SUBPART B — LIST OF ETSOs (INDEX 1 AND INDEX 2)

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INDEX 2

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ETSO-C3e
Date: 5.8.2016

European Aviation Safety Agency

European Technical Standard Order

Subject: TURN AND SLIP INSTRUMENT

1 — Applicability

This ETSO provides the requirements which Turn And Slip 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 the SAE Aerospace Standard AS8004, 'Turn and Slip Instruments', dated September 1975.

3.1.2 — Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1.

3.1.3 — Computer Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 — Electronic Hardware Qualification

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.

Failures of the function defined in paragraph 3.1.1 of this ETSO resulting in misleading or loss of information are minor failure 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.

ETSO-C5f
Date: 5.8.2016

European Aviation Safety Agency

European Technical Standard Order

Subject: DIRECTION INSTRUMENT, NON-MAGNETIC (GYROSCOPICALLY STABILIZED)

1 — Applicability

This ETSO provides the requirements which Direction Instruments, Non-Magnetic (Gyroscopically Stabilized) 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 Aerospace Standard AS8021, 'Direction Instrument, Non-Magnetic (Gyroscopically Stabilized)', dated March 16, 1981.

3.1.2 — Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1.

3.1.3 — Computer Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 — Electronic Hardware Qualification

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.

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 information 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.

ETSO-C70b

Date: 5.8.2016

European Aviation Safety Agency

European Technical Standard Order

Subject: LIFE RAFTS

1 — Applicability

This ETSO provides the requirements which life rafts 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 International Aerospace Standard AS1356, Life Rafts, dated July 2012, as modified by Appendix 1 to this ETSO.

3.1.2 — Environmental Standard

As specified in AS1356, Life Rafts, dated July 2012, as modified by Appendix 1 to this ETSO.

3.1.3 — Computer Software

None

3.1.4 — Electronic Hardware Qualification

None

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

As specified in SAE AS1356, subsection 7.9.

5 — Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

ETSO-C70b
Appendix 1

APPENDIX 1

MPS FOR LIFE RAFTS

The applicable standard is SAE AS1356, Life Rafts, dated July 2012.
It shall be modified as follows:

AS1356 section:	**Action:**
Section 1	To be disregarded.
Section 2	All subsections shall be applied unless disregarded or modified as below:
Section 2.1	To be replaced: 2.1 Applicable Documents The following publications form a part of this document to the extent specified herein. The applicable issue of cited 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 references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.
Section 2.2	To be disregarded.
Section 2.3	Shall be applied as written, the definitions of the following terms shall be replaced with the following text: APPROVED: The status of equipment that meets EASA standards. NOMINAL OPERATING PRESSURE: The median of the Normal Conditions Pressure Range. NORMAL CONDITIONS PRESSURE RANGE: The range of pressures attained during all types of inflations conducted at Normal Temperature Conditions. READILY ACCESSIBLE: Capable of being quickly obtained for operation without requiring removal of obstacles. On page 10, Section 2.3, the following definition shall be added: PRIMARY BUOYANCY CHAMBER: Any buoyancy chamber which independently provides sufficient buoyancy (at Minimum Operating Pressure) to achieve the minimum required freeboard around the entire periphery of the life raft with the life raft loaded at both rated and overload capacity. A minimum of two primary buoyancy chambers are required.

ETSO-C70b
Appendix 1

APPENDIX 1

MPS FOR LIFE RAFTS *(continued)*

AS1356 section:	Action:
Section 2.4	The definition of 'should' shall be replaced as follows: SHOULD: Indicates a criterion for which an alternative, including non-compliance, may be applied if an equivalent level of safety is documented, justified, and approved.
Section 3.1.3(a)	To be replaced by: Type I Marking: INTENDED FOR USE IN OPERATIONS REQUIRING A LIFE RAFT Type II Marking: NOT INTENDED FOR USE FOR EXTENDED OVER-WATER OPERATIONS NOR IN TRANSPORT CATEGORY AIRCRAFT.
Section 3.2.4.2	To be replaced by: 3.2.4.2 Extended Marine Exposure The life raft shall be demonstrated by a test and/or analysis based on the test to meet the pressure retention requirements of 5.2.1 and the canopy protection of 6.5.5.1 and 6.5.7 after exposure of the fully-inflated life raft to a saltwater marine environment for at least 15 days. Installed/attached features such as the overpressure protection mechanism (e.g., pressure relief valve), manual inflation means, boarding means, sea anchor, and lifeline attachments shall retain their full functionality.
Section 3.2.5	To be replaced by: The life raft assembly shall be constructed of material meeting the requirements of CS-25 Appendix F, Part I. Survival kit contents need not meet this requirement, provided that they are fully enclosed within a container that passes the 12 s vertical burn test in Appendix F. A listing of all the survival kit equipment that does not meet the requirements of CS-25 Appendix F, Part I, must be documented.
Section 4.3.2 and 4.3.3	The following note shall be added: Note: The deflation of each of the primary buoyancy chambers must be evaluated with the remaining primary buoyancy chamber(s) inflated to minimum operating pressure. Secondary compartments and inflatable floor, if present, are not considered 'buoyancy chambers' and, therefore, must also be deflated.

APPENDIX 1

MPS FOR LIFE RAFTS *(continued)*

AS1356 section:	**Action:**
Section 5.1.4	The following note shall be added: Note: This standard was developed for mechanically activated life raft inflation systems. Electric, electro/mechanical, or software based actuation systems are not adequately addressed by this standard.
Section 7.6	To be replaced by: The text, OPERATING INSTRUCTIONS, shall be marked, adjacent to the inflation instructions, in letters of 2 inches (5.1 cm) tall, followed by the below three instructions, or their equivalent, rendered in letters at least 0.5 inches (12.7 mm) tall: a. ATTACH TO AIRCRAFT b. THROW/PUSH AWAY FROM AIRCRAFT c. PULL UNTIL INFLATION OCCURS Comprehensibility of any variation(s) to these instructions shall be demonstrated in accordance with 2.3: Comprehensible. Life rafts stowed remotely and deployed automatically from remote location are eligible for partial approval under this ETSO. Any specific design features related to these kind of life rafts will not be covered by this ETSO approval and must be approved at installation level.
Section 7.7	To be replaced by: 7.7 Identification in Stowage The text, LIFE RAFT, shall be marked in block letters of at least 2 inches (5.1 cm) tall, and FOR EMERGENCY USE ONLY shall be marked in block letters at least 1 inch (2.54 cm) tall, on all surfaces of the Container/Valise. Life raft assemblies intended to be stored in a dedicated compartment or location may be marked only on the surfaces that will be visible when accessed if the installation instructions and limitations provided with the life raft provide that level of detail.

APPENDIX 1

MPS FOR LIFE RAFTS *(continued)*

AS1356 section:	**Action:**
Section 8.8.4	To be replaced by: 8.8.4 Lithium-containing batteries used in any emergency device shall meet the requirements of ETSO-C142a or equivalent. Note: An ETSO authorisation does not constitute an installation approval on an aircraft. However, special conditions may be required to gain installation approval if the design includes non-rechargeable (i.e. primary) lithium batteries.
Section 9.3	The first sentence shall be replaced by: 9.3 Content Survival information should be prioritised and shall contain the following, at a minimum:
Section 10	To be disregarded.

ETSO-C76b
Date: 5.8.2016

European Aviation Safety Agency

European Technical Standard Order

Subject: FUEL DRAIN VALVES

1 — Applicability

This ETSO provides the requirements which Fuel Drain Valves 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 Appendix 1, MINIMUM PERFORMANCE STANDARD (MPS) FOR FUEL DRAIN VALVES, dated 18 april 2012.

3.1.2 — Environmental Standard

As specified in Section 3 of Appendix 1.

3.1.3 — Computer Software

None.

3.1.4 — Electronic Hardware Qualification

None.

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

None.

5 — Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

APPENDIX 1

MINIMUM PERFORMANCE STANDARD (MPS) FOR FUEL DRAIN VALVES

1. PURPOSE: This Appendix provides the MPS for fuel drain valves that are intended to drain fuel or water from low points in aircraft fuel systems. Fluid discharge from the valve is intended to be drained into a container for inspection. Depending on the intended application and configuration of specific equipment, the performance may be enhanced, or made superior to this specification. The number of test samples shall be completed in accordance with **Table 1.**

2. SCOPE: The MPS covers the requirements for acceptance of fuel drain valves used as a quick means of draining fuel or water from aircraft fuel systems. These valves are intended to be used in fuel tank sumps, strainers and gascolators.

3. GENERAL REQUIREMENTS

a. Materials

(1) High-quality materials that are suitable for use with aviation fuels having an aromatic content from 0–30 % shall be used.

(2) Synthetic rubber parts age-dated in accordance with the SAE International's Aerospace Recommended Practice (ARP) 5316C 'Storage of Elastomer Seals and Seal Assemblies Which Include an Elastomer Element Prior to Hardware Assembly', dated 6 December, 2010, shall be used.

(3) The fuel drain valve shall be designed by using corrosion and galling resisting metals or metals protected to resist corrosion and galling during the normal service life of the valve.

(4) The use of magnesium or any magnesium alloy **is prohibited.**

b. Design and Construction.

(1) Fuel Spillage. The drain valve shall be designed to allow operation without spilling or leaking fuel on personnel. The valve shall be designed to a 'Fail-Closed' condition.

(2) Position Indication.
(a) An indication for the open and closed position of valves shall be provided.
(b) A legend for position indication marking shall be used.
(c) Detents or other suitable means to keep the valve in the full-closed position shall be used.
(d) The valve must automatically return to the closed position when manually released from the open position.

(3) Self-locking. A means to prevent accidental opening or opening of the valve due to vibration or air loads shall be provided.

