U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: Altitude Reporting Equipment and Transponder System Maintenance and Inspection Practices

Date: 7/15/14 **AC No:** 43-6C

Initiated by: AFS-300 **Change:** 1

1. PURPOSE. This advisory circular (AC) provides information concerning acceptable methods of testing altimeters, static systems, altitude encoders, and air traffic control (ATC) transponder systems (ATCTS). This guidance also applies to the above articles, but does not include all requirements for testing the article, when part of 1090 megahertz (MHz) Extended Squitter (ES) or Universal Access Transceiver (UAT) Automatic Dependent Surveillance Broadcast (ADS B) systems. Like all advisory material, this AC is not in itself mandatory and does not constitute a regulation. It provides a means, but not the only means, of testing at the time of original installation, after performing repairs, or during scheduled recertification. Where indicated, this AC ensures compliance with regulatory requirements. Operators may elect to follow an alternative method that the Federal Aviation Administration (FAA) has found acceptable.

2. PRINCIPAL CHANGES. This change corrects the numbers of several references to paragraphs within the AC.

PAGE CONTROL CHART

Remove Pages	Dated	Insert Pages	Dated
Pages 4, 7, 8, and 9	9/17/12	Pages 4, 7, 8, and 9	7/15/14

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U.S. Department of Transportation
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2. CANCELLATION. This AC cancels AC 43-6B, Altitude Reporting Equipment and Transponder System Maintenance and Inspection Practices, dated August 14, 2002.

3. RELATED TITLE 14 OF THE CODE OF FEDERAL REGULATIONS (14 CFR).

- Part 23, § 23.1325;
- Part 25, § 25.1325;
- Part 27, § 27.1325;
- Part 29, § 29.1325;
- Part 43, §§ 43.3, 43.5, 43.9, and 43.13, and Appendices E and F;
- Part 91, §§ 91.215, 91.217, 91.225, 91.227, 91.411, and 91.413; and
- Part 145, § 145.109.

4. RELATED READING MATERIAL. You can find this AC on the FAA's Web site at http://www.faa.gov/regulations_policies/advisory_circulars. You can find Technical Standard Orders (TSO) on the FAA's Regulatory Guidance Library (RGL) Web site at http://rgl.faa.gov.

- AC 43-2, Minimum Barometry for Calibration and Test of Atmospheric Pressure Instruments, current edition;
- TSO-C10, Aircraft Altimeter, Pressure Actuated, Sensitive Type;
- TSO-C74c, Airborne ATC Transponder Equipment;
- TSO-C88a, Automatic Pressure Altitude Reporting Code Generating Equipment;

- TSO-C112, Air Traffic Control Radar Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment;
- TSO-C166b, Extended Squitter Automatic Dependent Surveillance-Broadcast (ADS-B) and Traffic Information Service-Broadcast (TIS-B) Equipment Operating on the Radio Frequency of 1090 Megahertz (MHz);
- TSO-C195, Avionics Supporting Automatic Dependent Surveillance-Broadcast (ADS-B) Aircraft Surveillance Applications (ASA);
- TSO-C154c, Universal Access Transceiver (UAT) Automatic Depedent Surveillance-Broadcast (ADS-B) Equipment Operating on Frequency of 978 MHz; and
- TSO-C106, Air Data Computer.

5. BACKGROUND. Altitude reporting equipment and transponder systems are significant elements for the safe operation of aircraft in the National Airspace System (NAS). ATC monitors aircraft movements and ensures positive separation with identity and three-dimensional positional information obtained from individual aircraft altitude reporting equipment and transponder systems. Traffic Alert and Collision Avoidance Systems (TCAS) installed in nearly all commercial passenger air carrier aircraft and many other aircraft depend on reliable and accurate altitude reporting equipment and transponder systems in surrounding aircraft. ADS-B systems are dependent on aircraft being equipped with reliable and accurate position-reporting equipment and transponder systems.

6. INSTALLATION. Any appropriately rated person (as specified in § 43.3) may perform an aircraft alteration that consists of installing or reinstalling equipment (following maintenance). The equipment may consist of an encoding or non-encoding altimeter, air data system components, remote encoding devices (blind encoder), or transponders. ADS-B equipment includes an ADS-B transponder or UAT and the associated source system's components to broadcast the aircraft's identity, altitude, velocity, and other information. Only after the performance of the suitable functional check to determine that the altered system will perform its intended function(s) can an appropriately rated person grant approval of the aircraft for return to service (RTS). Additionally, if applicable, test and inspections requirements described in §§ 91.411 and 91.413 and part 43 appendices E and F must be satisfied.

> **NOTE: For those situations where the operator uses the services of a certificated repair station (CRS) for the installation of an altitude reporting system or for any component part of such a system, a repair station should possess either an Airframe, or Radio Class 3 and Instrument Class 1 (both ratings are required for the installation of a complete system), or a Limited class rating. The repair station ratings may be limited to specific make(s) and model(s) of airframes, transponders, altimeters, or blind encoders.**

a. Installation Preparation. Before attempting the installation or reinstallation of an aircraft altitude reporting system, the person installing should ensure the following:

(1) That required test equipment, technical data, and qualified personnel are available to perform a static system leak check if the system is opened or closed, and other testing as required by § 91.411(a)(2) to verify the integrity of the newly installed or altered system.

