



GOVERNMENT OF INDIA
OFFICE OF DIRECTOR GENERAL OF CIVIL AVIATION
TECHNICAL CENTRE, OPP SAFDARJANG AIRPORT, NEW DELHI

CIVIL AVIATION REQUIREMENTS

SECTION 2 - AIRWORTHINESS

SERIES 'R', PART IV

DATED 8TH FEB, 1994

EFFECTIVE: FORTHWITH

SUBJECT: INSTALLATION OF MODE 'A' / 'C' AND MODE 'S' TRANSPONDERS.

1. INTRODUCTION :

1.1 As part of modernisation of air traffic control facilities, Secondary Surveillance Radars are being provided to cover the major air routes in the country and also to provide the Minimum Safe Altitude Warning (MSAW) System. To derive full benefit of these facilities it is necessary that the aeroplanes operating in Indian airspace are fitted with the altitude reporting transponders.

1.2 ICAO Annex 6 Part II relating to operation of general aviation aeroplanes also requires that:

“all aeroplanes shall be equipped with a pressure-altitude reporting transponder which operates in accordance with the relevant provision of Annex10,Vol.IV.”

Further, the Asia Pacific Air Navigation Planning and Implementation Regional Group (APANPIRG), have also recommended in their report of eighth meeting held from 23rd to 29th September, 1997 that:

“from 1st January, 1999 all aeroplanes shall be equipped with a pressure altitude reporting transponder.

1.3 Mode 'A' / 'C' transponder provides traffic advisory in an aircraft fitted with ACAS-I/ TCAS-I and both traffic advisory and resolution advisory in an aircraft fitted with ACAS-II/ TCAS-II. Mode 'S' Transponder is a source of reliable air space surveillance. It enhances the operation of Air Traffic Control Radar Beacon System (ATCRBS) by adding a Data Link feature and interrogation capability over and above Mode 'A' / 'C' transponder operation which only determines the aircraft altitude. Mode 'S' transponder also

provides traffic advisory in an aircraft fitted with ACAS-I/ TCAS-I and both traffic advisory and resolution advisory in an aircraft fitted with ACAS-II/ TCAS-II.

- 1.4 The Data Link facility allows Mode 'S' transponder to perform additional Air Traffic Control and Air Separation Assurance (ASA) functions. Due to discrete addressing feature of Mode 'S' transponder, the capability of interrogators is enhanced to handle more number of aircraft. Installation of Mode 'A' / 'C' and Mode 'S' transponders enhances the safety of aircraft operations and gives relief to pilots and ATCOs by reducing voice communication.
- 1.5 Sub Rule 3 of Rule 9 and Rule 57 of the Aircraft Rules, 1937, stipulate that every aircraft shall be fitted and equipped with instruments and equipments including radio apparatus and special equipment as may be specified according to the use and circumstances under which the flight is to be conducted. This part of the CAR lays down the requirements for installation of Mode 'A' / 'C' and Mode 'S' transponders and describes the procedure for allotment of Mode 'S' address. This CAR is issued under the provisions of Rule 57 and Rule 133A of the Aircraft Rules, 1937.

2. DEFINITIONS:

- 2.1 **Primary Radar:** Primary Radar transmits a beam of radio frequency energy and subsequently receives the minute proportion of this energy which has been echoed back to it by the target. This reflected signal is picked up and processed to provide a display which shows the location of the target.
- 2.2 **Secondary Radar:** This radar transmits a characteristic group of pulses recognizable to the transponder in the target aircraft which then responds after a pre-determined precise interval with a coded train of pulses which identifies and/or provides information about the aircraft.
- 2.3 **Surveillance radar.** Radar equipment used to determine the position of an aircraft in range and azimuth.
 - 2.3.1 **INTERROGATION AND CONTROL (INTERROGATION SIDE-LOBE SUPPRESSION) RADIO FREQUENCIES (GROUND-TO-AIR)**
 - 2.3.1.1 The carrier frequency of the interrogation and control transmissions shall be 1030 MHz.
 - 2.3.1.2 The frequency tolerance shall be plus or minus 0.2 MHz.
 - 2.3.1.3 The carrier frequencies of the control transmission and of each of the interrogation pulse transmissions shall not differ from each other by more than 0.2 MHz.
 - 2.3.2 **REPLY CARRIER FREQUENCY (AIR-TO-GROUND)**
 - 2.3.2.1 The carrier frequency of the reply transmission shall be 1090 MHz.
 - 2.3.2.2 The frequency tolerance shall be plus or minus 3 MHz.