(4) Seals. The valve shall be designed so that:
(a) The inlet fuel pressure does not open the valve, and
(b) The inlet pressure keeps the valve in the closed and sealed position.

APPENDIX 1

MINIMUM PERFORMANCE STANDARDS (MPS) FOR FUEL DRAIN VALVES *(continued)*

(5) Loss of Parts.
(a) Fuel drain valves shall be designed to prevent the loss of parts.
(b) The valve shall be designed so the main seal will remain in place to prevent fuel from leaking in the event of possible damage or loss of the valve stem from operational loads anticipated in service.
(c) If threaded fittings are used to support the valve, the fittings shall be designed to prevent operational loads from rotating the valve body out of its boss or closed position.

(6) Screens. The valve shall be designed so that fuel tank features, such as screens or baffles, do not impair the valves effectiveness in draining fuel containing water and other contaminants.

c. Test Conditions.

(1) Atmospheric Conditions. Unless otherwise specified, all tests required by this standard shall be conducted at an atmospheric pressure of approximately 29.92 inches of mercury, ± 2 inches, and an ambient temperature of approximately 25 °C, ± 2 °C. When testing with atmospheric pressure or temperature different from these values, any variation due to the test setup shall be accounted for. The reason for varying from the specified conditions must be justified.

(2) Fluids. The type of fluid used must be specified unless commercial grade aviation fuels are used for all tests.

d. Test Methods and Performance Requirements.

(1) Functional. The ability of the valve to meet the design requirements specified in paragraphs **3.b.(1)** through **3.b.(6)** of this Appendix shall be demonstrated.

(2) Flow Test. The drain valve shall be connected to a suitable container and the time required to pass 1 quart of fuel with a maximum head of 6 inches of fuel shall be determined. The time to flow 1 quart must not take longer than 1 minute.

(3) Leakage Tests.

(a) Fuel Leakage. The fuel leakage test shall be conducted at pressures of 4 inches of fuel, 1 psi ± 0.1 psi, 20 psi ± 2 psi, and 60 psi ± 2 psi. The pressure to the drain valve inlet shall be applied with the valve in the closed position. The fuel drain valve must not leak any fuel from discharge or outlet port. Refer to **Figure 1** for test profile.

(b) Air Leakage. The air leakage test shall be conducted with the valve installed in a suitable test setup so the valve inlet port is covered by fuel. Air pressure shall be applied varying successively from 0.0 to 5.0 psi, with a tolerance of ± 10 % in each applied pressure, to the valve outlet port with the valve in the closed position. The fuel drain valve must not leak any air into the valve inlet. Refer to **Figure 2** for test profile.

(4) Fuel Resistance and Extreme Temperature. The fuel resistance and extreme temperature tests shall be conducted as specified in **Table 2**.

APPENDIX 1

MINIMUM PERFORMANCE STANDARDS (MPS) FOR FUEL DRAIN VALVES *(continued)*

(5) Vibration

(a) Resonance. The valve shall be subjected to a resonant frequency survey of the range specified in **Table 3** to determine if there are any resonant frequencies of the parts. If resonance is encountered, the valve shall be vibrated successively axis by axis along the three axes for four hours at the critical frequency.

(b) Cycling. The valve shall be mounted on a vibration device and fluid pressure shall be applied to the inlet port in the closed position. The valve shall be subjected to the three vibration scanning cycle tests in accordance with **Table 3.**

(c) With pressures of 0.5 psi ± 0.1 psi and 5.0 psi ± 0.5 psi, the valve shall be subjected to vibration cycle tests listed in **Table 3.** There must not be any fluid leaking during the tests.

(d) With air pressure varying successively from 0.0 to 5.0 psi gauge at the outlet port, the valve shall be subjected to vibration cycle tests listed in **Table 3.** Air leakage must not exceed 10 cc. per minute of free air during the 5.0 psi air suction test.

(e) The valve must not have damaged or loose parts as a result of the vibration tests.

(6) Proof Pressure

(a) With the valve in the closed position, a fuel pressure of 100 ± 2 psi for one minute at the inlet port shall be applied, with the outlet port open to atmospheric pressure.

(b) The valve must not show any evidence of permanent distortion or other damage. The valve must not have any external leaking when the pressure is uniformly reduced to 60 psi. Refer to **Figure 3** for test profile.

(7) Flammability. All materials used must be self-extinguishing when tested inaccordance with applicable requirements of RTCA/DO-160E or later as defined in CS-ETSO, Subpart A, paragraph 2.1., Section 26, Category C, Flammability Test. This requirement does not apply to small parts (where the greatest dimension of equipment (L) is less than 50 mm, such as knobs, fasteners, seals, grommets and small electrical parts) that would not propagate a fire.

(8) Reliability Tests. (Cycling Operations)

(a) Dry Test. The valve shall be dried in an oven at 158° ±2° F for four hours. Then the valve shall be subjected to 2 000 complete cycles of operation in the dry condition.

(b) Wet Test. The valve shall be moistened with fuel, supplied with a 6-inch head of fuel and then subjected to 6 000 complete cycles of operation. The fuel head must remain at six inches during the test.

(c) Post Reliability Test. After the cycling operations, the leakage test shall be performed. The valve must not leak as a result of the reliability test.

e. Test Samples.

APPENDIX 1

MINIMUM PERFORMANCE STANDARDS (MPS) FOR FUEL DRAIN VALVES *(continued)*

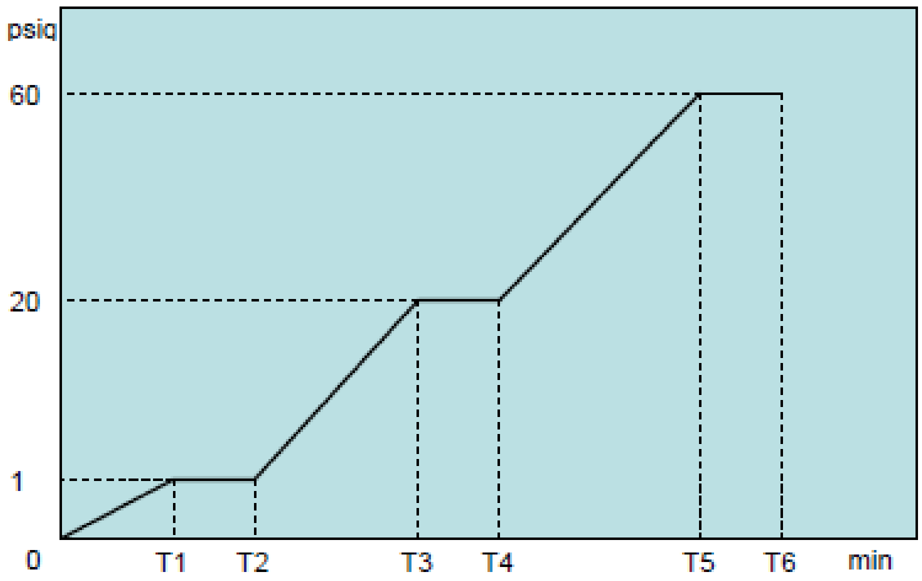
Table 1 Test Samples

Tests	**Paragraph 2 of this Appendix**	**Samples**
Functional	d.(1)	Valve 1
Flow Test	d.(2)	Valve 2
Fuel Leakage	d.(3)	Valve 3
Air Leakage	d.(3)	Valve 3
Fuel Resistance and Extreme Temperature	d.(4)	Valve 4
Resonance	d.(5)	Valve 5
Cycling	d.(5)	Valve 6
Proof Pressure	d.(6)	Valve 7
Fire Flammability Test	d.(7)	Valve 8
Reliability Test, Dry	d.(8)	Valve 9
Reliability Test, Wet	d.(8)	Valve 9
Post Reliability Test	d.(8)	Valve 9

APPENDIX 1

MINIMUM PERFORMANCE STANDARDS (MPS) FOR FUEL DRAIN VALVES *(continued)*

Figure 1 – Fuel Leakage Test



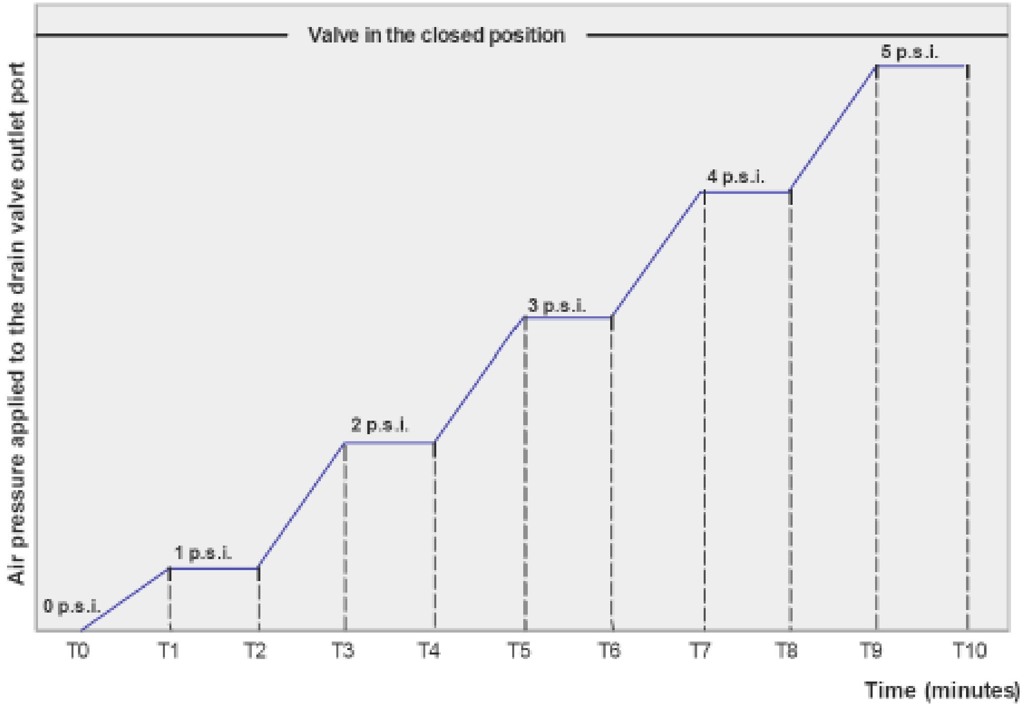
Notes:		
	T0 to T1 -----	No time restriction
	T1 to T2 -----	5 minutes minimum
	T2 to T3 -----	No time restriction
	T3 to T4 -----	5 minutes minimum
	T4 to T5 -----	No time restriction
	T5 to T6 -----	5 minutes minimum