NOTE: Combined probe and sensor assemblies that may be installed without opening or closing the static system do not require testing under § 91.411(a)(2).

(2) That the capability exists to determine the pressure altitude transmitted by the transponder as referenced against the primary required or pilot's altimeter display (see § 91.217(a)(2) for altitude reference).

(3) That appropriately rated and qualified personnel are available to perform any necessary structural modifications and appropriate tests and inspections following maintenance or alterations.

(4) That an appropriately rated person returns the aircraft to service following alteration or maintenance.

(5) That data is available to enable RTS of the aircraft following substitution of an encoding altimeter or remote encoding device for the equipment currently listed on the aircraft's approved equipment listing. The person installing may use equipment that meets the requirements of the appropriate TSO and is certificated to the maximum operating altitude of the intended aircraft to replace equipment listed on the aircraft's approved equipment list with no further data approval.

b. Installation and Inspection Data. Each installation and inspection should be in accordance with appropriate data and the work that appropriately rated persons performed or supervised. Data may consist of manufacturer's drawings or Service Bulletins (SB) that list acceptable replacements or equipment substitutes if specifically authorized by the Administrator.

c. For Mode Select (Mode S) Transponder and UAT Installation. To facilitate programming of transponders or UATs which require input of the raw Mode S octal code, the aircraft identification code may be obtained from the aircraft registration certificate or from the Aircraft Registration Branch (AFS-750). This information is also available online at the FAA's Aircraft Certification Registration Inquiry page or from the Aircraft Registration Branch (AFS-750), Post Office Box 25504, Oklahoma City, OK 73125-0504. Contact AFS-750 by telephone at 405-954-3116.

7. MAINTENANCE. Any appropriately rated person (as specified in § 43.3) may perform maintenance or preventive maintenance on an aircraft altitude reporting and transponder system. This work may include the removal of and/or replacement with an identical system component. An appropriately rated person can approve the aircraft for RTS only after the performance of a suitable functional check of the entire system (as installed in the aircraft) to determine that the system, as well as the component, will perform its intended function(s).

NOTE: For ADS-B systems, alteration of the transponder or any of the source system components may impact the system's ability to meet the requirements of § 91.227. For example, when initially certified, the ADS-B system shows that it meets the latency requirements. It is impossible to test or measure the latency requirements and they can only be determined by using technical data from the ADS-B transponder manufacturer, the position

source's manufacturer, and an analysis of the system interconnection. A change to any one of these articles could result in a change in the system data latency. Any alteration of the transponder, the position source, other source system components, or their interconnectivity must include an analysis and evaluation showing that the alteration does not impact the system's compliance with § 91.227. See the current edition of AC 20-165, Airworthiness Approval of Automatic Dependent Surveillance-Broadcast (ADS-B) Out Systems, for detailed information on certification requirements of the system.

NOTE: In the instance when the operator uses the services of a CRS for the maintenance, preventive maintenance, or replacement of an altitude reporting and transponder system, or for any portion of such a system, the repair station should be appropriately rated as described in the note in paragraph 7. Repair station ratings may be limited to specific make(s) and model(s) of airframes, transponders, or encoding altimeters.

8. FUNCTIONAL TESTING. An appropriately rated person (as specified in § 43.3) may make *major* repairs (as specified in part 43 appendix A) to component parts of an aircraft altitude reporting and transponder system. Such repairs require testing and inspection before RTS. Following reinstallation into the aircraft, an appropriately rated person will test the entire system for proper function to ensure that it performs its intended function(s). The scope of testing required in determining system functionality is dependent on the repaired component parts. See Appendix 1, Table 3, Test Association Matrix, to determine the appropriate tests necessary.

9. RECOMMENDED TEST PROCEDURES. The following test procedures provide one way, but not the only way, of demonstrating altitude reporting and transponder system performance and of testing individual components. The test procedures noted below are adequate to demonstrate compliance with the maintenance requirements of §§ 91.411 and 91.413.

a. Static Pressure System Test. Performance of this test on all instruments that rely on connected static air will ensure component leak integrity and that no leaks occurred while making connections to the encoding altimeter, blind encoder, or other instruments. This procedure is one method of demonstrating compliance with the requirements within § 91.411(a)(2). Section 91.411(b) lists the persons authorized to perform this test. While static systems contained within an article that the authorized person(s) did not open or close during article installation do not require post installation testing in accordance with § 91.411(a)(2), the FAA recommends completion of the items in subparagraphs 9a(1) and (2).

NOTE: Damage may occur to other aircraft instruments, such as the vertical speed indicator (VSI), if the altitude rate changes faster than the limit of the installed instruments.

(1) Visually inspect the ports, tubing, accessories, and instruments connected to the static system, and repair or replace those parts that are defective (e.g., broken "B" nuts, cracked flare sleeves, deteriorated flexible tubing, bad valves, etc.). Purge the system, if necessary, to remove foreign matter that may have accumulated in the tubing.

CAUTION: Be sure to remove all pitot pressure and static air connections to every instrument before purging the system tubing.

(2) Check the static port heater, if so equipped, to ensure proper operation. If a manufacturer has not developed a specific procedure, confirm static port heater operation by noting ammeter current or that the pitot tube or static port becomes hot.