2.4 Secondary Surveillance Radar (SSR): The SSR as per ICAO is required to provide an identification capability within the world's air traffic control systems. It was derived from Identification of Friend or Foe (IFF) system with which it co-exists and inter-operates the system comprising of interrogative radar on the ground and transponder beacons carried on aircraft.

2.5 Traffic information service – broadcast (TIS-B) IN. A surveillance function that receives and processes surveillance data from TIS-B OUT data sources.

2.6 Traffic information service – broadcast (TIS-B) OUT. A function on the ground that periodically broadcasts the surveillance information made available by ground sensors in a format suitable for TIS-B IN capable receivers.

2.7 Traffic Alert & Collision Avoidance System (TCAS): It is an independent aircraft equipment designed to detect potential conflicting aircraft that are equipped with Secondary Surveillance Radar (SSR) Transponders.

2.8 Airborne Collision Avoidance System (ACAS): An aeroplane system based on Secondary Surveillance Radar (SSR) transponder signals, which operates independently of ground based equipment to provide advice to the pilot on potential conflicting aircraft that are equipped with SSR Transponders.

Note - SSR transponders referred to above are those operating in Mode C or Mode S.

2.9 Aircraft address. A unique combination of twenty-four bits available for assignment to an aircraft for the purpose of air-ground communications, navigation and surveillance.

Note- SSR Mode S transponders transmit extended squitters to support the broadcast of aircraft-derived position for surveillance purposes. The broadcast of this type of information is a form of automatic dependent surveillance (ADS) known as ADS-broadcast (ADS-B).

2.10 Automatic dependent surveillance-broadcast (ADS-B) OUT. A function on an aircraft or vehicle that periodically broadcasts its state vector (position and velocity) and other information derived from on-board systems in a format suitable for ADS-B IN capable receivers.

2.11 Automatic dependent surveillance-broadcast (ADS-B) IN. A function that receives surveillance data from ADS-B OUT data sources.

2.12 Collision avoidance logic. The sub-system or part of ACAS that analyses data relating to an intruder and own aircraft, decides whether or not advisories are appropriate and, if so, generates the advisories. It includes the following functions: range and altitude tracking, threat detection and RA generation. It excludes surveillance.

- 2.13 Human Factors principles.** Principles which apply to design, certification, training, operations and maintenance and which seek safe interface between the human and other system components by proper consideration to human performance.
- 2.14 Multilateration (MLAT) System.** A group of equipment configured to provide position derived from the secondary surveillance radar (SSR) transponder signals (replies or squitters) primarily using time difference of arrival (TDOA) techniques. Additional information, including identification, can be extracted from the received signals.
- 2.15 Time Difference of Arrival (TDOA).** The difference in relative time that a transponder signal from the same aircraft (or ground vehicle) is received at different receivers.
- 2.16 Mode 'A' –** An interrogation that elicits reply from transponder for identity and surveillance.
- 2.17 Mode 'C' –** An interrogation that elicits reply from transponder for automatic pressure altitude transmission and surveillance.
- The above modes defined in 2.16, 2.17 and 2.18 are used during interrogation for air traffic services.
- 2.18 Mode 'A' / 'C' transponder–** Airborne equipment that generates specified responses to Mode 'A', Mode 'C' and intermode interrogations but does not reply to Mode 'S' interrogations.
- 2.19 Mode 'S':** It is a mode select - A transponder format to allow discrete interrogation and data link capability. The Mode 'S' ground equipment operates on the same frequency as SSR and comprises an interrogator and a receiver. Monopulse techniques are invariably used. In addition to Mode 'S' function, the ground station will also radiate standard SSR mode and will therefore be capable of operating in conjunction with aircraft carrying standard SSR equipment. In the same way, Mode 'S' transponder will be compatible with SSR ground stations.
- 2.20 Mode 'S' transponder:** It provides the communication capabilities (data link) required for ACAS/ TCAS as well as for Air Traffic Control Radar Beacon System (ATCRBS) transponder function (Mode 'A' and Mode 'C' operation).
- 2.21 Commercial Air Transport Operation:** An aircraft operation involving the transport of passengers, cargo or mail for remuneration or hire.
- 2.22 General Aviation Operation:** An aircraft operation other than a commercial air transport operation or an aerial work operation.