ETSO-C76b
Appendix 1

APPENDIX 1

MINIMUM PERFORMANCE STANDARDS (MPS) FOR FUEL DRAIN VALVES *(continued)*

Figure 2 – AIR Leakage Test



Notes : T0 to T1 -- no time restriction
T1 to T2 -- 1 minute, minimum.
T2 to T3 -- no time restriction.
T3 to T4 -- 1 minute, minimum.
T4 to T5 -- no time restriction.
T5 to T6 -- 1 minute, minimum.
T6 to T7 -- no time restriction.
T7 to T8 -- 1 minute, minimum.
T8 to T9 -- no time restriction.
T9 to T10 -- 1 minute, minimum
T10 -- end of test.

ETSO-C76b
Appendix 1

APPENDIX 1

MINIMUM PERFORMANCE STANDARDS (MPS) FOR FUEL DRAIN VALVES *(continued)*

Table 2 - Fuel Resistance and Extreme Temperature Test Schedule

Test	**Fuel Resistance**		
Period ***Note 1***	Phase I — Soak	Phase I — Dry	Low Temperature
Component configuration	***Note 2***	Drained and blown dry, normal condition as expected under service conditions, ports open	Mounted as expected under normal service conditions ***Note 2***
Test Fluid	*ASTM D471 Reference Fuel B	None	*ASTM D471 Reference Fuel A
Period duration	96 hours (4 days)	24 hours	18 hours
Ambient and test fluid temperature	158° ±2° F (70° ±2° C)or the normal operating temperature of the system where the component is used, whichever is higher	Circulating air at 158° ±2° F (70° ±2° C)or the normal operating temperature of the system in which the component is used, whichever is higher ***Note 4***	Fluid temperature lowered to -67°±2°F, (-55° ±2° C) then the fluid temperature shall be maintained at -67°±2° F (-55° ±2° C) for a minimum of 18 hours
Operation or tests during period	Component actuated at least 4 cycles per day in a normal manner ***Note 3***	None	None
Operation or tests Immediately after period	Leakage test shall be conducted, using *ASTM D471 Reference Fuel B	(a) Components actuated for 5 cycles. (b) Functional and leakage tests to be conducted in accordance with paragraphs 3.d.(1) and 3.d.(3) of this appendix, using *ASTM D471, Reference Fuel A ***Note 3***	With temperature not higher than -65° F (-54° C), functional and leakage tests to be conducted in accordance with paragraphs 3.d.(1) and 3.d.(3) of this appendix, using *ASTM D471, Reference Fuel A

Notes:

1. Each period shall be followed immediately (45 minutes maximum) after the preceding one in the order noted.
2. The component shall be maintained to ensure complete contact of all non-metallic parts with the test fluid as would be expected under normal service conditions.
3. There is no restriction in the actuation of the valve.
4. There is no restriction in the circulating velocity of air or mass flow.

* ASTM: American Society for Testing of Materials, International

APPENDIX 1
MINIMUM PERFORMANCE STANDARDS (MPS) FOR FUEL DRAIN VALVES *(continue)*

Table 3 — Vibration Test

Scanning cycle test	**1**	**2**	**3**
Axis of vibration	X	Y	Z
Fluid pressure	60 psi ± 2 psi	60 psi ± 2 psi	60 psi ± 2 psi
Scanning cycle time	15 min	15 min	15 min
Number of scanning cycles per test	2	2	2
Procedure	1. The valve shall be tested along three mutually perpendicular X, Y, and Z-axes; the X axis lies along centre lines of the valve. 2. The frequency time shall be increased uniformly through a range from 10 to 500 c.p.s. with an applied double amplitude of 0.036 inch up to 75 c.p.s. and an applied vibration acceleration not less than ±10g. 3. Double amplitude indicates the total displacement from positive to negative maximum. 4. The frequency shall be decreased so the complete cycle is accomplished in the specified cycle time.		

ETSO-C88b
Date: 5.8.2016

European Aviation Safety Agency

European Technical Standard Order

Subject: AUTOMATIC PRESSURE ALTITUDE REPORTING CODE GENERATING EQUIPMENT

1 — Applicability

This ETSO provides the requirements which Automatic Pressure Altitude Reporting Code-Generating 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 Society of Automotive Engineers, Inc., (SAE) Aerospace Standard AS8003, Automatic Pressure Altitude Reporting Code Generating Equipment, dated July 1974.

3.1.2 — Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1.

3.1.3 — Computer Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 — Electronic Hardware Qualification

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.

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 information 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.

ETSO-C89a
Date: 5.8.2016

European Aviation Safety Agency

European Technical Standard Order

Subject: CREW MEMBER OXYGEN REGULATOR, DEMAND

1 — Applicability

This ETSO provides the requirements which Crew Member Oxygen Regulator, Demand 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 AS8027, Crew Member Oxygen Regulator, Demand, dated 1 June2004, as modified by Appendix 1 to this ETSO.

Crew member oxygen regulators are separated into four types:

Type I:	Remote-mounted, panel or portable,
Type II:	Man-mounted, not mask-mounted,
Type III:	Mask-mounted, less valving, and
Type IV:	Mask-mounted, with integral valving.

The four types of oxygen regulators are further separated into five classes:

Class A:	Straight demand,
Class B:	Diluter demand,
Class C:	Straight demand, pressure breathing,
Class D:	Diluter demand, pressure breathing to 40 000 ft, and
Class E:	Diluter demand, pressure breathing to 45 000 ft.

3.1.2 — Environmental Standard

Refer to SAE AS8027, paragraph 4.5

3.1.3 — Computer Software

None.

3.1.4 — Electronic Hardware Qualification

None.

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

Type and class (refer to paragraph 3),

Maximum altitude (per AS8027, paragraph 1.2.3),

Inlet supply pressure range (per AS8027, paragraph 3.1.7).

5 — Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

ETSO-C89a
Appendix 1

APPENDIX 1

MPS FOR CREW MEMBER OXYGEN GENERATORS, DEMAND

The applicable standard is SAE AS8027, Crew Member Oxygen Regulator, Demand, dated 1 June 2004. It shall be modified as follows:

AS 8027 section:	Action:
Paragraph 1.1, Scope	Shall be disregarded
Paragraph 3.1.1	To be revised: Materials of a type, grade and quality shall be used where experience and/or tests have shown their suitability for the purpose. Materials contaminating oxygen or materials that are adversely affected by continuous service with oxygen must not be used. Except for small parts like knobs, triggers, fasteners, seals, and electrical parts that do not contribute significantly to fire propagation, materials including packaging must comply with CS 25.853, Appendix F, Part 1 (a)(1)(iv).
Paragraph 3.1.2	To be revised: Filters have to be provided at oxygen inlet ports to prevent entrance of particles, which may be hazardous to the user or impair the function of the device. Filters must be equivalent to that of a 200 mesh screen.
Paragraph 3.1.3	To be revised: For Class B, D, and E devices (diluter demand) an air inlet port has to be provided. The port shall be designed to prevent entrance of particles, which may impair performance of the device. A 100 mesh screen or equivalent filter shall be used.
Paragraph 3.2.1.2	To be revised: Outlet Proof Pressure (Class A and B except Type IV)
Paragraph 3.2.1.3	To be revised: Outlet Proof Pressure (Class C, D and E except Type IV)
Paragraph 3.4, Applicability Matrix, Table 7	To be revised: 3.2.1.2 Outlet Proof Pressure (Except Type IV) 3.2.1.3 Outlet Proof Pressure (Except Type IV) 3.2.8 Relief Valve (Except Type IV)

APPENDIX 1

MPS FOR CREW MEMBER OXYGEN GENERATORS, DEMAND *(continued)*

AS 8027 section:	**Action:**
Paragraph 4.5.1	To be revised: High-temperature exposure: The device shall be soaked for 12 hours at not less than 160° F (71.1 °C). Then the device shall be transferred to 70° F (21.1 °C), ambient temperature. Within 30 minutes of doing this, the device shall be tested to the requirements of paragraphs 4.4.3 through 4.4.9.
Paragraph 4.5.2	To be revised: Low temperature exposure: The device shall be soaked for 2 hours at not less than -65° F (-54°C). Then the device shall be transferred to 0° F (-17.8°C) for 2 hours to stabilise it. After this, the device shall be transferred to 70° F (21.1 °C), ambient temperature. Within 30 minutes of doing this, the device shall be tested to the requirements of paragraphs 4.4.3 through 4.4.9.
Paragraph 5.1, Identification	To be disregarded.

ETSO-C90d A1
Date: 5.8.2016

European Aviation Safety Agency

European Technical Standard Order

Subject: Cargo Pallets, Nets and Containers (Unit Load Devices)

1 — Applicability

This ETSO provides the requirements which Cargo Unit Load Devices 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

For new models of Type I ULDs standards set forth in standard of Aerospace Industries Association of America, Inc. (AIA), National Aerospace Standard, NAS 3610, 'Cargo Unit Load Devices.- Specification for', Revision 10, dated November 1, 1990

When using NAS 3610 Revision 10, the following errors must be corrected:

— in lieu of Figure 31, sheet 87, substitute Figure 31, sheet 88;
— for Figure 32 (missing from NAS 3610 Revision 10), use Figure 32 of NAS 3610 Revision 8 dated April 1987, or Revision 9 dated September 1987.

