

SUBPART B – LIST OF ETSOs (INDEX 1 AND INDEX 2)**Index 1**

EASA ETSO Ref	Title	Last amended by
ETSO-C1e	Cargo Compartment Fire Detection Instruments	CS-ETSO/ 13
ETSO-C2d	Airspeed Instruments	CS-ETSO/Initial Issue
ETSO-C3e	Turn and Slip Instruments	CS-ETSO/11
ETSO-C4c	Bank and Pitch Instruments	CS-ETSO/Initial Issue
ETSO-C5f	Direction Instrument, Non-Magnetic (Gyroscopically Stabilized)	CS-ETSO/11
ETSO-C6e	Direction Instrument, Magnetic (Gyroscopically Stabilized)	CS-ETSO/6
ETSO-C7d	Direction Instrument, Magnetic Non-Stabilized Type (Magnetic Compass)	CS-ETSO/Initial Issue
ETSO-C8e	Vertical Velocity Instrument (Rate-of-Climb)	CS-ETSO/6
ETSO-C10b	Aircraft Altimeter, Pressure Actuated, Sensitive Type	CS-ETSO/Initial Issue
ETSO-C13f	Life preservers	CS-ETSO/1
ETSO-C14b	Aircraft Fabric, Intermediate Grade; External Covering Material	CS-ETSO/Initial Issue
ETSO-C15d	Aircraft Fabric, Grade A; External Covering Material	CS-ETSO/Initial Issue
ETSO-C16b	Electrically Heated Pitot and Pitot-Static Tubes	CS-ETSO/13
ETSO-C20	Combustion Heaters	CS-ETSO/Initial Issue
ETSO-C21b	Aircraft Turnbuckle Assemblies and/or Turnbuckle Safetying Devices	CS-ETSO/Initial Issue
ETSO-C22g	Safety Belts	CS-ETSO/Initial Issue
ETSO-C23f	Personal Parachute Assemblies and Components	CS-ETSO/13
ETSO-C25a	Aircraft Seats and Berths (Type I Transport 6g Forward Load)	CS-ETSO/Initial Issue
ETSO-C26d	Aircraft Wheels and Wheel-Brake Assemblies (CS-23, 27 and 29 aircraft)	CS-ETSO/12
ETSO-C27	Twin Seaplane Floats	CS-ETSO/Initial Issue
ETSO-C28	Aircraft Skis	CS-ETSO/Initial Issue
ETSO-C30d	Aircraft Position Lights	CS-ETSO/13
ETSO-C39c	Aircraft Seats and Berths Certified by Static Testing only	CS-ETSO/6
ETSO-C42	Propeller Feathering Hose Assemblies	CS-ETSO/Initial Issue

EASA ETSO Ref	Title	Last amended by
ETSO-C43c	Temperature Instruments	CS-ETSO/Initial Issue
ETSO-C44c A1	Fuel Flowmeters	CS-ETSO/8
ETSO-C45b A1	Manifold Pressure Instruments	CS-ETSO/8
ETSO-C46a	Maximum Allowable Airspeed Indicator System	CS-ETSO/Initial Issue
ETSO-C47a A1	Pressure Instruments — Fuel, Oil, and Hydraulic (Reciprocating Engine-Powered Aircraft)	CS-ETSO/8
ETSO-C49b	Electric Tachometer: Magnetic Drag (Indicator and Generator)	CS-ETSO/Initial Issue
ETSO-C53a	Fuel and Engine Oil System Hose Assemblies	CS-ETSO/Initial Issue
ETSO-C54	Stall Warning Instruments	CS-ETSO/Initial Issue
ETSO-C55a	Fuel and Oil Quantity Instruments	CS-ETSO/7
ETSO-C56b A1	Engine-Driven Direct Current Generators/Starter Generators	CS-ETSO/8
ETSO-C59b	Airborne Selective Calling Equipment	CS-ETSO/13
ETSO-C62e	Aircraft Tyres	CS-ETSO/7
ETSO-C63e	Airborne Weather Radar Equipment	CS-ETSO/13
ETSO-C64b	Oxygen Mask Assembly, Continuous Flow, Passenger	CS-ETSO/12
ETSO-C69c	Emergency Evacuation Slides, Ramps and Slide/Rafts Combinations	CS-ETSO/Initial Issue
ETSO-C70b	Life Rafts	CS-ETSO/11
ETSO-C71	Airborne Static ('DC to DC') Electrical Power Converter (for Air Carrier Aircraft)	CS-ETSO/Initial Issue
ETSO-C72c	Individual Flotation Devices	CS-ETSO/Initial Issue
ETSO-C73	Static Electrical Power Inverter	CS-ETSO/Initial Issue
ETSO-C76b	Fuel Drain Valves	CS-ETSO/11
ETSO-C78a	Crewmember Demand Oxygen Mask	CS-ETSO/13
ETSO-C79	Fire Detectors (Radiation Sensing Types)	CS-ETSO/Initial Issue
ETSO-C80	Flexible Fuel and Oil Cell Material	CS-ETSO/Initial Issue
ETSO-C85b	Survivor Locator Lights	CS-ETSO/12
ETSO-C87a	Airborne Low-Range Radio Altimeter	CS-ETSO/8
ETSO-C88b	Automatic Pressure Altitude Reporting Code Generating Equipment	CS-ETSO/11

EASA ETSO Ref	Title	Last amended by
ETSO-C89a	Crew Member Oxygen Regulators, Demand	CS-ETSO/11
ETSO-C90d A1	Cargo Pallets, Nets and Containers	CS-ETSO/11
ETSO-C92c	Ground Proximity Warning, Glide Slope Deviation Alerting Equipment	CS-ETSO/Initial Issue
ETSO-C95a	Mach Meters	CS-ETSO/7
ETSO-C96b	Anticollision Light Systems	CS-ETSO/13
ETSO-C99a	Flight Deck (Sedentary) Crew Member Protective Breathing Equipment	CS-ETSO/11
ETSO-C100c	Aviation Child Safety Device (ACDS)	CS-ETSO/11
ETSO-C101	Overspeed Warning Instruments	CS-ETSO/Initial Issue
ETSO-C102	Airborne Radar Approach and Beacon Systems for Helicopters	CS-ETSO/Initial Issue
ETSO-C103	Continuous Flow Oxygen Mask Assembly (for Non-Transport Category Aircraft)	CS-ETSO/Initial Issue
ETSO-C105	Optional Display Equipment for Weather and Ground Mapping Radar Indicators	CS-ETSO/Initial Issue
ETSO-C106 A1	Air Data Computer	CS-ETSO/8
ETSO-C109	Airborne Navigation Data Storage System	CS-ETSO/Initial Issue
ETSO-C110a	Airborne Passive Thunderstorm Detection Systems	CS-ETSO/Initial Issue
ETSO-C112e	Secondary Surveillance Radar Mode S Transponder	CS-ETSO/11
ETSO-C113a	Airborne Multi-purpose Electronic Displays	CS-ETSO/11
ETSO-C114 A1	Torso Restraint Systems	CS-ETSO/8
ETSO-C115d	Required Navigation Performance (RNP) Equipment using Multi-Sensor Inputs	CS-ETSO/13
ETSO-C116a	Crew Member Portable Protective Breathing Equipment	CS-ETSO/11
ETSO-C117a	Airborne Wind Shear Warning and Escape Guidance Systems (Reactive Type) for Transport Aeroplanes	CS-ETSO/Initial Issue
ETSO-C118a	Traffic Alert and Collision Avoidance System I (TCAS I)	CS-ETSO/ 13
ETSO-C119d	Airborne Collision Avoidance System II (ACAS II) Version 7.1 with Hybrid Surveillance	CS-ETSO/11
ETSO-C121b	Underwater Locating Device	CS-ETSO/8
ETSO-C123c	Cockpit Voice Recorder Systems	CS-ETSO/13

EASA ETSO Ref	Title	Last amended by
ETSO-C124c	Flight Data Recorder Systems	CS-ETSO/13
ETSO-C126b	406 and 121.5 MHz Emergency Locator Transmitter	CS-ETSO/11
ETSO-C127b	Rotorcraft, Transport Aeroplane, and Small Aeroplane Seating Systems	CS-ETSO/11
ETSO-C132a	Geosynchronous Orbit Aeronautical Mobile Satellite Services Aircraft Earth Station Equipment	CS-ETSO/12
ETSO-C135a	Large Aeroplane Wheels, and Wheels and Brake Assemblies	CS-ETSO/6
ETSO-C139a	Aircraft Audio Systems and Equipment	CS-ETSO/11
ETSO-C141	Aircraft Fluorescent Lighting Ballast/Fixture Equipment	CS-ETSO/Initial Issue
ETSO-C142a	Non-Rechargeable Lithium Cells and Batteries	CS-ETSO/3
ETSO-C144a	Passive Airborne Global Navigation Satellite System (GNSS) Antenna	CS-ETSO/6
ETSO-C145e	Airborne Navigation Sensors Using the Global Positioning System Augmented by the Satellite-Based Augmentation System	CS-ETSO/13
ETSO-C146e	Stand-Alone Airborne Navigation Equipment Using the Global Positioning System Augmented by the Satellite-Based Augmentation System	CS-ETSO/13
ETSO-C147a	Traffic Advisory System (TAS) Airborne Equipment	CS-ETSO/12
ETSO-C151c	Terrain Awareness and Warning System (TAWS)	CS-ETSO/11
ETSO-C154c	Universal Access Transceiver (UAT) Automatic Dependent Surveillance-Broadcast (ADS-B) Equipment	CS-ETSO/7
ETSO-C155b	Recorder Independent Power Supply	CS-ETSO/13
ETSO-C157b	Flight Information Services-Broadcast (FIS-B) Equipment	CS-ETSO/12
ETSO-C158	Aeronautical Mobile High Frequency Data Link (HFDL) Equipment	CS-ETSO/7
ETSO-C159c	Next Generation Satellite Systems (NGSS) Equipment	CS-ETSO/13
ETSO-C160a	VDL Mode 2 Communications Equipment	CS-ETSO/8
ETSO-C161a	Ground-Based Augmentation System Positioning and Navigation Equipment	CS-ETSO/7
ETSO-C162a	Ground-Based Augmentation System Very High Frequency Data Broadcast Equipment	CS-ETSO/7
ETSO-C164	Night-Vision Goggles (NVG)	CS-ETSO/8

EASA ETSO Ref	Title	Last amended by
ETSO-C165a	Electronic Map Systems for Graphical Depiction of Aircraft Position	CS-ETSO/9
ETSO-C166b A3	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)	CS-ETSO/13
ETSO-C170	High-Frequency (HF) Radio Communication Transceiver Equipment Operating Within the Radio Frequency 1.5 to 30 Megahertz	CS-ETSO/7
ETSO-C172a	Cargo Restraint Strap Assemblies	CS-ETSO/12
ETSO-C173a	Nickel-Cadmium, Nickel Metal-Hydride, and Lead-Acid Batteries	CS-ETSO/11
ETSO-C174 A1	Battery-Based Emergency Power Unit (BEPU)	CS-ETSO/8
ETSO-C175	Galley Cart, Containers and Associated Components	CS-ETSO/3
ETSO-C176a	Aircraft Cockpit Image Recorder Systems	CS-ETSO/13
ETSO-C177a	Data Link Recorder Equipment	CS-ETSO/12
ETSO-C178	Single Phase 115 VAC, 400 Hz Arc Fault Circuit Breakers	CS-ETSO/8
ETSO-C179a	Rechargeable Lithium Cells and Lithium Batteries	CS-ETSO/7
ETSO-C184	Galley Equipment	CS-ETSO/7
ETSO-C190	Active Airborne Global Navigation Satellite System (GNSS) Antenna	CS-ETSO/6
ETSO-C194	Helicopter Terrain Awareness and Warning System (HTAWS)	CS-ETSO/7
ETSO-C195b	Avionics Supporting Automatic Dependent Surveillance-Broadcast (ADS-B) Aircraft Surveillance	CS-ETSO/12
ETSO-C196a	Airborne Supplemental Navigation Sensors for Global Positioning System Equipment Using Aircraft-Based Augmentation	CS-ETSO/7
ETSO-C198	Automatic Flight Guidance and Control System (AFGCS) Equipment	CS-ETSO/8
ETSO-C199	Traffic Awareness Beacon System (TABS)	CS-ETSO/13
ETSO-C200a	Low-Frequency Underwater Locating Device (ULD)	CS-ETSO/12
ETSO-C201	Attitude and Heading Reference Systems (AHRS)	CS-ETSO/11
ETSO-C202	Cargo Stopper Devices	CS-ETSO/11
ETSO-C203 A1	Fire containment covers (FCC)	CS-ETSO/13

EASA ETSO Ref	Title	Last amended by
ETSO-C207	Aeronautical Mobile Airport Communication System (AeroMACS)	CS-ETSO/12
ETSO-C209	Electronic Flight Instrument System (EFIS) Display	CS-ETSO/13
ETSO-C210	Airborne Head Up Display	CS-ETSO/13

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EASA ETSO Ref	Title	Last amended by
ETSO-2C11e	Power Plant Fire Detection Instruments (Thermal and Flame Contact Types)	CS-ETSO/Initial Issue
ETSO-2C19c	Portable Water-Solution Type Hand Fire Extinguishers	CS-ETSO/12
ETSO-2C34f	ILS Glide Slope Receiving Equipment Operating within the Radio Frequency Range of 328.6–335.4 Megahertz (MHz)	CS-ETSO/Initial Issue
ETSO-2C35d	Radar Marker Receiving Equipment	CS-ETSO/Initial Issue
ETSO-2C36f	Airborne ILS Localizer Receiving Equipment Operating within the Radio Frequency Range 108–112 Megahertz	CS-ETSO/Initial Issue
ETSO-2C40c	VOR Receiving Equipment Operating within the Radio Frequency Range of 108–117.95 Megahertz	CS-ETSO/Initial Issue
ETSO-2C41d	Airborne Automatic Direction Finding (ADF) Equipment	CS-ETSO/Initial Issue
ETSO-2C48a	Carbon Monoxide Detector Instruments	CS-ETSO/6
ETSO-2C66b	Distance Measuring Equipment (DME) Operating within the Radio Frequency Range 960–1215 Megahertz	CS-ETSO/Initial Issue
ETSO-2C75	Hydraulic Hose Assembly	CS-ETSO/Initial Issue
ETSO-2C93b	Airborne Interim Standard Microwave Landing System Converter Equipment	CS-ETSO/Initial Issue
ETSO-2C104a	Microwave Landing System (MLS) Airborne Receiving Equipment	CS-ETSO/Initial Issue
ETSO-2C122	Devices That Prevent Blocked Channels Used in Two-Way Radio Communications Due to Simultaneous Transmissions	CS-ETSO/Initial Issue
ETSO-2C128	Devices That Prevent Blocked Channels Used in Two-Way Radio Communications Due to Unintentional Transmissions	CS-ETSO/Initial Issue
ETSO-2C153	Integrated Modular Avionics (IMA) Platform and Modules	CS-ETSO/10
ETSO-2C169a	VHF Radio Communications Transceiver Equipment Operating within the Radio Frequency Range 117.975 to 137 Megahertz	CS-ETSO/6
ETSO-2C197	Information Collection and Monitoring Systems	CS-ETSO/7
ETSO-2C500a	Combined ILS/MLS Airborne Receiving Equipment	CS-ETSO/Initial Issue
ETSO-2C501	Mode S Aircraft Data Link Processor	CS-ETSO/Initial Issue
ETSO-2C502	Helicopter Crew and Passenger Integrated Immersion Suits	CS-ETSO/1
ETSO-2C503	Helicopter Crew and Passenger Immersion Suits for Operations to or from Helidecks Located in a Hostile Sea Area	CS-ETSO/1
ETSO-2C504	Helicopter Constant-Wear Life Jackets for Operations to or from	CS-ETSO/1

EASA ETSO Ref	Title	Last amended by
	Helidecks Located in a Hostile Sea Area	
ETSO-2C505	Helicopter Life Rafts for Operations to or from Helidecks Located in a Hostile Sea Area	CS-ETSO/1
ETSO-2C509	Light Aviation Secondary Surveillance Transponders (LAST)	CS-ETSO/2
ETSO-2C512	Portable Gaseous Oxygen Supply (PGOS)	CS-ETSO/3
ETSO-2C513	Tow Release	CS-ETSO/3
ETSO-2C514a	Airborne Systems for Non-Required Telecommunication Services (in Non-Aeronautical Frequency Bands) (ASNRT)	CS-ETSO/13
ETSO-2C515	Aircraft Halocarbon Clean Agent - Hand Held Fire Extinguishers	CS-ETSO/11

European Aviation Safety Agency

European Technical Standard Order

Subject : CARGO COMPARTMENT FIRE DETECTION INSTRUMENTS

1 - Applicability

This ETSO provides the requirements which cargo compartment fire detection instruments that are designed and manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO Subpart A.

2.2 - Specific

None.

3 - Technical Conditions

3.1 - Basic

3.1.1 - Minimum Performance Standard

Standards set forth in SAE Aerospace Standard (AS) 8036 'Cargo Compartment Fire Detection Instruments', Revision A, dated December 17, 2013, except for paragraphs 4.9, 4.10 and 4.11.

3.1.2 - Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1.

3.1.3 - Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 - Airborne Electronic Hardware

See CS-ETSO, Subpart A, paragraph 2.3.

3.2 - Specific

Demonstrate the required functional performance under the test conditions specified in Section 4 of AS8036, Revision A.

Demonstrate the required performance under the test conditions specified in Section 5 of AS8036, Revision A, using standard environmental conditions in accordance with 3.1.2.

3.2.1 - Failure Condition Classification

See CS-ETSO, Subpart A, paragraph 2.4.

4 - Marking

4.1- General

Marking is detailed in CS-ETSO, Subpart A, paragraph 1.2.

4.2 - Specific

None.

5 - Availability of Referenced Document

See CS-ETSO Subpart A, paragraph 3.

European Aviation Safety Agency

European Technical Standard Order

Subject: Electrically Heated Pitot And Pitot-Static Tubes

1 - Applicability

This ETSO provides the requirements which electrically heated pitot and pitot-static tubes, heated by aircraft electrical power, that are designed and manufactured on or after the date of this ETSO, must meet in order to be identified with the applicable ETSO marking.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO Subpart A.

2.2 - Specific

2.2.1 - Test Report

The test report identified in Section 2.4.2 and data identified in Chapter 4 of EUROCAE ED-225, Ice and Rain Minimum Qualification Standards for Pitot and Pitot-Static Probes, shall be provided to the installer to support installation approval.

2.2.2 - Rated Performance Documentation

The rated performance to be declared in the declaration of design and performance (DDP) shall at least contain:

- the probe type and class;
- the passed test conditions;
- the concentration factors used for icing tests; and
- the probe test voltage

3 - Technical Conditions

3.1 - Basic

3.1.1 - Minimum Performance Standard

Standards set forth in SAE International's Aerospace Standard AS8006A, Minimum Performance Standard for Pitot and Pitot-Static Tubes, revised August 2015, as modified in Appendix 1 of this ETSO, and EUROCAE ED-225, Ice and Rain Minimum Qualification Standards for Pitot and Pitot-Static Probes, issued February 2016, as modified in Appendix 2 of this ETSO.

Note: The electric heater function is defined as starting with the aircraft interface (connector). The pneumatic pressure function is defined as starting with the pressure transducer interface if it is integrated with the probe or starting with the aircraft interface if the pressure transducer is separated from the probe.

3.1.2 - Environmental Standard

EUROCAE ED-14G / RTCA DO-160G, Environmental Conditions and Test Procedures for Airborne Equipment, or later revision as permitted by CS-ETSO, Subpart A, paragraph 2.1 and complemented by the minimum performance standards specified in Section 3.1.1 of this ETSO.

3.1.3 - Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 - Airborne Electronic Hardware

See CS-ETSO, Subpart A, paragraph 2.3.

3.2 - Specific**3.2.1 - Failure Condition Classification**

See CS-ETSO, Subpart A, paragraph 2.4.

4 - Marking**4.1 - General**

Marking is detailed in CS-ETSO, Subpart A, paragraph 1.2.

4.2 - Specific

In addition, the following identification information must be permanently and legibly marked:

- (1) The TYPE and CLASS designation in accordance with EUROCAE ED-225, paragraph 1)
- (2) All the information in SAE AS8006A, paragraphs 3.5.4 and 3.6.

5 - Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

APPENDIX 1

MINIMUM PERFORMANCE STANDARDS FOR ELECTRICALLY HEATED PITOT AND PITOT-STATIC TUBES

This ETSO modifies SAE AS8006A, as follows:

AS8006A Section	EASA Modification
2.1	<p>Page 1, Replace Subsection 2.1, with the following text:</p> <p>2.1 Applicable Documents</p> <p>The following publications form a part of this document to the extent specified herein. The applicable issue of <i>cited</i> publications shall be the issue in effect on the date of the publication of this document, unless otherwise specified. In the event of conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific <i>deviation or exemption</i> has been obtained.</p>
3.4.2	<p>Page 3, replace Subsection 3.4.2 with the following text:</p> <p>3.4.2 Particle Separation Features</p> <p>The probe shall be designed with baffling or a pitot settling chamber, or both, to minimise the entry of liquid or solid particles into the tubing connecting the probe to the aircraft instruments. There shall be at least one drain hole to discharge or scavenge entrained liquid, such as rain or melted ice water. The probe design <i>shall</i> consider the effects of ingested solid particles such as ice, sand and dust.</p>
3.4.3	<p>Page 3, replace Subsection 3.4.3 with the following text:</p> <p>3.4.3 Mis-installation</p> <p>The probe <i>shall</i> incorporate design features to minimise the potential for mis-installation on the aircraft. For example, in the case where the probe contains multiple pneumatic or electrical connections these features may include the incorporation of different pneumatic fitting sizes or types, or different electrical connector keying.</p>
3.4.11	<p>Page 4, amend 3.4.11 as follows:</p> <p>Protective coatings and finishes utilised in the construction of the probe <i>shall</i> not crack, chip, or scale to the extent that the probe no longer meets the aerodynamic accuracy requirements when exposed to the qualification test requirements of this standard.</p> <p>Other FAA modification not retained.</p>
4.6	<p>Page 7, amend 4.6 as follows:</p> <p>Other means can be used to demonstrate compliance with this requirement provided there is evidence they are equivalent or better than the specified test. Such alternate means is considered a deviation.</p>
5.26	<p>Page 12, replace Subsection 5.26 with the following text:</p> <p>5.26 Fire, flammability</p> <p>Non-metallic probes shall be tested for compliance with the fire and flammability test</p>

AS8006A Section	EASA Modification
	standards specified in EUROCAE ED-14G / RTCA DO-160G, Section 26, Category C. <i>If ignition occurs</i> inside or outside of the equipment, the probe shall not propagate the flame. Tests are not required for metallic probes.

APPENDIX 2

ICE AND RAIN MINIMUM QUALIFICATION STANDARDS FOR PITOT AND PITOT-STATIC PROBES

ED-225 introduces the possibility to use alternate methods. EASA considers the following alternate means as deviations from this ETSO:

ED-225 Section	Alternate method
1.2	Modified test conditions
2.2	Modified test conditions
2.3	Scaling method not listed in section 2.3
Table 5	MMD value outside the specified range
Table 6	MVD value outside the specified range

In addition, this ETSO modifies EUROCAE ED-225, as follows:

ED-225 Section	EASA Modification
1.2	<p>Page 1: Replace the first 'NOTE' with the following:</p> <p>NOTE: Class 2 is divided into two subgroups identified as either Class 2a or Class 2b. Class 2a probe applications typically include aircraft that operate within the mid to lower end of the Class 2 altitude range and that only use probe outputs to display basic airspeed and/or altitude. As such, Class 2a probes do not have to be tested against ice crystals at an altitude-capable icing tunnel. Class 2b applications are for probe installations intended to serve a critical function and <i>shall</i> be tested at an altitude-capable icing tunnel. Probes qualified to Class 2 of this standard shall be identified as either Class 2a or Class 2b.</p>
1.2	<p>Replace the second 'NOTE' with the following:</p> <p>NOTE: This specification, when used in conjunction with AS8006A, provides a comprehensive design and test standard for the devices that fall within the scope of this document.</p>
1.6	<p>Page 3: Add subsection 1.6</p> <p>1.6 General Definitions</p> <p>SHALL: The word 'shall' is used in this document to express an essential requirement where compliance is mandatory.</p> <p>MUST: The word 'must' is used in this document to express an essential requirement where compliance is mandatory.</p>
3.5	<p>Page 8, Paragraph 3.5 add the following note:</p> <p>NOTE: The probe test voltage reported to the installer shall not include any voltage adjustments made per paragraph 3.9 to simulate worst-case heater performance.</p>

European Aviation Safety Agency

European Technical Standard Order

Subject: PERSONNEL PARACHUTE ASSEMBLIES AND COMPONENTS

1 - Applicability

This ETSO provides the requirements which emergency parachutes that are designed and manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO, Subpart A.

2.2 - Specific

None.

3 - Technical conditions

3.1 - Basic

3.1.1 - Minimum Performance Standard

Standards set forth for emergency parachutes in Parachute Industry Association (PIA) Technical Standard 135 (TS-135) Revision 1.4, issued April 22, 2010, 'Performance Standards for Personnel Parachute Assemblies and Components', as modified by Appendix 1 of this ETSO.

3.1.2 - Environmental Standard

As set forth in Parachute Industry Association (PIA) Technical Standard 135 (TS-135) Revision 1.4, issued April 22, 2010, 'Performance Standards for Personnel Parachute Assemblies and Components'.

3.1.3 - Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 - Airborne Electronic Hardware

See CS-ETSO, Subpart A, paragraph 2.3.

3.2 - Specific

3.2.1 - Failure Condition Classification

See CS-ETSO Subpart A paragraph 2.4

Equipment suitability for supporting the function defined in paragraph 3.1.1 of this ETSO is established by performing

the tests as prescribed in Parachute Industry Association (PIA) Technical Standard 135 (TS-135) Revision 1.4, issued April 22, 2010, 'Performance Standards for Personnel Parachute Assemblies and Components', as modified by Appendix 1 of this ETSO, with no further analysis required.

4 - Marking**4.1 - General**

Marking as detailed in CS-ETSO, Subpart A, paragraph 1.2.

4.2 - Specific

Also, mark the following permanently and legibly, with at least the manufacturer's name, subassembly part number, and the ETSO number:

- (1) Each component that is easily removable (without hand tools), and
- (2) Each subassembly of the article that you determined may be interchangeable.

