled in a neat and workmanlike manner and the workmanship throughout shall be of the highest order.

Instruction book and specifications:

45. The applicant shall prepare certain specifications and instructions which shall be made available with each unit of type certificated radio equipment. The specifications shall set forth in detail the normal operating characteristics of the unit with permissible maximum and minimum values of terminal voltages. The instruction publication shall include all pertinent information necessary to insure proper installation, maintenance and operation of the unit.

Operating Test:

46. Upon completion of the inspection to determine compliance with the requirements as set forth in paragraph 17 to 44 inclusive, the unit of equipment shall be subjected to the test outlined hereinafter, and during these tests the performance of the unit shall in all cases be satisfactory for the purpose for which the equipment is designed. If failures occur during this test or other unsatisfactory conditions

are disclosed, the manufacturer shall take such corrective action as necessary to remedy such defects. This remedial action shall be plainly outlined in the test data and shall be incorporated in the specifications and drawings furnished the Authority in accordance with the procedure hereinbefore outlined.

Humidity Test:

47. The unit shall remain for a period of 48 hours in an atmosphere of clear vapor maintained at not less than 95% humidity and at a temperature of 50 degrees centigrade. (Permissable tolerance of relative humidity 5% plus or minus, permissible tolerance of temperature 3 degrees). The percentage of humidity and the time element involved may be less than the maximum specified above if, in the opinion of the Inspector, the design of the unit is such that any inherent defects will be disclosed at a lower percentage of humidity or within a shorter period of time. Wherever possible, the unit shall be operated at intervals specified by the Inspector during the actual humidity test to determine the effects of such tests. When measurements are not being taken the unit must not be in the standby or operating positions. Upon completion of the humidity exposure the unit shall be tested and such pertinent information as required by the Inspector for purposes of comparison shall be made. The sensitivity performance of receivers, radio compasses, receiving equipment and power output of transmitting equipment after the test shall not be below the following values at the time periods stated:

> After 30 minutes warm up period, the sensitivity shall have returned to a value of 4 to 1 or better as compared to measurements taken prior to the test, and at the end of 4 hours of operation substantially complete recovery must be obtained. At the end of 15 minutes, transmitters and transmitting equipment shall return to within 75% of normal power output and at the end of 4 hours recovery shall be substantially complete.

Upon completion of the humidity exposure an inspection of the equipment shall disclose no evidence of corrosion or other condition, the presence of which, or the continuance of which will lower the performance of the unit below the minimum necessary for the service intended.

Temperature Test:

48. The unit shall be placed in an ambient temperature of plus 55 degrees centigrade for a period of time sufficient to permit component parts of the unit to assume that temperature. The unit shall then be operated for a period of one hour at a supply voltage 20% above

that specified as normal in the case of 12 volt or 24 volt DC equipment, and 10% above that specified as normal in case of 115 volt AC equipment. The unit shall then be operated under the direction of the Inspector for such period as he may deem necessary at a supply voltage 10% below normal. The unit shall then be placed in an ambient temperature of minus 40 degrees centigrade for a period of time sufficient to allow the component parts to assume that temperature, after which it shall be operated at supply voltages 10% below and 10% above that specified as normal for a series of operations to determine the effects of the tests.

Vibration test:

49. The unit shall be vibrated for a period of four hours at a frequency selected by the applicant which shall fall between the range of 30 to 60 cycles per second, with an amplitude and wafe form sufficient to produce a vertical acceleration of 10G. During this period of vibration, the unit shall be operated under the supervision of the Inspector in order to detect variation in output, frequency, etc., or any other harmful effects which may be caused by the vibration. At the termination of this test a visual inspection shall be made and shall disclose no condition produced by the vibration, the presence of or the continuance of which, would be detrimental to the satisfactory performance of the unit. The unit shall then be operated over a range of frequencies varying continuously from 25 to ~~150~~ 60 cycles per second with an amplitude which will permit the vibration to be easily felt by placing the hand on the table. This test shall be conducted under the supervision of the Inspector and will be of sufficient duration to permit the observation of all component parts at various frequencies. During this test all component parts and structures of the unit will be observed for evidence of resonant vibration and parts which show such tendencies shall be redesigned or remounted to eliminate the resonant condition. Where redesigning or remounting is not practical, the manufacturer shall satisfactorily demonstrate that the resonant vibration of the part will in no manner be detrimental to the performance of the unit. The use of shock mounts will not be permitted unless such mounts form an integral part of the design of the unit, in which case, the type certificate will be abrogated if the unit is mounted without the particular shock mount which forms an integral part of the equipment. A strobostac or stroboscope device shall be furnished by the applicant for use in observing the unit under vibration.

Drop Test:

50. At least 100 free drops from heights varying from 6 to 18 inches shall be made. No shock absorbers will be attached to the unit. If shock absorbers are incorporated in the design of the unit as an

integral part of the equipment these shock absorbers shall be removed. Commercial sponge rubber of a thickness not to exceed one inch may be interposed as a damping medium between the unit and the substantially solid platform upon which the equipment will come to rest. During this test the equipment will be released in the free drop in such manner as to insure it coming to rest in the same attitude for which it was designed and to further insure that stress will be equally distributed. During this test the Inspector may require that connecting plugs and external plug-in devices be connected to determine the suitability of locking devices employed thereon.

Pressure Test:

51. The unit shall be operated in a pressure chamber under conditions of pressures ranging from 8.52 to 31 inches of mercury (sea level to 31,000 feet altitude). The period of observation at the lower pressures shall be sufficient to disclose any defects which will be aggravated by reduced pressure. The unit shall show satisfactory performance at all pressure ranges. Transmitters subjected to this test shall be tuned to its lowest frequency and operated into the smallest antenna for which the transmitter is designed. The transmitter shall be modulated at the highest percentage of modulation for which the unit is designed.

52. The Authority will assume no responsibility for damage incurred to equipment subjected to type certificate tests.

53. The specifications contained herein supersede the "Specifications for the approval of airline aircraft radio equipment" issued August 21, 1937, by the Bureau of Air Commerce, Department of Commerce.