See correction

Title 14—AERONAUTICS AND SPACE

Chapter I—Federal Aviation Administration, Department of Transportation

SUBCHAPTER C—AIRCRAFT

[Docket No. 9724; Amdt. No. 37-21]

PART 37—TECHNICAL STANDARD ORDER AUTHORIZATIONS

Airborne ATC Transponder Equipment

The purpose of these amendments to Part 37 of the Federal Aviation Regulations is to update the standards for airborne ATC transponder equipment by revising the Technical Standard Order (TSO-C74a).

These amendments were proposed in Notice 69-29, issued on July 25, 1969 (34 F.R. 12287). While the comments received in response to Notice 69-29 were generally favorable, several of the comments recommended changes to the proposal. The FAA's disposition of these comments are set forth hereinafter.

One of the comments expressed concern over the transponder power limitation of 27 dbw set forth in paragraph 2.11 of the proposal. The comment indicated that the limit should be raised to 30 dbw in order to improve signal strength during aircraft maneuvers which shade the antenna from ground receivers. The FAA does not agree. The 27 dbw peak pulse power limitation refers to the antenna end of the transponder transmission line, not to the transponder. If the power limit there were changed to 30 dbw as recommended, the equipment would not comply with the ICAO standard or the U.S. National Standard for Radar Beacon Systems.

There were also comments to the effect that the −70 dbm maximum transponder self test signal level, specified in paragraph 2.15 of the proposal, is too restrictive. After further consideration, the FAA agrees. Tests show that increasing the self test signal to −40 dbm would permit utilization of test equipment of reasonable weight and cost while simultaneously limiting the radius within which the self test signal would cause a transponder located in an adjacent aircraft to be interrogated to less than 100 feet.

One commentator recommended that the antenna radiation characteristics of paragraph 2.17 be retained as a design objective only. The FAA does not concur with this recommendation. Antennas should meet an acceptable level of performance to insure proper operation. The antenna radiation characteristics referred to in this comment are in current TSO-C74a and no change to this requirement was proposed in the notice.

Proposed paragraph 2.14 requires that the transponder be provided with a means to remove the information pulses from the Mode C reply when requested by Air Traffic Control. This requires an additional operating control on the transponder. However, the regulation does not state where it should be located. The final regulation corrects this deficiency and requires that this control be mounted on the control box with all the other operating controls.

Based on the comments received, it is apparent that the second sentence of paragraph 1.2c of the proposal has caused some confusion. Since this sentence is unnecessary, it has been deleted from the final rule.

There was also a recommendation that the reply characteristics in proposed § 2.2d covering Receiver Sensitivity and Dynamic Range should be applicable over a received signal amplitude range between minimum triggering level and −27 dbm rather than minimum triggering level and 50 db above that level. The FAA does not agree. This recommendation is based on a transponder with a minimum triggering level of −77 dbm. It does not take into consideration a transponder with a minimum triggering level of −69 dbm. Under this recommendation, the dynamic range would only have to be 42 db rather than 50 db. The FAA does not consider a dynamic range of 42 db suitable for operation under all conditions normally encountered in service.

Finally, there was a comment recommending that the provision governing side lobe suppression be changed to require that the transponder be suppressed with a 99 percent efficiency over the received signal amplitude range between 3 db above minimum triggering level and −27 dbm rather than 3 db above minimum triggering level and 50 db above that level. The FAA does not agree. Under this recommendation, transponders would not be suppressed over the received signal amplitude range normally encountered in service.

In consideration of the foregoing, § 37.180 Airborne ATC Transponder Equipment—TSO-C74a of the Federal Aviation Regulations is amended, effective May 31, 1970, as follows:

1. Paragraphs (a), (b), (c), and (d) are amended to read as follows:

§ 37.180 Airborne ATC Transponder Equipment—TSO-C74b.

(a) *Applicability.* This technical standard order prescribes the minimum performance standards that ATC transponder equipment must meet in order to be identified with the applicable TSO marking. New models of equipment that are to be so identified, and that are manufactured on or after (the effective date of this section), must meet the requirements of the "Federal Aviation Administration Standard, Airborne ATC Transponder Equipment," set forth at the end of this section, and Radio Technical Commission for Aeronautics Document No. DO-138 entitled "Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments" dated June 27, 1968. RTCA document No. DO-138 is incorporated herein in accordance with 5 U.S.C. 552(a)(1) and § 37.23 of the Federal Aviation Regulations, and is available as indicated in § 37.23. Additionally, RTCA document No. DO-138 may be examined at any FAA Regional Office and may be obtained from the RTCA Secretariat, Suite 302, NADA Building, 20th and K Streets NW., Washington, D.C., 20006, at a cost of $4 per copy.