NOTE: It is unwise to touch an operational pitot probe to verify proper heating operation. Pitot probes are capable of reaching extremely high temperatures quickly.

(3) When an aircraft has more than one static system, separately test each system that was opened or closed to ensure their independence and that the leak rate for each system is within tolerances established in § 23.1325, § 25.1325, § 27.1325, or § 29.1325, whichever is applicable. Static systems that the authorized person(s) did not open or close do not require testing.

(4) Connect the test equipment directly to the static ports, if practicable. Otherwise, connect to a static system drain or tee connection and seal off the static ports. If the test equipment connects to the static system at any point other than the static port, it should be at a point where the authorized person(s) may readily inspect the connection for system integrity after returning the system to its normal configuration. Remove all static port seals after completion of the static system test.

(5) Test the alternate static system at field elevation to ensure the selection valve functions, if installed. If the reading of the altimeter when on the alternate static pressure system differs from the primary system by more than 50 feet, provide a correction card for the alternate static system in accordance with §§ 23.1325, 27.1325, and 29.1325.

(6) For unpressurized aircraft, conduct the static pressure system proof test to the standards prescribed in § 23.1325(b)(2)(i) or § 25.1325(c)(2)(i), as applicable (see paragraph 12).

(7) For pressurized aircraft, conduct the static pressure system proof test to the standards prescribed in § 23.1325(b)(2)(ii) or § 25.1325(c)(2)(ii), as applicable (see paragraph 14 for precautions).

(a) An authorized person may use an accurate vacuum gauge referenced to atmospheric pressure and connected to the static pressure system to measure the equivalent cabin differential pressure.

(b) An authorized person may use either the altimeter in the aircraft under test or that in the test equipment as a vacuum gauge, provided that he or she converts barometric pressure, measured in inches of mercury (inHg), to pressure in pounds per square inch (psi). A convenient formula for this conversion is:

$$\text{psi} = \frac{\text{inHg}}{2.036}$$

(c) The following steps are the suggested way of using the altimeter as a vacuum gauge:

1. **Step 1.** Convert the actual local barometric pressure (*not* reduced to sea level) to psi.

2. **Step 2.** Subtract the approved maximum cabin differential pressure in psi, located in the applicable aircraft service document, from the psi value obtained in Step 1.

3. **Step 3.** Convert the psi value obtained in Step 2 to inches of mercury, using the formula: $\text{inHg} = \text{psi} \times 2.036$.

4. **Step 4.** The test pressure expressed in inches of mercury can be converted to test altitude in feet (ft) using Table IV, Geopotential Altitude, English Units, contained in the document titled U.S. Standard Atmosphere, 1976 (Stock No. 003-017-00323-0), which is available from Superintendent of Documents, U.S. Government Printing Office (GPO), Washington, D.C.

psi = _____

EXAMPLE:

inHg = 25.39
Approved Maximum Cabin Differential Pressure = 5.3

Step 1. $\frac{25.39\,\text{inHg}}{2.036} = 12.47\,\text{psi}$
Step 2. $12.47\,\text{psi} - 5.3\,\text{psi} = 7.17\,\text{psi}$

Step 3. $7.17\,\text{psi} \times 2.036 = 14.60\,\text{inHg}$

Step 4. $14.60\,\text{inHg} = 18{,}600\,\text{ft}$ (altitude)

b. Altimeter Certification Test. This test ensures that an altimeter is calibrated and acceptable for use in the NAS. This procedure is adequate to ensure proper operation, but may not fulfill all the requirements of a manufacturer's minimum performance test required after maintenance of an altimeter.

(1) Section 91.411(b) lists the persons authorized to conduct the altimeter test. A certificated mechanic is only authorized to perform static leak testing and is not authorized to perform altimeter testing.

(2) Perform the test procedure in part 43 appendix E paragraph (b). This procedure demonstrates compliance with the maintenance requirements of § 91.411. An authorized person(s) may test altimeters that are the air data computer type with associated computing systems (or that incorporate air data correction internally) in a manner and to specifications developed by the manufacturer that are acceptable to the Administrator.

(3) An authorized person(s) should test the altimeter on the bench to the maximum altitude of its design specification. He or she should record the date of the actual altimeter test and maximum in-tolerance altitude on the altimeter. An authorized person(s) may put into service an altimeter found to have a lower maximum in-tolerance altitude than its design specification provided that the in-tolerance altitude is at least that of the maximum certificated altitude of the aircraft it will be installed into, or if there is an operational limitation on the aircraft and noted by placard.

NOTE: For altimeters of the air data computer type that consist of multiple components, an authorized person(s) should attach the label to the air data computer unless impractical. If an authorized person(s) cannot attach the label, he or she should provide the information on the accompanying Authorized Release Certificate, FAA Form 8130-3, Airworthiness Approval Tag.

c. Altimeter Field Elevation Verification. Normal installation of an altimeter or encoding altimeter should not alter its calibration or certification basis. A field elevation verification of performance is adequate after installation to ensure safe operation within the NAS.

(1) Section 91.411(b) lists the persons authorized to conduct the altimeter test. A certificated mechanic is only authorized to perform static leak testing and is not authorized to perform altimeter testing. The altimeter field elevation verification is an observation made at the time of installation and in the context of § 91.411(b), not a test of the altimeter.

