Department of Transportation
Federal Aviation Administration
Aircraft Certification Service
Washington, DC

TSO-C112

Date: 2/5/86

Technical Standard Order

Subject: TSO-C112, AIR TRAFFIC CONTROL RADAR BEACON SYSTEM/MODE SELECT (ATCRBS/MODE S) AIRBORNE EQUIPMENT

a. Applicability.

(1) Minimum Performance Standard. This technical standard order (TSO) prescribes the minimum performance standard that airborne Mode S air traffic control (ATC) transponder equipment must meet in order to be identified with the applicable TSO marking. All classes of equipment manufactured in accordance with the provisions of this TSO must meet the appropriate minimum performance standard of Section Two, Radio Technical Commission for Aeronautics (RTCA) Document No. RTCA/DO-181, "Minimum Operational Performance Standards For Air Traffic Control Radar Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment," dated March 1983, and Change 1 to RTCA/DO-181, dated November 13, 1984, and Change 2 to RTCA/DO-181, dated January 17, 1986, as amended by this TSO.

(i) Equipment marked as Class 1A must meet all performance and environmental standards for equipment intended for installation in aircraft that operate at altitudes exceeding 15,000 feet or must be equipment intended for installation in aircraft that have a normal cruising speed in excess of 175 knots on a standard day.

(ii) Equipment marked as Class 1B must meet all performance and environmental standards for equipment intended for installation in aircraft that operate at altitudes not exceeding 15,000 feet.

(iii) Equipment marked as Class 2A must meet all performance and environmental standards for equipment marked Class 1A, and in addition, must have the operational function of the minimum data link transponder (Comm A and Comm B), including multisite message protocol.

(iv) Equipment marked as Class 2B must meet all performance and environmental standards for equipment marked Class 1B, and in addition, must have the operational function of the minimum data link transponder (Comm A and Comm B), including multisite message protocol.

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A-FAC-0(MAX); A-X (CD)-4; AVN-1 (2 copies)

(v) Equipment marked as Class 3A must meet all performance and environmental standards for equipment marked Class 2A, and in addition, must have the operational function of the Uplink Extended Length Message (ELM) Capability (Comm C).

(vi) Equipment marked as Class 3B must meet all performance and environmental standards for equipment marked Class 2B, and in addition, must have the operational function of the Uplink Extended Length Message (ELM) Capability (Comm C).

(vii) Equipment marked as Class 4 must meet all performance and environmental standards for equipment marked Class 3A, and in addition, must have the operational function of the Full Extended Length Message (ELM) Capability (Comm D).

(2) Options. The manufacturer may incorporate in Mode S transponder equipment one or more of the following options, as defined in RTCA/DO-181 (including Change 1 and Change 2), and amended by this technical standard order.

(i) Equipment marked as Class 1B or Class 2B may have a reply transmission frequency of 1090, ±1 Megahertz.

(ii) Equipment marked as Class 1B or Class 2B may have a minimum RF Peak Output Power of 21.0 dBW (125 W).

(iii) All classes of equipment may include diversity operations.

(iv) Equipment marked as Class 2A, 3A, or 4 may have 25 foot altitude quantization, as defined in Change 1 to RTCA/DO-181.

(v) Equipment marked as Class 2A, 2B, 3A, 3B, or 4, may include aircraft identification, as defined in RTCA/DO-181 and Change 1 to RTCA/DO-181.

(3) Software. The computer software package must be validated and verified in a manner acceptable to the Administrator. One acceptable means of compliance for validation and verification of the computer software package is outlined in RTCA/DO-178A, “Software Considerations in Airborne Systems and Equipment Certification,” dated March 1985. For those applicants who elect to use RTCA document no. DO-178A to demonstrate compliance for the verification and validation of the computer software, the following requirements must be met:

(i) RTCA document DO-178A defines three levels of software: Level 1, Level 2, and Level 3. The applicant must declare the level (or levels) to which the computer software has been verified ad validated. The equipment may incorporate more than one software level.

(ii) The applicant must submit a software verification and validation plan for review and approval.

NOTE: The Federal Aviation Administration (FAA) strongly recommends early discussion and agreement between the applicant and the FAA on the applicant's proposed software verification and validation plan, and the applicant's proposed software level or levels.

(4) Environmental Standard. Change 2 to RTCA/DO-181 incorporates as a reference RTCA document no. DO-160B, "Environmental Conditions and Test Procedures for Airborne Equipment," dated July 1984.

b. Marking. In addition to the marking specified in the Federal Aviation Regulations (FAR) Section 21.607(d), the following information shall be legibly and permanently marked on the major equipment components:

(1) Each separate component of equipment that is manufactured under this TSO (antenna, receiver, transmitter, etc.) must be permanently and legibly marked with at least the name of the manufacturer and the TSO number.