For new models of Type II ULDs standards set forth in the Society of Automotive Engineers, Inc. (SAE) Aerospace Standard (AS) 36100, 'Air Cargo Unit Load Devices - Performance Requirements and Test Parameters', Revision A, dated April 2006.

For Type I and II ULDs, the standards set forth in SAE AS36102, Air Cargo Unit Load Devices - Testing Methods, dated March 2005 are applicable.

3.1.2 — Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1.

3.1.3 — Computer Software

None.

3.1.4 — Electronic Hardware Qualification

None.

3.2 — Specific

Environmental degradation due to ageing, ultra-violet (UV)-exposure, weathering, etc. for any non-metallic materials used in the construction of pallets, nets and containers must be considered.

In lieu of NAS 3610 Rev. 10, paragraph 3.7 and SAE AS36100 Rev. A, paragraph 4.7 use the following paragraph which provides the fire protection requirements for ULDs:

The materials used in the construction of pallets, nets and containers must meet the appropriate provisions in CS-25, Appendix F, Part I, paragraph (a)(2)(iv).

Textile Performance: See SAE Aerospace Information Report (AIR) 1490B, Environmental Degradation of Textiles, dated December 2007, for available data for textile performance when exposed to environmental factors. These data shall be taken into account for consideration of the effects of environmental degradation on nets commensurate with the expected storage and service life to satisfy SAE AS36100 Rev. A, paragraph 4.11.

Note: Environmental degradation data other than that documented in AIR1490B may be used if substantiated by the applicant and approved by EASA.

3.2.1 Failure Condition Classification

N/A

4 - Marking

4.1 - General

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

4.2 - Specific

In addition, the following information shall be legibly and permanently marked on the ULD:

1. The identification of the article in the code system explained in
   a. NAS 3610, Revision 10, paragraph 1.2.1, for Type I ULDs.
   b. SAE AS36100, Rev. A, paragraph 3.5 for Type II ULDs.
2. The nominal weight of the article in kilogram and pound in the format: Weight: …kg (…lb)
3. If the article is not omni-directional, the words ‘FORWARD’, ‘AFT’, and ‘SIDE’ must be conspicuously and appropriately placed.
4. The manufacturer’s serial number of the article, with the option to add the date of manufacture.
5. The burning rate determined for the article under paragraph 3.2 of this ETSO.
6. If applicable, the expiration date in the format ‘EXP YYYY-MM’ must be marked on the ULD.

5 — Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

ETSO-C99a
Date: 5.8.2016

European Aviation Safety Agency

European Technical Standard Order

Subject: Flight Deck (Sedentary) Crew Member Protective Breathing Equipment

1 — Applicability

This ETSO provides the requirements which Flight Deck (Sedentary) Crew Member Protective Breathing 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 SAE AS8031A, Personal Protective Devices for Toxic and Irritating Atmospheres Air Transport Flight Deck (Sedentary) Crew members, dated 3/1/1999 as amended by Appendix 1 to this ETSO.

3.1.2 — Environmental Standard

To be tested in accordance with the procedures in SAE AS8026A, Crewmember Demand Oxygen Mask for Transport Category Aircraft, dated July 1996, paragraph 4.5.

3.1.3 — Computer Software

None.

3.1.4 — Electronic Hardware Qualification

None.

3.2 — Specific

None.

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

In addition to 4.1, the mask assembly shall be marked with the following:

(1) Size (if more than one size is manufactured),

(2) Type (as specified in ETSO-C89a, paragraph 3), and

(3) 'Beards will not seal', if applicable.

5 — Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

ETSO-C99a
Appendix 1

APPENDIX 1

MPS FOR FLIGHT DECK (SEDENTARY) CREWMEMBER PROTECTIVE BREATHING EQUIPMENT

The applicable standard is SAE AS8031A, Personal Protective Devices for Toxic and Irritating Atmospheres Air Transport Flight Deck (Sedentary) Crewmembers, dated March 1999. It shall be modified as follows:

AS8031A section:	**Action:**
Section 1, SCOPE	To be disregarded.
Paragraph 7.1 a. Resistance to Flammability	To be revised: The device shall be designed, including packaging, (except small parts like knobs, triggers, fasteners, seals, and electrical parts) of materials that don't contribute significantly to the propagation of a fire, and that comply with CS 25.853(a), Appendix F, Part I(a)(1)(iv).
Paragraph 7.1j	To be revised: 'ANSI/ASSE Z87.1-2003, "Occupational and Educational Eye and Face Protection Devices."'
Paragraph 7.1k	To be revised: 'ANSI/ASSE Z87.1-2003, (Table 8) "Optical Quality, Normal Corrective Vision." Clear versus yellow tint and vision distortion testing for thermal protection.'
Paragraph 8.1	To be revised: 'Cleaning and Sterilising: Except for non-reusable or disposable systems, it must be ensured that cleaning and sterilising the device is possible without major disassembly and adverse effects on operation and performance. The cleaning method must be either manufacturer-recommended, or according to SAE ARP 1176, Oxygen System Component Cleaning and Packaging. Cleaning and sterilising procedures shall be included in the CMM.'

APPENDIX 1

MPS FOR FLIGHT DECK (SEDENTARY) CREWMEMBER PROTECTIVE BREATHING EQUIPMENT *(continued)*

AS8031A section:	**Action:**
Section 8, IDENTIFICATION	To be disregarded except of paragraph 8h
Paragraph 9.1	The following values shall be used: X=.05, Y=.10 and Z=.05.
Paragraph 10.1 For Flight deck Crewmembers	To be revised: An integral microphone shall be included in the protective device when it is necessary to allow the user to communicate (speak) through the aircraft's communication system. The microphone must be approved or meet the requirements of ETSO-C139a or later.

ETSO-C100c
Date: 5.8.2016

European Aviation Safety Agency

European Technical Standard Order

Subject: Aviation Child Safety Device (ACSD)

1 — Applicability

This ETSO provides the requirements which Aviation Child Safety Devices (ACSD) 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 AS5276/1, Performance Standard for Child Restraint Systems in Transport Category Airplanes, dated 11/1/2000, asamended by Appendix 1 to this ETSO.

3.1.2 — Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1.

3.1.3 — Computer Software

None.

3.1.4 — Electronic Hardware Qualification

None.

3.2 — Specific

None.

3.2.1 — Failure Condition Classification

4 — Marking

4.1 — General

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

4.2 — Specific

In addition, the ACSD shall be marked with the ACSD type designation (reference SAE AS52761, paragraph 2.5, as amended by Appendix 1).

Also, any applicable limitations or restrictions shall be marked to allow aircraft-specific or operational-specific installation limitations, such as: 'FOR USE ON [insert aircraft type or serial number] ONLY'; 'FOR USE ON AIRCRAFT USED IN PART [insert number] OPERATIONS ONLY'; 'FOR MILITARY USE ONLY'; or 'SEE DRAWING NO. [insert number] FOR INSTALLATION LIMITATIONS.'

5 — Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

APPENDIX 1

MPS FOR AVIATION CHILD SAFETY DEVICE

The applicable standard is SAE AS5276/1, 'Child Restraint Systems in Transport Category Airplanes', dated November 2000, with the following modifications:

AS 5276/1 section:	***Action:***
Entire document:	Throughout the document, 'Aviation Child Safety Device (ACSD)' shall be used instead of 'CRS'. SAE AS5276/1 incorporates, as references, the following test standards: 1. SAE RP J211, Instrumentation for Impact Tests. 2. SAE AS8049A, Performance Standard for Seats in Civil Rotorcraft, Transport Aircraft and General Aviation Aircraft. 3. SAE ARP4466, Dimensional Compatibility of Child Restraint System and Passenger Seat Systems in Civil Transport Airplanes. 4. 49 CFR part 572, Anthropomorphic Test Dummies. 5. CS 25.853(a) (Appendix F, Part I(a)(iv)).
Section 1	To be disregarded.
Paragraph 2.1	To be replaced with: 2.1 Documents: The following publications form part of this AS to the extent specified herein. Other publications are provided for reference. 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 exemption has been obtained.
Paragraph 2.1.1	To be revised: 2.1.1 SAE Publications: RP J211, Instrumentation for Impact Tests AS8049B, Performance Standard for Seats in Civil, Rotorcraft and Transport Aircraft and General Aviation Aircraft ARP4466, Dimensional Compatibility of Child Restraint Systems and Passenger Seat Systems in Civil Transport Airplanes

ETSO-C100c
APPENDIX 1

MPS FOR AVIATION CHILD SAFETY DEVICE *(continued)*

AS 5276/1 section:	*Action:*
Paragraph 2.1.2	To be revised: 2.1.2 Federal Aviation Administration (FAA) Regulations, Advisory Circulars, European Technical Standard Orders and Reports: EASA Part-21, Certification Procedures for Products and Parts CS-25, Airworthiness Standards: Transport Category Airplanes AC 91-62A, Use of Child Seats in Aircraft AC 120-87B, Use of Child Restraint Systems on Aircraft ETSO-C22g, Safety Belts ETSO-C39c, AIRCRAFT SEATS and BERTHS CERTIFIED BY STATIC TESTING ONLY ETSO-C127b, Rotorcraft, Transport Airplane, and Normal and Utility Airplane Seating Systems DOT/FAA/AAM/-94/19, The Performance of Child Restraint Devices in Transportation Category Seats, Gowdy and DeWeese, FAA Office of Aviation Medicine Report, September 1994 DOT/FAA/AR-00/12, Aircraft Materials Fire Test Handbook
Paragraph 2.1.3	To be revised: 2.1.3 National Highway Traffic Safety Administration (NHTSA) Regulations and Documents: 49 CFR 571.213, Federal Motor Vehicle Safety Standard No. 213 Child Restraint Systems 49 CFR 571.225, Federal Motor Vehicle Safety Standard No. 225 Child Restraint Anchorage Systems 49 CFR 572, Anthropomorphic Test Dummies NHTSA Drawing Package SAS-100-1000, dated June 1, 1993
Paragraph 2.1.4	To be revised: 2.1.4 ANSI Publications: ANSI Z535.4 -1998 Product Safety Signs and Labels

APPENDIX 1

MPS FOR AVIATION CHILD SAFETY DEVICE *(continued)*

<table>
<tr><th>AS 5276/1 section:</th><th>Action:</th></tr>
<tr><td>Paragraph 2.3</td><td>To be revised:

2.3 Classification of Children: The physical characteristics of small children govern the proper ACSD for use. Mass, standing height, and developmental maturity (i.e. age) are important for proper ACSD configuration and orientation. As children develop at different rates, combined application of these characteristics in selecting an ACSD may be difficult. To assist in this process, Table 1 defines three stages of child development each with a single dominant characteristic underlined. Where an occupant falls between categories, the dominant characteristic is used to determine the proper ACSD configuration and orientation.