5 - Availability of Referenced Document

You can download a free copy of PIA TS-135 Revision 1.4 issued April 22, 2010, Performance Standards for Personnel Parachute Assemblies and Components, at:

<http://www.pia.com/piapubs/TSDocuments/TS-135v1.4.pdf>

APPENDIX 1. MINIMUM PERFORMANCE STANDARD FOR PERSONNEL PARACHUTE ASSEMBLIES AND COMPONENTS

This Appendix prescribes the MPS for a personnel parachute assembly and its components. The applicable standard is PIA TS-135 Revision 1.4, issued April 22, 2010, Performance Standards for Personnel Parachute Assemblies and Components, as modified for this ETSO:

1. Page 2, replace paragraph 2.1.i. to read as follows:
'Cognisant Agency' — The European Aviation Safety Agency (EASA).
2. Page 2, replace paragraph 2.1.a. to read as follows:
'Administrator' — EASA.
3. Page 5, paragraph 4.1.2. delete: 'generally'.
Stitching should not ravel when it is broken. 'Generally' reduces the requirement for stitch choice, and adversely impacts the current standard.
4. Page 5, paragraph 4.1.3. delete: 'Ref: Table 2'.
Table 2 is not relevant to this requirement. Testing of a packed assembly will show if the main parachute will interfere with the proper function of the reserve parachute.
5. Page 8, paragraph 4.3.5.3 replace 'a 200 lbf (889.6 N)' with 'the greater of (200 lbf (889.6 N)) and the (maximum operating weight times 0.84)'.
To ensure that the compression load is at least the compression load of the body without legs and feet.
6. Page 9, paragraph 4.3.7. in first sentence delete: 'a weight not more than'.
The worst case is the maximum operating weight.
7. Page 11, paragraph 4.3.11. in the first sentence delete 'not more than'.
The worst case is the maximum operating weight.
8. Page 11, disregard paragraph 4.3.9.1., Rate of Descent Tests (Method 2).
9. Page 14, Table 1, under Marking Data Requirements, replace:
Statement of Authorisation under TSO-C-23e and/or (J) TSO-C-23e if applicable.
with:
Statement of Authorisation under ETSO-C23f.

European Aviation Safety Agency

European Technical Standard Order

Subject: AIRCRAFT POSITION LIGHTS

1 - Applicability

This ETSO provides the requirements which aircraft position lights that are designed and manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO, Subpart A.

2.2 - Specific

None.

3 - Technical conditions

3.1 - Basic

3.1.1 - Minimum Performance Standard

Standards set forth in the Society of Automotive Engineers, Inc., (SAE) Aerospace Standard (AS) Document AS8037C, 'Minimum Performance Standard for Aircraft Position Lights', dated July 2013.

3.1.2 - Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1.

3.1.3 – Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 - Airborne Electronic Hardware

See CS-ETSO, Subpart A, paragraph 2.3.

3.2 - Specific

3.2.1 - Failure Condition Classification

See CS-ETSO, Subpart A, paragraph 2.4.

4 - Marking

4.1 - General

In lieu of the marking detailed in CS-ETSO, Subpart A, paragraph 1.2, the minimum lamp candle

power or lamp part number shall be shown.

4.2 - Specific

NONE

5 - Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

European Aviation Safety Agency

European Technical Standard Order

Subject: AIRBORNE SELECTIVE CALLING EQUIPMENT

1 - Applicability

This ETSO provides the requirements which airborne selective calling equipment that are designed and manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO, Subpart A.

2.2 - Specific

None.

3 - Technical Conditions

3.1 - Basic

3.1.1 - Minimum Performance Standard

Standards set forth in RTCA document RTCA/DO-93A, Minimum Operational Performance Standards (MOPS) for Airborne Selective Calling (SELCAL) Equipment, dated March 17, 2016.

Demonstrate the required functional performance under the test conditions specified in RTCA/DO-93A, Minimum Operational Performance Standards for Airborne Selective Calling (SELCAL) Equipment, Section 2.4, dated March 17, 2016.

Demonstrate the required performance under the test conditions specified in RTCA/DO-93A, Section 2.3, using environmental conditions identified in paragraph 3.1.2 of this ETSO and test procedures appropriate for airborne equipment.

3.1.2 - Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1.

3.1.3 - Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 - Airborne Electronic Hardware

See CS-ETSO, Subpart A, paragraph 2.3.

3.2 - Specific

3.2.1 - Failure Condition Classification

See CS-ETSO, Subpart A, paragraph 2.4.

Failure of the function defined in paragraph 3.1.1 of this ETSO is a minor failure condition.

Loss of the function defined in paragraph 3.1.1 of this ETSO is a minor failure condition.

4 - Marking

4.1 - General

Marking as detailed in CS-ETSO, Subpart A, paragraph 1.2.

4.2 - Specific

None

5 - Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

European Aviation Safety Agency

European Technical Standard Order

Subject: Airborne Weather Radar Equipment

1 - Applicability

This ETSO provides the requirements that airborne weather radar equipment that is designed and manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

This ETSO standard addresses weather detection and ground mapping, forward-looking wind shear detection, forward-looking turbulence detection, and atmospheric threat awareness capability. It does not include flight guidance system functionality in support of an approved wind shear detection and avoidance system.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO, Subpart A.

2.2 - Specific

None.

3 - Technical Conditions

3.1 - Basic

3.1.1 - Minimum Performance Standard

Standards set forth in RTCA Document DO-220A, Minimum Operational Performance Standards (MOPS) for Airborne Weather Radar Systems, dated March 17, 2016, for the equipment classes defined in Table 1.

Equipment Class	Equipment Type	Minimum Performance Standards
A	Forward-Looking Wind shear Detection Capability	The following sections of RTCA DO-220A: Section 2.2, with the following exclusions: paragraphs 2.2.1.3.6, 2.2.1.3.7, 2.2.2, 2.2.4, and 2.2.5., and Sections 2.3 (performance under environmental conditions) and 2.4 (test requirements) as applicable to the class
B	Forward-Looking Turbulence Detection Capability	The following sections of RTCA DO-220A: Section 2.2, with the following exclusions: paragraphs 2.2.1.3.5, 2.2.1.3.7, 2.2.2, 2.2.3, and 2.2.5., and Sections 2.3 (performance under environmental conditions) and 2.4 (test requirements) as applicable to the class
C	Airborne Weather and Ground Mapping Pulsed Radar	The following sections of RTCA DO-220A: Section 2.2, with the following exclusions: paragraphs 2.2.1.3.5, 2.2.1.3.6, 2.2.1.3.7, 2.2.3, 2.2.4, and 2.2.5., and Sections 2.3 (performance under environmental conditions) and 2.4 (test requirements) as applicable to the class
D	Atmospheric Threat Awareness Capability	The following sections of RTCA DO-220A: Section 2.2, with the following exclusions: paragraphs 2.2.1.3.5, 2.2.1.3.6, 2.2.2, 2.2.3, and 2.2.4. Sections 2.3 (performance under environmental conditions) and 2.4 (test requirements) as applicable to the class

Table 1 - Airborne Weather Radar Equipment Classes and Applicable MPS

Any of these classes may be implemented individually or in combination. Therefore, a piece of equipment may be eligible for one or more classes.

Functionality

This ETSO standard applies to equipment intended to:

- (1) Provide airborne wind shear detection (equipment Class A). Equipment Class A provides forward-looking wind shear detection functionality. However, this ETSO does not include flight guidance system functionality in support of an approved wind shear detection and avoidance system;
- (2) Provide advanced and advisory indication of potentially hazardous turbulence conditions detectable by weather radar, together with other flight information, to assist pilots with turbulence avoidance decisions (Equipment Class B);

- (3) Detect and display echoes from precipitation to assist in flight crew analysis of weather. Maintain contact with geographic features such as international shoreline boundaries as a supplement to navigational orientation (Equipment Class C); and
- (4) Provide timely and advisory information to pilots to enhance their situational awareness of atmospheric activity and assist with atmospheric threat avoidance decisions (Equipment Class D).

3.1.2 - Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1

3.1.3 - Software

See CS-ETSO, Subpart A, paragraph 2.2

3.1.4 - Electronic Hardware

See CS-ETSO, Subpart A, paragraph 2.3

3.2 - Specific

3.2.1 - Failure Condition Classification

See CS-ETSO, Subpart A, paragraph 2.4.

Failure of the function defined in paragraphs 3.1.1(2) or 3.1.1(4) resulting in unannounced malfunction of the function is a minor failure condition.

Failure of the function defined in paragraph 3.1.1(1) or 3.1.1(3) resulting in unannounced malfunction of the function or missed detection is a major failure condition.

Loss of the functions defined in paragraph 3.1.1 is a minor failure condition.

3.2.2 - Installation Manual

The applicant should provide a manual(s) containing the following items:

- (1) Operating instructions and equipment limitations sufficient to describe the equipment's operational capability;
- (2) For Equipment Class B, identify the installation instructions for the identified aircraft class selected from RTCA/DO-220A, paragraph 2.2.4.1, Table 2-4;
- (3) Expected radome performance for the electromagnetic signals passing through it (paragraph 2.2 of RTCA DO-213A, Minimum Operational Performance Standards for Nose-Mounted Radomes, dated March 17, 2016);
- (4) Weather performance index (range) in accordance with the requirements of RTCA DO-220A; and
- (5) Wind shear detection range in accordance with the requirements of RTCA DO-220A.

4 - Marking

4.1 - General

Marking is detailed in CS-ETSO, Subpart A, paragraph 1.2.

4.2 - Specific

The marking must also include the equipment class, as defined in Table 1.

5 - Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

European Aviation Safety Agency

European Technical Standard Order

Subject: CREWMEMBER DEMAND OXYGEN MASK

1 - Applicability

This ETSO provides the requirements which crewmember demand oxygen masks that are designed and manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO, Subpart A.

2.2 - Specific

None.

3 - Technical Conditions

3.1 - Basic

3.1.1 - Minimum Performance Standard

Crewmember demand oxygen masks must meet the standards set forth in SAE International (SAE) Aerospace Standard (AS) 8026A, Crewmember Demand Oxygen Mask for Transport Category Aircraft, dated October 2001, as modified by Appendix 1 of this ETSO.

Crewmember oxygen masks are separated into four types;

- Type I: Quick donning mask with integral breathing valve(s);
- Type II: Quick donning mask without integral breathing valve(s);
- Type III: Non-quick donning mask with integral breathing valve(s); and
- Type IV: Non-quick donning mask without integral breathing valve(s)

This ETSO standard applies to crewmember demand oxygen masks to be used with straight-demand, diluter-demand and pressure-demand oxygen systems on transport category aircraft. The oxygen mask design should be either oronasal, covering the mouth and nose, or full face, covering the mouth, nose and eyes.

3.1.2 - Environmental Standard

Refer to CS-ETSO, Subpart A, as well as SAE AS8026A, paragraph 4.5.

3.1.3 - Software

See CS-ETSO Subpart A, paragraph 2.2.

3.1.4 - Electronic Hardware

See CS-ETSO Subpart A, paragraph 2.3.

3.2 - Specific**4 - Marking****4.1. - General**

Marking is detailed in CS-ETSO, Subpart A, paragraph 1.2.

4.2. - Specific**4.2.1 - Each demand flow mask shall be marked to indicate:**

- (a) whether it is a 'non-pressure-demand' or a 'pressure-demand' mask;
- (b) the maximum environmental (cabin) altitude for which it is qualified;
- (c) its type in accordance with paragraph 3.1.1; and
- (d) its size (if more than one size is manufactured).

5 - Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

APPENDIX 1**MPS FOR CREWMEMBER DEMAND OXYGEN MASKS**

This Appendix prescribes the MPS for crewmember demand oxygen masks. The applicable standard is SAE AS8026A, Crewmember Demand Oxygen Mask for Transport Category Aircraft, dated October 2001. It is modified as follows.

SAE AS8026A:	Modification:
Section 1, SCOPE	To be disregarded.
Paragraph 3.1.1	To be revised: 'General: Materials of a type, grade and quality that experience and/or tests have shown suitable for the purpose shall be used. Materials that contaminate oxygen or are adversely affected by continuous service with oxygen shall not be used. The following test methods shall be used to verify compliance with material requirements established in a design specification.'
Paragraph 3.1.1	
a. Resistance to Flammability	To be revised: 'Except for small parts like knobs, triggers, fasteners, seals, and electrical parts that don't contribute significantly to fire propagation, materials including packaging shall comply with CS 25.853(a) and Appendix F, Part I(a)(1)(iv)'
Paragraph 3.1.3	To be revised: 'Cleaning and Sterilizing: The oxygen mask shall be made of materials that permit cleaning and sterilising without adverse effects, and without major disassembly. The cleaning method shall be either manufacturer recommended, or according to SAE ARP1176, Oxygen System Component Cleaning and Packaging. Cleaning and sterilising procedures shall be included in the Component Maintenance Manual (CMM).'
Paragraph 3.1.4	To be revised: 'Elastomeric Components: A tag or leaflet describing service life limits of elastomeric components and a suggested method to inspect for deterioration in these components shall be attached to the mask. If not attached, the tag shall be included with the packaged mask as delivered to the user. Silicone rubber parts, having unlimited shelf life, are exempt from this requirement. Life limits and inspection procedures shall be included in the CMM.'
Paragraph 3.3	To be disregarded. Marking is specified in paragraph 4 of this ETSO.
Paragraph 3.5	To be revised: 'The oxygen mask face-piece of Type I and Type II masks shall be stored in a container, mounted (panel or sidewall) or attached to a suspension device. The mask assembly must be donned using only one hand and operating in 5 seconds or less, without disturbing eyeglasses. After donning, the mask must not prevent immediate communication between crewmembers of the airplane intercommunications system.'
	Type III and Type IV oxygen masks may be similarly installed, and may be designed to require use of two hands and/or take more than 5 seconds to don.

Paragraph 3.12	To be revised: 'Oxygen mask design shall permit the installation of a microphone and connecting communications cable. When microphones are furnished with the masks, these must conform to the current revision of ETSO-C139.'
Paragraph 5.1.4	To be disregarded.
Paragraph 5.1.5	To be disregarded.

European Aviation Safety Agency

European Technical Standard Order

Subject: ANTICOLLISION LIGHT SYSTEMS

1 - Applicability

This ETSO provides the requirements which anticollision light systems that are designed and manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO, Subpart A.

2.2 — Specific

None.

3 - Technical Conditions

3.1 - Basic

3.1.1 - Minimum Performance Standard

Standards set forth in the Society of Automotive Engineers, Inc., (SAE) Aerospace Standard (AS) Document AS8017C 'Minimum Performance Standard for Anticollision Light Systems', dated June 2011.

3.1.2 - Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1.

3.1.3 - Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 - Airborne Electronic Hardware

See CS-ETSO, Subpart A, paragraph 2.3.

3.2 - Specific

3.2.1 - Failure Condition Classification

See CS-ETSO, Subpart A, paragraph 2.4.

4 - Marking

4.1 - General

Marking is detailed in CS-ETSO Subpart A paragraph 1.2.

4.2 - Specific

None.

5 - Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

European Aviation Safety Agency

European Technical Standard Order

Subject: REQUIRED NAVIGATION PERFORMANCE (RNP) EQUIPMENT USING MULTI-SENSOR INPUTS

1 - Applicability

This ETSO provides the requirements which required navigation performance (RNP) equipment using multi-sensor inputs that is designed and manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

This ETSO supports performance-based operations using RNP values from RNP 0.3 through RNP 4.0 and advanced RNP functions.

This ETSO does not address RNP operations with authorisation required (RNP AR), localizer performance without vertical guidance/localizer performance with vertical guidance (LP/LPV), ground-based augmentation system landing system (GLS) approach operations or the positioning requirements to support ADS-B out capability.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO, Subpart A.

2.2 - Specific

None.

3 - Technical Conditions

3.1 - Basic

3.1.1 - Minimum Performance Standard

Standards set forth in RTCA DO-283B, Minimum Operational Performance Standards for Required Navigation Performance for Area Navigation, dated December 15, 2015, section 2, as modified by Appendix 1 of this ETSO. Section 1.8 of this standard defines 2 classes, A and B, of equipment. Requirements applicable to Class A and Class B equipment are specified in RTCA DO-283B, Table 2-13.

The applicant shall state the minimum RNP supported by the equipment, as well as the equipment class, in the DDP.

3.1.2 - Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1.

3.1.3 - Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 - Airborne Electronic Hardware

See CS-ETSO, Subpart A, paragraph 2.3.

3.2 - Specific

For databases that are used in the ETSO article but are not part of the ETSO article, the configuration number of the data quality requirements (DQR) shall be defined and provided to the user.

DQR documentation shall be in a form available to the Type 2 Database Provider (refer to Regulation (EU) 2017/373 Article 2(5)(b) for the definition of a Type 2 Database Provider).

3.2.1 - Failure Condition Classification

See CS-ETSO, Subpart A, paragraph 2.4.

Design the system to the appropriate failure condition classification(s) as detailed in the guidance material for the different types of navigation specification (for instance RNP1, Advanced RNP, RNP-APCH ...).

4 - Marking

4.1 - General

Marking as detailed in CS-ETSO, Subpart A, paragraph 1.2.

4.2 - Specific

None.

5 - Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

Appendix 1- MODIFICATIONS TO RTCA DO-283B REQUIREMENTS

Scope

This Appendix describes modifications and additions to the requirements found in RTCA DO-283B that the RNP equipment shall meet for compliance with this ETSO. EASA expects the RNP equipment to execute published instrument procedures designed to provide maximum efficiency, flexibility, and aircraft eligibility. These instrument procedure designs may include RNAV components and/or leg types associated with conventional procedures. The modifications and additions below are necessary to ensure RNP equipment can properly execute current and future instrument procedure designs. The modifications below refer to or add chapters in reference to RTCA DO-283B.

2.2.1.2.1 Leg Types

Add the following required leg types to Table 2-1:

FM	Fix to Manual Termination
VA	Heading to Altitude Leg
VI	Heading to Intercept
VM	Heading to Manual Termination
CA	Course to Altitude Leg

Add the following requirement and note after the sentence 'Refer to Appendix D for additional details for each of the leg types':

The equipment shall have the ability to use an IF that is a fly-by waypoint, fly-over waypoint, or the initial fix defining an RF leg segment. Additionally, the equipment shall have the ability to proceed 'direct to' an IF.

Note: This requirement is needed to support RNP departure procedures, particularly those with an RF leg as the first leg segment, where the IF defines the beginning of the RF leg. With LNAV available immediately after take-off, the equipment should provide guidance direct to the IF and sequence the next leg; particularly when the IF is the initial fix of an RF leg.

2.2.1.2.2 Flight Planning

Insert a new paragraph and note between the last paragraph and next to last paragraph as follows:

The equipment shall have the ability to use a single waypoint supporting multiple RNP terminal procedures (SID, DP, STAR) and multiple approach procedures using different tracks. When a single waypoint supports an arrival and an RNP instrument approach using different tracks, the equipment shall continue following the arrival procedure to the procedure's termination fix and shall not automatically sequence onto the RNP approach procedure using that same waypoint.

Note: Some waypoints may serve as: a transition fix for an instrument approach; an initial approach fix (IAF) for an instrument approach; the first fix in a terminal arrival procedure; and an intermediate waypoint on a terminal RNP procedure (SID, DP or STAR) (see Figure 1 below). This requirement ensures the equipment completes RNP procedures as assigned by ATC, and loaded by the flight crew into the active flight plan from the on-board navigation database.

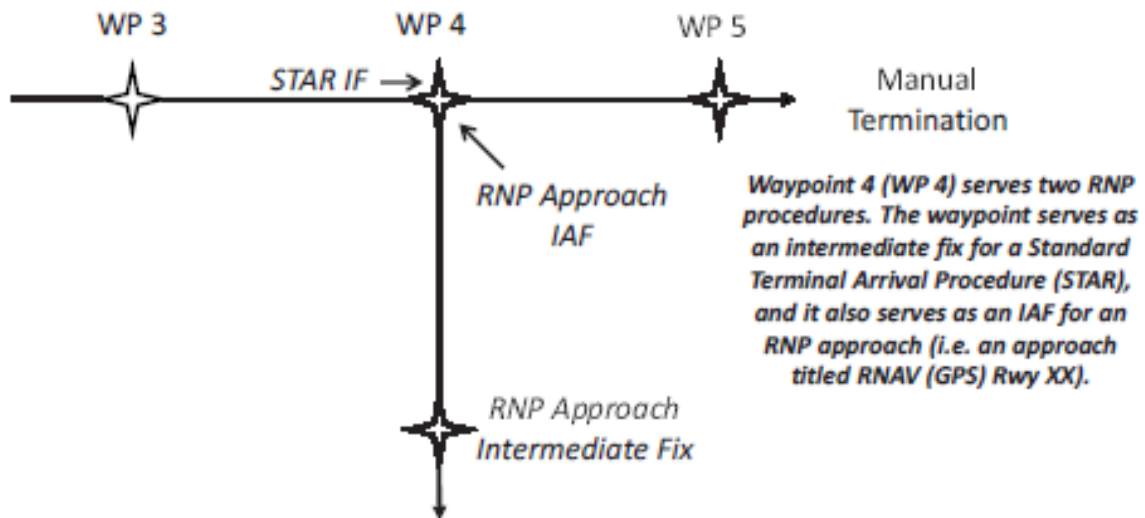


Figure 1- Single Waypoint Serving Multiple RNP Procedures

Add the following requirement and note after the last paragraph in Section 2.2.1.2.2:

The equipment shall not permit the flight crew to select a procedure or route, either manually or automatically, that is not supported by the equipment. For example, a procedure is not supported if it incorporates advanced RNP functions and the equipment does not provide those advanced RNP functions.

Note: Procedures (approaches, arrivals, departures, routes) are defined by a series of waypoints and leg types.

2.2.1.2.9 Transitions Between Legs

Change the first paragraph and note 1 as follows:

The navigation system shall provide a means to automatically transition from one leg to another. Three categories of transition between fixed path segments can be defined:

- Fly-by transitions;
- Flyover transitions; and
- Fixed radius transitions.

The navigation system shall be capable of accomplishing all three transitions. Fly-by transitions shall be the default transition when the transition type is not specified.

Note 1: For fly-by and flyover transitions, no predictable and repeatable path is specified because the optimum path varies with airspeed and bank angle. Fly-by and flyover transitions use a transition area. The aircraft should remain within the transition area for fly-by transitions.

2.2.1.2.9.1.1 Fly-Over Transitions

Insert a new Section 2.2.1.2.9.1.1 after Section 2.2.1.2.9.1 Fly-By Transitions as follows:

The navigation system shall define a path to accomplish fly-over transitions that passes through the transition waypoint. There are no requirements that apply to the transition area, as the equipment provides guidance relative to the two straight segments to and from the transition waypoint (see figure 2-4.1).

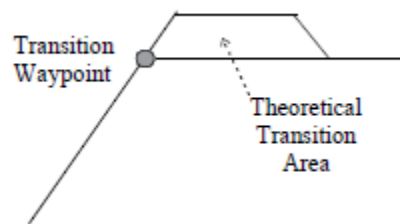


Figure 2-4.1: Fly-Over Theoretical Transition Area

2.2.1.2.9.2 Fixed Radius Transitions

Change the second paragraph as follows and delete the third paragraph:

The RNP system shall use the discrete, navigation database-specified FRT turn radius associated with an en route waypoint transition to execute a Fixed Radius Transition (FRT) from the airway inbound course to the outbound course. The RNP system shall output lateral guidance commands relative to the FRT path. The discrete turn radius is defined by a 3-digit numeric field representing the radius to one decimal place (tenths, decimal point suppressed) in nautical miles. A blank entry in the database field indicates that no fixed radius transition is required.

2.2.1.4. Displays and System Alerting

Add the following second sentence to the paragraph and Note 2:

If the equipment incorporates an electronic map display to provide a graphical depiction of navigation information, it shall meet the requirements of RTCA/DO-257A *'Minimum Operational Performance Standards for the Depiction of Navigational Information on Electronic Maps'*.

Note 2: Manufacturers should use RTCA/DO-257A with RTCA/DO-283A, Appendix K until RTCA/DO-257B is published.

2.2.2.2.6.1 Descent Path Construction

Add the following requirement and notes to the list of general requirements:

6. The RNP equipment shall always use the procedure-defined flight path angle to define the final approach segment of an RNP instrument approach procedure offering vertical guidance (RNP procedures offering LNAV/VNAV minima).

Note 1: Some RNP instrument approach procedures define the final approach fix with an 'AT' altitude constraint ('hard altitude') and the intent of this requirement is to use the published FPA, the designated end of the runway (DER) and the threshold crossing height for vertical path construction. The equipment should not generate a geometric, point-to-point vertical path between two 'AT' constraints on a final approach segment.

Note 2: This requirement is not intended to prohibit the optional use of baro-VNAV temperature compensation as described in RTCA/DO-283B Appendix H.

2.4.3.1 Test Scenario(s)

Add the following leg types to the list in paragraph (a):

FM, VA, VI, VM, CA.

Appendix D

Add the following leg type definitions to Appendix D:

D.10 Fix to Manual Termination (FM)

An FM leg defines a specified track over the ground from a database fix until a manual termination of the leg.

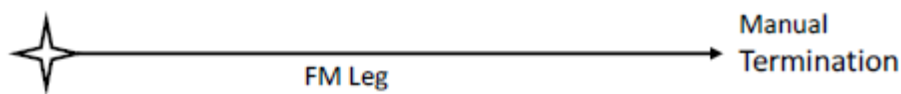


Figure D-6: Fix to Manual Termination (FM) Leg

D.11 Heading to Altitude (VA)

A VA leg defines a specified heading to a specific altitude termination at an unspecified position. No correction is made for wind.

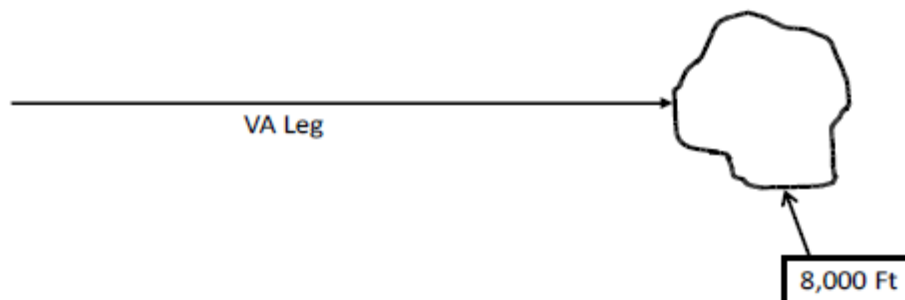


Figure D-7: Heading to Altitude (VA) Leg

D.12 Heading to Intercept (VI)

A VI leg defines a specified heading to intercept a subsequent leg at an unspecified position. No correction is made for wind.

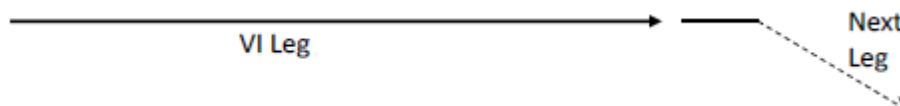


Figure D-8: Heading to Intercept (VI) Leg

D.13 Heading to Manual Termination (VM)

A VM leg defines a specified heading until a manual termination of the leg. No correction is made for wind.

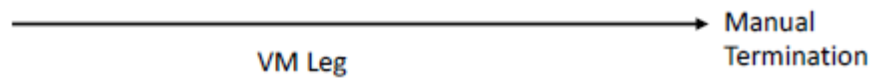


Figure D-9: Heading to Manual Termination (VM) Leg

D.14 Course to Altitude (CA)

A CA leg defines a specified course to a specific altitude at an unspecified position. The course is flown making adjustment for wind.



Figure D-10: Course to Altitude (CA) Leg

European Aviation Safety Agency

European Technical Standard Order

Subject: TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (TCAS) AIRBORNE EQUIPMENT, TCAS I.

1 - Applicability

This ETSO provides the requirements which active traffic alert and collision avoidance system airborne equipment that are designed and manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO Subpart A.

2.2 - Specific

None.