(2) With regard to FAR 21.607(d)(2), the part number is to include hardware and software identification or a separate part number may be utilized for hardware and software. Either approach must include a means for showing modification status.

(3) The equipment shall be identified by a designator. The marking shall use the general form as follows:

$$CL_{1x1\ x2x3x4\ x5x6x7}$$

Where "x_i" stands for an alphanumeric character describing the capability and the options incorporated in the transponder. The marking will be described here as three blocks of three characters each:

First Block: CL_1 stands for the class of equipment and identifies this marking as the classification label, coded

1A = Class 1A, 1B = Class 1B, 2A = Class 2A,
2B = Class 2B, 3A = Class 3A, 3B = Class 3B,
04 = Class 4

x_1 shall reflect the appropriate CA capability code that the transponder reports in its All-Call reply (reference RTCA/DO-181, paragraph 2.2.14.4.5)

Second Block: x_2: describes the RF power level of the reply transmitter, coded

0 = low level, 1 = high level

x_3: Aircraft Identification, coded

0 = no AIS report, 1 = reports tail number only,
2 = reports either tail number or flight plan number

x_4: 25 foot altitude quantization, coded

0 = 100 foot (standard) quantization
1 = 25 foot and 100 foot quantization
(100 foot above 50,175 ft.)

Third Block: x_5: Maximum Comm-D segment capability.

Comm-D transponders are permitted to limit their burst capability to at least four and at most 16 segments per reply sequence. This information should be considered depending on the mission requirements of the transponder.

The burst capability will be coded as a hexadecimal expression of value n-1, where n represents the maximum number of segments to be announced in a burst (the hexadecimal values would be 3 through E).

x_6: describes the reply transmission frequency, coded

0 = 1090 ±3MHz, 1 = 1090 ±1MHz

x_7: Describes diversity operation, coded

0 = No diversity capability, 1 = Diversity capability

(4) The level, or levels, to which the computer software has been verified and validated.

c. Data Requirements.

(1) In addition to FAR § 21.605, the manufacturer must furnish the Manager, Aircraft Certification Office (ACO), Federal Aviation Administration (FAA), having purview of the manufacturer's facilities, one copy each of the following technical data:

(i) Operating instructions.

(ii) Equipment limitations.

(iii) Installation procedures and limitations.

(iv) Schematic drawings as applicable to the installation procedures.

(v) Wiring diagrams as applicable to the installation procedures.

(vi) Specifications.

(vii) List of the major components (by part number) that make up the equipment system complying with the standards prescribed in this TSO.

(viii) An environmental qualification form as described in RTCA document DO-160B.

(ix) Manufacturer's TSO qualification test report.

(x) Nameplate drawing.

(xi) The appropriate documentation as defined in RTCA/DO-178A or equivalent, necessary to support the verification and validation of the computer software to Level 1, Level 2, or Level 3. If the software is verified and validated to more that one level, the appropriate documentation for all levels must be submitted.

(2) In addition to those data requirements that are to be furnished directly to the FAA, each manufacturer must have available for review, by the Manager of the ACO having purview of the manufacturer's facilities, the following technical data:

(i) A drawing list, enumerating all of the drawings and processes that are necessary to define the article design.

(ii) The functional test specification to be used to test each production article to ensure compliance with this TSO.

(iii) Equipment calibration procedures.

(iv) Corrective maintenance procedures (within 12 months after TSO authorization).

(v) Schematic drawings.

(vi) Wiring diagrams.

(vii) Documentation to support the computer software verification and validation plan for Level 1, Level 2, or Level 3 software.

(viii) The appropriate documentation as defined in RTCA/DO-178A or equivalent, necessary to support the verification and validation of the computer software to Level 1, Level 2, or Level 3. If the software is verified and validated to more than one level, the appropriate documentation for all levels must be available for review.

d. Data to be furnished with manufactured units. One copy of the data and information specified in paragraphs (c)(1)(i) through (viii) of this TSO and instructions for periodic maintenance and calibration which are necessary for continued airworthiness must go to each person receiving for use one or more articles manufactured under this TSO.

e. Availability of Reference Documents.

(1) Copies of RTCA document nos. DO-160B, DO-178A and DO-181 (including Change 1 and Change 2) may be purchased from the Radio Technical Commission for Aeronautics Secretariat, One McPherson Square, 1425 K Street, NW., Suite 500, Washington, DC 20005.

(2) Federal Aviation Regulations Part 21, Subpart O, and Advisory Circular 20-110B, "Index of Aviation Technical Standard Orders," may be reviewed at the FAA Headquarters in the Office of Airworthiness, Aircraft Engineering Division (AWS-110), and at all regional ACO's.

/S/ M. C. Beard
Director of Airworthiness