(2) Compare the altitude displayed on the subject altimeter when referenced to 29.92 inches of mercury (1013.2 millibars) with that of a calibrated reference altimeter (as described in subparagraph 11a or 11b) and ensure agreement within ± 20 feet.

d. Pressure Altitude Correspondence Test. The pressure altitude correspondence test ensures that the altitude reporting equipment associated with a radar beacon transponder, 1090 MHz ES, or UAT ADS-B system is calibrated to transmit altitude data corresponding within 125 feet (on a 95-percent probability basis) of the indicated or calibrated datum of the altimeter normally used to maintain flight altitude, as required by § 91.217(a)(2). This procedure is adequate to ensure proper operation of a pressure altitude encoding device installed in a transponder system but may not fulfill all the requirements of a manufacturer's minimum performance test required after maintenance of an encoder. The following test procedure (as specified in part 43 appendix E paragraph (c)) demonstrates compliance with the maintenance requirements of § 91.411.

(1) Section 91.411(b) lists the persons authorized to conduct the altimeter test. A certificated mechanic is only authorized to perform static leak testing and is not authorized to perform altimeter or encoder testing.

(2) Procedures:

(a) Connect the transponder test set so as not to radiate an interfering signal. To accomplish this, connect directly to the transponder antenna terminal or to the antenna end of the system transmission line, or use a test apparatus to shield the antenna.

NOTE: It also may be necessary to isolate or shield the antennas of a diversity transponder that are not under test to prevent interference.

(b) Check to ensure that the equipment transmits only the framing pulses (F1 and F2) in response to Mode C interrogations when the altitude reporting feature is turned off.

(c) Alternately interrogate the transponder on Mode 3/A and Mode C while observing the pulse train output, or the decoded altitude display on those test sets capable of decoding the pulse train.

(d) Set the altimeter normally used to maintain flight altitude to 29.92 inches of mercury (1013.2 millibars). Verify that the ATC transponder altitude output and the altimeter displayed altitude are within ± 125 feet.

(e) For Gillham code altimeters, apply suction to the static system or directly to the altimeter and compare transponder altitude output with altimeter-displayed altitude at the test points in Appendix 1, Table 1, Abbreviated Correspondence Test Altitude Information Pulse Positions, or Appendix 1, Table 2, Correspondence Test Altitude Information Pulse Positions. Test each point while increasing altitude and while decreasing altitude. If separate static systems serve altimeters and digitizers, simultaneously apply identical pressures to each. Approach each test point slowly, decreasing pressure for increasing altitude and vice versa, until a transition to the test point value occurs in the digital output. Apply vibration to a pneumatically driven altimeter when taking readings to reduce any error due to friction. Record the altimeter reading at the instant of digital code transition. Appendix 1, Table 3 provides a test association matrix to assist in the determination of the appropriate test to perform.

NOTE: Subparagraph 9d(2)(e) is not required if a data bus provides altitude information to the transponder in a digital form. The instructions in subparagraph 9d(2)(d) ensure data integrity.

(3) An authorized person(s) should check encoding digitizers, which are separate units (blind encoders) that have their own individual pressure sensor, against the pilot's altimeter upon installation to ensure that they meet the overall system accuracy. In addition, where an installation allows for the blind encoder to be connected to a static source other than the static source connected to the altimeter normally used to maintain flight altitude, an authorized person(s) should apply the following corrections during certification of compliance to § 91.411(a):

(a) An authorized person(s) should determine and record the difference between both static sources. (This information may be available from the original aircraft certification data.)

(b) An authorized person(s) should use the differences determined in subparagraph 9d(3)(a) (static source errors) as a correction factor when checking for compliance with § 91.217(a)(2).

(4) Altitude encoding devices not connected to an ATC transponder do not require testing under § 91.411; however, due to the importance of ensuring correspondence between all pressure altitude systems, the FAA recommends testing in accordance with subparagraphs 9d(2)(d)

and 9d(2)(e), using Appendix 1, Table 1. An authorized person(s) should test units not equipped with a display or means of monitoring altitude input to ensure data integrity, when possible.

e. Test and Inspection Requirements of Aircraft Approved for Operation Where Reduced Vertical Separation Minimum (RVSM) is Applied. Aircraft authorized for RVSM have an aircraft-specific approved RVSM maintenance program. An appropriately rated person(s) must follow the altimeter and static system testing requirements listed in the approved maintenance program. The required test and inspections may not ensure compliance with § 91.411, and he or she may need to complete the additional tests or inspections listed in part 43 appendix E.

f. Transponder Test and Inspection. This test ensures the proper operation of a transponder in the NAS. This procedure is adequate to ensure proper operation of a transponder system but may not fulfill all the requirements of a manufacturer's minimum performance test required after maintenance of a transponder. This procedure demonstrates compliance with the maintenance requirements of § 91.413.

(1) Section 91.413(c) lists the persons authorized to conduct transponder tests and inspections.

(2) Procedures:

(a) Perform the test procedure in part 43 appendix F. For TSO-C112d and later transponders, see Appendix 3 to determine the appropriate class reference.