3 - Technical Conditions

3.1 - General

3.1.1 - Minimum Performance Standard

Standards set forth in Radio Technical Commission for Aeronautics (RTCA) Document DO-197A, Minimum Operational Performance Standards for An Active Traffic Alert and Collision Avoidance System I (Active TCAS 1) Section 2.1 and 2.2, dated September 12, 1994, as modified by Change 1 dated July 29, 1997.

Equipment test procedures set forth in Radio Technical Commission for Aeronautics (RTCA) Document DO-197A, Minimum Operational Performance Standards for An Active Traffic Alert and Collision Avoidance System I (Active TCAS 1) Section 2.4, dated September 12, 1994, as modified by Change 1 dated July 29, 1997.

3.1.2 - Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1

3.1.3 - Software

See CS-ETSO, Subpart A, paragraph 2.2

3.1.4 - Electronic Hardware

See CS-ETSO, Subpart A, paragraph 2.3.

3.2 - Specific

3.2.1 Failure Condition Classification

See CS-ETSO, Subpart A, paragraph 2.4.

Failure of the function defined in paragraph 3.1.1 is a major failure condition for malfunctions causing the display or annunciation of hazardously misleading information in airborne aircraft.

Loss of the function defined in paragraph 3.1.1 is a minor failure condition.

4 - Marking

4.1 - General

Marking is detailed in CS-ETSO, Subpart A, paragraph 1.2.

4.2 - Specific

None.

5 - Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

European Aviation Safety Agency

European Technical Standard Order

Subject: Cockpit Voice Recorder Systems

1 – Applicability

This ETSO provides the requirements that cockpit voice recorder (CVR) systems that are designed and manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO, Subpart A.

2.2 - Specific

None

3 - Technical Conditions

3.1 - Basic

3.1.1 - Minimum Performance Standard

Standards set forth in EUROCAE document ED-112A, MOPS for Crash Protected Airborne Recorder Systems, dated September 2013, that pertain to the CVR type, except Chapters I-1 and I-6, and Sections 2-1.1 , 2-1.5 , 2-1.6 , 2-1.11 , 2-1.12 , 2-3.1 , 2-5 , 3-1.1, 3-1.2, 3-1.3, 3-1.4, 3-1.5 , 3-1.7, Annex I-A, Annex I-C, and other ED-112A requirements related to installation, flight testing, aircraft maintenance

Table 1 lists CVR types and the ED-112A section and part containing the MPS for each type:

Table 1. CVR MPS Requirements

CVR Type	ED-112A Reference
Single function CVR	Section 2 and Part I
CVR function in a <u>deployable</u> recorder	Section 2, Section 3 and Part I
CVR function in a <u>combined</u> recorder	Section 2, Section 4, and Part I

Note: a CVR article may cover multiple types. A CVR may be a combined CVR and may also be deployable, in which case the applicable MOPS are Sections 2, 3, 4 and Part I, following the table above.

3.1.2 - Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1

3.1.3 - Software

See CS-ETSO, Subpart A, paragraph 2.2

3.1.4 - Airborne Electronic Hardware

See CS-ETSO, Subpart A, paragraph 2.3.

3.2 - Specific

3.2.1 - Failure Condition Classification

See CS-ETSO, Subpart A, paragraph 2.4.

Failure of the function defined in paragraph 3.1.1 of this ETSO is a minor failure condition.

Loss of the function defined in paragraph 3.1.1 of this ETSO is a minor failure condition.

The applicant must develop the system to at least the development assurance level commensurate with these failure conditions.

Note: The failure classification requirement is driven by the use of CVRs in accident investigations.

4 - Marking

4.1 - General

Marking is detailed in CS-ETSO, Subpart A, paragraph 1.2

4.2 - Specific

4.2.1 - Lettering identification

The equipment shall comply with the identification requirement in EUROCAE ED-112A, Section 2-1, paragraph 2-1.16.3.

5 - Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

European Aviation Safety Agency

European Technical Standard Order

Subject: Flight Data Recorder Systems

1 - Applicability

This ETSO provides the requirements that flight data recorder (FDR) systems that are designed and manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

2 - Procedures

2.1. - General

Applicable procedures are detailed in CS-ETSO Subpart A.

2.2 - Specific

None

3 - Technical Conditions

3.1 - Basic

3.1.1 - Minimum Performance Standard

Standards set forth in the applicable sections of EUROCAE document ED-112A, MOPS for Crash Protected Airborne Recorder Systems, dated September 2013, that pertain to the FDR type, except Chapters II-1 and II-6, and Sections 2-1.1 , 2-1.5 , 2-1.6, 2-1.11 , 2-1.12 , 2-3.1 , 2-5 , 3-1.1, 3-1.2, 3-1.3, 3-1.4, 3-1.5 , 3-1.7, Annex II-A, Annex II-B, and other ED-112A requirements related to aircraft-level equipment installation, test, and maintenance.

Table 1 lists FDR types and the ED-112A section and part containing the MPS for each type:

Table 1. Recorder MPS Requirements

Recorder Type	ED-112A Reference
Single function FDR	Section 2 and Part II
FDR function in a <u>deployable</u> recorder	Section 2, Section 3 and Part II
FDR function in a <u>combined</u> recorder	Section 2, Section 4, and Part II

Note: an FDR article may cover multiple types. An FDR may be a combined FDR and may also be deployable, in which case the applicable MOPS are Sections 2, 3, 4 and Part I, following the table above.

3.1.2 - Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1

3.1.3 - Software

See CS-ETSO, Subpart A, paragraph 2.2

3.1.4 Airborne Electronic Hardware

See CS-ETSO, Subpart A, paragraph 2.3

3.2 - Specific**3.2.1 Failure Condition Classification**

See CS-ETSO, Subpart A, paragraph 2.4.

Failure of the function defined in paragraph 3.1.1 of this ETSO is a minor failure condition.

Loss of the function defined in paragraph 3.1.1 of this ETSO is a minor failure condition.

The applicant must develop the system to at least the development assurance level commensurate with this failure condition.

Note: The failure classification requirement is driven by the use of FDRs in accident investigations.

4 - Marking**4.1 - General**

Marking is detailed in CS-ETSO, Subpart A, paragraph 1.2

4.2 - Specific**4.2.1 - Lettering Identification**

The equipment shall comply with the identification requirement in EUROCAE ED-112A, Section 2-1, paragraph 2-1.16.3.

5 - Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

European Aviation Safety Agency

European Technical Standard Order

Subject: AIRBORNE NAVIGATION SENSORS USING THE GLOBAL POSITIONING SYSTEM AUGMENTED BY THE SATELLITE BASED AUGMENTATION SYSTEM

1 - Applicability

This ETSO provides the requirements which airborne navigation sensors using the Global Positioning System (GPS) augmented by the Satellite-Based Augmentation System (SBAS) that are designed and manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

The standards of this ETSO apply to equipment intended to provide position information to a navigation management unit that outputs deviation commands referenced to a desired flight path. Pilots or autopilots will use these deviations to guide the aircraft.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO, Subpart A.

2.2 - Specific

None.

3 - Technical conditions

3.1 - Basic

3.1.1 - Minimum performance standard

Standards set forth for functional equipment Class Beta in RTCA document DO-229E, Minimum Operational Performance Standards for Global Positioning System/Satellite-Based Augmentation System Airborne Equipment, dated December 15, 2016, Section 2, as modified by Appendix 2 and 4 of this ETSO.

Class Beta equipment is defined in DO-229E, Section 1.4.

The standards in this ETSO apply to equipment intended to provide position, velocity, and time information for a navigation management unit application that outputs deviation commands keyed to a desired flight path, or a non-navigation application such as an automatic dependent surveillance-broadcast (ADS-B) or terrain awareness and warning system (TAWS). In navigation applications, pilots or autopilots will use the deviations output by the navigation management unit to guide the aircraft. In non-navigation applications, the position, velocity, and time outputs will provide the necessary inputs for the end-use equipment. These ETSO standards do not address integration issues with other avionics.

3.1.2 - Environmental standard

See CS-ETSO, Subpart A, paragraph 2.1.

The required performance under test conditions is defined in RTCA document DO-229E, Minimum

Operational Performance Standards for Global Positioning System/Satellite-Based Augmentation System Airborne Equipment, dated December 15, 2016, Section 2.4.

3.1.3 - Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 - Airborne electronic hardware

See CS-ETSO, Subpart A, paragraph 2.3.

3.2 - Specific

3.2.1 - Failure condition classification

See CS-ETSO, Subpart A, paragraph 2.4.

Failure of the function defined in paragraph 3.1.1 of this ETSO is a:

- *Major* failure condition for loss of function and malfunction of en route, terminal, approach lateral navigation (LNAV), and approach LNAV/vertical navigation (VNAV) position data,
- *Major* failure condition for loss of function of approach localiser performance without vertical guidance (LP), and approach localiser performance with vertical guidance (LPV) position data, and
- *Hazardous* failure condition for malfunction of approach (LP and LPV) position data resulting in misleading information.

3.2.2 - Additional Specific

If the equipment can satisfy the requirements of RTCA/DO-229E only when used with a particular antenna, the use of that antenna (by part number) shall be a requirement on the installation. This requirement shall be included in the installation manual (IM) as a limitation.

The applicant shall have all the data necessary to evaluate the geostationary (GEO) satellite bias as defined in RTCA/DO-229E, Section 2.1.4.1.5 available for review by EASA.

If the equipment uses barometric-aiding to enhance FDE availability, then the equipment shall meet the requirements in RTCA/DO-229E, Appendix G.

3.3. - Functional qualifications.

None.

4 - Marking

4.1 - General

Marking as detailed in CS-ETSO, Subpart A, paragraph 1.2.

4.2 - Specific

At least one major component must be permanently and legibly marked with the operational equipment class as defined in Section 1.4.2 of RTCA document DO-229E (e.g., Class 2). A marking of Class 4 indicates compliance to Delta-4 requirements. The functional equipment class defined in Section 1.4.1 of RTCA document DO-229E (e.g. Gamma, Delta) is not required to be marked. It is sufficient to declare the proper functional equipment class in the DDP (declaration of design and performance).

5 - Availability of referenced document

See CS-ETSO, Subpart A, paragraph 3.

APPENDIX 1

Reserved.

APPENDIX 2

ADDITION TO RTCA/DO-229E SECTION 1.

This Appendix adds a new Section 1.8.3, on cybersecurity and GPS spoofing mitigation to RTCA/DO-229E. The new section provides information for cybersecurity and spoofing mitigation to make RTCA/DO-229E consistent with the new RTCA MOPS template and RTCA/DO-253D, Minimum Operational Performance Standards for GPS Local Area Augmentation System Airborne Equipment.

1.8.3 Cybersecurity and Spoofing Mitigation.

This section contains information to address intentional interference with the GPS. Spoofing is caused by RF waveforms that mimic true signals in some ways, but deny, degrade, disrupt, or deceive a receiver's operation when they are processed. Spoofing may be unintentional, such as effects from the signals of a GPS repeater, or may be intentional and even malicious. There are two classes of spoofing:

- Measurement spoofing introduces RF waveforms that cause the target receiver to produce incorrect measurements of time of arrival or frequency of arrival or their rates of change;
- Data spoofing introduces incorrect digital data to the target receiver for its use in processing of signals and the calculation of PNT.

Either class of spoofing can cause a range of effects, from incorrect outputs of PNT to receiver malfunction. The onset of effects can be instantaneous or delayed, and the effects can continue even after the spoofing has ended. Improperly used or installed GNSS re-radiators act like spoofers. Re-radiators replay and GNSS emulator devices can present misleading information to GNSS equipment and/or could cause lasting effects.

Equipment manufacturers should implement measures to mitigate processing of erroneous data. Cross-checks of GNSS sensor data against independent position sources and/or other detection monitors using GNSS signal metrics or data checks can be implemented in the antenna, receiver, and/or through integration with other systems at the aircraft level. Data validity checks to recognize and reject measurement and data spoofing should be implemented in the receiver. Additional guidance and best practices related to GPS equipment can be found in the U.S. Department of Homeland Security document 'Improving the Operation and Development of Global Positioning System (GPS) Equipment Used by Critical Infrastructure'¹ and GLOBAL POSITIONING SYSTEMS DIRECTORATE SYSTEMS ENGINEERING & INTEGRATION: INTERFACE SPECIFICATION, IS-GPS-200, Navstar GPS Space Segment/Navigation User Interfaces, Revision H, IRN-IS-200H-003, 28 July 2016.

Aircraft equipment information vulnerabilities (such as cybersecurity risks) have been present for digital systems since the development of the personal computer (PC) in the late 70's and even longer for RF systems, and the advent of internet connectivity has substantially increased those risks. Typically, access to navigation receivers has been controlled such that they are considered vulnerable only through RF signals and OEM and/or aircraft operator controlled processes for maintenance and update. In some cases, aircraft GNSS receivers may be field-loadable by approved personnel, requiring physical access and physical interface to the ground receivers. However, it is expected that not all aircraft in the future will rely on such physical isolation for the security of avionics. Internet and Wi-Fi connectivity have become popular as a means for aircraft or equipment manufacturers to update installed avionics software, to update databases, or provide an alternate means of communicating with the flight crew or cabin (e.g., in-flight entertainment, weather, etc.).

In most countries, the State provides oversight of safety-of-flight systems (sometimes referred to as 'authorised services') which provide information to aircraft, such as ILS, VOR, GNSS, and DME, to name a few. However, the State typically does not provide oversight on 'non-trusted' connectivity such as the internet, Wi-

¹ [https://ics-cert.us-cert.gov/sites/default/files/documents/Improving_the_Operation_and_Development_of_Global_Positioning_System_\(GPS\)_Equipment_Used_by_Critical_Infrastructure_S508C.pdf](https://ics-cert.us-cert.gov/sites/default/files/documents/Improving_the_Operation_and_Development_of_Global_Positioning_System_(GPS)_Equipment_Used_by_Critical_Infrastructure_S508C.pdf).

Fi, or manufacturer-supplied equipment interfaces which permit input of externally-supplied data into aircraft systems. A manufacturer may expose aircraft information vulnerability through equipment design, or become vulnerable as a result of being connected to a common interface. Therefore, it is important that manufacturers consider aircraft information security risk mitigation strategies in their equipment design, particularly when the equipment is responsible for an interface between the aircraft and aircraft-external systems.

Apart from any specific aircraft-information-security-related performance requirements that are contained in the MOPS, it is recommended that manufacturers look at a layered approach to aircraft information security risk mitigation that includes both technical (e.g., software, signal filtering) and physical strategies. From a technical perspective, for example, this could include signal spoofing detection capabilities or more stringent, multi-factored authentication techniques such as passwords, PINs, and digital certificates. From a physical perspective, a manufacturer could consider connectors that require special tools to remove them to prevent passenger tampering; although navigation avionics are typically located in an avionics bay inaccessible to passengers. And finally, but just as important, manufacturers should consider supply chain risk management; for example, if a manufacturer is outsourcing software code development, are the contractor and its staff properly vetted?

Civil Aviation Authorities (CAAs) have a regulatory interest when an applicant's design makes use of a non-trusted connectivity where the installation can potentially introduce aircraft information security vulnerability. This requires the applicant to address not only the information security vulnerabilities and mitigation techniques for the new installation, but to also consider how vulnerability could propagate to existing downstream systems. Therefore, it is recommended that manufacturers reference their equipment aircraft information security review and mitigation strategies in the equipment's installation manual so that the applicant can consider them in meeting the installation regulatory requirements.

APPENDIX 3

Reserved.

APPENDIX 4

This Appendix prescribes EASA modifications to RTCA document DO-229E, Section 2.

In Section 2.1.1.2, after the first sentence add:

‘The demodulation of data from the GPS signals shall be restricted to the necessary subset of the data defined in Appendix II of IS-GPS-200D, “Navstar GPS Space Segment / Navigation User Interfaces”, December 2004, provided on RF link L1. The pseudo-ranging shall be performed on RF link L1 utilizing the coarse/acquisition (C/A) code.’

This is to ensure that only the L1 NAV data, for which the SBAS provides corrections and integrity, is used, and that no CNAV data, which is defined in Appendix III of IS-GPS-200D, is used, for which the SBAS does not provide integrity.

European Aviation Safety Agency

European Technical Standard Order

Subject: STAND-ALONE AIRBORNE NAVIGATION EQUIPMENT USING THE GLOBAL POSITIONING SYSTEM AUGMENTED BY THE SATELLITE BASED AUGMENTATION SYSTEM

1 - Applicability

This ETSO provides the requirements which stand-alone airborne navigation equipment using the Global Positioning System (GPS) augmented by the Satellite-Based Augmentation System that are designed and manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO, Subpart A.

2.2 - Specific

None.

3 - Technical Conditions

3.1 - Basic

3.1.1 - Minimum Performance Standard

Standards set forth for functional equipment Class Gamma or Delta in RTCA document DO-229E, Minimum Operational Performance Standards for Global Positioning System/Satellite-Based Augmentation System Airborne Equipment, dated December 15, 2016, Section 2, except as modified by Appendix 2 and 4 of this ETSO.

Classes Gamma and Delta of equipment are defined in DO-229E, Section 1.4.

The standards in this ETSO apply to equipment intended to accept a desired flight path and provide deviation commands keyed to that path. Pilots and autopilots will use these deviations to guide the aircraft. Except for automatic dependent surveillance with Class Gamma, these ETSO standards do not address integration issues with other avionics.

3.1.2 - Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1. The required performance under test conditions is defined in RTCA document DO-229E, Minimum Operational Performance Standards for Global Positioning System/Satellite-Based Augmentation System Airborne Equipment, dated December 15, 2016, Section 2.4.

3.1.3 - Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 - Airborne Electronic Hardware

See CS-ETSO, Subpart A, paragraph 2.3.

3.2 - Specific

3.2.1 - Failure Condition Classification

See CS-ETSO, Subpart A, paragraph 2.4.

Failure of the function defined in paragraph 3.1.1 of this ETSO is a:

- Major failure condition for loss of function and malfunction of en-route, terminal, approach lateral navigation (LNAV), and approach LNAV/vertical navigation (VNAV) position data,
- Major failure condition for loss of function of approach localiser performance without vertical guidance (LP), and approach localiser performance with vertical guidance (LPV) position data, and
- Hazardous failure condition for malfunction of approach (LP and LPV) position data resulting in misleading information.

3.2.2 - Additional Specific

If the equipment can satisfy the requirements of RTCA/DO-229E only when used with a particular antenna, the use of that antenna (by part number) shall be a requirement on the installation. This requirement shall be included in the installation manual (IM) as a limitation.

Applicants shall have all the data necessary to evaluate the geo stationary (GEO) satellite bias as defined in RTCA/DO-229E, Section 2.1.4.1.5 available for review by EASA.

If the equipment uses barometric-aiding to enhance FDE availability, then the equipment shall meet the requirements in RTCA/DO-229E, Appendix G.

3.3 - Functional Qualifications.

None

4 - Marking

4.1 - General

Marking as detailed in CS-ETSO, Subpart A, paragraph 1.2.

4.2 - Specific

At least one major component shall be permanently and legibly marked with the operational equipment class as defined in Section 1.4.2 of RTCA document DO-229E (e.g., Class 2). A marking of Class 4 indicates compliance with Delta-4 requirements. The functional equipment class defined in Section 1.4.1 of RTCA document DO-229E (e.g. Gamma, Delta) is not required to be marked.

It is sufficient to declare the proper functional equipment class in the DDP (declaration of design and performance).

5 - Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

APPENDIX 1

Reserved.

APPENDIX 2

MPS for stand-alone airborne navigation equipment using GPS augmented by SBAS

This Appendix describes required modifications and additions to RTCA/DO-229E for compliance with this ETSO. This Appendix adds a new Section 1.8.3 on cybersecurity and GPS spoofing mitigation and additional required leg types in Section 2.2.1.3 to RTCA/DO-229E.

The new Section, 1.8.3, contains no new requirements but provides information for cybersecurity and spoofing mitigation to make RTCA/DO-229E consistent with the new RTCA MOPS template and RTCA/DO-253D, Minimum Operational Performance Standards for GPS Local Area Augmentation System Airborne Equipment.

The new 2.2.1.3 leg type requirements are applicable to Class Gamma equipment only and are necessary to properly execute published instrument procedures designed to provide maximum efficiency, flexibility, and aircraft eligibility. These instrument procedure designs may include RNAV components and/or leg types associated with conventional procedures. The modifications and additions to Section 2.2.1.3 are necessary to ensure Class Gamma equipment can properly execute current and future instrument procedure designs.

1.8.3 Cybersecurity and Spoofing Mitigation.

This section contains information to address intentional interference with the GPS. Spoofing is caused by RF waveforms that mimic true signals in some ways, but deny, degrade, disrupt, or deceive a receiver's operation when they are processed. Spoofing may be unintentional, such as effects from the signals of a GPS repeater, or may be intentional and even malicious. There are two classes of spoofing. Measurement spoofing introduces RF waveforms that cause the target receiver to produce incorrect measurements of time of arrival or frequency of arrival or their rates of change. Data spoofing introduces incorrect digital data to the target receiver for its use in processing of signals and the calculation of PNT. Either class of spoofing can cause a range of effects, from incorrect outputs of PNT to receiver malfunction. The onset of effects can be instantaneous or delayed, and the effects can continue even after the spoofing has ended. Improperly used or installed GNSS re-radiators act like spoofers. Re-radiators, replay and GNSS emulator devices can present misleading information to GNSS equipment and/or could cause lasting effects.

Equipment manufacturers should implement measures to mitigate processing of erroneous data. Cross-checks of GNSS sensor data against independent position sources and/or other detection monitors using GNSS signal metrics or data checks can be implemented in the antenna, receiver, and/or through integration with other systems at the aircraft level. Data validity checks to recognize and reject measurement and data spoofing should be implemented in the receiver. Additional guidance and best practices related to GPS equipment can be found in the U.S. Department of Homeland Security document 'Improving the Operation and Development of Global Positioning System (GPS) Equipment Used by Critical Infrastructure'² and GLOBAL POSITIONING SYSTEMS DIRECTORATE SYSTEMS ENGINEERING & INTEGRATION: INTERFACE SPECIFICATION, IS-GPS-200, Navstar GPS Space Segment/Navigation User Interfaces, Revision H, IRN-IS-200H-003 28 July 2016.

Aircraft equipment information vulnerabilities (such as cybersecurity risks) have been present for digital systems since the development of the personal computer (PC) in the late 70's and even longer for RF systems, and the advent of internet connectivity has substantially increased those risks. Typically, access to navigation receivers has been controlled such that they are considered vulnerable only through RF signals and OEM and/or aircraft operator controlled processes for maintenance and update. In some cases, aircraft GNSS

² [https://ics-cert.us-cert.gov/sites/default/files/documents/Improving_the_Operation_and_Development_of_Global_Positioning_System_\(GPS\)_Equipment_Used_by_Critical_Infrastructure_S508C.pdf](https://ics-cert.us-cert.gov/sites/default/files/documents/Improving_the_Operation_and_Development_of_Global_Positioning_System_(GPS)_Equipment_Used_by_Critical_Infrastructure_S508C.pdf)

receivers may be field loadable by approved personnel, requiring physical access and physical interface to the ground receivers. However, it is expected that not all aircraft in the future will rely on such physical isolation for the security of avionics. Internet and Wi-Fi connectivity have become popular as a means for aircraft or equipment manufacturers to update installed avionics software, to update databases, or provide an alternate means of communicating with the flight crew or cabin (e.g., in-flight entertainment, weather, etc.).

In most countries, the State provides oversight of safety-of-flight systems (sometimes referred to as 'authorised services') which provide information to aircraft, such as ILS, VOR, GNSS, and DME, to name a few. However, the State typically does not provide oversight on 'non-trusted' connectivity such as the internet, Wi-Fi, or manufacturer-supplied equipment interfaces which permit input of externally-supplied data into aircraft systems. A manufacturer may expose aircraft information vulnerability through equipment design, or become vulnerable as a result of being connected to a common interface. Therefore, it is important that manufacturers consider aircraft information security risk mitigation strategies in their equipment design, particularly when the equipment is responsible for an interface between the aircraft and aircraft-external systems.

Apart from any specific aircraft-information-security-related performance requirements that are contained in the MOPS, it is recommended that manufacturers look at a layered approach to aircraft information security risk mitigation that includes both technical (e.g., software, signal filtering) and physical strategies. From a technical perspective, for example, this could include signal spoofing detection capabilities or more stringent, multi-factored authentication techniques such as passwords, PINs, and digital certificates. From a physical perspective, a manufacturer could consider connectors that require special tools to remove them to prevent passenger tampering; although navigation avionics are typically located in an avionics bay inaccessible to passengers. And finally, but just as important, manufacturers should consider supply chain risk management; for example, if a manufacturer is outsourcing software code development, is the contractor and its staff properly vetted?

Civil Aviation Authorities (CAAs) have a regulatory interest when an applicant's design makes use of a non-trusted connectivity where the installation can potentially introduce aircraft information security vulnerability. This requires the applicant to address not only the information security vulnerabilities and mitigation techniques for the new installation, but to also consider how vulnerability could propagate to existing downstream systems. Therefore, it is recommended that manufacturers reference their equipment aircraft information security review and mitigation strategies in the equipment's installation manual so that the applicant can consider them in meeting the installation regulatory requirements.

2.2.1.3 Path Definition

Replace the list of required leg types in the first paragraph after the last sentence as shown:

The desired path shall be defined according to the following leg types:

Leg Type	Description
IF	Initial Fix
CF	Course to Fix leg
DF	Direct to Fix leg
TF	Track to Fix leg
FA	Fix to Altitude leg
FM	Fix to Manual Termination
VA	Heading to Altitude leg
VI	Heading to Intercept
VM	Heading to Manual Termination
CA	Course to Altitude Leg

Holding legs

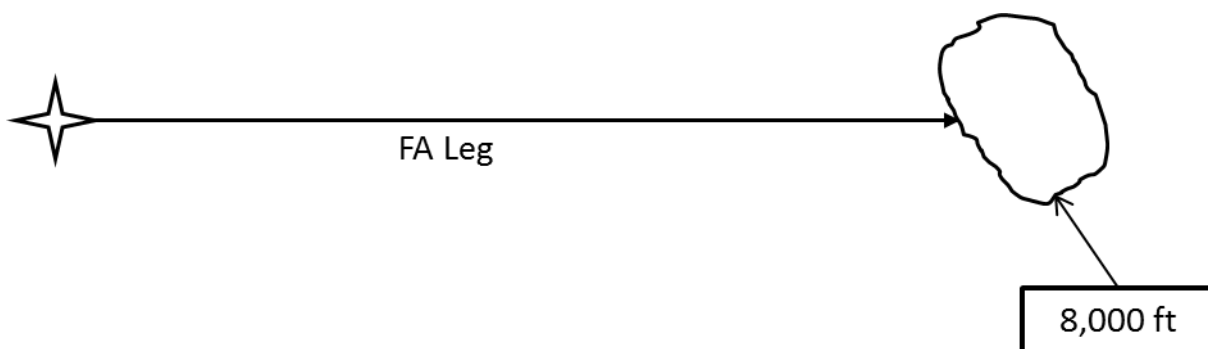
Leg Type	Description
HA	Terminates at an altitude
HF	Terminates at a fix after one orbit
HM	Manual termination

Note: There is no intent to require a heading or altitude source connected to the equipment to automatically execute leg types with heading or altitude components. Manual equipment inputs for heading/altitude with manual aircraft control methods are acceptable for these leg types.