(b) *Marketing.* (1) In addition to the markings specified in § 37.7, the equipment must be marked to indicate the environmental extremes over which it has been designed to operate. There are 12 environmental test procedures outlined in the RTCA document which have categories established. These must be identified on the nameplate by the words "Environmental Categories" or, as abbreviated, "Env. Cat." followed by 12 letters which identify the categories designated. Reading from left to right, the category designations must appear on the nameplate in the following order, so that they may be readily identified:

(i) Temperature-Altitude category;
(ii) Humidity category;
(iii) Vibration category;
(iv) Audiofrequency magnetic field susceptibility category;
(v) Radiofrequency susceptibility category;
(vi) Emission of spurious radiofrequency energy category;
(vii) Explosion category;
(viii) Waterproofness category;
(ix) Hydraulic fluid category;
(x) Sand and dust category;
(xi) Fungus resistance category;
(xii) Salt spray category.

(As published in the Federal Register /35 F.R. 6914/ on May 1, 1970)

(2) Equipment intended for installation in aircraft that operate at altitudes above 15,000 feet must be identified on the nameplate as Class I equipment.

(3) Equipment intended for installation in aircraft that operate at altitudes not exceeding 15,000 feet must be identified on the nameplate as Class II equipment.

(4) Where a manufacturer desires to substantiate his equipment in dual categories for one environment, the nameplate must be marked with both categories in the space designated for that category by placing one letter above the other in the following manner:

Env. Cat. A AJAAAXWHDFS Class I
D

(5) Each separate component of equipment (antenna, power supply, etc.) must be identified with at least the name of the manufacturer, the TSO number and the environmental categories over which the equipment component is designed to operate. Where an environmental test procedure is not applicable to that component and the test is not conducted, an X should be placed in the space assigned for that category.

(c) *Data requirements.* In accordance with § 37.5 the manufacturer must furnish to the Chief, Engineering and Manufacturing Branch, Flight Standards Division, Federal Aviation Administration, in the region in which the manufacturer is located, the following technical data:

(1) One copy of the operating instructions and equipment limitations of the manufacturer.

(2) One copy of the installation procedures with applicable schematic drawings, wiring diagram, and specifications, and a listing of components (by part number) or possible combinations thereof, which make up a system complying with this TSO. Indicate any limitations, restrictions, or other conditions pertinent to the installation.

(3) One copy of the test report of the manufacturer.

(d) *Previously approved equipment.* Airborne ATC transponder equipment approved prior to (the effective date of this section) may continue to be manufactured under the provisions of its original approval.

* * * * *

2. Paragraph 1.2 is amended by amending subparagraph 1.2c and by adding a new subparagraph 1.2e to read as follows:

1.2 *Operating controls.*

* * * * *

c. Selection of Modes 3/A and C combined.

* * *

e. Removal of all information pulses on the Mode C reply.

3. Paragraph 2.1 as amended by striking out the symbol "Mc" wherever it appears, and inserting the symbol "MHz" in place thereof.

4. Paragraph 2.2 is amended to read as follows:

2.2 *Receiver sensitivity and dynamic range.* a. The minimum triggering level (MTL) of the transponder must be such that replies are generated to 90 percent of the interrogation signals when—

1. The two pulses P_1 and P_3 constituting an interrogation are of equal amplitude and P_2 is not detected; and

2. The amplitude of these signals received at the antenna end of the transmission line of the transponder is nominally 71 db below 1 milliwatt with limits between 69 and 77db below 1 milliwatt.

b. With the transponder adjusted to comply with paragraph a, the random triggering rate (squitter) must not be greater than five reply pulse groups or suppressions per second averaged over a period of at least 30 seconds.

c. The variation of the minimum triggering level between modes must not exceed 1 db for nominal pulse spacings and pulse widths.

d. The reply characteristics apply over a received signal amplitude range between minimum triggering level and 50 db above that level.

e. The standards of this section assume a transmission line loss of 3 db and an antenna performance equivalent to that of a simple quarter wave antenna. In the event that these assumed conditions do not apply, the equipment must be adjusted as necessary to provide a sensitivity equivalent to that specified.