(b) Perform an ATC radar beacon system (ATCRBS) all-call test. Interrogate the transponder with an ATCRBS (Mode A and C) all-call interrogation signal at a nominal repetition rate of 235 interrogations per second and at a signal level 3 dBm above receiver minimum trigger level. Adjust P4 pulse equal in amplitude to P3 pulse and verify that the reply rate is equal to or greater than 223 replies per second. Verify proper response. An ATCRBS transponder should reply to an ATCRBS all-call interrogation, a Mode S transponder should not reply.

(3) An authorized person(s) may bench-test transponders to part 43 appendix F specifications for compliance with § 91.413 and functionally check them after installation in the aircraft, provided that during the bench check the transponder operates into an antenna system presenting the same Voltage Standing Wave Ratio (VSWR) characteristics and cable attenuation as that in the airplane.

(4) The accomplishment of the removal and replacement of transponder units without repeating § 91.413 testing is possible; however, the next 24-month test and inspection date will be relative to the replacement transponder's previous § 91.413(a) test and inspection. An authorized person(s) will perform a manufacturer's minimum performance test before RTS. Any time an authorized person(s) removes and reconnects the aircraft connections to a transponder, he or she must test each altitude reporting Gillham code line or the digital data bus (if equipped) for integrity of connection. Successful reporting of a single altitude may verify the integrity of connection for systems using a digital data bus to convey altitude information to a transponder. Performing an abbreviated correspondence test at the test points of Appendix 1, Table 1 using

the installed automatic pressure altitude encoding device or through the use of an encoder substation test unit capable of simulation of the Appendix 1, Table 1 altitudes may verify the integrity of connection for systems using Gillham code connections.

10. SECTIONS 91.411 AND 91.413 COMPLIANCE FLOWCHART. See the compliance flowchart provided in Appendix 4 to determine compliance with §§ 91.411 and 91.413. Since both sections contain multiple requirements, compliance is not ensured until all decision points have been satisfied.

11. ALTIMETER TEST EQUIPMENT. The following test equipment is acceptable for testing altimeters:

a. Barometers. Mercurial, aneroid, or digital barometers with accuracy specified in and in accordance with AC 43-2 and newer equipment with accuracies that meet RVSM tolerances.

b. Portable Test Equipment. High accuracy portable test equipment (with correction card, if appropriate) maintained in accordance with § 145.109(b). Calibration checks of the test equipment in accordance with the following schedule provide a satisfactory level of performance:

(1) Every 30 days, after initial calibration, the repair station should check the equipment for accuracy against:

(a) A barometer described in subparagraph 12a; or

(b) An altimeter (with appropriate correction card) that the repair station has calibrated within the past 30 days against a barometer described in subparagraph 12a.

(2) Before use, the repair station should check the equipment for proper operations within calibration limits at station pressure using a digital, aneroid, or mercurial barometer, or in accordance with subparagraph 12a.

(3) It is possible to extend the 30-day calibration period in subparagraph 12b(1), provided the calibration records of the individual test equipment reflect continued accuracy, as specified by technical information or recommendations of the equipment manufacturer.

12. MAINTENANCE RECORD ENTRY. The following example of a permanent maintenance record entry will be satisfactory for compliance with § 43.9:

EXAMPLE:

I certify that the altimeter and static system tests required by 14 CFR part 91, § 91.411 and transponder tests, including data correspondence, required by § 91.413, have been performed and found to comply with 14 CFR part 43, appendicies E and F.

Altimeter Model _____ Serial No. _____
Transponder Model _____ Serial No. _____
Encoder Model _____ Serial No. _____

The altimeter was tested to _____ feet on (date of altimeter test).
The transponder was tested on (date of transponder test).
Encoder data correspondence was tested to _____ feet on (date of correspondence test).
Static system leak tested on (date of static test).

Signature _____
Certificate Number _____

13. TESTING PRECAUTIONS. This paragraph contains precautions that technicians should take during tests to avoid damage to the sensitive instruments connected to static systems.

a. Determining Design Limits. Before testing any static system, determine that the instruments attached to it will not exceed design limits during the test. To determine this, locate and identify all instruments attached to the system. In addition to the altimeter, airspeed, and rate of climb, many airplanes use static pressure for the operation of autopilots, flight recorders, air data computers, altitude reporting digitizers, etc. The use of a static system diagram of the airplane involved may be helpful in locating all of the instruments. If a diagram is not available, locate the instruments by tracing the physical installation.

b. Static System and Pitot System. Damage can occur to instruments that are connected to both the static system and pitot system when only the static system is evacuated. These instruments may exceed the maximum design differential pressure. One method to prevent this type of damage is to tie both the pitot and static systems together when conducting static system checks. This should result in zero differential pressure regardless of the degree of static system evacuation. Note that a leak in either system will affect the test process.

c. Accidental Disconnection. Technicians should take safeguards to prevent accidental disconnection of the test equipment plumbing from the aircraft or the test equipment while evacuating the static system. The resultant sudden pressure change may damage both the test instruments and the aircraft instruments. The aircraft static system should be returned to ambient pressures before disconnecting static test equipment from the system.

d. Marking Blockage Devices. If a technician covers the static ports for the purpose of testing, it is recommended that he or she attach a bright-colored tape (red or orange) or similar method of warning to the blockage device.