Table 1 — Definitions of Child Categories
<table>
<tr><td>Child category</td><td>Mass, kg (lb)</td><td>Height, cm (in.)</td><td>Age, month</td></tr>
<tr><td>Newborn</td><td>Birth to 5 (11)</td><td>Birth to 65 (26)</td><td>N/A</td></tr>
<tr><td>Infant</td><td>5–10 (11–22)</td><td>65–85 (26–34)</td><td>under 12</td></tr>
<tr><td>Toddler</td><td>10–18 (22–40)</td><td>85–110 (34–44)</td><td>over 12</td></tr>
</table></td></tr>
<tr><td>Paragraph 2.5d</td><td>To be revised:

d. Any child that has attained his or her first birthday, with a mass greater than 10 kg (22 lb) and having a standing stature of less than 110 cm (44 in.) in height is considered a ‘toddler’ and should be seated in a forward-facing ACSD with both upper and lower torso restraint (Type III).</td></tr>
<tr><td>Paragraph 2.6</td><td>New paragraph to be added:

2.6 Definitions: Refer to 49 CFR 571.213 S4. for aircraft child safety device definitions.</td></tr>
<tr><td>Paragraph 3.2</td><td>To be revised:

3.2 ACSD Design/Functional Performance:</td></tr>
<tr><td>Paragraph 3.2.5</td><td>To be revised:

3.2.5 If an ACSD is equipped with a means of attaching to a rigid bar anchorage system, as prescribed by 49 CFR 571.225 S9, then the provided attachment hardware must comply with the requirements of 49 CFR 571.213 S5.9(a). If rigid prongs are provided for that attachment, they shall be retractable to the extent necessary to ensure proper positioning of the ACSD in an airplane passenger seat not equipped with rigid bar lower anchorages to avoid damage to the airplane seat or injury to nearby seat occupants.</td></tr>
</table>

APPENDIX 1

MPS FOR AVIATION CHILD SAFETY DEVICE *(continued)*

AS 5276/1 section:	***Action:***
Paragraph 3.2.6	New paragraph 3.2.6 to be added: Except for components designed to attach to a child restraint anchorage system, an ACSD must not have any means designed for attaching the system to an aircraft seat cushion or aircraft seat back and any component (except belts) that is designed to be inserted between the aircraft seat cushion and the aircraft seat back. An ACSD shall be capable of meeting the requirements of this standard when installed solely by the passenger seat lap belt (pelvic portion of the restraint). If the ACSD is equipped with a child restraint anchorage system, then it shall also be capable of meeting the requirements of this standard when installed solely by attachment to rigid bar lower anchorages as prescribed by 49 CFR 571.225 S9. No passenger seat belt may contact the child-occupant of the ACSD. Each belt that is part of an ACSD and that is designed to restrain the child using the system, shall, when tested in accordance with Section 4 of this standard, impose no loads on the child as a result from the mass of the system or from the mass of the standard seat assembly specified therein.
Paragraph 3.2.7	New paragraph 3.2.7 to be added: 3.2.7 An ACSD shall comply with the force distribution requirements of 49 CFR 571.213 S5.2.1.1, S5.2.1.2, S5.2.2.1 (a), (b) and (c), S5.2.2.2, and S5.2.4.
Paragraph 3.2.8	New paragraph 3.2.8 to be added: 3.2.8 ACSD belt systems shall comply with the requirements of 49 CFR 571.213 S5.4.1.2, S5.4.1.3, S5.4.2, S5.4.3.1, S5.4.3.3, S5.4.3.5. References to paragraph S6.1 therein shall be considered to refer to Section 4 of this standard.
Paragraph 3.3	To be revised: 3.3 Fire Protection: Cushions, upholstery, and all other exposed materials used in the ACSD except small parts (knobs, triggers, fasteners, seals and electrical parts) that would not contribute significantly to the propagation of a fire shall meet the fire protection provisions of CS 25.853(a) (Appendix F, Part I (a)(1)(ii)). Seat belts and shoulder harnesses shall meet the provisions of CS 25 (Appendix F, Part I (a)(iv)).

APPENDIX 1

MPS FOR AVIATION CHILD SAFETY DEVICE *(continued)*

AS 5276/1 section:	***Action:***
Paragraph 4	To be revised: 4. PERFORMANCE TEST SPECIFICATIONS: The dynamic test described in this section is used to evaluate the performance of the ACSD in a horizontal impact where the force is applied against the longitudinal axis of a forward-facing airplane passenger seat that holds the ACSD. The structural adequacy of the ACSD, the effectiveness of the ACSD attachments, and the adequacy of restraint of the child occupant, as prescribed in paragraph 4.1 of this AS, are the issues evaluated. One dynamic impact test shall be performed, with the ACSD secured using the passenger seat lap belt, for each category of child-occupant, as defined in paragraph 2.3 of this AS, for which the ACSD is intended for use. ACSD equipped with lower anchorage attachment hardware per 49 CFR 571.213 S5.9(a) must be tested with each category of child occupant when secured using the rigid bar lower anchorages, except when the ACSD is in full compliance with 49 CFR 571.213.
Paragraph 4.1	To be revised: 4.1 Child-Occupant Simulation: One or more ATD representing the child categories for which the ACSD is intended for use shall be used to simulate a child-occupant in the dynamic test. Selection of the ATD shall be based on compliance with the following requirements: a. A newborn infant ATD, per 49 CFR part 572, Subpart K, shall be used to test a Type I ACSD. b. A newborn infant ATD and a 12-month-old child ATD, per 49 CFR part 572, Subpart R, shall be used to test a Type II ACSD. c. A 12-month-old child ATD and a 3-year-old child ATD, per 49 CFR part 572, Subpart P, shall be used to test a Type III ACSD.
Paragraph 4.1.2	To be revised: 4.1.2 ATD Preparation and Clothing: All three types of ATDs used shall have a target point marker on each side of the head that is located on the transverse axis passing through the centre of mass of the ATD's head and perpendicular to the head's midsgittal plane. The 12-month-old and 3-year-old ATD's must also have target points located on each knee pivot axis. ATDs must be clothed and prepared for use, as prescribed in 49 CFR 571.213 S9.

APPENDIX 1

MPS FOR AVIATION CHILD SAFETY DEVICE *(continued)*

AS 5276/1 section:	***Action:***
Paragraph 4.2	To be revised: 4.2 Test Fixtures: The fixture on which the ACSD is installed for the dynamic test is based on the FMVSS-213 standard seat assembly test fixture defined in 49 CFR 571.213 S6.1.1(a)(1)(i). For the test specified by this AS, the back cushion, seat cushion, lap belts, and belt anchor points are different from the FMVSS-213 standard seat test fixture configuration. Appendix A to this AS presents the locations, dimensions, and materials used to reconfigure the FMVSS-213 standard seat assembly test fixture for the test specified by this AS.
Paragraph 4.2.1	To be revised: 4.2.1 Passenger Seat Restraints: Airplane passenger seat lap belts shall be installed on the seat test fixture as the primary means of attaching the ACSD to the seat test fixture depicted in Appendix A to this AS. The buckle shall be a lift latch type release mechanism. The belts shall meet the requirements of ETSO-C22g and conform to the length dimensions shown in Appendix A, Figure A5, to this AS. The webbing shall be made of nylon.
Paragraph 4.2.2	New paragraph 4.2.2 to be added: 4.2.2 Rigid Bar Lower Anchorages: If testing ACSD equipped with lower anchorage attachment hardware, the aforementioned modified seat test fixture must have rigid bar lower anchorages installed per Figures 1A and 1B of 49 CFR 571.213.
Paragraph 4.5	The last sentence of paragraph 4.5 Photometric Instrumentation shall be revised: The resolution of the images shall be sufficient to enable accurate measurements of the maximum excursion of the head and knee of the ATD in Type III ACSD tests, or the maximum rotation of the ACSD in aft-facing Type I and Type II ACSD tests.
Paragraph 4.6	To be revised: 4.6 Test Severity: The dynamic impact pulse shall meet the requirements specified for Type A seats in AS8049B, i.e. the 16 g, 13.4 m/s (44 ft/s) horizontal test condition for transport category airplane seats. The pulse described in Figure 2A of 49 CFR 571.213 is acceptable to show compliance with this requirement. The yaw and floor deformation specified in AS8049B are not required.