5. Paragraph 2.6a(2) is amended to read as follows:

2.6 *Decoding performance.* a. * * *

(2) The received amplitude of P_2 is in excess of a level 1 db below the received amplitude of P_1 but no greater than 3 db above the received amplitude of P_1.

* * * * *

6. Paragraph 2.6c is amended to read as follows:

2.6 *Decoding performance.*

* * * * *

c. *Side-lobe suppression.* The transponder must be suppressed for a period of 35±10 microseconds following receipt of a pulse pair of proper spacing and amplitude indicative of side-lobe interrogation. This suppression action must be capable of being reinitiated for the full duration within 2 microseconds after the end of any suppression period. The transponder must be suppressed with a 99 percent efficiency over a received signal amplitude range between 3 db above minimum triggering level and 50 db above that level and upon receipt of properly spaced interrogations when the received amplitude of P_2 is equal to or in excess of the received amplitude of P_1 and spaced 2.0±0.15 microsecond from P_1.

7. Paragraph 2.7d is amended to read as follows:

2.7 *Transponder discrimination and desensitization.*

* * * * *

d. *Reply rate control.* A sensitivity-reduction type reply rate control must be provided. The range of this control must permit adjustment of the reply rate to any value between 500 replies per second and the maximum rate of which the transponder is capable, or 2,000 replies per second, whichever is the lesser, without regard to the number of pulses in each reply. Sensitivity reduction in excess of 3 db must not take effect until 90 percent of the selected reply rate is exceeded. The sensitivity must be reduced by at least 30 db when the rate exceeds the selected value by 50 percent. The reply rate limit must be set at 1,200 replies per second, or the maximum value below 1,200 replies per second of which the transponder is capable.

8. Paragraph 2.10 is amended by striking out the symbol "Mc" and inserting the symbol "MHz" in place thereof.

9. Paragraph 2.11 is amended to read as follows:

2.11 *Transmitter power output.* a. For equipment intended for installation in aircraft which operate at altitudes above 15,000 feet (Class I), the peak pulse power available at the antenna end of the transmission line of the transponder must be at least 21 db and not more than 27 db above 1 watt at any reply rate up to 1,200 per second for a 15-pulse coded reply.

b. For equipment intended for installation in aircraft which operate at altitudes not exceeding 15,000 feet (Class II), the peak pulse power available at the antenna end of the transmission line of the transponder must be at least 18.5 db and not more than 27 db above 1 watt at any reply rate up to 1,200 per second for a 15-pulse coded reply.

c. The standards of this section assume a transmission line loss of 3 db and an antenna performance equivalent to that of a simple quarter wave antenna. In the event that these assumed conditions do not apply, the equipment must be adjusted as necessary to provide a transmitter power output equivalent to that specified.

10. Paragraph 2.14 is amended to read as follows:

2.14 *Pressure-altitude transmission.* The equipment must have the capability for automatic pressure-altitude transmission in 100-foot increments on Mode C when operated in conjunction with a pressure-altitude encoder (digitizer). The equipment must be capable of automatic reply to Mode C interrogations with combinations of information pulses coded in binary form in 100-foot increments necessary for the equipment to operate up to design maximum altitude. The transponder must be provided with a means to remove the information pulses from the Mode C reply when requested by Air Traffic Control. The transponder must continue transmitting the framing pulses on Mode C when the information pulses have been removed or are not provided. Automatic pressure altitude transmission codes pulse position assignment are set forth in figure 2.

11. Paragraph 2.15 is amended to read as follows:

2.15 *Self test and monitor.* If a self test feature or monitor is provided, the devices that radiate test interrogation signals, or prevent transponder reply to proper interrogation during the test period, must be limited to intermittent use which is no longer than that required to determine the transponder status. The test interrogation rate must not exceed 450 per second and the interrogation signal level at the antenna end of the transmission line must not exceed a level of −40 dbm.

12. Paragraph 2.16 is amended to read as follows:

2.16 *Antenna.* The equipment antenna radiation pattern must be predominantly vertically polarized and be essentially omnidirectional in the horizontal plane with a nominal vertical beamwidth of at least ±30° from the horizontal plane. The voltage standing wave ratio (VSWR) produced on the antenna transmission line by the antenna must not exceed 1.5:1 when operating on the radiofrequencies of 1030 and 1090 MHz.

13. Paragraph 2.17 is amended to read as follows:

2.17 *Interference suppression pulse response.* If the equipment is designed to accept and respond to suppression pulses from other electronic equipment in the aircraft

(to disable it while the other equipment is transmitting), the equipment must regain normal sensitivity, within 2 db, not later than 15 microseconds after the end of the applied suppression pulse.