e. Barometric Correlation Adjustment. Technicians should not perform a barometer correlation adjustment of an altimeter in the field; changing this adjustment will nullify the correspondence between the altimeter and its encoding digitizer or the associated blind encoder. Barometric correlation adjustment of an altimeter is a repair action and technicians should not perform this action without an appropriate instrument or repair station limited rating.

f. Altimeter Jerkiness. Some altimeters may exhibit a tendency toward jerkiness (when not under vibration). If the jerkiness appears excessive, then conduct a friction test as described in part 43 appendix E.

g. Encoder Errors. Some encoders may exhibit errors and excessive drift during initial warmup. Lack of correspondence within 125 feet between altimeter and encoder, if observed 5 minutes after initial power turnon or later, should be considered failure to meet the standards of § 91.411(a). Only after the repair of the encoder should subsequent retesting occur.

h. Encoder Calibration. Adjustment of encoder calibration, including high or low reference settings, is considered a repair action not part of certification and requires an appropriate instrument or limited rating. Limited ratings authorizing the test of encoders *only* do not include authorization for this adjustment.

> **NOTE: No field adjustments are allowed unless the repair station is rated for this adjustment.**

14. INSTALLATION AND TESTING CONCERNS.

a. Altitude Encoding Capability. The blind encoder, altimeter, air data system components, and encoding altimeter should have an altitude encoding capability of at least the service ceiling or maximum certificated altitude of the aircraft. If the altitude reporting system will not function throughout the aircraft operational envelope (up to the aircraft maximum operating altitude), install a placard stating the aircraft altitude limitation.

b. Installation Location. The altimeter and encoder must be installed in the same environmental location unless the person performing the installation obtains specific FAA engineering approval to deviate from this requirement.

c. Shop Testing and Functional Tests. Altitude reporting system installations (either blind encoder or encoding altimeter types) may be tested in the shop by a technician for correspondence (using the transponder decoded output) and then functionally checked after installation in the aircraft, provided the transponder encoding digitizer, altimeter, wiring harness, and coaxial cable are either installed in the aircraft or accurately compensated for.

d. Deterioration and Repairs. Transponder antenna systems may deteriorate to the point that they pull transponder frequency out of tolerance. If this occurs, then the repair station should notify the operator that the antenna system requires repair. The practice of offsetting transponder output frequency to compensate for antenna system pull is not acceptable.

e. Purging. Whenever there is reason to suspect that the static lines are blocked, purge them before performing the static pressure system test. Besides the obvious benefits of removing

foreign objects from the lines, purging may keep such objects from entering the test equipment. Since purging applies positive pressure to lines, take the following precautions:

(1) Disconnect all instruments and air data sensors;

(2) Cap off those lines not being purged;

(3) Restrain hoses that can whip due to purge pressure;

(4) Ensure that lines are clear by feeling discharge pressure at ports; and

(5) Clean system drains and traps after purging since they can act as a sump for foreign material.

APPENDIX 1. TABLES

TABLE 1. ABBREVIATED CORRESPONDENCE TEST ALTITUDE INFORMATION PULSE POSITIONS

RANGE	PULSE POSITION									
(0 or 1 in a pulse position indicates absence or presence of a pulse, respectively)										
INCREMENTS (FEET)	**D4**	**A1**	**A2**	**A4**	**B1**	**B2**	**B4**	**C1**	**C2**	**C4**
-1000	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**
-900	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**
-700	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**
-400	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**
-200	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**1**
800	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**1**
2800	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**1**
6800	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**1**
14800	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
30800	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**

Integrity of code lines is ensured through testing at these increments.

TABLE 2. CORRESPONDENCE TEST ALTITUDE INFORMATION PULSE POSITIONS

RANGE	PULSE POSITION									
(0 or 1 in a pulse position indicates absence or presence of a pulse respectively)										
INCREMENTS (FEET)	**D4**	**A1**	**A2**	**A4**	**B1**	**B2**	**B4**	**C1**	**C2**	**C4**
- 1050 to - 950	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**
- 50 to + 50	**0**	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**1**	**0**
450 to 550	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**0**
950 to 1050	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**1**	**0**
1050 to 1150	**0**	**0**	**0**	**0**	**1**	**1**	**0**	**1**	**1**	**0**
1250 to 1350	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**0**
1450 to 1550	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**0**	**1**	**0**
1750 to 1850	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**1**
1950 to 2050	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**0**	**1**	**0**
2550 to 2650	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**1**
2650 to 2750	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**1**
2950 to 3050	**0**	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**1**	**0**
3950 to 4050	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**1**	**0**
5950 to 6050	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**0**	**1**	**0**
6750 to 6850	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**1**
7950 to 8050	**0**	**0**	**1**	**1**	**0**	**1**	**1**	**0**	**1**	**0**
9950 to 10050	**0**	**0**	**1**	**1**	**1**	**0**	**1**	**0**	**1**	**0**
11950 to 12050	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**0**	**1**	**0**
13950 to 14050	**0**	**0**	**1**	**0**	**0**	**0**	**1**	**0**	**1**	**0**
14750 to 14850	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
15950 to 16050	**0**	**1**	**1**	**0**	**0**	**1**	**1**	**0**	**1**	**0**
17950 to 18050	**0**	**1**	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**
19950 to 20050	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**0**	**1**	**0**
21950 to 22050	**0**	**1**	**1**	**1**	**0**	**0**	**1**	**0**	**1**	**0**
24950 to 25050	**0**	**1**	**0**	**1**	**1**	**1**	**0**	**0**	**1**	**0**
29950 to 30050	**0**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**0**
30750 to 30850	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
34950 to 35050	**1**	**1**	**0**	**1**	**1**	**0**	**0**	**0**	**1**	**0**
39950 to 40050	**1**	**1**	**1**	**1**	**0**	**1**	**1**	**0**	**1**	**0**
44950 to 45050	**1**	**1**	**1**	**0**	**0**	**1**	**0**	**0**	**1**	**0**
49950 to 50050	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**	**1**	**0**