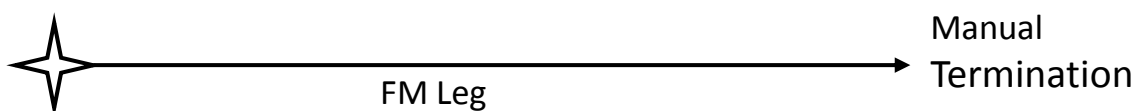
Replace Section 2.2.1.3.6 as shown and add the following leg type descriptions. Re-number existing paragraphs (starting with 2.2.1.3.7) to account for the newly added sections:

2.2.1.3.6 Fix to Altitude (FA).

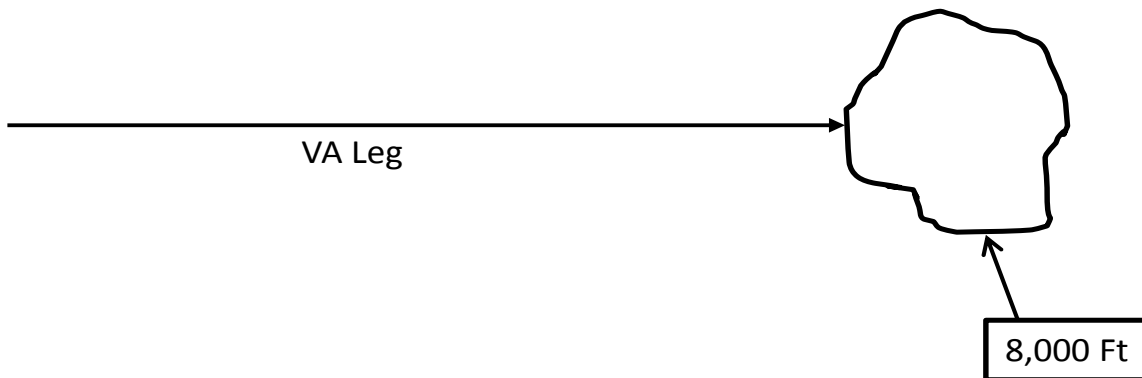
An FA leg shall be defined as a specified track over the ground from a database waypoint to a specified altitude at an unspecified position.

**2.2.1.3.7 Fix to Manual Termination (FM).**

An FM leg shall be defined as a specified track over the ground from a database fix until a manual termination of the leg.

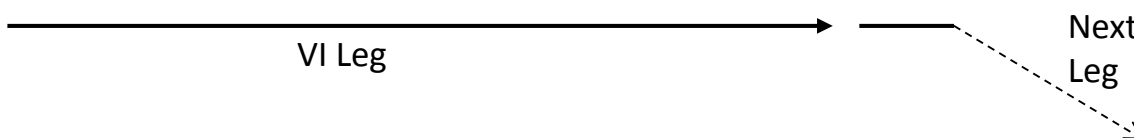
**2.2.1.3.8 Heading to Altitude (VA).**

A VA leg shall be defined as a specified heading to a specific altitude termination at an unspecified position. No correction is made for wind.



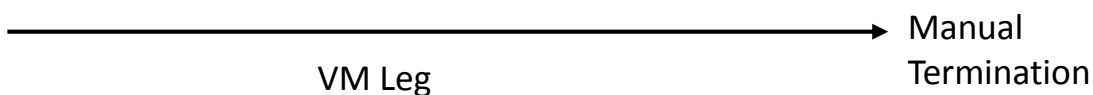
2.2.1.3.9 Heading to Intercept (VI).

A VI leg shall be defined as a specified heading to intercept a subsequent leg at an unspecified position. No correction is made for wind.



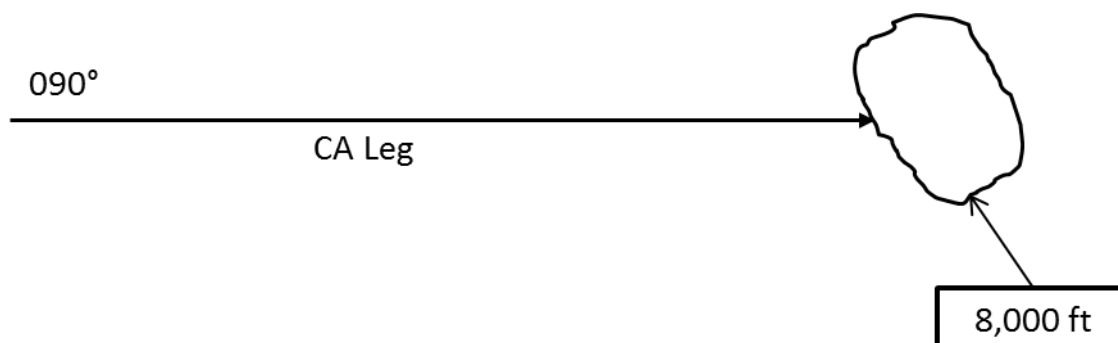
2.2.1.3.10 Heading to Manual Termination (VM).

A VM leg shall be defined as a specified heading until a manual termination of the leg. No correction is made for wind.



2.2.1.3.12 Course to Altitude (CA).

A CA leg shall be defined as a specified course to a specific altitude at an unspecified position. The course is flown making adjustment for wind.



2.2.1.3.13 Hold to Altitude (HA).

An HA leg is a holding pattern which terminates at the next crossing of the hold fix when the aircraft altitude is at or above the specified altitude. The altitude is provided by the navigation database. The source of the magnetic variation needed to convert magnetic courses to true courses is detailed in Section 2.2.1.3.12.

2.2.1.3.14 Hold to Fix (HF).

An HF leg is a holding pattern which terminates at the first crossing of the hold fix after becoming established on the inbound course. This is typically after the entry procedure is performed. The source of the magnetic variation needed to convert magnetic courses to true courses is detailed in Section 2.2.1.3.12.

2.2.1.3.14 Hold for Clearance (manual termination) (HM).

An HM leg is a holding pattern which terminates only after flight crew action. The source of the magnetic variation needed to convert magnetic courses to true courses is detailed in Section 2.2.1.3.12.

Table 2-14 through Table 2-20.

The tables incorrectly reference and label RTCA/DO-160 Sections 16.5.1.2 and 16.6.1.2 regarding '2.1.1.7 Acquisition Time' and '2.1.1.9 Reacquisition Time.' Change the table references as follows:

The MOPS Initial Acquisition Time requirement (2.1.1.7) applies to both AC and DC equipment under abnormal operating conditions (DO-160E Sections 16.5.2 and 16.6.2) and the Satellite Reacquisition Time requirement (2.1.1.9) applies to both AC and DC equipment under normal operating conditions (DO-160E Sections 16.5.1 and 16.6.1).

APPENDIX 3

Reserved.

APPENDIX 4

This Appendix prescribes EASA modifications to RTCA document DO-229E, Section 2.

At Section 2.1.1.2, after the first sentence add:

‘The demodulation of data from the GPS signals shall be restricted to the necessary subset of the data defined in Appendix II of IS-GPS-200D, “Navstar GPS Space Segment/Navigation User Interfaces”, December 2004 provided on RF link L1. The pseudo-ranging shall be performed on RF link L1 utilizing the coarse/acquisition (C/A) code.’

This is to ensure that only the L1 NAV data, for which the SBAS provides corrections and integrity, is used, and no CNAV data, which is defined in Appendix III of IS-GPS-200D, is used, for which the SBAS does not provide integrity.

European Aviation Safety Agency

European Technical Standard Order

Subject: Recorder Independent Power Supply

1 - Applicability

This ETSO provides the requirements which recorder independent power supplies (RIPs) that are designed and manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

ETSOs that may be used in conjunction with this ETSO are those covering:

- rechargeable lithium cells and lithium batteries;
- digital flight data recorders;
- cockpit voice recorders;
- data link recorders;
- cockpit image recorders.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO, Subpart A.

2.2 - Specific

None.

3 - Technical Conditions

3.1 - Basic

3.1.1 - Minimum Performance Standard

Standards set forth in Sections 5-2, 5-3, 5-4 and 5-5 of EUROCAE ED-112A, MOPS for Crash Protected Airborne Recorder Systems, dated September 2013, with the following changes:

- in paragraph 5-2.1.1:
 - ‘b. The intent of the RIPS is to allow for continued operation for 10 or more minutes applied in all cases when aircraft power to the recorder is removed.’
- in paragraph 5-2.2:
 - the following sentence ‘The RIPS shall detect and report any internal failures, if maintenance is required, and of any conditions affecting the ability of the RIPS to perform its intended function.’ shall be replaced by
 - ‘The RIPS shall detect and report internal failures, whether maintenance is required, and any conditions affecting the ability of the RIPS to perform its intended function.’
- in paragraph 5-3.2.1:

‘The backup time shall be at least 9 minutes and not exceed 30 minutes’.

Other ED-112A requirements related to installation, flight testing, and aircraft maintenance are excluded from this ETSO.

3.1.2 - Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1.

3.1.3 - Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 - Airborne Electronic Hardware

See CS-ETSO, Subpart A, paragraph 2.3.

3.2 - Specific

The applicant shall declare the rated performance of the equipment associated to the time of recording (Output power, rated capacity, as applicable ...).

If any battery is used in the RIPS, it must meet the requirements of the applicable ETSO related to the battery type or any other battery standards acceptable to EASA.

3.2.1 - Failure Condition Classification

See CS-ETSO, Subpart A, paragraph 2.4.

Failure of the function defined in paragraph 3.1.1 of this ETSO is a minor failure condition.

Loss of the function defined in paragraph 3.1.1 of this ETSO is a minor failure condition.

The applicant must develop the system to at least the development assurance level commensurate with these failure conditions.

Note: The failure classification is driven by the use of recorders in accident investigations.

4 - Marking

4.1 - General

Marking as detailed in CS-ETSO, Subpart A, paragraph 1.2.

4.2 - Specific

None.

5 - Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

European Aviation Safety Agency

European Technical Standard Order

Subject: Next Generation Satellite Systems (NGSS) Equipment

1 - Applicability

This ETSO provides the requirements which Next Generation Satellite Systems (NGSS) Equipment that are designed and manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO, Subpart A.

2.2 - Specific

None.

3 - Technical Conditions

3.1 - Basic

3.1.1 - Minimum Performance Standard

Standards set forth in the RTCA DO-262B, Minimum Operational Performance Standards for Avionics Supporting Next Generation Satellite Systems (NGSS), dated June 17, 2014; except that they are not required to meet any requirement of RTCA DO-326, Airworthiness Security Process Specification, in Normative Appendix D or E (as applicable) where referenced.

Note: There are no MPS security requirements for NGSS equipment. However, a security risk assessment may be required at the time of installation, and if needed, security controls may be implemented in connected aircraft systems or addressed by flight crew procedures.

3.1.2 - Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1.

3.1.3 - Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 - Airborne Electronic Hardware

See CS-ETSO, Subpart A, paragraph 2.3

3.2 - Specific

The MPS allows for different equipment classes and subclasses as defined by RTCA DO-262B. There are 6 applicable equipment classes and 13 equipment subclass components identified (see RTCA DO-262B, Appendix D and Appendix E). The manufacturer must declare the equipment class requirements from those identified in the applicable appendix. The equipment configuration shall satisfy the relevant requirements of the RTCA DO-262B minimum operational performance standards (MOPS) as identified in Tables 1 and 2 in Appendix 1 of this ETSO.

This ETSO standard applies to equipment intended for long-range communication services, aeronautical mobile satellite (route) services (AMS(R)S) by means of satellite communications between AES, corresponding satellites, and ground earth stations (GES). The NGSS supports data communications, or data and voice communications, between aircraft users and ground-based users, such as air navigation service providers (ANSP) and aircraft operators. Equipment class AES1 supports data communications only. All other equipment classes support both data and voice communications.

- (1) The functionality of an NGSS supports four categories of communication service. Two are in the safety of flight category: air traffic services (ATS) and aeronautical operational control (AOC). The other two are in the non-safety of flight category: aeronautical administrative communication (AAC) and aeronautical passenger communication (APC).
- (2) NGSS equipment is intended for procedural airspace area operations. The failure conditions specified in paragraph 3.2.1 of this ETSO have been determined based on NGSS equipment operating as an approved Long-Range Communication System (LRCS) in oceanic airspace area environments. Use of NGSS equipment in other operating environments (for example, high-density terminal/en route airspace) may impact equipment performance and safety considerations.

3.2.1 - Failure Condition Classification

See CS-ETSO, Subpart A, paragraph 2.4

Failure of the function defined in paragraph 3.b of this ETSO is a minor failure condition.

Loss of the function as defined in paragraph 3.b of this ETSO is a minor failure condition.

Note: The use of NGSS equipment for primary voice or data communications may necessitate the development of the NGSS equipment to a higher design assurance level than required for the failure criticality levels specified above and may drive a revision to this ETSO.

4 - Marking

4.1 - General

Marking as detailed in CS-ETSO, Subpart A, paragraph 1.2.

4.2 - Specific

The NGSS class and subclass markings shall include the complete equipment identifier reference (such as AES1, AES4, or AES7). An example subclass component (such as a high-gain antenna (HGA), Transceiver, or Diplexer/Low Noise Amplifier(DLNA)) marking would display AES6-2/HGA, Type A Transceiver AES7-7/7MA, or Type F Diplexer AES6-3/DF, etc. For valid combinations of system component markings, see table 3 in Appendix 1 to this ETSO.

5 - Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

European Aviation Safety Agency

European Technical Standard Order

Subject: EXTENDED SQUITTER AUTOMATIC DEPENDENT SURVEILLANCE-BROADCAST (ADS-B) AND TRAFFIC INFORMATION SERVICES-BROADCAST (TIS-B) EQUIPMENT OPERATING ON THE RADIO FREQUENCY OF 1090 MEGAHERTZ (MHz)

1 - Applicability

This ETSO provides the requirements which Extended Squitter Automatic Dependent Surveillance-Broadcast (ADS-B) and Traffic Information Services-Broadcast (TIS-B) Equipment Operating on the Radio Frequency of 1090 Megahertz (MHz) that are designed and manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO, Subpart A.

2.2 - Specific

None.

3 - Technical Conditions

3.1 - Basic

3.1.1 - Minimum Performance Standard

Standards set forth in the EUROCAE ED-102A, Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance-Broadcast (ADS-B) and Traffic Information Services-Broadcast (TIS-B), dated December 2009, section 2. EUROCAE ED-102A Corrigendum 1 dated January 2012 is also acceptable.

This ETSO supports two major classes of 1090 MHz ADS-B and TIS-B equipment:

- (a) Class A equipment, consisting of transmit and receive subsystems; and
- (b) Class B equipment, containing a transmit subsystem only.

Class A equipment includes Classes A0, A1, A1S, A2 and A3. This standard requires 1090 MHz airborne Class A equipment to include the capability of receiving both ADS-B and TIS-B messages and delivering both ADS-B and TIS-B reports, as well as transmitting ADS-B messages. A receive-only Class of equipment is allowed.

Class B equipment includes Classes B0, B1, and B1S. Classes B0, B1, and B1S are the same as A0, A1, and A1S, except they do not have receive subsystems. Note that Classes B2 and B3 are not for aircraft use.

3.1.2 - Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1. The required performance under test conditions is defined in EUROCAE ED-102A, section 2.4.

3.1.3 - Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 - Airborne Electronic Hardware

See CS-ETSO, Subpart A, paragraph 2.3.

3.2 - Specific

3.2.1 - Failure Condition Classification

See CS-ETSO, Subpart A, paragraph 2.4.

Failure of the function defined in paragraph 3.1.1 of this ETSO resulting in misleading information is a major failure condition.

Failure of the function defined in paragraph 3.1.1 of this ETSO resulting in loss of function is a minor failure condition at equipment level.

Note: The major failure condition for transmission of incorrect ADS-B messages is based on the use of the data by other aircraft or Air Traffic Control for separation services.

Note: COMMISSION IMPLEMENTING REGULATION (EU) No 1207/2011 of 22 November 2011 laying down requirements for the performance and the interoperability of surveillance for the single European sky requires that the probability of discontinuity of the transmit function defined in paragraph 3.1.1 of this ETSO at aircraft level shall be equal to or less than $2 \cdot 10^{-4}$ per flight hour.

4 - Marking

4.1 - General

Marking as detailed in CS-ETSO, Subpart A, paragraph 1.2.

4.2 - Specific

Transmitting and receiving components must be permanently and legibly marked.

The following table explains how to mark components.

EUROCAE ED-102A provides the equipment class in Section 2.1.11, and the receiving equipment type in Section 2.2.6.

<i>If the component can:</i>	<i>Mark it with the:</i>	<i>Sample marking pattern:</i>
Transmit and receive	Equipment class it supports, and Receiving equipment type	Class A0/Type 1
Transmit, but not receive	Equipment class it supports	Class B1, or Class A3-Transmitting only
Receive, but not transmit	Equipment class it supports, and Receiving equipment type	Class A2/Type 2-Receiving only

5 - Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3

European Aviation Safety Agency

European Technical Standard Order

SUBJECT: Aircraft Cockpit Image Recorder Systems

1 - Applicability

This ETSO provides the requirements that aircraft cockpit image recorder systems (CIR) that are designed and manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO, Subpart A.

2.2 - Specific

None

3 - Technical Conditions

3.1 - Basic

3.1.1 - Minimum Performance Standard

Standards set forth in the applicable sections of EUROCAE document ED-112A, MOPS for Crash Protected Airborne Recorder Systems, dated September 2013, that pertain to the cockpit image recorder (CIR) type, except chapters III-1 and III-6, and Sections 2-1.1, 2-1.5, 2-1.6, 2-1.11, 2-1.12, 2-3.1, 2-5, 3-1.1, 3-1.2, 3-1.3, 3-1.4, 3-1.5, 3-1.7, Annex III-A, Annex III-B, and other ED-112A requirements related to installation, flight testing, and aircraft maintenance.

The table below lists recorder types and the ED-112A section or part with the MPS for each:

Table 1. CIR MPS Requirements

CIR Type	ED-112A Reference
Single CIR	Section 2 and Part III
CIR function in a deployable recorder	Section 2, Section 3 and Part III
CIR function in a combined recorder	Section 2, Section 4 and Part III

Note : a CIR article may cover multiple types. A CIR may be a combined CIR and may also be deployable, in which case the applicable MOPS are in Sections 2, 3, 4 and Part I, following the table above.

3.1.2 - Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1

3.1.3 - Software

See CS-ETSO, Subpart A, paragraph 2.2

3.1.4 Airborne Electronic Hardware

See CS-ETSO, Subpart A, paragraph 2.3

3.2 - Specific

3.2.1 - Failure Condition Classification

See CS-ETSO, Subpart A, paragraph 2.4.

Failure of the function defined in paragraph 3.1.1 of this ETSO is a minor failure condition.

Loss of the function defined in paragraph 3.1.1 of this ETSO is a minor failure condition.

Note: The failure classification requirement is driven by the use of recorders in accident investigations.

4 - Marking

4.1 - General

Marking is detailed in CS-ETSO, Subpart A, paragraph 1.2.

4.2 - Specific

4.2.1 - Lettering Identification

The equipment shall comply with the identification requirement in EUROCAE ED-112A, Section 2-1, paragraph 2-1.16.3.

5 - Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

European Aviation Safety Agency

European Technical Standard Order

Subject: TRAFFIC AWARENESS BEACON SYSTEM (TABS)

1 - Applicability

This ETSO provides the requirements for the applicable equipment class defined by this ETSO which traffic awareness beacon systems (TABSs) that are designed and manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

TABS devices are distinctly different from other transponders. TABS devices are intended for voluntary equipage on aircraft exempted from carrying a transponder or automatic dependent surveillance-broadcast (ADS-B) equipment, such as gliders, balloons and aircraft without electrical systems. TABS devices do not meet the transponder or ADS-B requirements defined in Commission Implementing Regulation (EU) No 1207/2011 of 22 November 2011 laying down requirements for the performance and the interoperability of surveillance for the single European sky. TABS equipment built to the minimum requirements of this ETSO will enable an aircraft to be visible to other aircraft equipped with:

- a Traffic Advisory System (TAS) as defined in ETSO-C147();
- a Traffic Alert and Collision Avoidance System I (TCAS I) as defined in ETSO-C118();
- a Traffic Alert and Collision Avoidance System II, (TCAS II), as defined in ETSO-C119d;
- ADS-B IN capability as defined in ETSO-C154c, ETSO-C166b (), and ETSO-C195b.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO, Subpart A.

2.2 - Specific

None.

3 - Technical conditions

3.1 - Basic

3.1.1 - Minimum performance standard

TABS requirements are derived from existing transponder and ADS-B requirements. Equipment meeting only the minimum TABS requirements will provide the capability to be seen by other aircraft equipped with traffic advisory systems but may not support detection by ground surveillance systems relying on full transponder functionality. A designer building equipment to meet this ETSO may decide

to incorporate more capability than what is outlined in this ETSO as long as it meets the applicable requirements in the referenced standards (e.g., EUROCAE ED-73E, MOPS for Secondary Surveillance Radar Mode S Transponders, as amended by Appendix 1 to ETSO-C112e).

TABS functionality is divided into four categories: the transponder function, the altitude source function, the ADS-B OUT function, and the position source function.

A Class A TABS:

- includes the transponder, altitude source, and ADS-B OUT functionality; refer to Subparagraphs (1), (2), and (3) below;
- consists of a Class A device, or a TSO-C112e and TSO-C166b compliant device.

A Class B TABS:

- includes the Global Navigation Satellite System (GNSS) position source functionality; refer to Subparagraph (4) below;
- consists of a Class B device, or a ETSO-C129a (cancelled), ETSO-C145c or later revision, ETSO-C146c or later revision or ETSO-C196b-compliant GPS.

A TABS may include an ADS-B IN function but it is not required. If implemented, the ADS-B IN function shall meet the performance specified in ETSO-C195b as well as ETSO-C154c, or ETSO-C166b, or all three. A TABS is intended to make the aircraft a valid TIS-B and ADS-R client.

- (a) The transponder functionality must meet a subset of the requirements in document RTCA/DO-181E, MOPS for Air Traffic Control Radar Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment, dated March 17, 2011, section 2, for a Level 2, Class 2 transponder as modified by Appendix 1.
- (b) The altitude source functionality must meet the requirements of ETSO-C88a or later revision, Automatic Pressure Altitude Reporting Code Generating Equipment, dated August 5, 2016.
- (c) The ADS-B OUT function must meet a subset of the requirements found in document EUROCAE ED-102A, Minimum Operational Performance Standards for 1090 MHz Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services-Broadcast (TIS-B), dated December, 2009, including Corrigendum-1, section 2, dated January, 2012, Class B0 as modified by Appendix 1. The system must be built such that it transmits Navigation Integrity Code (NIC), Navigation Accuracy Category for Position (NACp), Navigation Accuracy Category for Velocity (NACv), Geometric Vertical Accuracy (GVA), and Safety Integrity Level (SIL) values appropriate for the GNSS receiver used.
- (d) The position source function must use a GNSS receiver that meets the requirements defined in Appendix 1. The intent of this ETSO is to allow the use of commercially available GNSS position sources. The receiver must be capable of using SBAS provided corrections and health messages, as defined in Appendix 1, in order to provide a means to prevent the TABS from transmitting false or misleading information. The receiver may continue to provide position when outside of SBAS coverage or when using unmonitored satellites. TABS Class B position sources may not be used for certified navigation equipment.

3.1.2 - Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1.

For Class A equipment, demonstrate the required performance under the test conditions specified in RTCA/DO-181E Section 2.3 and EUROCAE ED-102A, including Corrigendum-1, Section 2.3, dated January, 2012,

For Class B equipment, demonstrate the required performance under the test conditions specified in Appendix 3.

3.1.3 - Software

See CS-ETSO, Subpart A, paragraph 2.2.

This requirement applies to Class A equipment only. Class B equipment is exempt from software qualification defined in this paragraph.

3.1.4 - Airborne Electronic Hardware

See CS-ETSO, Subpart A, paragraph 2.3.

This requirement applies to Class A equipment only. Class B equipment is exempt from electronic hardware qualification defined in this paragraph.

3.2 - Specific

3.2.1 - Failure Condition Classification

See CS-ETSO, Subpart A, paragraph 2.4.

Failure of the function defined in paragraph 3.1.1 of this ETSO resulting in misleading information is a minor failure condition.

Failure of the function defined in paragraph 3.1.1 of this ETSO resulting in loss of function is a minor failure condition.

Class B equipment is intended to be met by commercially available GNSSs and is unlikely to be designed specifically to support a minor hazard classification. Class B equipment suitability for supporting the function in paragraph 3.1.1 of this ETSO is established by performing the functional and environmental testing in Appendix 2 and Appendix 3 of this ETSO with no further analysis required.

4 - Marking

4.1 - General

Marking as detailed in CS-ETSO, Subpart A, paragraph 1.2.

4.2 - Specific

None.

5 - Availability of Referenced Documents

See CS-ETSO, Subpart A, paragraph 3.

EUROCONTROL Documents: EUROCONTROL, STA/R/460/0001/1, Study to Address the Detection and Recognition of Light Aircraft in the Current and Future ATM Environment, Issue 1.0, Final Report, dated 31 March 2005.

EUROCONTROL Surveillance Document Library:

<https://www.eurocontrol.int/articles/surveillance-library>

FCC Documents: Federal Communication Commission document OET Bulletin 65 Ed 97-01, Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields is available on the internet at:

http://transition.fcc.gov/Bureaus/Engineering_Technology/Documents/bulletins/oet65/oet65.pdf

US Code of Federal Regulations (CFR) Documents: order copies of 14 CFR parts 21, 45 and 91 from the Superintendent of Documents, Government Printing Office, P.O. Box 979050, St. Louis, MO 63197. Telephone (202) 512-1800, fax (202) 512-2250. You can also download copies online at: <http://www.ecfr.gov/cgi-bin/text-idx?tpl=/ecfrbrowse/>

UK Public Health Documents Public Health England document HPA-RPD-031, Exposure to EMFs from Lightweight Aviation Transponders, dated September 2007, ISBN 978-0-85951-605-1, can be obtained on line by going to:

<http://www.hpa.org.uk/Publications/Radiation/HPARPDSeriesReports/HpaRpd031/>

Global Positioning System Signals, Measurements, and Performance, Ganga-Jamuna Press, by Pratap Misra and Per Enge. ISBN: 0-9709544-0-9

APPENDIX 1

Traffic Awareness Beacon System Requirements

A1 Introduction

A1.1 TABS Intent

A1.1.1 The intent of a TABS is to increase safety by encouraging the voluntary equipage of a low cost, compact, easy to install device that will allow other aircraft equipped with collision avoidance systems and traffic advisory systems to track and display the TABS aircraft. TABS are intended to be used on aircraft that are exempted from carrying a transponder or Automatic Dependent Surveillance - Broadcast (ADS-B) equipment, such as gliders, balloons and aircraft without electrical systems. TABS devices do not meet the transponder requirements defined in Commission Implementing Regulation (EU) No 1207/2011 of 22 November 2011 laying down requirements for the performance and the interoperability of surveillance for the single European sky. A TABS will allow these exempted aircraft to be visible to other aircraft equipped with:

- a Traffic Advisory System (TAS) as defined in ETSO-C147();
- a Traffic Alert and Collision Avoidance System I (TCAS I) as defined in ETSO-C118();
- a Traffic Alert and Collision Avoidance System II, (TCAS II), as defined in ETSO-C119d;
- ADS-B IN capability as defined in ETSO-C166b, and ETSO-C195b;
- ADS-B IN capability as defined in ETSO-C154c in airspace where UAT is used.