14. Paragraph 2.18 is amended to read as follows:

2.18 *Emission of spurious radiofrequency energy.* The levels of conducted and radiated spurious radiofrequency energy emitted by the equipment must not exceed those levels specified in Appendix A of RTCA Document No. DO-138 entitled "Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments," dated June 27, 1968.

15. Section 3 is amended to read as follows:

3.0 *Minimum performance standards under environmental conditions.* Unless otherwise specified, the test procedures applicable to a determination of the performance of airborne ATC transponder equipment under environmental conditions are set forth in RTCA Document No. DO-138 entitled "Environmental Conditions and Test Procedures for Airborne Electronic/Electrical Equipment and Instruments," dated June 27, 1968.

3.1 *Temperature-Altitude*—a. *Low temperature.* (1) When the equipment is subjected to this test, the standards of the following paragraphs must be met: 2.1a; 2.2, except that at temperatures below −15° C., the sensitivity must not be less than −69 dbm and the variation of sensitivity of the receiver between any mode on which it is capable of operating must be less than 2 db; 2.6a(1); 2.6b(1); 2.6c; 2.7b; 2.7c; 2.10; 2.11; 2.12, except that at temperatures below −15° C., the delay variation between modes on which the transponder is capable of replying must be less than 0.4 microsecond; 2.13c; 2.13d; and 2.13e.

(2) Following the low temperature test, the requirements of paragraph 2.16 must be met.

b. *High temperature.* (1) When the equipment is subjected to the high short-time operating temperature test, the equipment must operate electrically and mechanically.

(2) When the equipment is subjected to the high operating temperature test, the standards of the following paragraphs must be met: 2.1a; 2.2, except that at temperatures above +40° C., the sensitivity must not be less than −69 dbm and the variation of sensitivity of the receiver between any mode on which it is capable of operating must be less than 2 db; 2.6a(1); 2.6b(1); 2.6c; 2.7b; 2.7c; 2.10; 2.11; 2.12, except that at temperatures above +40° C. the delay variation between modes on which the transponder is capable of replying must be less than 0.4 microsecond; 2.13c; 2.13d; and 2.13e.

(3) Following the high temperature test, the requirements of paragraph 2.16 must be met.

c. *Altitude.* (1) When the equipment is subjected to this test, the standards of the following paragraphs must be met: 2.1 a and b; 2.10; 2.11; and 2.13d.

(2) Following the altitude test, the requirements of paragraph 2.16 must be met.

d. *Decompression (when required).* When the equipment is subjected to this test, the standards of paragraphs 2.1 a and b; 2.10;

e. *Overpressure (when required).* When the equipment is subjected to this test, the standards of paragraphs 2.1 a and b; 2.10; 2.11; and 2.13a must be met.

3.2 *Humidity.* After being subjected to this test, the equipment must meet the following:

a. Within 15 minutes from the time primary power is applied, the receiver sensitivity must be within 3 db of that specified in paragraph 2.2, the transmitter power output must be within 3 db of that specified in paragraph 2.11, and the requirements of 2.1a; 2.1b; and 2.10 must be met.

b. Within 4 hours from the time primary power is applied, the standards of paragraphs 2.1 a and b; 2.2; 2.10; 2.11; and 2.16 must be met.

3.3 *Shock.* a. Following the application of the 6G shocks, the standards of the following paragraphs must be met: 2.1a; 2.2; 2.6 a(1); 2.6c; 2.7b; 2.7c; 2.10; 2.11; 2.12; 2.13c; 2.13d; 2.13e; and 2.16.

b. Following the application of the 15G shocks, the equipment must have remained in its mounting and no parts of the equipment or its mounting become detached and free of the shock test equipment. The application of the 15G shock test may result in damage to the equipment. Therefore, this test may be conducted after the other tests are completed.

3.4 *Vibration.* a. When the equipment is subjected to this test, the standards of the following paragraphs must be met: 2.1a; 2.2; 2.6a(1); 2.6b(1); 2.6c; 2.7b; 2.7c; 2.10; 2.11; 2.13c; 2.13d; and 2.13e.

b. Following the vibration test, the requirements of paragraph 2.16 must be met.