APPENDIX 1

MPS FOR AVIATION CHILD SAFETY DEVICE *(continued)*

AS 5276/1 section:	***Action:***
Paragraph 4.7	New paragraph 4.7 to be added: 4.7 Test Conditions: During the test, maintain the environmental conditions specified in 49 CFR 571.213 S6.1.1(d).
Paragraph 5.1	To be revised: 5.1 ACSD Installation: Install the ACSD at the centre of the seating position of the modified FMVSS-213 standard seat assembly test fixture in accordance with the manufacturers instructions provided with the system except that no tether strap shall be used. For the belted test condition, use only the aircraft lap belt. For tests with a child restraint anchor system, use only the lower anchorages of the child restraint anchor system.
Paragraph 5.2	New paragraph 5.2 to be added: 5.2 ATD Installation: The ATD shall be placed in the ACSD. Position it, and attach the child restraint belts, if appropriate, per 49 CFR 571.213 S10.
Paragraph 5.3	To be revised: 5.3 ACSD Integral Restraint Adjustment: The ACSD integral restraint system shall be routed through the ACSD and fastened over the ATD as called for by the manufacturer’s instructions and per 49 CFR 571.213 S6.1.2(d)(1)(i).
Paragraph 5.4	To be revised: 5.4 ACSD Attachment Adjustment: The aircraft lap belt or child restraint anchor system straps attaching the ACSD to the standard seat assembly test fixture shall be adjusted per 49 CFR 571.213 S6.1.2(d)(1)(ii) or (iii) as appropriate.
Paragraph 6.1	To be revised: 6.1 Excursion Limits: The ATD and ACSD excursions and initial positions described below shall be obtained by measuring the high-speed film or video images recorded during the test, or in the case of initial position, measured directly prior to the test.

APPENDIX 1

MPS FOR AVIATION CHILD SAFETY DEVICE *(continued)*

AS 5276/1 section:	***Action:***
Paragraph 6.1.1	To be revised: 6.1.1 Test of Forward-Facing ACSD: The ACSD shall retain the ATD's torso within the system. No portion of the ATD head shall pass through a vertical transverse plane passing through a point 813 mm (32 in.) forward of the seat back pivot axis on the standard seat assembly test fixture shown in Appendix A, Figure A2. This limit is referred to as the head excursion limit.
Paragraph 6.1.2	The second paragraph shall be revised: 6.1.2 Test of Aft-Facing ACSD: The angle between the ACSD back child support surface and the vertical transverse plane shall not exceed 70 degrees at any time during the test. The initial (pre-test) angle between the ACSD back child support surface and the vertical transverse plane shall not be less than 45 degrees. All portions of the ATD torso shall be retained within the ACSD. The centre of the target points on either side of the ATD head shall not pass through the transverse orthogonal planes whose intersection contains the forward-most and top-most points on the ACSD surfaces.
Paragraph 6.2	To be revised: The Head Injury Criterion (HIC36) is calculated according to the following equation: $$\mathrm{HIC} = \left\{ (t_1 - t_2) \left[(1/(t_2 - t_1)) \int_{t_1}^{t_2} a(t)dt \right]^{2.5} \right\} \mathrm{Max}$$ Where: t1, t2 = Any two points in time during the head impact which are not separated by more than a 36 millisecond time interval a(t) = The resultant head acceleration at the centre of gravity of the ATD head expressed as a multiple of g (the acceleration of gravity). The maximum value of the HIC36 computation from data acquired during the impact test, including rebound motion of the ATD and ACSD, shall not exceed a value of 1 000.

ETSO-C100c
APPENDIX 1

APPENDIX 1

MPS FOR AVIATION CHILD SAFETY DEVICE *(continued)*

AS 5276/1 section:	*Action:*
Paragraph 6.4	A new second paragraph shall be added: The ACSD shall also meet the requirements of 49 CFR 571.213 S5.1.1. References to paragraph S6.1 therein shall be considered to refer to Section 4 of this standard.
Paragraphs 7.1a through 7.1e	Paragraphs 7.1a. through e. shall be disregarded. Marking of the article shall be in accordance with paragraphs 7.1f. through 7.1h., and paragraph 4 of this ETSO.
Paragraph 7.1g	The second paragraph shall be revised: 'Place this Type I , II and III child restraint in a rear-facing position when using it with an infant weighing less than ____ pounds (______Kg).'
Paragraphs 7.1h through 7.1m	To be disregarded.
Paragraph 7.1h	New paragraph 7.1h to be added: 7.1h The following statement on yellow background with black text, regarding the installation and use of ACSD*:* *'WARNING! DEATH OR SERIOUS INJURY CAN OCCUR. Follow all instructions on this aviation child restraint and in the manufacturer's written instructions located [insert location[.* — *Do not place this device behind any wall or seat back in an airplane that has an airbag.* — *Do not use in any passenger seat that has an inflatable seat belt.* — *Use only in a forward-facing seat. Do not use in a rear-facing seat or a side-facing seat.* — *Attach this aviation child restraint with the airplane passenger seat lap belt or rigid bar anchorage system if so equipped.* — *This aviation child restraint is not designed to be used with a shoulder strap or any other tether strap to the seat or airplane.* — *Snugly adjust the belts provided with this aviation child restraint around your child.'*

APPENDIX 1

MPS FOR AVIATION CHILD SAFETY DEVICE *(continued)*

AS 5276/1 section:	***Action:***
Paragraph 7.1i	New paragraph 7.1i to be added: 7.1i Additional label for ACSD that do not meet FMVSS-213. Any ACSD that meets the MPS of this TSO, but does not met the requirements of FMVSS-213, the label in new Figure A6 must be permanently affixed to the webbing of the ACSD so that it is clearly visible when the ACSD is installed.
Figure A1	Figure A1 shall be revised as follows: The horizontal distance between the seat back pivot axis to the lap belt anchor axis shall be changed from 269 (10.6) to 246 (9.7).
Figure A2	Figure A2 shall be revised as follows: The horizontal distance between the seat back pivot axis to the lap belt anchor axis shall be changed from 269 (10.6) to 246 (9.7). A new item 9 shall be added: Aluminium rod: 25.4 (1.0) Dia. welded to the front edge of item 1 such that the rod surface is tangent to the plane of the bottom of the aluminium plate.
Figure A3	Figure A3 shall be revised as follows: The vertical dimension of the anchor pivot shall be changed from 47.8 (1.88) to 50.8 (2.0), and the vertical dimension of the anchor height from 60.5 (2.38) to 63.5 (2.5).
Figure A4	Figure A4 shall be revised as follows: A depiction of the 25.4 (1.0) Dia. rod defined in Figure A2 shall be added.

APPENDIX 1

MPS FOR AVIATION CHILD SAFETY DEVICE *(continued)*

AS 5276/1 section:	***Action:***
Figure A6	Figure A6 shall be replaced as follows: FIGURE A6 — Label for ACSD Not Meeting FMVSS-213  — Box outline of label is red, 6-point line width. — Box is 4.75 inches long by 1.25 inches high. — Interior of box is yellow background. — Text is Arial bold black letters. — Large text is 18 point. — Smaller text is 16 point.

ETSO-C112e
Date: 5.8.2016

European Aviation Safety Agency

European Technical Standard Order

Subject: Secondary Surveillance Radar Mode S Transponder

1 — Applicability

This ETSO provides the requirements which Secondary Surveillance Radar Mode S Transponder 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-73E, Minimum Operational Performance Standards for Secondary Surveillance Radar Mode S Transponders, dated May 2011 as amended by Appendix 1 to this ETSO.

Note: Level 2 transponders are expected to comply with the Overlay Command Capability as per ED-73E section 3.23.1.12 and 3.18.4.40.

3.1.2 — Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1.

3.1.3 — Computer Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 — Electronic Hardware Qualification

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.

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.

4 — Marking

4.1 — General

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

4.2 — Specific

The marking must also include the transponder's functional level and optional additional features as provided in ED-73E, Section 1.4.2.2, as well as minimum peak output power identified by the transponder class as defined in ED-73E, Section 1.4.2.4.

5 — Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

APPENDIX 1

SECONDARY SURVEILLANCE RADAR MODE S TRANSPONDER

AMENDMENT TO EUROCAE ED-73E REQUIREMENTS

This Appendix lists the EASA modification to MPS for Secondary Surveillance Radar Mode S Transponder.

The applicable standard is EUROCAE ED-73E Secondary Surveillance Radar Mode S Transponder, dated May 2011, amended as described below.

Text from EUROCAE ED-73E is provided here as needed to provide context. Text to be added is <u>underlined</u>. Text to be removed is ~~lined through~~.