A1.1.2 A TABS is designed to:

- reply to ATCRBS Mode C, and Mode S UF=0, 4, 5, 20 and 21 interrogations;
- not reply to ATCRBS Mode A interrogations;
- not reply to Mode S UF=11, and 16 interrogations;
- incorporate ETSO-C88b, Automatic Pressure Altitude Reporting Code-Generating Equipment;
- transmit ADS-B Messages: Aircraft Identification and Category, Airborne Position, Airborne Velocity, Emergency Priority Status Message, and Aircraft Operational Status;
- optionally provide Surface Position Messages;
- optionally use a commercial GNSS source meeting the requirements of this ETSO.

A1.1.3 A TABS can potentially act as a low-cost platform for other aviation applications. Although additional capabilities are beyond the scope of this ETSO, TABS may include additional functions such as data loggers, search and rescue transmitter, or provide flight information services.

A1.2 Requirements

A1.2.1 TABS requirements are derived from existing Mode S transponder and 1090 MHz Extended Squitter ADS-B requirements. A designer building equipment to meet this ETSO may decide to incorporate the full transponder and ADS-B capability by using a device that meets ETSO-C112e and ETSO-C166b. If electing to implement full functionality, they must demonstrate that functionality against the unmodified test procedures EUROCAE ED-102A, including Corrigendum-1, dated January, 2012, required by ETSO-C112e and ETSO-C166b respectively. Designers that wish to take advantage of the reduced transponder requirements afforded to

ETSO-C199 Class A devices must meet the modified requirements outlined in paragraphs A1.2.3 Transponder Function Requirements, A1.2.4 Altitude Source Function Requirements, and A1.2.5 ADS-B OUT Function Requirements in this Appendix in their entirety. Designers wishing to take advantage of the Class B reduced GNSS requirements will need to meet the requirements outlined in paragraphs A1.2.6 GNSS Position Source Function Requirements.

A1.2.2 MOPS text is used here with the permission of the RTCA. Table 1 provides notes in italics and parenthesis explaining how to read the tables that modify the text in the source documents.

(Source document reference)	Modified text for this ETSO
(This is a copy of the original text from the source document. Material to be deleted from this original text is marked with strikethrough formatting .)	(This is the requirement for this ETSO. Modifications to the source text are marked in bold and underlined to assist in identifying changes).

Table 1 (Source document reference) (type of change)

A1.2.3 Transponder Function Requirements Derived From DO-181E (For Class A Devices)

A1.2.3.1 The transponder function must meet the Minimum Performance Standards (MPS) qualification and documentation requirements in RTCA, Inc. document RTCA/DO-181E, Section 2, for a Level 2, Class 2, transponder as modified below.

A1.2.3.1.1 Flight Crew Control Function Changes

A1.2.3.1.2 A cost factor in any device is the control and display functions to interface with the human operator. TABS display and control requirements are a subset of those required for transponders. Some user controls are allowed via an external device prior to flight (e.g., a personal electronic device (PED)). If the system is powered by batteries, display of available battery life is recommended. Table 2 provides an overview of flight crew control functions.

Operation mode	Required Controls	Required Indicators
In flight (i.e., control head)	- Power, - Emergency (3/A code 7700) - IDENT (optional)	Power on, Transponder Fail ADS-B Fail Battery indicator (optional)
Non flight (optional in flight) (i.e., Personal Electronic Device PED)	- Set 4096 code, - Set Flight ID	Display of 4096 code, Display of Flight ID
Maintenance actions (allowed in non-flight conditions only)	- Set ICAO 24 bit aircraft address, - Set implementation specific configuration	Display of ICAO 24 bit aircraft address, Display of implementation specific configuration. Display software version (optional)

Table 2 Summary of Control and Indication Requirements by Operation Mode

A1.2.3.1.3 RTCA/DO-181E, Section 2.1.7 a, Flight Crew Control Functions, is amended as shown in Table 3.

DO-181E text	Modified text for this ETSO
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<p>The following functions Shall be provided</p> <p>a. A means of selecting each of the ATCRBS 4096 reply codes, and of indicating the code selected.</p>	<p>The following functions SHALL be provided as indicated in items a-f.</p> <p>a. A means of selecting and displaying the ATCRBS 4096 code on the ground SHALL be provided. A means of selecting and displaying the ATCRBS 4096 code in flight is optional. A means of setting the Mode 3/A code to 7700 (emergency), either by entering in the value or an automated means such as a switch, SHALL be provided. A means of setting an alternate 4096 code other than the primary 4096 code, either by entering in the value or an automated means such as a switch, SHALL be provided.</p>
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Table 3 DO-181E Section 2.1.7 a amendment

A1.2.3.1.4 RTCA/DO-181E, Section 2.1.7 b, Flight Crew Control Functions, is amended as shown in Table 4.

DO-181E text	Modified text for this ETSO
<p>The following functions Shall be provided</p> <p>b. A means of selecting the air/ground state:</p> <p>1) An automatic means Shall be the only acceptable means to determine the air/ground state.</p> <p>2) If an automatic means is not available, the transponder Shall ensure that the air/ground state is Airborne</p>	<p>The following functions SHALL be provided as indicated in items a-f.</p> <p>b. A means of selecting the air/ground state:</p> <p>1) An automatic means to determine the air/ground state is recommended.</p> <p>2) If an automatic means is not implemented, the transponder SHALL ensure that the air/ground state is Airborne.</p>

Table 4 DO-181E Section 2.1.7 b amendment

A1.2.3.1.5 RTCA/DO-181E, Section 2.1.7 c, Flight Crew Control Functions, is amended as shown in Table 5.

DO-181E text	Modified text for this ETSO
<p>The following functions Shall be provided</p> <p>c. A means of selecting the condition in which all transponder functions, other than transmission on the reply frequency and associated self-testing, are operational (i.e., the Standby condition). Return to normal operation from this condition Shall be possible within five seconds.</p>	<p>The following functions SHALL be provided as indicated in items a-f.</p> <p>c. A means of selecting the condition in which all transponder functions, other than transmission on the reply frequency and associated self-testing, are operational (i.e., the Standby condition) is not required. However, if provided, return to normal operation from Standby condition SHALL be possible within five seconds.</p>

Table 5 DO-181E Section 2.1.7 c amendment

A1.2.3.1.6 RTCA/DO-181E, Section 2.1.7 d, Flight Crew Control Functions, is amended as shown in Table 6.

DO-181E text	Modified text for this ETSO
<p>The following functions Shall be provided</p> <p>d. A means of initiating the IDENT (SPI) feature.</p>	<p>The following functions SHALL be provided as indicated in items a-f.</p> <p>d. A means of initiating the IDENT (SPI) feature</p>

	<u>is optional.</u>
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Table 6 DO-181E Section 2.1.7 d amendment

A1.2.3.2 Reply Rate Capability Changes

A1.2.3.2.1 This section reduces the minimum reply rate capability of the TABS consistent with the interrogation acceptance based on two assumptions. The following rationale describes how the modified reply rates were chosen.

A1.2.3.2.1.1 Assumption 1. The worst case Mode C interrogation count in a 100-millisecond interval from one ATCRBS radar is approximately 14 interrogations. Four ATCRBS radar overlapping beam dwells in a second is approximately 53 Mode C interrogations. The Mode C interrogation acceptance rate from 10 TCAS I units is approximately 15 interrogations per second. This represents a total demand on the TABS of 68 Mode C replies per second for this example.

A1.2.3.2.1.2 Assumption 2. The worst case Mode S reply rate is primarily derived from the expected interrogation pattern of a set of 50 nearby TCAS II units all equipped with hybrid surveillance. The radar load from only roll-call interrogations would be small and would require networked sensors, otherwise the Mode S ground interrogation acceptance rate from radar systems would be zero.

A1.2.3.2.2 Based on assumptions 1 and 2, RTCA/DO-181E Section 2.2.3.4 Reply Rate Capability is changed as follows:

A1.2.3.2.2.1 RTCA/DO-181E, Section 2.2.3.4.1 a, ATCRBS Reply Rate Capability is amended as shown in Table 7.

DO-181E text	Modified text for this ETSO
The transponder Shall be able to continuously generate at least 500 ATCRBS 15-pulse replies per second.	The transponder Shall be able to continuously generate at least 100 ATCRBS 15-pulse replies per second.

Table 7 DO-181E Section 2.2.3.4.1 a amendment

A1.2.3.2.2.2 RTCA/DO-181E, Section 2.2.3.4.1 c, ATCRBS Reply Rate Capability is amended as shown in Table 8.

DO-181E text	Modified text for this ETSO
For Class 2 equipment, the transponder Shall be capable of a peak reply rate of 1000 ATCRBS 15-pulse replies per second for a duration of 100 milliseconds.	For Class 2 equipment, the transponder SHALL be capable of a peak reply rate of 150 ATCRBS 15-pulse replies per second for a duration of 100 milliseconds.

Table 8 DO-181E Section 2.2.3.4.1 c added

A1.2.3.2.2.3 RTCA/DO-181E, Section 2.2.3.4.2 a, Mode S Reply Rate Capability, is amended as shown in Table 9.

DO-181E text	Modified text for this ETSO
A transponder equipped for only short Mode S downlink formats (DF), Shall have the following minimum reply rate capabilities: 50 Mode S replies in any 1-second interval.	A transponder equipped for only short Mode S downlink formats (DF), SHALL have the following minimum reply rate capabilities: 29 Mode S replies in any 1-second interval.

18 Mode S replies in a 100-millisecond interval. 8 Mode S replies in a 25-millisecond interval. 4 Mode S replies in a 1.6-millisecond interval.	10 Mode S replies in a 100-millisecond interval. 5 Mode S replies in a 25-millisecond interval. 3 Mode S replies in a 1.6-millisecond interval.
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Table 9 DO-181E Section 2.2.3.4.2 a amendment

A1.2.3.2.2.4 RTCA/DO-181E, Section 2.2.3.4.2 b, Mode S Reply Rate Capability, is amended as shown in Table 10.

DO-181E text	Modified text for this ETSO
A transponder equipped for long Mode S reply formats Shall be able to transmit as long replies: At least 16 of the 50 Mode S replies in any 1-second interval. At least 6 of the 18 Mode S replies in a 100 millisecond interval. At least 4 of the 8 Mode S replies in a 25 millisecond interval. At least 2 of the 4 Mode S replies in a 1.6 millisecond interval.	A transponder equipped for long Mode S reply formats SHALL be able to transmit as long replies: At least 10 of the 29 Mode S replies in any 1-second interval. At least 4 of the 10 Mode S replies in a 100-millisecond interval. At least 3 of the 5 Mode S replies in a 25-millisecond interval. At least 2 of the 4 Mode S replies in a 1.6-millisecond interval.

Table 10 DO-181E Section 2.2.3.4.2 b amendment

A1.2.3.3 Reply Rate Limiting Changes

A1.2.3.3.1 The modifications in this section address reply rate limiting for ATRBS and Mode S reply rates consistent with the previous section.

A1.2.3.3.2 RTCA/DO-181E, Section 2.2.7.3.1, ATRBS Reply Rate Limiting is amended as shown in Table 11.

DO-181E text	Modified text for this ETSO
A sensitivity-reduction reply rate limit Shall be incorporated in the transponder for ATRBS replies. The limit Shall be capable of being adjusted between 500 continuous ATRBS Mode A and Mode C replies per second and the maximum continuous rate of which the transponder is capable, or 2000 replies per second, whichever is less, without regard to the number of pulses in each reply. Sensitivity reduction Shall apply only to the receipt of ATRBS, ATRBS/Mode S All-Call, and ATRBS-Only All-Call interrogations.	A sensitivity-reduction reply rate limit SHALL be incorporated in the transponder for ATRBS replies. The limit SHALL be capable of being adjusted between 100 continuous ATRBS Mode C replies per second and the maximum continuous rate of which the transponder is capable, or 200 replies per second, whichever is less, without regard to the number of pulses in each reply. Sensitivity reduction SHALL apply only to the receipt of ATRBS interrogations.

Table 11 DO-181E Section 2.2.7.3.1 amendment

A1.2.3.4 RTCA/DO-181E, Section 2.2.13.1.2 c, Variable Direct Data is amended as shown in Table 12.

DO-181E text	Modified text for this ETSO
<p>c. <u>On-the-Ground Condition</u> The transponder shall report the automatically determined on-the-ground state as determined by the aircraft in the Flight Status (FS), Vertical Status (VS), and Capability (CA) fields (see §2.2.14.4.15, §2.2.14.4.42, and §2.2.14.4.6), except when reporting airborne status when on-the-ground is reported to the transponder under the conditions specified in §2.2.18.2.7.</p>	<p>c. <u>On-the-Ground Condition</u> The transponder may report the automatically determined on-the-ground state as determined by the aircraft in the Flight Status (FS), Vertical Status (VS), and Capability (CA) fields (see paragraphs 2.2.14.4.15, 2.2.14.4.42, and 2.2.14.4.6), except when reporting airborne status when on-the-ground is reported to the transponder under the conditions specified in paragraph 2.2.18.2.7.</p>

Table 12 DO-181E Section 2.2.13.1.2 c amendment

A1.2.3.5 RTCA/DO-181E, Section 2.2.13.1.2 d, Variable Direct Data, is amended as shown in Table 13.

DO-181E text	Modified text for this ETSO
<p>d. Special Position Identification (SPI) In the ATCRBS mode, an SPI pulse shall be transmitted upon request, following a Mode A reply. In the FS field of Mode S replies, an equivalent of the ATCRBS SPI pulse shall be transmitted upon the same request. The code is transmitted for 18 ±1.0 seconds after initiation and can be reinitiated at any time.</p>	<p>d. Special Position Identification (SPI) In the FS field of Mode S replies, an equivalent of the ATCRBS SPI pulse shall be transmitted upon <u>request if the optional IDENT flight crew control is implemented per A1.2.3.1.6 of this ETSO.</u> The code is transmitted for 18 ± 1.0 seconds after initiation and can be reinitiated at any time.</p>

Table 13 DO-181E Section 2.2.13.1.2 c amendment

A1.2.3.6 RTCA/DO-181E, Section 2.2.13.1.2 e, Variable Direct Data, is amended as shown in Table 14.

DO-181E text	Modified text for this ETSO
<p>e. Aircraft Identification Data If the aircraft uses a flight number for aircraft identification, a means shall be provided for the variable aircraft identification to be inserted by the pilot while on the ground, or during flight. The means for modifying and displaying aircraft identification shall be a simple crew action independent of the entry of other flight data.</p>	<p>e. Aircraft Identification Data If the aircraft uses a flight number for aircraft identification, a means SHALL be provided for the variable aircraft identification to be inserted by the pilot while on the ground. <u>A means may be provided for modifying aircraft identification in flight.</u></p>

Table 14 DO-181E Section 2.2.13.1.2 e amendment

A1.2.3.7 Interrogation Acceptance Protocol Changes (All-Call reply capability)

A1.2.3.7.1 The transponder All-Call interrogation reply acceptance requirements are reduced to reply only to ATCRBS Mode C (P1-P3) interrogations. The purpose is to reduce the reply rate of TABS while maintaining TCAS and TAS interoperability. The requirements of this ETSO are identical to RTCA/DO-181E except for the changes shown below.

A1.2.3.7.2 RTCA/DO-181E, Section 2.2.18.2.2 b, Interrogation Acceptance Protocol (Figure 2-12), is amended as shown in Table 15.

DO-181E text	Modified text for this ETSO
All-Call Address – If the address extracted from the received interrogation consists of 24 ONEs and UF=11, the transmission is a Mode S-Only All-Call and the received interrogation Shall be accepted according to “i” below unless the lockout protocol is in effect. Mode S-Only All-Call Shall not be accepted (no replies) when in the on-the-ground state (consistent with the CA, VS and FS fields)	All-Call Address – If the address extracted from the received interrogation consists of 24 ONEs and UF=11, the transmission is a Mode S-Only All-Call and the received interrogation SHALL not be accepted.

Table 15 DO-181E Section 2.2.18.2.2 b amendment

A1.2.3.7.3 RTCA/DO-181E, Section 2.2.18.2.2 c, Interrogation Acceptance Protocol (Figure 2-12), is amended as shown in Table 16.

DO-181E text	Modified text for this ETSO
ATCRBS/Mode S All-Call – An ATCRBS/Mode S All-Call interrogation (1.6 microseconds P4) Shall be accepted unless the TD timer is running or side lobe suppression is in effect or when in the “on-the-ground” state (consistent with the CA, VS and FS fields).	ATCRBS/Mode S All-Call – An ATCRBS/Mode S All-Call interrogation (1.6 microseconds P4) SHALL not be accepted.

Table 16 DO-181E Section 2.2.18.2.2 c amendment

A1.2.3.8 RTCA/DO-181E, Section 2.2.18.2.2 g, Interrogation Acceptance Protocol, paragraph g, All-Call Lockout Conditions, is amended as shown in Table 17.

DO-181E text	Modified text for this ETSO
All-Call Lockout Conditions – On receipt of a Mode S-Only All-Call (UF=11) containing an Interrogator Code (IC and CL fields) corresponding to the designator of a running TL timer, the interrogation Shall not be accepted. unless the contained PR code is 8 through 12 and the “on-the-ground” report (CA, VS or FS field) does not include the ground condition. Upon receipt of a Mode S-Only All-Call (UF=11) containing II=0, the interrogation Shall be accepted if the TD timer is not running or if the received PR code is 8 through 12 and the “on-the-ground” report (CA, VS or FS field) does not include the ground condition.	All-Call Lockout Conditions – On receipt of a Mode S-Only All-Call (UF=11) the interrogation SHALL not be accepted.

Table 17 DO-181E Section 2.2.18.2.2 g amendment

A1.2.3.9 RTCA/DO-181E, Section 2.2.18.2.2 i, Interrogation Acceptance Protocol Stochastic All-Calls, should not be implemented in Class A TABS.

A1.2.3.10 Two new sections are added here to explicitly define interrogation acceptance criteria for TABS.

A1.2.3.10.1 RTCA/DO-181E, Section 2.2.18.2.2 L, Interrogation Acceptance Protocol (Figure 2-12), is added as shown in Table 18.

DO-181E text	Modified text for this ETSO
None	<u>ATCRBS Mode A Rejection</u> – ATCRBS Mode A interrogations (P1-P3 spacing 8 microseconds) SHALL not be accepted. Recovery from a Mode A interrogation shall adhere to the requirements of Section 2.2.7.2 defined for recovery from a desensitizing pulse.

Table 18 DO-181E Section 2.2.18.2.2 L addition

A1.2.3.10.2 RTCA/DO-181E, Section 2.2.18.2.2 m, Interrogation Acceptance Protocol (Figure 2-12), is added to as shown in Table 19. This change reduces the range at which addressed Mode S ground interrogations would be replied to. The intent is to reduce the reply rate of the TABS. Sensitivity to TCAS interrogations are not affected.

DO-181E text	Modified text for this ETSO
None	<u>Ground-to-Air Mode S Acceptance</u> – Mode S interrogations, excluding UF=0 SHALL be accepted at the Mode S MTL (paragraph 2.2.2.4 b) +3dB ± 1dB.

Table 19 DO-181E Section 2.2.18.2.2 m addition

A1.2.3.11 RTCA/DO-181E, Section 2.2.18.2.3, Interrogation Reply Coordination, is amended as shown in Table 20.

DO-181E text		Modified text for this ETSO	
The transponder SHALL generate replies as follows, except when in the on-the-ground state:		The transponder SHALL generate replies as follows, except when in the on-the-ground state:	
Interrogations	Replies	Interrogations	Replies
ATCRBS Mode A	4096 Codes	ATCRBS Mode A	<u>SHALL not reply</u>
ATCRBS Mode C	Altitude Codes	ATCRBS Mode C	Altitude Codes
ATCRBS Mode A/Mode S All-Call	Reply is DF=11	ATCRBS Mode A/Mode S All-Call	<u>SHALL not</u> Reply
ATCRBS Mode C/Mode S All-Call	Reply is DF=11	ATCRBS Mode C/Mode S All-Call	<u>SHALL not</u> Reply
Mode S-only All-Call (UF=11)	Reply is DF=11	Mode S-only All-Call (UF=11)	<u>SHALL not</u> Reply

Table 20 DO-181E Section 2.2.18.2.3 amendment

A1.2.3.12 RTCA/DO-181E, Section 2.2.18.2.4, Lockout Protocol, should not be implemented in Class A TABS.

A1.2.3.13 RTCA/DO-181E, Section 2.2.18.2.5, Multisite Lockout Protocol, should not be implemented in Class A TABS.

A1.2.3.14 RTCA/DO-181E, Section 2.2.18.2.7, Flight Status and Vertical Status Protocols are amended as shown in Table 21.

DO-181E text	Modified text for this ETSO
<p>Mode S-equipped aircraft Shall report details of their flight status. The source of and the rules for such reports are as follows:</p> <p>a. Alert – The transponder Shall transmit the 4096 identification code in ATCRBS Mode A replies and in the ID field of downlink format DF=5. This code can be changed by the pilot, and when a change is made an alert condition Shall be established. If the identification code is changed to 7500, 7600 or 7700, the alert condition Shall be permanent. If the identification code is changed to any other value, the alert condition Shall be temporary and self-canceling after 18 ± 1 seconds (TC timer). The TC timer Shall be retriggered and continued for 18 ± 1 seconds after any change has been accepted by the transponder function. The alert condition Shall be reported in the FS field. The permanent alert condition Shall be terminated and replaced by a temporary alert condition when the identification code is set to a value other than 7500, 7600 or 7700.</p>	<p>Mode S-equipped aircraft SHALL report details of their flight status. The source of and the rules for such reports are as follows:</p> <p>a. Alert – The transponder SHALL transmit the 4096 identification code in the ID field of downlink format DF=5. When a change is made an alert condition SHALL be established. If the identification code is changed to 7500, 7600 or 7700, the alert condition SHALL be permanent. If the identification code is changed to any other value, the alert condition SHALL be temporary and self-cancelling after 18 ± 1 seconds (TC timer). The TC timer SHALL be retriggered and continued for 18 ± 1 seconds after any change has been accepted by the transponder function. The alert condition SHALL be reported in the FS field. The permanent alert condition SHALL be terminated and replaced by a temporary alert condition when the identification code is set to a value other than 7500, 7600 or 7700.</p>

Table 21 DO-181E Section 2.2.18.2.7 amendment

A1.2.3.15 RTCA/DO-181E, Section 2.2.18.2.9, All-Call Reply Protocol, should not be implemented in Class A TABS.

A1.2.3.16 RTCA/DO-181E, Section 2.2.19.1, Minimum Level 2 Transponder Requirements, is amended as shown in Table 22.

DO-181E text	Modified text for this ETSO
<p>The operational functions described in §1.4.3.2 require that this transponder Shall, in addition to the functions of the Level 1 transponder:</p> <p>a. Process uplink and downlink formats DF=16, UF=DF=20 and 21 (Figure 2-14). The format UF=16 is optional.</p> <p>Note: UF=16 is supported by transponders connected to an on-board operational TCAS (see §2.2.22).</p> <p>b. Receive broadcast transmissions from sensors (§2.2.19.1.11).</p> <p>c. Follow the protocols for: Comm-A (see §2.2.19.1.10). Comm-B (see §2.2.19.1.12). Comm U/V (air-air) (see §2.2.19.1.16).</p>	<p>The operational functions described in paragraph 1.4.3.2 require that this transponder SHALL, in addition to the functions of the Level 1 transponder:</p> <p>a. Process uplink and downlink formats DF=16, UF=DF=20 and 21 (Figure 2-14). The format UF=16 <u>SHALL not be accepted. TABS SHALL not be installed with an on-board TCAS system.</u></p> <p>b. <u>Requirement Deleted.</u></p> <p>c. Follow the protocols for: Comm-B (see paragraph 2.2.19.1.12.1 through 2.2.19.1.12.3). Report Codes 4 through 7 in the CA field (see paragraph 2.2.14.4.6).</p>

Multisite message operation (see §2.2.19.2). Report Codes 4 through 7 in the CA field (see §2.2.14.4.6). TCAS crosslink capability (see §2.2.19.1.18).	TCAS crosslink capability (see paragraph 2.2.19.1.18).
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Table 22 DO-181E Section 2.2.19.1 amendment

A1.2.3.17 RTCA/DO-181E, Section 2.2.19.1.3, Information Transfer, should not be implemented in Class A TABS.

A1.2.3.18 RTCA/DO-181E, Section 2.2.19.1.4, Interrogation-Reply Coordination, is amended per Table 23. Equipment using Minimum Level 2 Transponder Requirements, SHALL follow the text in DO-181E as written.

DO-181E text		Modified text for this ETSO	
The transponder SHALL generate replies to interrogations as follows:		The transponder SHALL generate replies to interrogations as follows:	
Interrogation	Reply	Interrogation	Reply
ATCRBS Mode A (see Note)	4096 code	ATCRBS Mode A (see Note)	SHALL not reply
ATCRBS Mode C (see Note)	Altitude Code	ATCRBS Mode C (see Note)	Altitude Code
ATCRBS/Mode S All-Calls (see Note)	DF=11	ATCRBS/Mode S All-Calls (see Note)	SHALL not reply
UF=4 and UF=5	as below	UF=4 and UF=5	as below
UF=11 (see Note)	DF=11	UF=11 (see Note)	SHALL not reply
UF=20 and UF=21	as below	UF=20 and UF=21	as below
Broadcast	None	Broadcast	None

Table 23 DO-181E Section 2.2.19.1.4 amendment

A1.2.3.19 The Lockout Protocol described in RTCA/DO-181E, Section 2.2.19.1.5, should not be implemented in Class A TABS.

A1.2.3.20 The UM Protocol described in RTCA/DO-181E, Section 2.2.19.1.9, should not be implemented in Class A TABS.

A1.2.3.21 The Comm-A Protocol described in RTCA/DO-181E, Section 2.2.19.1.10, should not be implemented in Class A TABS.

A1.2.3.22 The Broadcast Protocol described in RTCA/DO-181E, Section 2.2.19.1.11, should not be implemented in Class A TABS.

A1.2.3.23 The Air-Initiated Comm-B Protocol described in RTCA/DO-181E, Section 2.2.19.1.12.4, should not be implemented in Class A TABS.

A1.2.3.24 The Comm-B Broadcast Protocol described in RTCA/DO-181E, Section 2.2.19.1.12.5, should not be implemented in Class A TABS.

A1.2.3.25 The Updating the Data Link Capability Report described in RTCA/DO-181E, Section 2.2.19.1.12.6.3 should not be implemented in Class A TABS.

A1.2.3.26 The Change of Aircraft Identification described in RTCA/DO-181E, Section 2.2.19.1.13.e, should not be implemented in Class A TABS.

A1.2.3.27 Linked Comm-A Coding described in RTCA/DO-181E, Section 2.2.19.1.14, should not be implemented in Class A TABS.

A1.2.3.28 The Comm-U/V Protocol described in RTCA/DO-181E, Section 2.2.19.1.16, should not be implemented in Class A TABS.