3.5 *Temperature variation.* a. When the equipment is subjected to this test, the standards of the following paragraphs must be met: 2.1a; 2.2, except that at temperatures below −15° C. and above +40° C., the sensitivity must be not less than −69 dbm and the variation of sensitivity of the receiver between any mode on which it is capable of operating must be less than 2 db; 2.6a(1); 2.6b(1); 2.6c; 2.7b; 2.7c; 2.10; 2.11; 2.12, except that at temperatures below −15° C. and above +40° C., the delay variation between modes on which the transponder is capable of replying must be less than 0.4 microsecond; 2.13c; 2.13d; and 2.13e.

b. Following the temperature variation test, the requirement of paragraph 2.16 must be met.

3.6 *Power input variation.* When the equipment is subjected to this test, the standards of the following paragraphs must be met: 2.1a; 2.2; 2.6a(1); 2.6b(1); 2.6c; 2.7b; 2.7c; 2.10; 2.11; 2.12; 2.13c; 2.13d; and 2.13e.

3.7 *Low voltage.* a. When the primary power voltage(s) of d.c. operated equipment is 80 percent and when that of a.c. operated equipment is 87½ percent of design voltage(s), the equipment must operate electrically and mechanically.

b. D.c. operated equipment must meet the standards of paragraphs 2.1 a and b; 2.2; 2.10; and 2.11 within two (2) minutes upon returning the primary power voltage(s) to design voltage, after the gradual reduction of the primary voltage(s) from 80 percent to 50 percent of design voltage(s).

c. The gradual reduction of the primary power voltage(s) of d.c. operated equipment from 50 percent to 0 percent of design voltage(s) must produce no evidence of the presence of fire or smoke. Paragraph 1.2 does not apply.

3.8 *Conducted voltage transient.* When the equipment is subjected to this test, the standards of paragraphs 2.1 a and b; 2.2; 2.10; and 2.11 must be met.

3.9 *Conducted audiofrequency susceptibility.* When the equipment is subjected to this test, the standards of paragraphs 2.1 a and b; 2.2; 2.10; and 2.11 must be met.

3.10 *Audiofrequency magnetic field susceptibility.* When the equipment is subjected to this test, the standards of paragraphs 2.1 a and b; 2.2; 2.10; and 2.11 must be met.

3.11 *Radiofrequency susceptibility (radiated and conducted).* When the equipment is subjected to this test, the standards of paragraphs 2.1 a and b; 2.2b; 2.10; and 2.11 must be met.

3.12 *Explosion (when required).* When the equipment is subjected to this test, the equipment must cause no detonation of the explosive mixture within the test chamber.

3.13 *Waterproofness (drip proof) test (when required).* After subjection to this test, the standards of paragraphs 2.1; 2.2; 2.10; 2.11; and 2.13a must be met.

3.14 *Hydraulic fluid test (when required).* After subjection to this test, the standards of paragraphs 2.1; 2.2; 2.10; 2.11; and 2.13a must be met.

3.15 *Sand and dust test (when required).* After subjection to this test, the standards of paragraphs 2.1, 2.2; 2.10; 2.11; and 2.13a must be met.

3.16 *Fungus resistance test (when required).* After subjection to this test, the standards of paragraphs 2.1; 2.2; 2.10; 2.11; and 2.13a must be met.

3.17 *Salt spray test (when required).* After subjection to this test, the standards of paragraphs 2.1; 2.2; 2.10; 2.11; and 2.13a must be met.

16. Paragraph 1.0b of Appendix A is amended by striking out the letters "Cps" and inserting the letters "Hz" in place thereof.

17. Paragraph 1.0h of Appendix A is amended by striking out the letters "mc" and inserting the letters "MHz" in place thereof.

(Secs. 313(a), 601, and 603, Federal Aviation Act of 1958, 49 U.S.C. 1354(a), 1421, and 1423; sec. 6(c), Department of Transportation Act, 49 U.S.C. 1655(c))

Issued in Washington, D.C., on April 24, 1970.

WILLIAM G. SHREVE, Jr.,
Acting Director,
Flight Standards Service.

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Chapter I—Federal Aviation Administration, Department of Transportation

SUBCHAPTER C—AIRCRAFT

[Docket No. 9724, Amdt. 37-21]

PART 37—TECHNICAL STANDARD ORDER AUTHORIZATIONS

Airborne ATC Transponder Equipment

Correction

In F.R. Doc. 70-5315 appearing at page 6914 in the issue for Friday, May 1, 1970, make the following change under amendatory paragraph 15 to § 37.180: At the end of paragraph d. of section 3.1, add "2.11; and 2.13a must be met.".