TABLE 3. TEST ASSOCIATION MATRIX

The following table lists appropriate tests to assure system functionality after removal, replacement, or installation of altitude reporting equipment and transponder system components.

COMPONENT	DESCRIPTOR	TEST(S)
Altimeter	Pilot reference.	1. Field elevation verification. 2. Correspondence test. 3. Static leak test.
Altimeter	Pilot reference. Matched to encoder prior to installation.	1. Field elevation verification. 2. Abbreviated correspondence test. 3. Static leak test.
Altimeter	Other than pilot reference.	1. Field elevation verification. 2. Static leak test.
Encoding altimeter	Pilot reference.	1. Field elevation verification. 2. Abbreviated correspondence test. 3. Static leak test.
Encoding altimeter	Other than pilot reference.	1. Field elevation verification. 2. Correspondence test. 3. Static leak test.
Encoding altimeter	Other than pilot reference. Matched to pilot reference altimeter prior to installation.	1. Field elevation verification. 2. Abbreviated correspondence test. 3. Static leak test.
Blind altitude encoder	Connected to transponder.	1. Correspondence test. 2. Static leak test.
Blind altitude encoder	Connected to transponder. Matched to pilot reference altimeter prior to installation.	1. Abbreviated correspondence test. 2. Static leak test.
Blind altitude encoder	Not connected to transponder.	1. Abbreviated correspondence test (modified). 2. Static leak test.
Combined static probe/air data computer	Installed as single component without opening static system.	1. Single indicated altitude and transponder pressure altitude correspondence verification.
Transponder	High reliability style connector system.	1. Transponder test and inspection.
Transponder	Non-high reliability style connector system.	1. Transponder test and inspection. 2. Abbreviated correspondence test.

APPENDIX 2. DEFINITIONS

1. Approved. Unless used with reference to another person, means approved by the Administrator.

2. Blind Encoder (Digitizer). An altitude reporting encoder that is pressure operated, having no altitude display; is not part of a pressure/altitude indicating device or system; does not contain an external means for barometric setting; and may supply altitude reporting information to the air traffic control (ATC) transponder, Global Positioning System (GPS), or other onboard system.

3. Calibrated Datum of the Altimeter. The correction applied via a specific calibration card applicable to a specific altimeter to correct for instrument error (scale error) only.

4. Correspondence. The maximum absolute difference between altimeter display and encoder output for a constant encoder output. The altimeter's displayed pressure/altitude (referenced to 29.92) compared to encoded altitude output from the blind encoder or encoding altimeter for the entire period (from the moment that the code output changes to a value to the moment the code output changes to the next value while the pressure/altitude is changing).

5. Data. Drawings, sketches, stress analyses, reports, operating limitations, or photographs that support or describe an alteration.

6. Encoding Altimeter (Pressure Altitude). An altitude indicator that displays to the pilot the pressure/altitude sensed by the device and produces an altitude reporting output.

7. Gillham Encoder. An altitude reporting encoder that provides parallel data output employing the Gillham (Grey) code.

8. Indicated Datum of the Altimeter. The altitude displayed by the altimeter when an ideal absolute pressure is applied to the sensing member of the altimeter and not corrected for instrument error (scale error), nor corrected for static source error.

9. Matched Components. An altimeter and a blind encoder that have been tested and calibrated together and, as a combination, meet the requirements of 14 CFR part 91, § 91.411(a).

10. High Reliability Style Connectors. Connectors designed to or meeting Military or similar industry standards.

11. Pilot Reference Altimeter. The altimeter normally used to maintain flight altitude.

APPENDIX 3. TSO-C112C MARKING AND PART 43 APPENDIX F CLASS

1. The Technical Standard Order (TSO)-C112c, Air Traffic Control Radar Beacon System/Mode Select (ATCBS/Mode S) Airborne Equipment, labeling scheme does not match the labeling called out in 14 CFR part 43 appendix F. The new TSO labeling is based on RTCA DO-181D, Minimum Operational Performance Standards for Air Traffic Control Radar Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment, Section 1.4.6, rather than the labeling that had been defined previously in TSO-C112.

2. To assist operators in complying with part 43, the following table shows the relationship between the TSO-C112c (or later version) labeling scheme and the part 43 appendix F requirement. Equipment approved under previous versions of TSO-C112 are not affected and may continue to use the label from the equipment directly. Manufacturers of TSO-C112c equipment are encouraged to include this cross-reference information in their operating guide and maintenance instructions.