3. REQUIREMENTS

3.1 Unless otherwise authorised by DGCA, no person shall operate in the Indian airspace, an aeroplane having maximum certified take off mass of 5700 kg and above or a maximum cruising true airspeed capability in excess of 463 km/h (250kt) and having maximum certified passenger seating configuration (excluding any pilot seats) of more than 30 seats or maximum payload capacity of more than 3 tones without antenna diversity as prescribed in 3.1.1

3.1.1 Transponder antenna system and diversity operation. Mode S transponders equipped for diversity operation shall have two RF ports for operation with two antennas, one antenna on the top and the other on the bottom of the aircraft's fuselage. The received signal from one of the antennas shall be selected for acceptance and the reply shall be transmitted from the selected antenna only.

3.2 Unless otherwise authorised by DGCA, no person shall operate for commercial air transport operation in the Indian airspace, from 1st January, 2001,

- (a) an aeroplane having a maximum certified passenger seating configuration of 20 to 30 or a maximum certificated take off mass in excess of 5700kg, if such aeroplane is not equipped with Mode 'S' transponder.
- (b) an aeroplane having a maximum certified passenger seating configuration of 10 to 19 and a maximum certificated take off mass less than 5700kg, if such aeroplane is not equipped with Mode 'A' / 'C' transponder.
- (c) a twin jet engined aeroplane having a maximum certified passenger seating configuration of less than 10 and a maximum certificated take off mass less than 5700kg, if such aeroplane is not equipped with Mode 'A' / 'C' transponder
- (d) a helicopter if it is not equipped with Mode 'A' / 'C' transponder.

3.3 Unless otherwise authorised by DGCA, no person shall acquire for the purpose of commercial air transport operation in the Indian airspace, from 1st January, 2000:

- (a) an aeroplane having a maximum certified passenger seating configuration of 20 to 30 or a maximum certificated take off mass in excess of 5700kg, if such aeroplane is not equipped with Mode 'S' transponder.
- (b) an aeroplane having a maximum certified passenger seating configuration of 10 to 19 and a maximum certificated take off mass less than 5700kg, if such aeroplane is not equipped with Mode 'A' / 'C' transponder .
- (c) a twin jet engined aeroplane having a maximum certified passenger seating configuration of less than 10 and a maximum certificated take off

mass less than 5700kg, if such aeroplane is not equipped with Mode 'A'/'C' transponder.

(d) a helicopter if it is not equipped with Mode 'A' / 'C' transponder.

3.4 Unless otherwise authorised by DGCA, no person shall operate for general aviation operation in the Indian controlled airspace or on promulgated ATS routes, from 1st January, 2003, an aeroplane or helicopter, if it is not equipped with Mode 'A' / 'C' transponder.

4. ASSIGNMENT OF AIRCRAFT ADDRESSES

4.1 For an aircraft delivery, the aircraft operator is expected to inform the airframe manufacturer of an address assignment. The airframe manufacturer or other organization responsible for a delivery flight is expected to ensure installation of a correctly assigned address supplied by DGCA. Exceptionally, a temporary address may be supplied under the arrangements detailed in paragraph 6.

4.2 When an aircraft changes its State of Registry, the new registering State shall assign the aircraft a new address from its own allocation address block, and the old aircraft address shall be returned to DGCA.