1. *EUROCAE ED-73E, page 59, Section 3.23.1.12.d, is modified here to ensure multiple Comm-B message changes are processed properly.*

d. Comm-B Broadcast

Note <u>1</u>: *A Comm-B broadcast is a message directed to all active interrogators in view. Messages are alternately numbered 1, 2, and are available for 18 seconds unless a waiting air-initiated Comm-B interrupts the cycle. Interrogators have no means to cancel the Comm-B broadcast.*

<u>***Note 2:*** *If there is more than one Comm-B message waiting for transmission, the timer is only started once the message becomes the current Comm-B broadcast.*</u>

A Comm-B broadcast starts, when no air-initiated Comm-B transaction is in effect, with the <u>loading of the broadcast message into the Comm-B buffer,</u> insertion of DR codes 4, 5, 6 or 7 into downlink transmissions of DFs 4, 5, 20, 21 and with the starting of the B-timer <u>for the current Comm-B message</u>. On receipt of the above DR codes, interrogators may extract the broadcast message by transmitting RR=16 with DI≠3 or 7 or with DI=3 or 7 and RRS=0 in subsequent interrogations. <u>The change of the DR value is used by the interrogator to detect that a new Comm-B broadcast is announced and to extract the new Comm-B message. A new Comm-B broadcast shall not interrupt a current Comm-B broadcast.</u> When the B-timer runs out after 18 ± 1 seconds, the transponder will reset the DR codes as required, will discard the previous broadcast message, and changes the broadcast message number from 1 to 2 (or vice versa).
If an air-initiated Comm-B transaction is initiated during the broadcasting interval (i.e., while the B-timer is running), the B-timer is stopped and reset, the appropriate code is inserted into the DR field, and the Comm-B transaction proceeds per Figure 3-18. The previous Comm-B broadcast message remains ready to be reactivated for 18 ± 1 seconds after conclusion of the air-initiated Comm-B transaction.
<u>Waiting Comm-B broadcasts shall be retained for transmission once the current Comm-B broadcast is finished. If the contents of a waiting Comm-B broadcast changes, only the most recent value shall be broadcast. This prevents multiple changes from generating a sequence of broadcasts. Currently only BDS registers 1,0, Downlink Capability Report and, 2,0, Flight ID, make use of the Comm-B Broadcast protocol.</u>

2. *A test procedure is added here to ensure the modified requirements in Section 1 of this Appendix are met. This test is intended to be introduced in EUROCAE ED-73E, Section 5.5.8.23, on pages 253 and 254.*

5.5.8.23 Procedures #21A and #21B Comm-B Broadcast

(§3.23.1.12 d protocol)

5.5.8.23.1 Test Procedure #21A Comm-B Broadcast

Note 1: *The command to the transponder that a Comm-B broadcast message shall be sent originates in a peripheral device or in the device that holds the extended capability report.*

Note 2: *The Comm-B broadcast does not affect the existing Comm-B protocol, air- or ground-initiated. The existing test procedures remain unchanged.*

Note 3: *Verification of interface patterns is already part of the Comm-B test procedures and need not be repeated for the Comm-B Broadcast.*

This test procedure verifies that the DR code command and the MB field of the Comm-B broadcast protocol is carried out correctly.

a. STEP 1 — General Broadcast Protocol Test

During the Comm-B protocol test procedure (Procedure #18) insert the appropriate DR Code command and the MB field of the Comm-B broadcast into the transponder.

Verify that:

(1) The transponder can correctly show the DR codes 4, 5, 6, 7 when NO air initiated Comm B is in progress and that it cannot show DR codes 4, 5, 6, 7 when an air initiated Comm B is in progress.

(2) The Comm-B broadcast message can be extracted by the interrogator for 18 ± 1 seconds.

(3) The Comm-B broadcast annunciation (DR = 4, 5, 6, or 7) and the Comm-B broadcast MB field are interrupted by an air-initiated Comm-B and reappear when that transaction is concluded. For transponders implementing the enhanced airinitiated Comm-B protocol, the transponder will be independently interrupted by up to 16 Comm-B messages that are assigned to each II code. After the Comm-B is concluded for each II code, the Comm-B broadcast is again available to that interrogator. Verify that the next waiting broadcast message is not announced to any interrogators until the current broadcast message has timed out.

(4) After interruption another 18 ± 1 seconds of broadcast time is available to the interrogator. For transponders implementing the enhanced air-initiated Comm-B protocol, the transponder will be independently interrupted by up to 16 Comm-B messages that are assigned to each II code. After interruption, another 18 ± 1 seconds of broadcast time is available for each II code.

(5) A subsequent and different Comm-B broadcast message is announced with the alternate DR code and that this DR code also follows the verifications above. For transponders implementing the enhanced air-initiated Comm-B protocol, the transponder will be independently interrupted by up to 16 Comm-B messages that are assigned to each II code. The subsequent Comm-B broadcast is announced only after each Comm-B is broadcast timer has expired for all II codes.

b. STEP 2 — Transponder-Initiated Broadcast

(1) Enter an AIS Flight Identification into the transponder.

Verify that a broadcast is automatically initiated by the transponder.

Extract the broadcast and verify the correct flight ID.

Wait 20 seconds to allow the broadcast timer to time out and enter the same AIS value again.

Verify that no new broadcast is initiated by the transponder.

Repeat the test with a different AIS flight identification.

(2) Enter a datalink capability report into the transponder.

Verify that a broadcast is automatically initiated by the transponder.

Extract the broadcast and verify the correct datalink capability report.

Wait 20 seconds to allow the broadcast timer to time out and enter the same datalink capability report again.

Verify that no new broadcast is initiated by the transponder.

Repeat the test with a different datalink capability report.

5.5.8.23.2 Test Procedure #21B Processing of multiple Comm-B messages

Note 1: *The command to the transponder that a Comm-B broadcast message shall be sent originates in a peripheral device or in the device that holds the extended capability report.*

Note 2: *The Comm-B broadcast does not affect the existing Comm-B protocol, air- or ground-initiated. The existing test procedures remain unchanged.*

Note 3: *Verification of interface patterns is already part of the Comm-B test procedures and need not be repeated for the Comm-B Broadcast.*

This test procedure verifies that multiple Comm-B broadcast messages are queued and processed correctly.

Generate one flight identification change followed by a data link capability report change and two more flight identification changes in less than 18 seconds.

Verify that:

(1) The first Flight ID change is available as a Comm-B Broadcast.

(2) The data link capability report change is made available as a Comm-B broadcast after the Flight ID Broadcast times out.

(3) The last flight ID change is made available as a Comm-B Broadcast after the Data Link Capability Broadcast times out.

(4) All three Comm-B Broadcasts are available for 18 ± 1 seconds each.

ETSO-C113a
Date: 5.8.2016

European Aviation Safety Agency

European Technical Standard Order

Subject: Airborne Multipurpose Electronic Displays

1 — Applicability

This ETSO provides the requirements which Airborne Multipurpose Electronic 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 the SAE AS8034B, Minimum Performance Standards for Airborne Multipurpose Electronic Displays, dated 6/1/2011. Additional requirements on colour can be found in Appendix 1 to this document.

To be eligible to this ETSO standard, the equipment shall at least contain a Display Unit providing the visualisation function.

3.1.2 — Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1.

3.1.3 — Computer Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 — Electronic Hardware Qualification

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 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.

ETSO-C113a
APPENDIX 1

Appendix 1 — Colour

SAE AS8034B, Section 4.3.4, requires colour-coding requirements. This Appendix provides additional guidance on colour.

1. Display features, precipitation, and turbulence areas should be colour-coded as depicted in Table A1 and Table A2 respectively, unless otherwise specified by the ETSO application being displayed.

Table A1

Display Feature	Colour
Warnings	Red
Flight envelope and system limits	Red [Note 1]
Cautions, non-normal sources	Amber/Yellow
Scales and associated figures	White [Note 2]
Earth	Tan/Brown
Sky	Cyan/Blue
Engaged Modes/normal conditions/safe operation	Green

Note 1: Use of Amber/Yellow as appropriate is also acceptable.

Note 2: Use of the colour green for tape elements (for example, airspeed and altitude) has also been found acceptable if the colour green does not adversely affect flight crew alerting.

Table A2

Precipitation and Turbulence	Colour
Precipitation up to 4 millimeters per hour (mm/hr)	Green
Precipitation 4–12 mm/hr	Amber/Yellow
Precipitation 12–50 mm/hr	Red
Precipitation Above 50 mm/hr	Magenta
Turbulence	White or Magenta

2. Background colour (gray or other shade) may be used to enhance display presentation.

3. Colours should track brightness so that chrominance and relative chrominance separation are maintained as much as possible during day-night operations.

ETSO-C116a
Date: 5.8.2016

European Aviation Safety Agency

European Technical Standard Order

Subject: Crewmember Portable Protective Breathing Equipment

1 — Applicability

This ETSO provides the requirements which Crewmember Portable Protective Breathing 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 SAE AS8047, Performance Standard for Cabin Crew Portable Protective Breathing Equipment for Use During Aircraft Emergencies, dated 6/1/2002, as modified by Appendix 1 to this ETSO.

Crew member portable PBE are separated into four classes suitable for use by crew members during the following scenarios:

Class 1:	For an in-flight cabin or accessible compartment smoke/fire conditions at normal cabin altitude (up to 8 000 ft equivalent).
Class 2:	In addition to the requirements of Class 1, protection against a subsequent depressurisation to 40 000 ft while wearing the unit.
Class 3:	Emergency ground evacuation of the aircraft during fire/smoke conditions, operating escape systems and assisting passengers.
Class 4:	In-flight emergency and ground evacuation during smoke/fire conditions (as per Class 1 & 3 combined).

3.1.2 — Environmental Standard

See paragraph 6.3 of Appendix 1 to this ETSO.

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3.1.3 — Computer Software

None.

3.1.4 — Electronic Hardware Qualification

None.

3.2 — Specific

None.

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

In addition, the crew member's portable PBE shall be marked permanently and legibly with the class (see paragraph 3.1.1 above).