A1.2.3.29 The Data Handling Interfaces described in RTCA/DO-181E, Section 2.2.19.1.17, should not be implemented in Class A TABS.

A1.2.3.30 The Multisite Message Protocol described in RTCA/DO-181E, Section 2.2.19.2, should not be implemented in Class A TABS.

A1.2.3.31 Surveillance Identifier (SI) requirements contained in RTCA/DO-181E, Section 2.2.24.2, should not be implemented in Class A TABS.

A1.2.3.32 The Elementary Surveillance (ELS) Compliant Transponder requirements in RTCA/DO181E, Section 2.2.24, do not apply to TABS equipment. TABS SHALL not claim ELS compliance. Changes made to ELS registers do not need to be indicated via a Comm-B broadcast. If one or more of the ELS registers are supported, then Section 2.2.24 requirements SHALL apply except Sections 2.2.24 b 4, 2.2.24 c, 2.2.24.2, 2.2.24.3.2.5, and 2.2.24.3.4, which do not apply.

A1.2.3.33 The Enhanced Surveillance (EHS) Compliant Transponders requirements in RTCA/DO-181E, Section 2.2.25, do not apply to TABS. TABS equipment SHALL not claim EHS compliance. Changes made to EHS registers do not need to be indicated via a Comm-B broadcast. If one or more of the EHS registers are supported, then Section 2.2.25 requirements SHALL apply except Sections 2.2.25.1.2.4 and 2.2.25.2.3, which do not apply. Also, Section 2.2.25, paragraph 6 'Transponder capable of supporting EHS...', must support ELS per A1.2.3.32 of this ETSO.

A1.2.4 Altitude Source Function Requirements (For Class A Devices)

A1.2.4.1 The altitude source function shall meet the performance requirements of ETSO-C88b, Automatic Pressure Altitude Reporting Code-Generating Equipment, dated August 5, 2016. It is recommended that the altitude source provide 25 ft or better resolution.

A1.2.5 ADS-B OUT Function Requirements Derived From EUROCAE ED-102A, including Corrigendum-1, (For Class A Devices)

A1.2.5.1 The ADS-B OUT function must be 1090 Extended Squitter (ES) OUT, to support TCAS surveillance. The 1090ES OUT function must meet the Minimum Performance Standards (MPS) qualification and documentation requirements in EUROCAE ED-102A, MOPS for 1090 MHz Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B), dated December, 2009, including Corrigendum-1, Section 2, dated January, 2012, for a Class B0 ADS-B OUT transmitter with the following modifications.

A1.2.5.2 EUROCAE ED-102A, including Corrigendum-1, Section 2, dated January, 2012, Paragraph 2.2.2.1 c, Mode S Transponder Based Transmitters, is amended as shown in Table 24.

ED-102A text	Modified text for this ETSO
If the ADS-B transmitter is based on Mode S transponders, then for transponder functions it Shall comply with RTCA/DO-181D (EUROCAE ED-73C) for each class of transponder specified in the latest version of FAA TSO C112 (ETSO 2C112)	If the ADS B transmitter is based on Mode S transponders, then for The transponder functions SHALL comply with RTCA/DO-181E (EUROCAE ED-73E) for each class of transponder specified in the latest version of ETSO-C112 (FAA TSO C112), except where modified by Appendix 1 of this ETSO.

Table 24 ED-102A Section 2.2.2.1 c amendment

A1.2.5.3 The output power SHALL be as specified in EUROCAE ED-102A, including Corrigendum-1, dated January, 2012, Section 2.2.2.2.10.1.a., for Class A0 and B0 equipment. The RF Peak Output power SHALL be at least 18.5 dBW (70 watts).

A1.2.5.4 Broadcast of the ADS-B Surface Position Messages defined in EUROCAE ED-102A including Corrigendum-1, Section 2.2.3.2.4 is optional.

A1.2.5.5 EUROCAE ED-102A including Corrigendum-1, Section 2.2.3.2.7.2, Aircraft Operational Status Messages, is amended as shown in Table 25.

ED-102A text	Modified text for this ETSO
<p>The 'Aircraft Operational Status Message' is used to provide the current status of the aircraft. The format of the Aircraft Operational Status Message shall be as specified in Figure 2-11, while further definition of each of the subfields is provided in the subsequent paragraphs.</p>	<p>The 'Aircraft Operational Status Message' is used to provide the current status of the aircraft. The format of the Aircraft Operational Status Message shall be as specified in Figure 2-11, while further definition of each of the subfields is provided in the subsequent paragraphs. <u>Broadcast of Aircraft Operational Status Message subtype=1, Surface Messages, is optional.</u></p>

Table 25 Aircraft Operational Status Message

A1.2.5.6 When TABS is installed with a position source meeting the Class B requirements of this ETSO and transmitting a valid position, the transmitted NIC SHALL be set to 6 (0.5 NM), reference EUROCAE ED-102A including Corrigendum-1, dated January, 2012, Section 2.2.8.1.6. The transmitted SIL SHALL be set to 1, (1x1E-3/ hr), reference EUROCAE ED-102A including Corrigendum-1, dated January, 2012, Section 2.2.5.1.40. When TABS is installed with a position source compliant with ETSO-C145, ETSO-C146 or ETSO-C196, NIC and SIL SHALL be set in accordance with EUROCAE ED-102A including Corrigendum-1, dated January, 2012. When the position is not valid, NIC and SIL SHALL be set to zero.

A1.2.5.7 The System Design Assurance (SDA), SHALL be set to 1, reference EUROCAE ED-102A, including Corrigendum-1, dated January, 2012, Section 2.2.5.1.50. The probability of an undetected fault causing transmission of false or misleading information SHALL be less than or equal to 1E-3.

A1.2.5.8 Navigation Accuracy Category for Position, (NACp) SHALL be derived from the Horizontal Figure of Merit (HFOM) in accordance with EUROCAE ED-102A, including Corrigendum-1, dated January, 2012, Section A.1.4.9.9, however, TABS Class B position sources may not provide HFOM directly. When HFOM is not available directly, HFOM SHALL be derived from Horizontal Dilution of Precision (HDOP) according to the following formula: $HFOM = 2 * HDOP * User\ Equivalent\ Range\ Error\ (UERE)$, where the UERE is 6 metres. This UERE is based on typical single frequency (L1) receiver performance and an assumption of mid-latitude atmospheric propagation. Although the real-time UERE may fluctuate, this assumption is sufficient to support the TABS use case. (Ref Global Positioning System Signals, Measurements and Performance, by Pratap Misra and Per Enge, copyright 2001).

A1.2.5.9 When a TABS is installed with a position source meeting the Class B requirements of this ETSO and transmitting a valid position, the transmitted Navigation Accuracy Category for Velocity, (NACv) SHALL be set to 1 (10 m/s), reference EUROCAE ED-102A including Corrigendum-1, dated January, 2012, Section 2.2.5.1.19. When position is not valid, NACv SHALL be set to zero.

A1.2.5.10 Geometric Vertical Accuracy (GVA) SHALL be derived from Vertical Figure of Merit, (VFOM) in accordance with EUROCAE ED-102A including Corrigendum-1, dated January, 2012, Section 2.2.3.2.7.2.8. Class B position sources may not provide VFOM directly. When VFOM is not available directly, VFOM SHALL be derived from Vertical Dilution of Precision (VDOP) according to the following formula: $VFOM = 2 * VDOP * UERE$, where the UERE is 6 metres.

A1.2.5.11 The Type Code 31, Operational Status Message, subfield 'Airborne Capability Class Code', SHALL be changed to indicate the device is a TABS.

A1.2.5.11.1 The Operational Status Message SHALL be modified to indicate that it meets the performance standards of this ETSO. ED-102A, including Corrigendum-1, dated January, 2012, paragraph 2.2.18.4.7 and Figure 2-40, is modified by this ETSO. Message bits 53-54, (ME Bits 21-22), SHALL describe the capabilities of the TABS per Table 26. Set bit 54 to 1 (one) to indicate that either TABS Class A, Class B, or both classes of equipment are installed.

Bit 53	Bit 54	Description
0	0	Not TABS equipped
0	1	TABS Equipped
1	0	TABS device (reserved for future use)
1	1	TABS device (reserved for future use)

Table 26 ED-102A Airborne Capability Class Message format

A1.2.6 GNSS Position Source Function Requirements (For Class B Devices)

A1.2.6.1 Manufacturers may use commercial off-the-shelf (COTS) GNSS position sources to meet the performance of this ETSO as long as the sensor meets the requirements in this section. The position source shall be capable of using Satellite-Based Augmentation System (SBAS) corrections and health messages to exclude satellites from the position solution or to correct satellite range errors. In areas where the SBAS is available, the TABS shall use the SBAS corrections and health messages to exclude satellites from the position solution or to correct satellite range errors. In areas where the SBAS is not available or out of service, the TABS may continue to operate. The regional airspace authority will determine what operational impacts this may have on air-to-ground usage of TABS equipment. According to the FAA the GPS constellation experiences a significant ramp error approximately once a year. During these events, a chipset which uses the SBAS will, depending on the received SBAS messages, either correct or exclude the faulty satellite. Refer to RTCA/DO-229E, Minimum Operational Performance Standards for Global Positioning System/Satellite-Based Augmentation System Airborne Equipment, when interpreting SBAS-related requirements.

A1.2.6.2 The GNSS position source SHALL provide a GPS-only solution for use by the TABS ADS-B function. The FAA and EASA have not evaluated the performance of other GNSS systems for use in support of aviation intended functions. This ETSO will be updated once sufficient analysis has been done to show that other GNSS are appropriate for use by TABS equipment. Note, the GPS-only solution refers to the use of the GPS satellite constellation, it does not exclude augmentation of the GPS solution, such as provided by SBAS or GBAS systems.

A1.2.6.3 The GNSS horizontal position error SHALL not exceed 30 metres, 95th percentile, when the Horizontal Dilution of Precision (HDOP) is 2.5 or less. The GNSS position source SHALL either transmit a Horizontal Figure of Merit (95 %) (HFOM) or a HDOP metric.

Note: The 30 metre horizontal position fixing error requirement assumes a UERE of 6 metres, consistent with Section A1.2.5.8.

A1.2.6.4 Removed

A1.2.6.5 The GNSS position source SHALL be capable of transmitting horizontal velocity measurements more accurate than 10 m/s, 95th percentile.

A1.2.6.6 The GNSS position source SHALL not transmit false or misleading data in the presence of broadband interference. There is no minimum interference rejection requirement for TABS equipment and loss of position in the presence of interference is acceptable behaviour.

A1.2.6.7 The GNSS position source SHALL not use SBAS corrections when the SBAS satellite is broadcasting message type 0.

A1.2.6.8 The GNSS position source SHALL exclude satellites with UDREI=15 reported in the SBAS fast corrections.

A1.2.6.9 The GNSS position source SHALL apply SBAS fast and long term corrections when available.

A1.2.6.10 The GNSS position source SHALL be capable of transmitting geometric altitude, Height Above the Ellipsoid (HAE) measurements more accurate than 45 metres, 95th percentile when the Vertical Dilution of Precision (VDOP) is 3.7 or less. The GNSS position source SHALL either transmit a Vertical Figure of Merit (95 %) (VFOM) or a Vertical Dilution of Precision (VDOP) metric.

Note: The 45 metre vertical position fixing error requirement assumes a UERE of 6 metres, consistent with Section A1.2.5.10.

A1.2.7 Antenna Function Requirements

A1.2.7.1 The requirements for transponder antennas are specified in ETSO-C112e. The requirements for GNSS antennas are specified in ETSO-C190 and ETSO-C144a. The antennas should be designed to meet the performance specified in the applicable ETSO. However, the TABS may benefit significantly in installation costs from implementations where the antennas are integrated in the TABS equipment. Small degradations in antenna performance may be acceptable as a trade-off for installation cost.

A1.2.7.2 Antennas may be installed internally on aircraft that are transparent to radio frequencies. An internal antenna may not be appropriate on aircraft with a metal hull. If an antenna is installed internally, testing will need to be conducted to ensure the TABS is not negatively impacted and installation guidance must accompany the unit to ensure the system is properly fitted to the aircraft.

A1.2.7.3 Because TABS may be installed on a radio frequency (RF) transparent fuselage near a pilot or passenger, or in a cockpit in close proximity to a pilot or passenger, consideration must be given to antenna placement to ensure it does not pose a hazard to humans or combustible materials. Manufacturers must provide installation guidance describing the minimum safe distance the antenna can be to the nearest human body or if applicable, combustible material. Appendix 3 of this ETSO provides a more in-depth discussion of this subject based on FCC and European documents.

A1.2.8 Form factor and power

A1.2.8.1 An ideal implementation of the TABS would be a single integrated unit with minimal connections to the airframe, such as; mechanical mounting, power, and static air source. Where the equipment might be shared between multiple airframes, the mechanical mounting could incorporate an airframe specific configuration module (containing such items as the ICAO 24 bit aircraft address), and be designed such that no tools are required to remove or install the TABS.

A1.2.8.2 Low power consumption design is important. Designs specifically intended for long-term battery operation are ideal. If the TABS is battery powered, it should be designed to provide system integrity commensurate with the failure condition category / classification stated in paragraph 3.2.1.

Appendix 2. Test Requirements

A2 Testing Introduction

A2.1 Testing Intent

A2.1.1 This appendix provides an acceptable means to verify the major functions of the TABS.

A2.1.2 The TABS is not intended to accept and reply to any UF=11 All-Call interrogations. RTCA/DO-181E tests like 2.4.2.1 Step 6 that use the Mode S Only All-Call interrogation (UF=11) will need to use a different interrogation, such as a UF=0 interrogation.

A2.2 Testing Requirements

A2.2.1 The tests defined here are derived from tests in the reference documents or written here to ensure compliance with the intended capabilities of TABS equipment. These tests are one acceptable means to demonstrate the equipment meets the functional requirements defined in Appendix 1 of this ETSO. Functionality not modified by Appendix 1 should be verified by the test outlined in the applicable standards, e.g. RTCA/DO-181E.

A2.2.2 Table 27 provides notes in italics and parenthesis explaining how to read the tables that modify the text in the source documents.

(Source document reference)	Modified text for this ETSO
(This is a copy of the original text from the source document. Material to be deleted from this original text is marked with strikethrough formatting .)	(This is the requirement for this ETSO. Modifications to the source text are marked in <u>bold and underlined</u> to assist in identifying changes).

Table 27 (Source document reference) (type of change)

A2.2.3 Testing Transponder Function Requirements Derived From DO-181E (For Class A Devices)

A2.2.3.1 Testing of the transponder function of the TABS should follow the tests outlined in document RTCA/DO-181E, Minimum Operational Performance Standards for Air Traffic Control Radar Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment, dated March 17, 2011, Section 2.3, 2.4, and 2.5, with the following exceptions:

A2.2.3.1.1 Testing of Flight Crew Control Functions

A2.2.3.1.2 Testing should verify the requirements of RTCA/DO-181E, as modified by paragraph A1.2.3.1.2 of this ETSO have been properly incorporated.

A2.2.3.1.3 Testing should verify changes made to paragraph 2.1.7 a, in RTCA/DO-181E, per Section A1.2.3.1.3 have been properly incorporated.

A2.2.3.1.3.1 Testing should verify the requirements of A1.2.3.1.3, by performing the test outlined in RTCA/DO-181E Section 2.5.4.11. Test results should verify that the 4096 code can be set while on the ground. If the 4096 code can be set in flight, testing should verify the 4096 code can be set while in the air (weight-off-wheels condition) per RTCA/DO-181E Section 2.5.4.11.

A2.2.3.1.3.2 Testing should verify the requirements of A1.2.3.1.3, by performing the test outlined in RTCA/DO-181E Section 2.5.4.11. Testing should verify that a means of selecting and transmitting Mode 3/A code 7700 (emergency) is provided and tested per RTCA/DO-181E Section 2.5.4.11.

A2.2.3.1.3.3 Testing should verify the requirements of A1.2.3.1.3, by performing the test outlined in RTCA/DO-181E Section 2.5.4.11. Testing should also verify that a means of selecting and transmitting an alternate Mode 3/A codes is provided and tested per RTCA/DO-181E Section 2.5.4.11.

A2.2.3.1.4 Testing should verify the requirements of A1.2.3.1.4, by performing the test outlined in RTCA/DO-181E 2.5.4.3.b. Test results should verify aircraft without a means of determining air/ground state, reports in-the-air at all times. Aircraft with an automatic means to determine the air/ground state, must verify that the air/ground state is set properly. Perform the test outlined in RTCA/DO-181E 2.5.4.3.b. If capable of determining the air-ground state, test results should verify the aircraft reports in-the-air when in the air, and on-the-ground when on the ground.

A2.2.3.1.5 Testing should verify the requirements of A1.2.3.1.5, have been properly incorporated. If a means of selecting the Standby condition is provided, testing should verify return to normal operation from standby condition is within five seconds.

A2.2.3.1.6 Testing should verify the requirements of A1.2.3.1.6, have been properly incorporated. If a means of initiating the IDENT (SPI) feature is installed, testing shall verify it functions properly per RTCA/DO-181E Section 2.5.4.3. (see Also A1.2.3.5 and A2.2.3.5)

A2.2.3.2 Testing Reply Rate Capability Changes

A2.2.3.2.1 This section provides test criteria for the reply rate changes based on assumptions made in Section A1.2.3.2.1.

A2.2.3.2.2 Testing should verify changes made to A1.2.3.2.2, have been correctly incorporated into TABS equipment.

A2.2.3.2.2.1 Testing should verify the requirements of A1.2.3.2.2.1, of this ETSO have been satisfied. Testing outlined in DO-181E, Section 2.3.2.2.3 step 1 should verify that the transponder be able to continuously generate at least 100 ATCRBS 15-pulse replies per second.

A2.2.3.2.2.2 Testing should verify the requirements of A1.2.3.2.2.2, of this ETSO have been satisfied. Testing outlined in DO-181E, Section 2.3.2.2.3 step 3 should verify that the transponder is capable of a peak reply rate of 150 ATCRBS 15-pulse replies per second for a duration of 100 milliseconds.

A2.2.3.2.2.3 Testing should verify changes made to RTCA/DO-181E Section 2.2.3.4.2.a have been correctly incorporated into TABS equipment per A1.2.3.2.2.3.

A2.2.3.2.2.3.1 Testing should verify the requirements of RTCA/DO-181E, Section 2.2.3.4.2.a, as modified by paragraph A1.2.3.2.2.3 of this ETSO have been satisfied. Testing outlined in DO-181E, Section 2.3.2.2.3 step 2 should verify that the transponder provide at least 29 short Mode S replies in any 1-second interval.

A2.2.3.2.2.3.2 Testing should verify the requirements of RTCA/DO-181E, Section 2.2.3.4.2.a, as modified by paragraph A1.2.3.2.2.3 of this ETSO have been satisfied. Testing outlined in DO-181E, Section 2.3.2.2.3 step 3 should verify that the transponder provide at least 10 short Mode S replies in a 100-millisecond interval.

A2.2.3.2.2.3.3 Testing should verify the requirements of RTCA/DO-181E, Section 2.2.3.4.2.a, as modified by paragraph A1.2.3.2.2.3 of this ETSO have been satisfied. Testing outlined in DO-181E, Section 2.3.2.2.3 step 4 should verify that the transponder provide at least 5 short Mode S replies in a 25-millisecond interval.

A2.2.3.2.2.3.4 Testing should verify the requirements of RTCA/DO-181E, Section 2.2.3.4.2.a, as modified by paragraph A1.2.3.2.2.3 of this ETSO have been satisfied. Testing outlined in DO-181E, Section 2.3.2.2.3 step 5 should verify that the transponder provide at least 3 short Mode S replies in a 1.6-millisecond interval.

A2.2.3.2.2.4 Testing should verify changes made to RTCA/DO-181E Section 2.2.3.4.2.b have been correctly incorporated into TABS equipment per A1.2.3.2.2.4.

A2.2.3.2.2.4.1 Testing should verify the requirements of RTCA/DO-181E, Section 2.2.3.4.2.b, as modified by paragraph A1.2.3.2.2.4, of this ETSO have been satisfied. Testing outlined in DO-181E, Section 2.3.2.2.3 step 2 should verify that the transponder provide at least 10 of the 29 Mode S replies as long format replies in any 1-second interval.

A2.2.3.2.2.4.2 Testing should verify the requirements of RTCA/DO-181E, Section 2.2.3.4.2.b, as modified by paragraph A1.2.3.2.2.4, of this ETSO have been satisfied. Testing outlined in DO-181E, Section 2.3.2.2.3 step 3 should verify that the transponder provide at least 4 of the 10 Mode S replies as long format replies in a 100-millisecond interval.

A2.2.3.2.2.4.3 Testing should verify the requirements of RTCA/DO-181E, Section 2.2.3.4.2.b, as modified by paragraph A1.2.3.2.2.4, of this ETSO have been satisfied. Testing outlined in DO-181E, Section 2.3.2.2.3 step 4 should verify that the transponder provide at least 3 of the 5 Mode S replies as long format replies in a 25-millisecond interval.

A2.2.3.2.2.4.4 Testing should verify the requirements of RTCA/DO-181E, Section 2.2.3.2.4.2.b, as modified by paragraph A1.2.3.2.2.4, of this ETSO have been satisfied. Testing outlined in DO-181E, Section 2.3.2.2.3 step 5 should verify that the transponder provide at least 2 of the 4 Mode S replies as long format replies in a 1.6-millisecond interval.

A2.2.3.3 Testing Reply Rate Limiting Changes

A2.2.3.3.1 Testing should verify the requirements of RTCA/DO-181E, Section 2.2.7.3.1, as modified by paragraph A1.2.3.3.1, of this ETSO have been satisfied. Testing outlined DO-181E Section 2.4.2.2.5 step 1 should be performed to verify the unit does not reply to Mode A interrogations.

A2.2.3.3.2 Testing should verify the requirements of RTCA/DO-181E, Section 2.2.7.3.1, as modified by paragraph A1.2.3.3.2 of this ETSO have been satisfied. Testing outlined in DO-181E Section 2.4.2.2.5 step 1 should be performed to verify the unit is capable of between 100 continuous ATCRBS Mode C replies per second and the maximum continuous rate of which the transponder is capable, or 200 replies per second, whichever is less, without regard to the number of pulses in each reply. Sensitivity reduction SHALL apply only to the receipt of ATCRBS interrogations.

A2.2.3.4 Testing should verify the requirements of RTCA/DO-181E, Section 2.2.13.1.2 c, as modified by paragraph A1.2.3.4 of this ETSO have been satisfied. Testing should show airborne status is set to in the air unless the aircraft is air/ground determination capable. If the aircraft can determine air/ground state, testing should show this capability determines on the ground when on the ground and in the air when in the air.

A2.2.3.5 Testing should verify the requirements of RTCA/DO-181E, Section 2.2.13.1.2 d, as modified by paragraph A1.2.3.5 of this ETSO have been satisfied. If the aircraft is capable of providing SPI, follow the test outlined in A2.2.3.1.6 of the ETSO to verify it functions properly per RTCA/DO-181E Section 2.5.4.3. (See also, Section A1.2.3.1.6 and A2.2.3.1.6)

A2.2.3.6 Testing should verify the requirements of RTCA/DO-181E, Section 2.2.13.1.2 e, as modified by paragraph A1.2.3.6 of this ETSO have been satisfied. Testing should show the Aircraft ID loaded while on the ground is broadcast. If aircraft ID can be changed in flight, testing should verify aircraft ID can be changed in flight and the new aircraft ID is broadcast.

A2.2.3.7 Testing of Interrogation Acceptance Protocol Changes (All-Call reply capability)

A2.2.3.7.1 Except where noted here, testing of the Interrogation Acceptance Protocol capability should follow that called out in RTCA/DO-181E. Testing of the Interrogation Acceptance Protocol capability should be modified from those called out in RTCA/DO-181E to meet the changes made in A1.2.3.7.1.

A2.2.3.7.2 Testing should verify the requirements of RTCA/DO-181E, Section 2.2.18.2.2 b, as modified by paragraph A1.2.3.7.2 of this ETSO have been satisfied. Various tests in RTCA DO-181E Section 2.4 utilize the Mode S Only All-Call interrogation and expected reply to execute the test procedure. A discrete interrogation should be used as a substitute for these test procedures. Testing outlined in RTCA/DO-181E, Section 2.5.4.2 should verify that UF=11 interrogations are not accepted.

A2.2.3.7.3 Testing should verify the requirements of RTCA/DO-181E, Section 2.2.18.2.2 c, as modified by paragraph A1.2.3.7.3 of this ETSO have been satisfied. Testing outlined in RTCA/DO-181E, Section 2.5.4.2 should verify that an ATCRBS/Mode S All-Call interrogation (1.6 microseconds P4) is not accepted. The pulse decoder tests in Section 2.4.2.5 for ATCRBS/Mode S All-Call interrogation acceptance shall be modified to verify no ATCRBS/Mode S All-Call interrogations that meet the criteria for acceptance in RTCA DO-181E, Section 2.2.6.2, produce a reply.

A2.2.3.8 Testing of the requirements of RTCA/DO-181E, Interrogation Acceptance Protocol, per Section 2.5.4.4 and 2.5.4.5 are not required per A1.2.3.8 of this ETSO.

A2.2.3.9 Testing of the requirements of RTCA/DO-181E, Stochastic All-Calls, per 2.5.4.13 is not required per A1.2.3.9 of this ETSO.

A2.2.3.10 Testing should verify the modified Mode S MTL requirements added to RTCA/DO-181E, per Section A1.2.3.10. Test to ensure paragraph 2.2.18.2.2 L, and 2.2.18.2.2 m, have been properly incorporated.

A2.2.3.10.1 Testing outlined in RTCA/DO-181E, Section 2.4.2 should verify that ATCRBS Mode A interrogations (P1-P3 spacing 8 microseconds) are not accepted per A1.2.3.10.1. Various tests in RTCA DO-181E Section 2.4 utilize Mode A interrogations to execute the test procedure. Mode C interrogations should be used as a substitute for these test procedures. The pulse decoder tests in DO-181E, Section 2.4.2.5 for Mode A interrogation acceptance shall be modified to verify that no Mode A interrogations that meet the criteria for acceptance in DO-181E, Section 2.2.6.2 produce a reply. Requirement for recovery from a Mode A interrogation per A1.2.3.10.1 shall be tested according to DO-181E Section 2.4.2.6, Step 1 except using a Mode A interrogation from the master and a Mode C interrogation from the slave.

A2.2.3.10.2 Testing should verify the requirements added to RTCA/DO-181E, paragraph 2.2.18.2.2 m, have been properly incorporated per Section A1.2.3.10.2. Verify the requirement added by this ETSO, by performing the test procedure in RTCA/DO-181E, Section 2.4.2.1. step 6, using a UF=0 to verify the Mode S MTL in Section 2.2.2.4 b and UF=4, 5, 20 and 21 to verify the modified MTL per A1.2.3.10.2.

A2.2.3.11 Testing should verify the requirements of RTCA/DO-181E, Interrogation Reply Coordination, Section 2.2.18.2.3, as modified by A1.2.3.11 of this ETSO are satisfied. Testing outlined in DO-181E Section 2.5.4.2 shall be modified to verify the unit does not reply to ATCRBS Mode A interrogations. Test ATCRBS Mode A/Mode S All-Calls, ATCRBS Mode C/Mode S All-Calls or UF=11 interrogations per testing outlined in A2.2.3.7 and A2.2.3.10.