4.3 the address shall serve only a technical role for addressing and identification of aircraft and shall not be used to convey any specific information; and

5. PROCEDURE FOR ALLOTMENT OF MODE 'S' ADDRESS

5.1 Aircraft fitted with Mode 'S' transponder will be provided with Mode 'S' address by DGCA which consists of a total of 24 bits. The first six bits indicate the country code and the remaining 18 bits give the Mode 'S' address. The code allotment shall be as given below: -

1 0 0 0 0 0	- - - - -
<-- (6 bits) ---->	<----- (18 bits) ----->
Country Code	Mode S Address
for India	

5.2 Whenever an aircraft is equipped with Mode 'S' transponder, the aircraft operator/owner shall apply to Director General of Civil Aviation, (Attn.: Director of Airworthiness) Technical Center, Opp. Safdarjung Airport, New Delhi -110003, for allotment of specific Mode 'S' address giving the following information:

- (i) Aircraft Type and Registration Number.
- (ii) Serial Number of the aircraft.
- (iii) Name and address of the Operator.

After the above information is received, the specific code shall be allotted by Director General of Civil Aviation.

5.3 Register of aircraft allotted with Mode 'S' address.

The Director General of Civil Aviation will maintain a register of all aircraft allotted with Mode 'S' address. This register will be open to inspection by any person desirous of doing so.

5.4 All Indian registered aircraft fitted with Mode 'S' transponder shall be issued with Mode 'S' address by DGCA. Mode 'S' address issued by any other foreign regulatory authority shall stand cancelled after issue of Indian registration.

6. ADMINISTRATION OF THE TEMPORARY AIRCRAFT ADDRESS ASSIGNMENTS

6.1 Temporary addresses shall be assigned by ICAO to aircraft in exceptional circumstances, such as when operators have been unable to obtain an address from DGCA in a timely manner.

6.2 When requesting a temporary address, the aircraft operator shall supply to ICAO: aircraft identification, type and make of aircraft, name and address of the operator, and an explanation of the reason for the request.

6.2.1 Upon issuance of the temporary address to the aircraft operators, ICAO shall inform DGCA of the issuance of the temporary address, reason and duration.

6.3 The aircraft operator shall:

- (a) inform DGCA of the temporary assignment and reiterate the request for a permanent address; and
- (b) inform the airframe manufacturer.

6.4 When the permanent aircraft address is obtained from DGCA, the operator shall:

- (a) inform ICAO without delay;
- (b) relinquish his/her temporary address; and
- (c) arrange for encoding of the valid unique address within 180 calendar days.

6.5 If a permanent address is not obtained within one year, the aircraft operator shall reapply for a new temporary aircraft address. Under no circumstances shall a temporary aircraft address be used by the aircraft operator for over one year.

7. OPERATIONAL REQUIREMENTS:

7.1 Prior to commencing operation of the aircraft fitted with Mode 'A' / 'C' or Mode 'S' transponder as required by para 3 above, the aeroplane flight manual shall be amended to include:

- (i) appropriate procedure for the use of transponders;
- (ii) necessary amendment to the checklist.

7.2 The operator shall lay down its procedure to ensure that the transponder is kept 'ON' throughout the operations.

7.3 The transponder should be operated in accordance with the relevant provision of ICAO Annex 10 Volume IV.

8. MAINTENANCE AND CERTIFICATION OF TRANSPONDERS

8.1 The transponder shall be of approved type and meet the specifications given in TSO-C74 C for Mode 'A'/'C' transponder and TSO-C112 for Mode 'S' transponder or any other specifications acceptable to DGCA.

8.2 The transponder shall be installed in an approved manner by an approved organisation / manufacturer.

8.3 The transponder shall be maintained in serviceable condition. For release of aircraft under MEL due to defect in the transponder system, an entry shall be made in the maintenance record that includes the date and time of invoking the MEL and proper placarding in the cockpit.

8.4 Engineers inspecting/certifying the transponders should hold appropriate type rated licence in category "B2" and should be adequately trained on this equipment.

(Charan Dass)

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