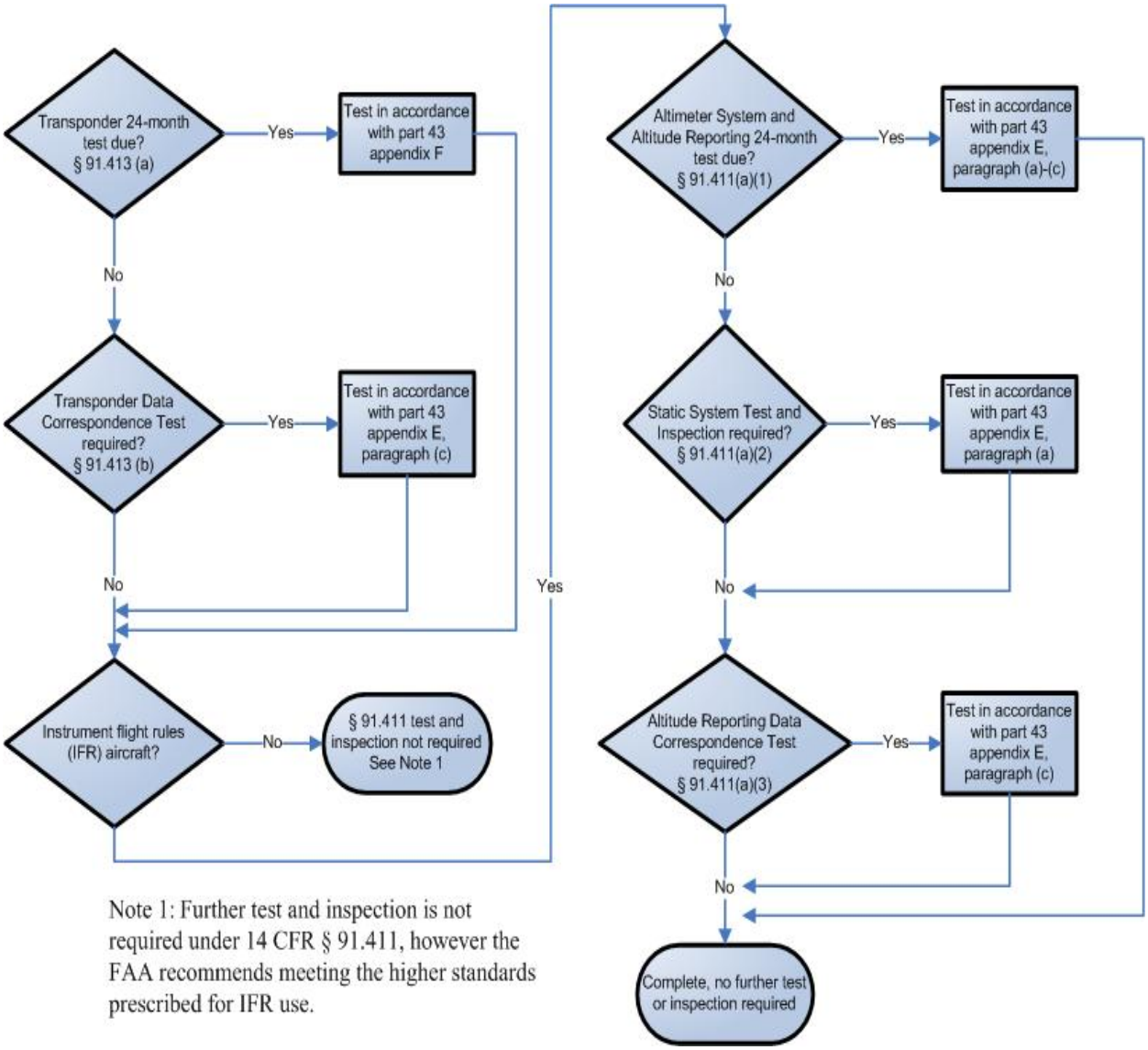
TABLE 1. TSO-C112C MARKING AND PART 43 APPENDIX F CLASS

ATC Mode S Transponder Equipment Part 43, Appendix F Class Reference	
TSO-C112c (or later version) Transponder[1] marking:	**14 CFR Part 43[2], Appendix F class:**
Level 1, Class 1	Class 1A
Level 1, Class 2	Class 1B, with optional 1090 ± 1 MHz reply frequency
Level 2, Class 1	Class 2A
Level 2, Class 2	Class 2B, with optional 1090 ± 1 MHz reply frequency
Level 3, Class 1	Class 3A
Level 3, Class 2	Class 3B, with optional 1090 ± 1 MHz reply frequency
Level 4, Class 1	Class 4
Level 4, Class 2	Class 4, except for RF peak output power and suppression, which should apply Class 3B
Level 5, Class 1	Class 4
Level 5, Class 2	Class 4, except for RF peak output power and suppression, which should apply Class 3B

[1] Per RTCA DO-181E, Section 1.4.6—with options noted in Section 1.4.4.
[2] The part 43 marking shown here originated in the original version of TSO-C112.

APPENDIX 4. SECTIONS 91.411 AND 91.413 COMPLIANCE FLOWCHART

FIGURE 1. SECTIONS 91.411 AND 91.413 COMPLIANCE FLOWCHART



Note 1: Further test and inspection is not required under 14 CFR § 91.411, however the FAA recommends meeting the higher standards prescribed for IFR use.