A2.2.3.12 Testing of RTCA/DO-181E, Lockout Protocol, Section 2.2.18.2.4, is not required since TABS devices do not reply to All-Call interrogations per A1.2.3.12 of this ETSO. Testing using interrogations in RTCA/DO-181E Section 2.5.4.4 should be performed to verify the unit properly replies to interrogations containing lockout commands from ground interrogations.

A2.2.3.13 Testing of RTCA/DO-181E, Multisite Lockout Protocol, Section 2.2.18.2.5, is not required since TABS devices do not reply to All-Call interrogations per A1.2.3.13 of this ETSO. Testing using interrogations in RTCA/DO-181E Section 2.5.4.5 should be performed to verify the unit properly replies to interrogations containing multisite lockout commands from ground interrogations.

A2.2.3.14 Testing should verify the requirements of RTCA/DO-181E, Flight Status and Vertical Status Protocols, Section 2.2.18.2.7, as modified by A1.2.3.14 of this ETSO are satisfied. Testing outlined in DO-181E Section 2.5.4.7 should be performed to verify the unit sets the flight status bits properly consistent with the capabilities provided for Mode 3/A code entry per A1.2.3.1.3.

A2.2.3.15 Testing the requirement of RTCA/DO-181E, All-Call Reply Protocol, Section 2.2.18.2.9, as modified by A1.2.3.15 is not required. Testing outlined in DO-181E Section 2.5.4.8 does not need to be performed since the TABS does not support the All-Call Protocol.

A2.2.3.16 Testing should verify the Level 2 Transponder Requirements of RTCA/DO-181E, Minimum Level 2 Transponder Requirements, Section 2.2.19.1, as modified by A1.2.3.16 of this ETSO are satisfied. Testing outlined in RTCA/DO-181E Section 2.5.3 should be performed to verify the unit performs per design specifications. Also, testing outlined in RTCA/DO-181E section 2.5.4.17 should be performed to verify the unit does not process DF=16 messages.

A2.2.3.17 No test is required to verify the requirements of RTCA/DO-181E, Information Transfer, Section 2.2.19.1.3, per A1.2.3.17.

A2.2.3.18 Testing should verify the requirements of RTCA/DO-181E, Interrogation-Reply Coordination, Section 2.2.19.1.4, as modified by A1.2.3.18 are met. Use tests in A2.2.3.7 and A2.2.3.10 in this ETSO to verify the TABS does not reply to ATCRBS Mode A, ATCRBS/Mode S All Calls and UF=11 interrogations.

A2.2.3.19 Testing of the requirements of RTCA/DO-181E, Lockout Protocol, Section 2.2.19.1.5, per Section 2.5.4.4, are not required per A1.2.3.19 of this ETSO. Testing should verify the TABS does not perform the UM Protocol per RTCA/DO-181E Section 2.5.4.18.

A2.2.3.20 Since TABS do not support the Comm-B protocol except for GICB extraction requests, the requirements of RTCA/DO-181E, UM Protocol, Section 2.2.19.1.9, do not apply, per A1.2.3.20. Using a subset of the interrogations identified in RTCA/DO-181E Section 2.5.4.18, select 12 interrogations with UF 4, 5, 20 and 21 and containing DI=0, 1 and 7 and verify that the reply contains UM field of ZERO.

A2.2.3.21 Testing of the requirements of RTCA/DO-181E, Comm-A Protocol, Section 2.2.19.1.10, per Section 2.5.4.15 are not required per A1.2.3.21 of this ETSO. Testing should verify the TABS does not perform the Comm-A Protocol per RTCA/DO-181E Section 2.5.4.15.

A2.2.3.22 Testing of the requirements of RTCA/DO-181E, Broadcast Protocol, Section 2.2.19.1.11, as modified by A1.2.3.22 is not required since TABS do not support this protocol.

A2.2.3.23 Testing of the requirements of RTCA/DO-181E, Air-Initiated Comm-B Protocol, Section 2.2.19.1.12.4, per Section 2.5.4.18 is not required per A1.2.3.23. To verify GICB extraction requirements, perform the portion of the test procedure of RTCA/DO-181E, Section 2.5.4.18 using interrogation patterns 1 to 24, to test the transponder in state 1 of the test matrix to verify proper reply content.

A2.2.3.24 Testing the requirements of RTCA/DO-181E, Comm-B Broadcast Protocol, Section 2.2.19.1.12.5, per 2.5.4.21 is not required per A1.2.3.24.

A2.2.3.25 Testing should verify the requirements of RTCA/DO-181E, Updating the Data Link Capability Report, Section 2.2.19.1.12.6.3, as modified by A1.2.3.25. Testing should verify the TABS does not perform the Updating the Data Link Capability Report per RTCA/DO-181E, Section 2.5.4.33.

A2.2.3.26 Testing should verify the requirements of RTCA/DO-181E, Change of Aircraft Identification, Section 2.2.19.1.13 e, as modified by A1.2.3.26. Testing should verify the TABS does not perform the Change of Identification per RTCA/DO-181E, Section 2.5.4.19.

A2.2.3.27 Testing the requirements of RTCA/DO-181E, Linked Comm-A Coding, Section 2.2.19.1.14, per 2.5.4.15, is not required per A1.2.3.27.

A2.2.3.28 Testing the requirements of RTCA/DO-181E, Comm-U/V Protocol, Section 2.2.19.1.16, per 2.5.4.17, as modified by A1.2.3.28 is not required.

A2.2.3.29 Testing the requirements of RTCA/DO-181E, Data Handling Interfaces, Section 2.2.19.1.17, per 2.5.4.20, as modified by A1.2.3.29 is not required.

A2.2.3.30 Testing the requirements of RTCA/DO-181E, Multisite Message Protocol, Section 2.2.19.2, per Section 2.5.4.5, as modified by A1.2.3.30 is not required.

A2.2.3.31 Testing the requirements of RTCA/DO-181E, Surveillance Identifier (SI), Section 2.2.24.2, per 2.6.2, as modified by A1.2.3.31 is not required.

A2.2.3.32 Testing the requirements of RTCA/DO-181E, Elementary Surveillance Capability, Section 2.2.24 as modified by A1.2.3.32 is not required. If one or more ELS registers are supported, test per RTCA/DO-181E, Section 2.6.

A2.2.3.33 Testing the requirements of RTCA/DO-181E, Enhanced Surveillance Capability, Section 2.2.25.3.2, as modified by A1.2.3.33 is not required. If the unit is Enhanced Surveillance Capability capable test per RTCA/DO-181E, Section 2.7.

A2.2.4 Testing Altitude Source Function Requirements

A2.2.4.1 Testing of the Altitude Source Function should follow that called out in ETSO-C88b, Automatic Pressure Altitude Reporting Code Generating Equipment, dated August 5, 2016.

A2.2.5 Testing ADS-B OUT Function Requirements (For Class A Devices)

A2.2.5.1 Testing should verify the ADS-B system performs its intended function per EUROCAE ED-102A, MOPS for 1090 MHz Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B), dated December, 2009, including Corrigendum-1, dated January, 2012, except as modified by Section A1.2.5. Testing should follow the tests outlined in EUROCAE ED-102A, including Corrigendum-1, dated January, 2012, Section 2.3 and 2.4 with the following exceptions:

A2.2.5.2 Per Section A1.2.5.2, testing of transponder functions should follow the requirements in Section A1.2.3 and A2.2.3 of this ETSO.

A2.2.5.3 Testing should verify the System RF Peak Power Output has a peak output level of at least 18.5 dBW (70 watts) per A1.2.5.3, reference EUROCAE ED-102A, including Corrigendum-1, dated January, 2012, RF Peak Power, Section 2.2.2.2.10.1 a. Testing outlined in ED-102A, Section 2.3.2.2.6.1 step 5 should verify the unit under test provides a peak output power level of at least 18.5 dBW (70 watts).

A2.2.5.4 If the optional ADS-B Surface Position Messages function is provided, per Section, A1.2.5.4, testing should verify the ADS-B Surface Position Message is correctly populated and broadcast per EUROCAE ED-102A Section 2.4.3.2.1.2.2.

A2.2.5.5 If the optional Typecode 31, subtype 1, Aircraft Operational Status Messages is provided per Section A1.2.5.5, testing should verify the Aircraft Operational Status Messages is correctly populated and broadcast per EUROCAE ED-102A Section 2.4.3.2.7.2

A2.2.5.6 Per Section A1.2.5.6, testing should verify that NIC=6, and SIL=1 when using position from a Class B position source using test procedures in EUROCAE ED-102A, including Corrigendum-1, dated January, 2012, Sections 2.4.8.1.5, 2.4.5.1.40.

A2.2.5.7 Testing should verify the System Design Assurance (SDA) is set to 1 to verify the requirement in Section A1.2.5.7, reference EUROCAE ED-102A, including Corrigendum-1, dated January, 2012, System Design Assurance (SDA), Section 2.2.5.1.50.

A2.2.5.8 Per Section A1.2.5.8, testing should verify that Navigation Accuracy Category for Position (NACp) is set according to EUROCAE ED-102A including Corrigendum-1, dated January, 2012, Section 2.4.3.2.7.1.3.8. Testing should verify that the NACp is set appropriately when the position source is providing HDOP and not HFOM.

A2.2.5.9 If a TABS Class B position source is installed, verify Navigation Accuracy Category Velocity (NACv) is set to 1 (10 m/s) per A1.2.5.9.

A2.2.5.10 Verify Geometric Vertical Accuracy (GVA) is set per A1.2.5.10. Testing outlined in EUROCAE ED-102A, including Corrigendum-1, dated January, 2012, Section 2.4.3.2.7.2.8 should verify GVA is set appropriately when the position source is providing VDOP and not VFOM.

A2.2.5.11 Verify Type Code 31, Airborne Capability Class Message indicates the unit under test is a TABS per A1.2.5.11.

A2.2.6 Testing of GNSS Position Source Function Requirements (For Class B Devices)

A2.2.6.1 A TABS incorporating a position source that is compliant with ETSO-C129, ETSO-C145, ETSO-C146 or ETSO-C196 must also meet the additional ADS-B criteria defined in AMC1 ACNS.D.ADSB.070 of CS-ACNS, to include any required testing. GNSS position sources that are not compliant with an existing GNSS ETSO will need to meet the requirements in paragraph A1.2.6 of this ETSO and verify it meets the minimum

requirements by performing the tests outlined in Section A2.2.6 of this ETSO. The following tests were derived from a reduced set of requirements and associated tests found in RTCA/DO-229E.

A2.2.6.2 GPS Only Solution.

A2.2.6.2.1 Per paragraph A1.2.6.2, verify that the position source provides a GPS-SBAS or GPS Only solution for use by Class A TABS.

A2.2.6.3 Position Accuracy Tests.

A2.2.6.3.1 Two tests are used to verify the horizontal position accuracy to ensure the requirement in paragraph A1.2.6.3 is met. The first test is a 24-hour static scenario using live satellite signals. The second test uses a GNSS simulator to generate a scenario incorporating both static and dynamic aircraft manoeuvres.

A2.2.6.3.2 24 Hour Accuracy Test.

A2.2.6.3.2.1 The equipment SHALL be tested over a 24-hour period using live GPS satellite signals at a surveyed location. The equipment SHALL use an antenna representative of what will be used in an actual airborne installation. The horizontal position error SHALL be computed for each position estimate output by the equipment.

A2.2.6.3.2.2 Monitor the sensor provided HFOM and VFOM, or HFOM and VFOM derived from the sensor provided HDOP and VDOP per paragraphs A1.2.5.8 and A1.2.5.10. In order to pass the test, the horizontal position error must be less than 30 metres for at least 95 % of the samples and the horizontal accuracy reported must be greater than the actual position error for at least 95 % of the samples. In order to pass the test, the vertical position error must be less than 45 metres for at least 95 % of the samples and the vertical accuracy reported must be greater than the actual position error for at least 95 % of the samples.

A2.2.6.3.2.3 The horizontal position error SHALL not exceed 0.5 NM at any time during the test.

A2.2.6.3.2.4 Only those position outputs that are reported as valid by the equipment need to be considered for the accuracy evaluation. In order to pass the test, 99.9 % of the position outputs must be reported as valid, excluding those position reports prior to the first position fix.

A2.2.6.3.3 GPS Simulator-based Accuracy Tests.

A2.2.6.3.3.1 The equipment SHALL be tested using a GPS simulator scenario that includes both static and dynamic aircraft manoeuvres. The horizontal and vertical position errors SHALL be computed for each position estimate output by the equipment.

A2.2.6.3.3.2 Monitor the sensor provided HFOM and VFOM, or HFOM and VFOM derived from the sensor provided HDOP and VDOP per paragraphs A1.2.5.8 and A1.2.5.10. In order to pass the test, the horizontal position error must be less than 30 metres for at least 95 % of the samples and the horizontal accuracy reported must be greater the actual position error for at least 95 % of the samples. In order to pass the test, the vertical position error must be less than 45 metres for at least 95 % of the samples and the vertical accuracy reported must be greater than the actual position error for at least 95 % of the samples.

A2.2.6.3.3.3 The horizontal position error SHALL not exceed 0.5 NM at any time during the test.

A2.2.6.3.3.4 Simulator Scenario Details

A2.2.6.3.3.4.1 Only those position outputs that are reported as valid by the equipment need to be considered for the accuracy evaluation. In order to pass the test, 99.9 % of the position outputs must be reported as valid, excluding those position reports prior to the first position fix.

A2.2.6.3.3.4.2 The simulator scenario SHALL use the standard 24 satellite constellation in RTCA/DO-229E Appendix B. The initial position and time should be chosen to ensure the satellite geometry supports the test Pass/Fail criteria and the HDOP is close to 2.5 and VDOP is close to 3.7.

A2.2.6.3.3.4.3 The simulation SHALL include both stationary and dynamic portions, as follows:

A2.2.6.3.3.4.3.1 At least 10 minutes of stationary position.

A2.2.6.3.3.4.3.2 A sequence of different manoeuvres, including acceleration to a constant velocity, climbs, descents, and turns.

A2.2.6.3.3.4.3.2.1 A series of turns should be included to ensure a constantly changing velocity to expose any effects of filtering on the position output.

A2.2.6.3.3.4.3.3 At least 10 minutes of accelerated manoeuvres SHALL be simulated.

A2.2.6.3.3.4.3.4 Aircraft dynamics are as follows: ground speed = 200 kt, horizontal acceleration=0.58 g, vertical acceleration of 0.5 g.

A2.2.6.3.3.4.4 The simulated satellite signals SHALL be set to -134 dBm while position measurements are taken. Signal powers may be increased at the beginning of the scenario to allow for initial acquisition.

A2.2.6.3.3.4.5 Simulated signals SHALL include ranging errors for atmospheric effects (troposphere and ionosphere) that adhere to approved models. Refer to DO-229E, Appendix A, Section A.4.2.4 and IS-GPS-200G dated September 5, 2012.

A2.2.6.3.3.4.6 No interference needs to be simulated.

2.2.6.4 Reserved

A2.2.6.5 Velocity Accuracy Tests.

A2.2.6.5.1 The velocity accuracy tests specified AC 20-138D Appendix 4, Sections 4-2, 4-3 and 4-4 SHALL be performed per the requirement in A1.2.6.5 and show the unit provides an accuracy of 10 m/s or less, at least 95 % of the time. It is assumed that the GPS position source does not provide a velocity accuracy output and the TABS will broadcast NACv = 1. Only the tests required to demonstrate a NACv = 1 need be run.

A2.2.6.6 Interference Tests.

A2.2.6.6.1 The equipment SHALL be tested using simulated GPS signals mixed with an interfering signal of gradually increasing power until the equipment loses position to verify the requirement outlined in paragraph A1.2.6.6. The horizontal position accuracy will be evaluated.

A2.2.6.6.2 Simulator Scenario Details.

A2.2.6.6.2.1 Use the same simulator scenario set up found in A2.2.6.3.3.4 with the following exceptions:

A2.2.6.6.2.2 The interfering signal SHALL be broadband noise with bandwidth of 20 MHz centred on 1575.42 MHz. The initial power spectral density SHALL be -170.5 dBm/Hz (-97.5 dBm total power).

A2.2.6.6.2.3 The scenario may to be extended to allow sufficient time for increasing interference power.

A2.2.6.6.3 Test Procedure

A2.2.6.6.3.1 Step 1: The interfering signal SHALL initially be turned off.

A2.2.6.6.3.2 Step 2: The simulator scenario SHALL be engaged and the satellites' RF SHALL be turned on.

A2.2.6.6.3.3 Step 3: The equipment SHALL be powered on and initialized. It is assumed that the receiver has obtained a valid almanac for the simulator scenario to be tested prior to conducting these tests.

A2.2.6.6.3.4 Step 4: The receiver SHALL be allowed to reach steady state. When the receiver has reached steady state, an interfering broadband noise signal of -170.5 dBm/Hz SHALL be applied.

A2.2.6.6.3.5 Step 5: The interference power SHALL be maintained until the accuracy has reached steady-state. Position measurements and validity indications SHALL be recorded during this interval.

A2.2.6.6.3.6 Step 6: The power of the interfering signal SHALL be increased by 2 dB and maintained for 200 seconds.

A2.2.6.6.3.7 Step 7: Go to Step 5 and repeat until the receiver is unable to maintain a position fix.

A2.2.6.6.4 Pass/Fail Criteria

A2.2.6.6.4.1 The horizontal position errors SHALL be computed for each position estimate output by the equipment.

A2.2.6.6.4.2 The horizontal position error SHALL not exceed 0.5 NM at any time during the test.

A2.2.6.6.4.3 Only those position outputs that are reported as valid by the equipment need to be considered for the accuracy evaluation. There is no minimum interference rejection requirement for TABS equipment and loss of position in the presence of interference is acceptable behaviour.

A2.2.6.7 Verification of SBAS Message Type 0

A2.2.6.7.1 Test to verify the GNSS position source does not use SBAS corrections when the SBAS satellite is broadcasting message type 0 per A1.2.6.7.

A2.2.6.7.2 Simulator Scenario Details

A2.2.6.7.2.1 The simulator scenario SHALL use the standard 24 satellite constellation in RTCA/DO-229E Appendix B

A2.2.6.7.2.2 A single SBAS satellite SHALL be simulated with a fast corrections (MT 2-5) update rate of 6 seconds.

A2.2.6.7.2.3 At 500 seconds into the scenario, the SBAS satellite SHALL start broadcasting message type 0 for 60 seconds. The message type 0 broadcast SHALL contain message type 2 data (if appropriate for the SBAS service being simulated).

A2.2.6.7.2.4 The scenario SHALL have a static user position.

A2.2.6.7.2.5 The simulated satellite signals SHALL be set to a nominal power level (-128 dBm).

A2.2.6.7.2.6 Simulated signals SHALL include ranging errors for atmospheric effects (troposphere and ionosphere) that adhere to approved models. Refer to DO-229E Appendix A Section A.4.2.4 and IS-GPS-200G dated September 5, 2012.

A2.2.6.7.2.7 No interference needs to be simulated.

A2.2.6.7.3 Test Procedure

A2.2.6.7.3.1 Step 1: The simulator scenario SHALL be engaged and the satellites' RF SHALL be turned on.

A2.2.6.7.3.2 Step 2: The equipment SHALL be powered on and initialized. It is assumed that the receiver has obtained a valid almanac for the simulator scenario to be tested prior to conducting the tests.

A2.2.6.7.3.3 Step 3: Monitor the receiver output for the indication of SBAS use. Verify that the receiver indicates that SBAS is not in use before an SBAS satellite has been acquired.

A2.2.6.7.3.4 Step 4: Allow the receiver to reach steady state navigation. Verify that the receiver indicates that SBAS is in use before proceeding to the next step.

A2.2.6.7.3.5 Step 5: 500 seconds into the scenario, the SBAS satellite SHALL start broadcasting message type 0.

A2.2.6.7.3.6 Step 6: Monitor the receiver output for the indication of SBAS use. Verify that the receiver indicates that SBAS is not used within 8 seconds.

A2.2.6.8 Exclusion of satellites identified by SBAS as unhealthy

A2.2.6.8.1 Test to verify the GNSS position source excludes satellites with UDREI=15 reported in the SBAS fast corrections per A1.2.6.8. The ability of the position source to exclude unhealthy satellites based on the SBAS

UDREI will be tested by injecting a ramp error on a satellite measurement and subsequently broadcasting a SBAS UDREI of 15 ('do not use') for that satellite.

A2.2.6.8.2 UDREI = 15 in fast corrections message (MT 2-5, 24)

A2.2.6.8.2.1 The equipment SHALL be tested to verify that the UDREI data contained in the SBAS fast corrections messages (MT 2-5, 24) is used to exclude unhealthy satellites.

Note: The test does not assume that the receiver outputs an indication that the unhealthy satellite has been removed from the position solution. Instead it uses a pass criteria based on horizontal position error.

A2.2.6.8.2.2 Simulator Scenario Details

A2.2.6.8.2.2.1 The simulator scenario SHALL use the standard 24 satellite constellation in RTCA/DO-229E Appendix B.

A2.2.6.8.2.2.2 A single SBAS satellite SHALL be simulated with a fast corrections (MT 2-5, 24) update rate of 6 seconds. The integrity information message (MT 6) SHALL not be broadcast.

A2.2.6.8.2.2.3 The simulation start time and location SHALL be such that the resulting HDOP is close to 5.0.

A2.2.6.8.2.2.4 The simulation SHALL use nominal aircraft dynamics, defined to be ground speed = 200 kt and horizontal acceleration = 0.58 g. These dynamics can be simulated as a series of turns.

A2.2.6.8.2.2.5 The scenario SHALL allow the receiver time to achieve steady state navigation before introducing any satellite errors.

A2.2.6.8.2.2.6 The scenario SHALL introduce a ramp error on each simulated GPS satellite individually, as follows:

A2.2.6.8.2.2.6.1 Step 1: A 5 m/s ramp error SHALL be introduced on the simulated GPS satellite.

A2.2.6.8.2.2.6.2 Step 2: Six seconds after the introduction of the ramp error, the simulated SBAS satellite SHALL broadcast a UDREI of 15 for the GPS satellite in the fast correction message.

A2.2.6.8.2.2.6.3 Step 3: The ramp error SHALL be applied until one of the following conditions occur:

- The horizontal position error of a valid position output exceeds 0.5 NM; or
- The ramp error exceeds 2 000 m; or
- The affected GPS satellite is excluded from the solution.

A2.2.6.8.2.2.6.4 Step 4: Allow the receiver time to return to steady state before repeating steps 1 to 3 on the next satellite.

A2.2.6.8.2.2.7 The simulated satellite signals SHALL be set to -134 dBm while position measurements are taken. Signal powers may be increased at the beginning of the scenario to allow for initial acquisition.

A2.2.6.8.2.2.8 Simulated signals SHALL include ranging errors for atmospheric effects (troposphere and ionosphere) that adhere to approved models. Refer to DO-229E, Appendix A, Section A.4.2.4 and IS-GPS-200G dated September 5, 2012.

A2.2.6.8.2.2.9 No interference needs to be simulated.

A2.2.6.8.2.3 Pass/Fail Criteria

A2.2.6.8.2.3.1 The test SHALL be run on two different space-time scenarios. The two scenarios SHALL be sufficiently separated to ensure that different satellite geometry is presented to the receiver.

A2.2.6.8.2.3.2 The horizontal position errors SHALL be computed for each position estimate output by the equipment during the test.

A2.2.6.8.2.3.3 The horizontal position error SHALL not exceed 0.5 NM at any time during the test.

A2.2.6.8.2.3.4 Only those position outputs that are reported as valid by the equipment need to be considered for the accuracy evaluation.

A2.2.6.9 Testing GNSS Position Source SBAS Fast and Long Term Corrections

A2.2.6.9.1 Application of Fast Corrections (MT 2-5, 24) and Long-Term Corrections (MT 24, 25) The equipment SHALL be tested to verify that fast corrections and long-term corrections are applied properly per A1.2.6.9.

A2.2.6.9.2 Simulator Scenario Details

A2.2.6.9.2.1 The simulator scenario SHALL use the standard 24 satellite constellation in RTCA/DO-229E Appendix B.

A2.2.6.9.2.2 A single SBAS satellite SHALL be simulated with a fast corrections (MT 2-5, 24) update rate of 6 seconds and standard long-term corrections (MT 24, 25) update rate of 120 seconds.

A2.2.6.9.2.3 The simulation start time and location SHALL be such that the resulting HDOP is close to 5.0.

A2.2.6.9.2.4 The simulation SHALL use nominal aircraft dynamics, defined to be ground speed = 200 kt and horizontal acceleration = 0.58 g. These dynamics can be simulated as a series of turns.

A2.2.6.9.2.5 The scenario SHALL introduce a bias and ramp error on a single satellite selected so that the range error will result in the maximum horizontal position error if not corrected by SBAS. The SBAS long-term corrections will be applied to correct the bias error. At each 6 seconds update, SBAS fast corrections will be provided to correct the ramp error for the affected satellite, as follows:

A2.2.6.9.2.5.1 Step 1: A 70 metre bias SHALL be introduced on the simulated GPS satellite. Provide SBAS long-term corrections to correct the bias term. The bias magnitude was chosen to approximate the maximum value that can be corrected by the δa_{r0} term in a type 25 message (using velocity code 0).

A2.2.6.9.2.5.2 Step 2: Start the scenario broadcasting MT25 with the correction for the bias error introduced on the selected satellite.

A2.2.6.9.2.5.3 Step 3: Allow the receiver time to acquire the GPS and SBAS satellites and obtain a steady-state differential fix, including sufficient time to acquire a type 25 message for the selected GPS satellite.

A2.2.6.9.2.5.4 Step 4: Inject a 5 m/s ramp error on the selected satellite in the same direction as the bias error.

A2.2.6.9.2.5.5 Step 5: At each 6 second update, provide SBAS fast corrections equivalent to the size of the growing ramp error.

A2.2.6.9.2.5.6 Step 6: The ramp error SHALL be applied until the ramp error plus bias error reaches 325 metres. Maintain the error of 325 metres for 5 minutes.

A2.2.6.9.2.6 The simulated satellite signals SHALL be set to -134 dBm while position measurements are taken. Signal powers may be increased at the beginning of the scenario to allow for initial acquisition.

A2.2.6.9.2.7 Simulated signals SHALL include ranging errors for atmospheric effects (troposphere and ionosphere) that adhere to approved models. Refer to DO-229E Appendix A Section A.4.2.4 and IS-GPS-200G dated September 5, 2012.

A2.2.6.9.2.8 No interference needs to be simulated.

A2.2.6.9.3 Pass/Fail Criteria

A2.2.6.9.3.1 The horizontal and vertical position errors SHALL be computed for each position estimate output by the equipment during the test.

A2.2.6.9.3.2 Monitor the sensor provided HFOM and VFOM, or HFOM and VFOM derived from the sensor provided HDOP and VDOP per paragraphs A1.2.5.8 and A1.2.5.10. Compare the HFOM against the horizontal

position error for each valid position estimate. Compare the VFOM against the vertical position error for each valid position estimate. In order to pass the test, the horizontal and vertical position accuracy output must be greater the actual position error at least 95 % of the time. Analyse the position estimates to determine if the fast corrections and long-term corrections are being applied correctly.

A2.2.6.9.3.3 Only those position outputs that are reported as valid by the equipment need to be considered for the accuracy evaluation.

A2.2.6.9.3.4 The test only needs to be run using a single space/time scenario.

A2.2.6.10 Test the GNSS position source requirements in Section 0 by running the test outlined in Section A2.2.6.3.3.

Appendix 3. Environmental Testing for Class B Equipment

A3 Environmental Test Considerations

A3.1 The environmental tests and performance requirements described in this subsection provide a laboratory means of determining the overall performance characteristics of the equipment under conditions representative of those that may be encountered in actual aeronautical operations.

A3.2 The following test procedures must be run when performing environmental testing on Class B Equipment. Class B equipment only needs to be tested under DO-160D change 3 or later Environmental Test, Section 4 Temperature and Altitude, and Section 5 Temperature Variation Testing.

A3.3 The test procedure set forth below is considered satisfactory for use in determining equipment performance under environmental conditions. Although specific test procedures are cited, it is recognised that other methods may be preferred. These alternative procedures may be used if the manufacturer can show that they provide at least equivalent information. In such cases, the procedures cited herein should be used as one criterion in evaluating the acceptability of the alternative procedures.

Note: The intent of this section is to minimise the testing of commercial off-the-shelf (COTS) devices.

A3.4 Class B Equipment System Test

A3.4.1 Equipment Required: A representative antenna of what will be installed in an actual airborne TABS.

A3.4.2 Figure 1 provides a representation of the test setup.

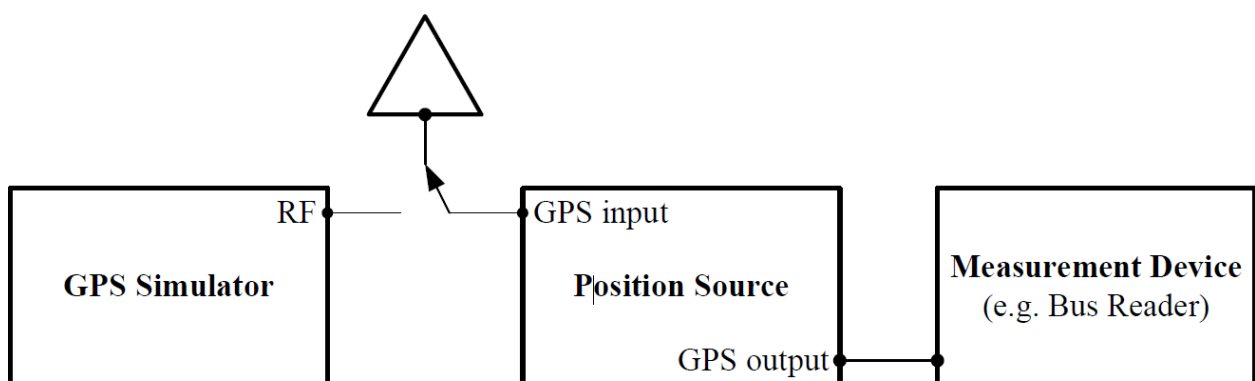


Figure 1 Test Setup

A3.4.3 Measurement Procedure:

A3.4.3.1 Set the test equipment to measure the output of the position source.

A3.4.3.1.1 Verify the position information output by the GPS to the TABS is correct for:

A3.4.3.1.1.1 The latitude and longitude of the surveyed location when connecting the device to a live (e.g. rooftop) antenna, or;

A3.4.3.1.1.2 The output by the GPS simulator for the scenario outlined in Section A2.2.6.3.3

A3.4.3.1.2 Using the test setup in A3.4.2, monitor the sensor provided HFOM, or HFOM derived from the sensor provided HDOP per paragraph A1.2.5.8. This output SHALL be compared against the horizontal position error for each valid position estimate. In order to pass the test, the horizontal position accuracy output must be greater than the actual position error for at least 95 % of the samples. The horizontal position error SHALL not exceed 0.5 NM at any time during the test.

European Aviation Safety Agency

European Technical Standard Order

Subject: Fire Containment Cover (FCC)

1 - Applicability

This ETSO provides the requirements which Fire Containment Covers (FCCs) that are designed and manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO Subpart A.

2.2 - Specific

None.

3 - Technical Conditions

3.1 - Basic

3.1.1 - Minimum Performance Standard

Standards set forth in the SAE International AS6453, Fire Containment Cover - Design, Performance, and Testing Requirements, August 2013, as amended by Appendix 1 of this ETSO.

3.1.2 - Environmental Standard

The required performance under the test conditions specified in SAE AS6453 Section 4.6 and Sections 6.1.2 through 6.1.5 as modified in the appendix of this TSO shall be demonstrated.

3.1.3 – Software

None.

3.1.4 - Airborne Electronic Hardware

None.

3.2 - Specific

3.2.1 - Failure Condition Classification

See CS-ETSO Subpart A, paragraph 2.4.

4 - Marking

4.1 - General

Marking as detailed in CS-ETSO, Subpart A, paragraph 1.2.

4.2 - Specific

Each fire containment cover conforming to this Standard shall bear at least the following markings near the bottom edges on the two opposite long sides:

- 'FIRE CONTAINMENT COVER', in bold characters at least 150 mm (6 in) high,
- Substantiated protection time (e.g. 'Minimum protection duration 6 hours'),
- The IATA ULD ID (size) codes for the pallets and nets with which the FCC can be used.
- Expiration date in the format 'EXP YYYY-MM'.

In addition, each fire containment cover conforming to this Standard shall bear the markings identified in SAE AS6453 Section 7.3 and Section 7.4 as amended in Appendix 1 of this ETSO.

5 - Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

APPENDIX 1**MINIMUM PERFORMANCE STANDARD (MPS) FOR FIRE CONTAINMENT COVERS**

This Appendix prescribes the MPS for Fire Containment Covers. The applicable standard is SAE International AS6453, Fire Containment Cover – Design, Performance, and Testing Requirements dated August 2013 and modified as follows:

AS6453 Section	Action
1.1 – 1.2	Disregard
1.4	Disregard
1.7	Disregard
2	Disregard references to Japanese Airworthiness Standard Part 3 and Civil Aviation Agency of China Regulations CAAC CCAR-25 and CTSO C90
3.2	Disregard second sentence
4.1	Disregard
4.2.1	Disregard Note 4 and Note 6
4.3.1	Add to the end of the sentence 'which is sufficiently flexible to allow the FCC to collapse with the fire load'.
4.3.3 – 4.3.6	Disregard
4.4	Disregard
4.5.3	Disregard
4.5.4	Disregard
4.5.6 – 4.5.8	Disregard
4.6.5	Disregard the phrase 'as part of the required traceability code (see 7.2)'
4.6.7	Disregard
4.7	Disregard
5.1.1	Add 'seams and corners' after 'The fire container cover's material'.
5.1.1	Disregard references to CCAR-25 and JAS Part 3
5.1.2	Disregard
5.1.3	Disregard
5.2.2	Disregard references to CCAR-25 and JAS Part 3
5.2.4	Disregard
5.3	Disregard
6.1.1.1	Disregard references to CCAR-25 and JAS Part 3
6.1.1.2.b	Disregard references to CCAR-25 and JAS Part 3
6.1.1.5	Add the following sentence to the end of this section 'The FAA Aircraft Materials Fire Test Handbook includes an allowance for a brief ignition on the upper surface of the test specimen as long as the 400 degree F requirement is not exceeded.'
6.1.1.6 – 6.1.1.7	Disregard

AS6453 Section	Action
6.1.6	Disregard
6.2.1	Replace the words in the end of the second sentence 'paragraph 4.3.2 of the US DOT/FAA/AR-TN05/20 document (see reference [16] in Bibliography).' with the following, 'the bulk load fire scenario section of report US DOT/FAA/TC-TN12/11.'
6.2.3	Disregard references to CCAR-25 and JAS Part 3
6.2.4	Disregard
6.2.6	Disregard 'hen with a repaired unit in order to substantiate the retained repair method. The test record files shall be used to substantiate the defined degree of damage as allowable operational serviceability limits, and repair method approval.'
6.2.7 – 6.2.9	Disregard
7.1 – 7.2	Disregard
7.3	Disregard last sentence
7.5	Disregard
8	Disregard
9	Disregard
Annex D	Disregard

European Aviation Safety Agency

European Technical Standard Order

Subject: Electronic Flight Instrument System (EFIS) Display

1 - Applicability

This ETSO provides the requirements which electronic flight instrument system (EFIS) displays that are designed and manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO, Subpart A.

2.2 - Specific

None.

3 - Technical Conditions

3.1 - Basic

3.1.1 - Minimum Performance Standard

Standards set forth in SAE AS6296, Electronic Flight Instrument System (EFIS) Display, dated March 2016, and AS8034B, Minimum Performance Standard for Airborne Multipurpose Electronic Displays, dated 27th June 2011.

Note1: The hardware, physical, and optical (ocular) requirements of EFIS displays are addressed in SAE AS8034B. The EFIS display requirements, expressed for a broad set of aircraft functions, are addressed in SAE AS6296.

Note2: This ETSO standard covers basic display standards (SAE AS8034B) and specific displayed functions requirements (SAE AS6296). Specific displayed functions can include, but are not limited to, flight instrumentation, navigation, engine and system status, alerting, surveillance, communication, terrain awareness, weather, and/or other displays. This ETSO standard does not provide standards for head up displays. Two functions covered within SAE AS6296 are required as a minimum. This ETSO does not address sensor requirements. This ETSO standard does not address the display of single function equipment (e.g., airspeed). Sensor requirements and single function equipment requirements are located in their respective ETSO.

3.1.2 - Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1.

3.1.3 - Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 - Airborne Electronic Hardware

See CS-ETSO, Subpart A, paragraph 2.3

3.2 - Specific

None.

3.2.1 Failure Condition Classification

See CS-ETSO, Subpart A, paragraph 2.4

The failure condition classification appropriate for the equipment will depend on the intended use of the equipment in a specific aircraft. The loss of function and malfunction failure condition classification for which the equipment is designed should be documented.

4 - Marking**4.1 - General**

Marking as detailed in CS-ETSO, Subpart A, paragraph 1.2.

4.2 - Specific

Per SAE AS6296 Section 3.14, a specific marking is required:

‘See Installation Manual (IM) for Declared EFIS Functions’, or equivalent, on the primary (most prominent) component of the EFIS.

5 - Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

European Aviation Safety Agency

European Technical Standard Order

Subject: Airborne Head-Up Display

1 - Applicability

This ETSO provides the requirements which airborne head up displays that are designed and manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

This ETSO standard does not address enhanced vision systems (either infrared, millimeter wave or other imaging technologies), displays worn by the pilot (goggles, helmet-mounted displays) or specific symbology to be displayed.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO, Subpart A.

2.2 - Specific

None.

3 - Technical Conditions

3.1 - Basic

3.1.1 - Minimum Performance Standard

Standards set forth in SAE AS8055A, Minimum Performance Standards for Airborne Head Up Display, dated July 2015.

Some requirements of SAE AS8055A Section 4 are installation-dependent and cannot be fully verified at TSO article level. When the manufacturer is not able to test the TSO article in conditions representative of the overall range of the intended installation cases:

- the installation conditions for which the manufacturer has performed the test should be documented
- the installation procedures must define the functional qualification required to ensure the installed performance meets AS8055A.

3.1.2 - Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1.

3.1.3 - Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 - Airborne Electronic Hardware

See CS-ETSO, Subpart A, paragraph 2.3.

3.2 - Specific

None.

3.2.1 - Failure Condition Classification

See CS-ETSO, Subpart A, paragraph 2.4.

The failure condition classification appropriate for the equipment will depend on the intended use of the equipment in a specific aircraft. The loss of function and malfunction failure condition classification for which the equipment is designed should be documented, considering also obstructions to the pilot's field of view resulting from potential malfunction conditions.

4 - Marking**4.1 - General**

Marking as detailed in CS-ETSO, Subpart A, paragraph 1.2.

4.2 - Specific

None

5 - Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

European Aviation Safety Agency

European Technical Standard Order

Subject: AIRBORNE SYSTEMS FOR NON REQUIRED TELECOMMUNICATION SERVICES (IN NON AERONAUTICAL FREQUENCY BANDS) (ASNRT)

1 - Applicability

This ETSO provides the requirements which airborne systems to be installed on aircraft for non-required telecommunication services (in non-aeronautical frequency bands) (ASNRT) that are designed and manufactured on or after the date of this ETSO must meet in order to be identified with applicable ETSO marking.

Note: An antenna alone without an ASNRT controller does not fall under this standard.

2 - Procedures

2.1 - General

Applicable procedures are detailed in CS-ETSO Subpart A.

2.2 - Specific

None.

3 - Technical Conditions

3.1 - Basic

3.1.1 - Minimum Performance Standard

Standards set forth in the Appendix 1.

3.1.2 - Environmental Standard

Equipment providing telecommunication services shall be tested in accordance with Appendix 1, Chapter 4 of this ETSO.

3.1.3 - Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 - Airborne Electronic Hardware

See CS-ETSO Subpart A, paragraph 2.3.

3.2 - Specific

None.

3.2.1 - Failure Condition Classification

See CS-ETSO Subpart A, paragraph 2.4.

4 - Marking

4.1 - General

Marking is detailed in CS-ETSO, Subpart A, paragraph 1.2.

4.2 - Specific

The label shall indicate the communication system or network used.

5 - Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

APPENDIX 1

AIRBORNE SYSTEMS FOR NON REQUIRED TELECOMMUNICATION SERVICES (IN NON AERONAUTICAL FREQUENCY BANDS) (ASNRT)

1. GENERAL

PURPOSE AND SCOPE

This minimum operational performance specification defines the minimum performance expected from an airborne system to be installed on aircraft for non-required communication services in non-aeronautical frequency bands (ASNRT). The performance of specific equipment may be enhanced or superior to this specification, depending on the intended application and configuration.

Chapter 1 describes typical equipment applications and operational objectives and is the basis for the performance criteria specified in Chapter 2 and Chapter 3. Definitions essential to proper understanding of this document are also provided in Chapter 1.

Chapter 2 contains general design requirements.

Chapter 3 contains the minimum performance specification for the equipment, defining performance under standard operating conditions.

Chapter 4 prescribes the environmental test conditions which provide a laboratory means of determining the performance characteristics of the equipment under conditions representative of those which may be encountered in actual operations.

Chapter 5 specifies the performance of the equipment and gives guidance for the installation.

APPLICATION

Compliance with this minimum operational performance specification by manufacturers, installers and users is recommended as a means of ensuring that the equipment will satisfactorily perform its intended functions under the conditions normally encountered in routine aircraft operations.

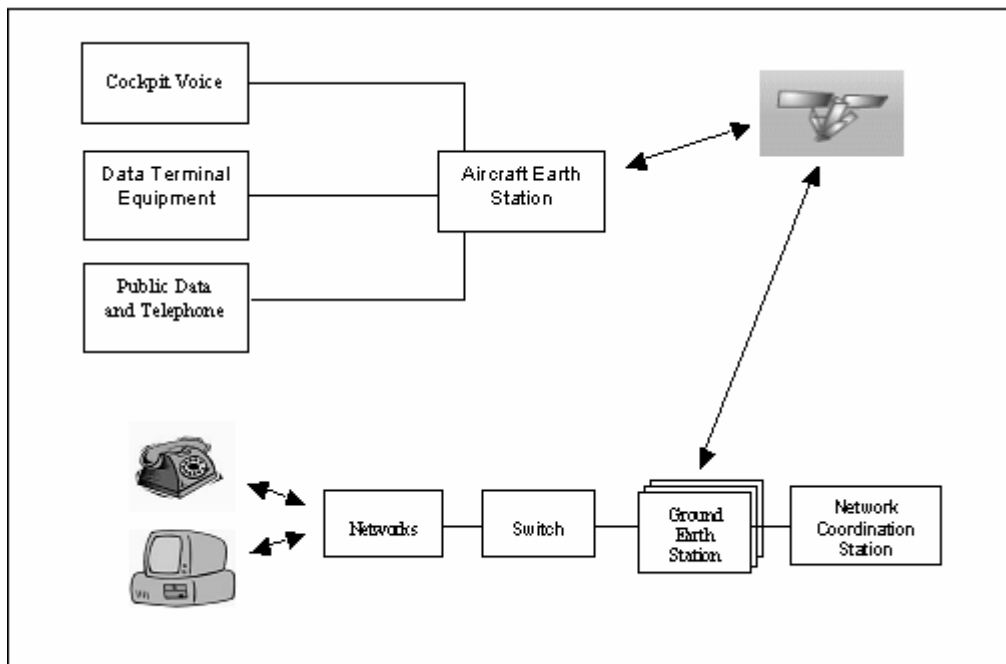
This specification does not cover telecommunication aspects. It is the responsibility of the manufacturer as well as the operator to obtain the necessary approvals from the responsible telecommunication authority and from the network provider, if applicable.

DESCRIPTION OF SYSTEM

The purpose of the airborne system for non-required communication services (ASNRT) is to provide flight crew and passengers with additional air- ground / air-air voice and data communication service. The system does not support safety-related applications like air traffic service (ATS).

It consists of electronic on board equipment which is not required for any phase of flight by any aviation rule. It is normally not connected to, nor interacts with, any aircraft system except the intercom, electrical power and mechanical mounting. In special cases, it may be useful to establish additional interfaces to other systems. Examples are communication management systems for transmission of data such as position, heading, etc. as well as company data. Furthermore, it might be useful to connect the ASNRT to devices serving as antenna steering units.

The following drawing shows an example of such a system utilizing the Iridium satellite network. It does not define a requirement.



Example Block Diagram:
Airborne System for Non-Required Communication Services using the IRIDIUM satellite network

2. GENERAL DESIGN REQUIREMENTS

AIRWORTHINESS

The equipment shall not, under either normal or failure conditions, impair the airworthiness of the aircraft in which it is installed.

OPERATION OF CONTROLS

None of the possible positions, combinations and sequences of the controls intended for use during flight shall result in a condition whose presence or continuation would be detrimental to the continued safe operation of the aircraft.

Operating the system shall not significantly affect the workload of the air crew.

The issuance of a radio or telecommunication station license in accordance with national regulations is mandatory. For non-aviation services which are not covered by EASA ETSOs, an European Norm (EN) standard is the appropriate definition for the transmission characteristic for a specific service in Europe. The EN applicable standard should be identified in the installation manual and DDP.

DESIGN CONSIDERATIONS

Controls and indicators intended for use by flight crew shall be of suitable design for the intended cockpit environment / philosophy (e.g. size, readability, illumination).

If an ASNRT equipment is integrated with a required A/C system, the ASNRT equipment shall not adversely affect the safety of the aircraft or its occupants, or the proper functioning of required equipment or systems under all foreseeable conditions.

EFFECTS OF TESTS

Unless otherwise provided, the design of the equipment shall be such that, subsequent to the application of the specific tests, no condition exists which would be detrimental to the continued safe operation of the aircraft.

AIRCRAFT EQUIPMENT INFORMATION VULNERABILITIES

If the equipment interfaces with aircraft busses and has connectivity to non-governmental services (e.g., Wi-Fi, Internet, etc.), the manufacturer may expose aircraft information vulnerability (such as cybersecurity risks) through equipment design, or become vulnerable as a result of being connected to a common interface. Therefore, it is important that manufacturers consider aircraft information security risk mitigation strategies in their equipment design, particularly when the equipment is responsible for an interface between the aircraft and aircraft-external systems.

It is recommended that manufacturers look at a layered approach to aircraft information security risk mitigation that includes both technical (e.g., software, signal filtering) and physical strategies. From a technical perspective, for example, this could include signal spoofing detection capabilities or more stringent, multi-factored authentication techniques such as passwords, PINs, and digital certificates. From a physical perspective, for example, such as in an in-flight entertainment system in the cabin, a manufacturer could consider connectors that require special tools to remove them to prevent passenger tampering. And finally, but just as important, manufacturers should consider supply chain risk management; for example, if a manufacturer is outsourcing software code development, are the contractor and its staff properly vetted?

Civil Aviation Authorities (CAAs) have a regulatory interest when an applicant's design makes use of a non-trusted connectivity where the installation can potentially introduce aircraft information security vulnerability. This requires the applicant to address not only the information security vulnerabilities and mitigation techniques for the new installation, but to also consider how vulnerability could propagate to existing downstream systems. Therefore, it is recommended that manufacturers reference their equipment aircraft information security review and mitigation strategies in the equipment's installation manual so that the applicant can consider them in meeting the installation regulatory requirements.

3. MINIMUM PERFORMANCE SPECIFICATION UNDER STANDARD CONDITIONS

GENERAL

The aeronautical system for non-required telecommunication services (ASNRT) must meet the basic requirement not to interfere with on-board systems.

It must be ensured that the equipment can neither become a source of danger in itself, nor threaten the proper functioning of any essential system or service.

Note: It is assumed that the manufacturer will also consult the telecommunication administration and (if applicable) the network provider as early as possible for approval of the technical parameters and requirements for the usage of the equipment.

SYSTEM SPECIFIC PARAMETERS

If appropriate, the manufacturer shall define details to show compliance with the 'GENERAL' subpart of this document.

A set of technical parameters showing that the system performs its intended functions shall be declared by the manufacturer. This set of data should include the quality, availability and reliability of the information channel and all the requirements which may be defined by the telecommunication administration or network provider for such equipment. However, when agreed by EASA, compliance demonstration is only necessary for a very basic requirement like 'communication link established'.

If the system interfaces to other on board equipment, compliance with the interface related requirements for that equipment has to be shown in order to exclude adverse effects on connected systems and the aircraft itself. In case of the intercom system electrical interface related parts of RTCA DO-214, or later revisions, (Audio Systems Characteristics and Minimum Operational Performance Standards for Aircraft Audio Systems and Equipment) Section 2.4 apply.

Means to disconnect the equipment from power bus or other systems (if applicable) shall be provided (i.e. Master Switch) for the case of unexpected interference, fire, smoke or other hazards.

Note: Compliance with this requirement can be achieved by the design of the equipment itself or by measures described in the installation manual.

CLASSES OF EQUIPMENT

There are two classes defined in accordance with technical means to ensure the proper operation of the equipment. There may be additional operational requirements which are not covered by this specification.

- Class 1: Equipment with the operation restriction to parked and (air-) taxiing aircraft:

Technical means shall be provided to ensure that the equipment cannot be operated during other phases of flight (e.g. by connection to sensors for airspeed, weight on wheels, etc.).

Note: Equipment which can, due to interference problems, only be allowed to operate in a parked aircraft with engines and other systems switched off, is not in the scope of this specification.

- Class 2: Equipment for operation during all phases of flight:

The manufacturer shall obtain concurrence for the intended operation from the telecommunication authority or network provider (if applicable) before applying for an airworthiness approval.

4. MINIMUM PERFORMANCE SPECIFICATION UNDER ENVIRONMENTAL TEST CONDITIONS

INTRODUCTION

The environmental tests and performance requirements described in this chapter provide a laboratory means of determining the performance characteristics of the equipment under conditions representative of those which may be encountered in actual operations.

The airborne system for non-required telecommunication services in non-aeronautical frequency bands (ASNRT) needs to comply with environmental tests so far as it is necessary to ensure that the equipment cannot become a source of danger under environmental conditions.

Some of the tests contained in this chapter are identified with the phrase 'if required'. They do not have to be performed unless the manufacturer wishes to qualify the equipment to these additional environmental conditions or if requested by EASA.

Unless otherwise specified, the test procedures applicable to a determination of equipment performance under environmental test conditions are specified in ETSO-2C514 paragraph 3.1.2.

EQUIPMENT PERFORMANCE COMPLIANCE

The performance requirements as defined in chapter 3 are not required to be tested under all of the conditions specified in CS-ETSO Subpart A paragraph 2.1.

When exposed to high temperature and/or pressure as well as a power input and voltage spike test, it shall be ensured that there is no risk of fire, smoke or similar induced by the equipment.

During all shock and vibration tests, the equipment shall remain in its mounting and no part of the equipment or its mounting shall become detached and free of the shock test table.

Direct lightning tests for antennas or other equipment to be mounted outside the aircraft are only intended to ensure that a lightning strike is already blocked at the antenna itself and cannot influence other installations or the aircraft itself.

PERFORMANCE TESTS

The equipment is sorted into two categories. Category 1 is for devices which are to be installed inside the aircraft, e.g. in the avionics bay. Category 2 covers subsystems to be installed outside, especially antennas.

EUROCAE ED-14 / RTCA-DO160 Test	Section	Category 1	Category 2
Temperature and Altitude	4	+	+
Temperature Variation	5.0	-	-
Humidity	6.0	-	-
Operational Shocks and Crash Safety	7.0	+	+
Vibration	8.0	+	+
Explosion Proofness	9.0	-	-
Water Proofness	10.0	-	-
Fluids Susceptibility	11.0	-	-
Sand and Dust	12.0	-	-
Fungus Resistance	13.0	-	-
Salt Spray	14.0	-	-
Magnetic Effect	15.0	+	+(1)
Power Input	16.0	+	-
Voltage Spike	17.0	+	-
Audio Frequency Cond. Susceptibility	18.0	-	-
Induced Signal Susceptibility	19.0	-	-
Radio Frequency Susceptibility	20.0	-	-
Emission of Radio Frequency Energy	21.0	+	+(1),(3)
Lightning Induced Transient Susceptibility	22.0	-	-
Lightning Direct Effects	23.0	-	+(2)
Icing	24.0	-	-
Electrostatic Discharge	25.0	+	+
Fire, Flammability	26.0	+	-

+ mandatory test

- if required

(1) active antenna only

(2) This test can be omitted if compliance with the requirement is ensured by other means

(3) non intended radiation

The tests marked with 'if required' may become mandatory in case of specific technical reasons. This shall be agreed with EASA.

Note: The table above is based on ED-14G / DO-160G. When test conditions or test levels are reevaluated, CS-ETSO requires compliance with ED-14G / RTCA-DO160G or later revisions as endorsed by CS-ETSO paragraph 2.1.

5. INSTALLED EQUIPMENT PERFORMANCE

The material contained in the following paragraphs is intended as guidance material only and does not have direct significance in the type certification of the equipment concerned. The aircraft installation must comply with the applicable airworthiness requirements and needs to be agreed by EASA.

EQUIPMENT INSTALLATION

Special care should be taken in selecting the antenna installation location in relation to other receiving and transmitting RF systems. A non-interference demonstration is required. Aircraft lightning zones and system lightning protection have to be determined. Additionally, for satellite systems, a free sight to the sky is necessary for good system performance. Covering the antenna by structural elements will directly influence the installed communication performance. The interface to the on-board intercom or other systems shall be installed in a manner so that a malfunction of the communication system does not cause conditions which prevent the safe continuation of the flight. The equipment shall be installed in accordance with the manufacturer's installation instructions.

If the ASNRT equipment contains a memory retention device which is a rechargeable lithium battery, the flammability risk must be addressed. Installed ASNRT equipment employing a rechargeable lithium battery must ensure the lithium ion battery meet airworthiness standards appropriate for the battery size and intended function.

OPERATING RESTRICTIONS

All operation restrictions which are defined e.g. by the rules of telecommunication authority and/or network provider should be enforced by technical provisions and procedures stated in the installation manual as well as the operation manual.