5 — Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

Appendix 1

MPS FOR CREWMEMBER PORTABLE PBE

The applicable standard is SAE AS8047, Performance Standard for Cabin Crew Portable Protective Breathing Equipment for Use During Aircraft Emergencies, dated 6/1/2002. It shall be modified as follows:

SAE AS 8047 section:	**Action:**
Section 1.1 Scope:	To be disregarded.
Paragraph 2.1 Applicable Documents:	The following documents shall be added: AS 8026A, Crewmember Demand Oxygen Mask for Transport Category Aircraft AS 1303A, Portable Chemical Oxygen
	To be revised: CS-25, Certification Specifications Large Aeroplanes AS 8010C, Aviator's Breathing Oxygen Purity Standard AS 8031A, Personal Protective Devices for Toxic and Irritating Atmospheres, Air Transport Crew Members ETSO-C99a, Flight Deck (Sedentary) Crewmember Protective Breathing Equipment ETSO-C69c, Emergency Evacuation Slides, Ramps and Slide/Ramp Combinations ASTM D1149, Standard Test Method for Rubber Deterioration — Surface Ozone Cracking in a Chamber ASTM D624, Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers ASTM D750, Standard Test Method for Rubber Deterioration Using Artificial Weathering Apparatus ASTM D228, Abrasion Resistance ASTM D1922-REVA, Standard Test Method for Propagation Tear Resistance of Plastic Film and Thin Sheeting by Pendulum Method ASTM D1004, Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting ASTM D2582, Standard Test Method for Puncture-Propagation Tear Resistance of Plastic Film and Thin Sheeting

Appendix 1

MPS FOR CREWMEMBER PORTABLE PBE *(continued)*

SAE AS 8047 section:	**Action:**
Paragraph 3.1.1	Following paragraphs to be added: 3.1.1 Unit must be a self-contained device, (containing a supply or source of breathable gas) which will not increase the risk to the user or the aircraft during storage or use, and must satisfy the requirements of the applicable sections of CS 25.1439 and the required operational regulations. 3.1.1.1 Breathable gas source may be either oxygen or air. 3.1.1.2 Use of a chemical oxygen generator is an acceptable alternative. 3.1.1.3 Breathable gas must meet the gas standard for purity, SAE AS8010 Rev C, Aviator's Breathing Oxygen Purity Standard. For air, compliance with the purity standards in AS8010C, Table 2, Constituent Maximum Concentrations for Chemical Oxygen, has to be shown. Type IV chemically-generated oxygen for emergency-use shall be used.
Paragraph 3.1.2	To be revised: 3.1.2 Portable PBE unit must adequately protect any adult (within the 5th percentile female (107 lbs, 11.1-inch neck circumference) to 95th percentile male (220 lbs, 16.4-inch neck circumference) body dimensions), including spectacle users. To demonstrate compliance with spectacles, eyeglasses must be a minimum of 152 mm (6 inches) wide by 51 mm (2 inches) high. 3.1.2.1 Facepiece designers should consider extremes of Naison-Menton, Bizygomatic, Bigonial and Naison-Supramentale measurements and other applicable anthropometric data to provide a device with adequate fit. Sources of data are listed in paragraph 2. 3.1.2.2 Limitations/recommendations shall be included in the IM/CMM (required in paragraph 5.b of this ETSO) for using portable PBE with long hair and/or beards. 3.1.2.3 The size of the portable PBE unit when donned must allow the wearer to pass through any access opening 18 inches (460 mm) × 18 inches (460 mm) to investigate and/or combat an in-flight fire.

ETSO-C116a
Appendix 1

MPS FOR CREWMEMBER PORTABLE PBE *(continued)*

SAE AS 8047 section:	Action:
Paragraph 3.1.4	To be revised: 3.1.4 Failure of the unit to operate or to cease operation must be apparent to the user. This must be accomplished with aural and/or visual warning that also must activate at gas supply exhaustion.
Paragraph 3.1.5	To be disregarded.
Paragraph 3.1.6	To be revised: 3.1.6 Unit must not cause a hazard when stored, in use, or during inadvertent operation.
Paragraph 3.1.8	To be revised: 3.1.8 The portable PBE unit must have a 98 % minimum reliability factor at 90 % confidence level during its design service life. A shelf life, operational limit and/or maintenance interval must be established and included in the CMM.
Paragraph 3.1.10	To be revised: 3.1.10 Portable PBE must wear comfortably in use leaving both hands free. It must not displace during normal tasks of locating and combating a fire, such as crawling, kneeling or running.
Paragraph 3.1.11	To be revised: 3.1.11 Hoods, Full-Face Masks with Lenses, and/or Integral Goggles 3.1.11.1 Range of Vision: Portable PBE must permit peripheral vision in the horizontal meridian of at least 120 degrees (60 degrees on each side of the centre point) and in the vertical meridian of at least 60 degrees (40 degrees above and 20 degrees below the centre point) when evaluated by standard arc perimeter techniques. 3.1.11.2 Fogging: The portable PBE shall be designed to minimise moisture condensation on the inside surface, or include a means of preventing or removing any moisture that may condense on surfaces during use.

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Appendix 1

Appendix 1

MPS FOR CREWMEMBER PORTABLE PBE *(continued)*

SAE AS 8047 section:	**Action:**
Paragraph 3.1.12	To be revised: 3.1.12 Portable PBE must allow intelligible two-way communication, including the use of airplane interphone (handset or microphone) and megaphone. User must be able to communicate with another user or non-user at a distance of at leastfour meters. Use a background noise of 65db and a user communication sound level of 85db or equivalent method.
Paragraph 3.1.15	New paragraph to be added: 3.1.15 Material used to fabricate the unit must be puncture/tear-resistant.
Paragraph 3.2.1	To be revised: 3.2.1 Average inspiratory limits must be within the following: — Carbon dioxide concentration level at mouth/nose must not exceed 4 %at sea level. Concentration may increase to 5 % at sea level for a period not to exceed 2 minutes. — Carbon monoxide level must not exceed 50 ppm, time-weighted average. — Chloride level must not exceed 1 ppm, time weighted-average.
Paragraph 3.2.2	To be revised: 3.2.2 When a user puts on portable PBE, the unit must be self-purging by enough breathable gas to ensure one complete dead volume displacement within 20 seconds of initial operation.
Paragraph 3.2.3	To be revised: 3.2.3 Portable PBE must protect the user against toxic fumes and smoke. The test procedures in AS 8031A shall be used. An alternative challenge gas may be used. Aerosols, such as sodium chloride (NaCl) or corn oil are not acceptable as an alternative. Component sensitivity to particle size and the potential to precipitate on the unit surface make aerosols unacceptable to measure a contaminant protection factor. User’s eyes, nose, and mouth must be protected to 0.05 mean contaminant protection factor during the work profiles specified in paragraph 3.2.4.

Appendix 1

MPS FOR CREWMEMBER PORTABLE PBE *(continued)*

SAE AS 8047 section:	**Action:**
Paragraph 3.2.4	First sentence to be revised: 3.2.4 Portable PBE must provide the minimum required protection for the following work profiles, at an ambient 70 °F (21.1 °C) for the intended population (generally 107 to 220 lb).
Paragraph 3.2.5	To be revised: 3.2.5 Internal temperature of the portable PBE must not exceed 104 °F (40 °C) wet bulb at an ambient temperature of + 70 °F (21.1 °C).
Paragraph 3.2.6	To be revised: 3.2.6 Portable PBE must function satisfactorily in a 212 °F (100 °C) environment, where the internal temperatures must not exceed 122 °F (50 °C) wet bulb for a 2-minute exposure.
Paragraph 3.2.9	To be revised: 3.2.9 Portable PBE must operate at a mean positive pressure and incorporate a relief valve(s) to prevent over-pressurisation.
Paragraph 3.2.10	To be revised: 3.2.10 Portable PBE must support peak flows of 250 liters per minute (LPM) and must be capable of supporting a minute breathing minute volume of 80 litres for a 30-second period at any time throughout its operation.
Paragraph 3.2.11	To be revised: 3.2.11 Portable PBE must be easily put on and activated, after the user gains access to the stowed unit within 15 seconds. The unit shall be designed so it can be donned and worn by users wearing eyeglasses, as specified in paragraph 3.1.2. Unit face must not displace eyeglasses or be flexible enough to allow adjustment of eyeglasses.
Section 4 CONSTRUCTION	To be disregarded.
Paragraph 6	To be revised: TESTING PROCEDURES:

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Appendix 1

Appendix 1

MPS FOR CREWMEMBER PORTABLE PBE *(continued)*

SAE AS 8047 section:	Action:
Paragraph 6.1	First sentence to be revised: Manufacturer of the portable PBE is responsible for performing the required tests in paragraph 3.2 to verify its performance.
Paragraph 6.2	To be disregarded.
Paragraph 6.2	New paragraph to be added: 6.2 FLAMMABILITY. All materials used in the portable PBE and any stowage container/case (including insulation on electrical wires) in a typical installed arrangement must be self-extinguishing. Materials must comply with CS 25.853(a), Appendix F, Part I (a)(1)(iv). 6.2.1 Any exposed portions of the portable PBE and stowage container/case must withstand a radiant heat flux of 1.0 BTU/ft^2 per second for 60 seconds, and remain functional when exposed to it. 6.2.2 Radiant heat flux source must be of sufficient size so the portable PBE, any stowage container/case, and exposed parts of the unit are exposed in a manner that creates the heat flux at all the surfaces, in a typical as installed arrangement. 6.2.3 Portable PBE must protect the user's head and neck from dripping 392 °F (200 °C) plastic materials and withstand an 1 832 °F (1 000 °C) flame for 5 seconds without material penetration while operating. 6.2.3.1 Protection from dripping plastic material may be tested by several methods. One is to ignite a polypropylene rod and allow the drops to impinge on the various external materials, seams, and transparency. Adjust the drop height so that the drop contact temperature is at least 392 °F (200 °C).

Appendix 1

MPS FOR CREWMEMBER PORTABLE PBE *(continued)*

SAE AS 8047 section:	Action:
Paragraph 6.2 *(continued)*	6.2.3.2 The 5-second 1 832 °F (1 000 °C) test is meant to protect a crew member wearing the portable PBE from an unexpected flame lick. Two main concerns are failure of the unit that would injure the wearer, and leakage of the breathable atmosphere that could produce an explosion or hazard. The test rig must expose the unit, while operating, to a 1 832 °F (1 000 °C) flame envelope. One company has used German Teklu burners with a flow rate of about 21 liters per minute. The flow rate and distance of the burner to the surface of the PBE unit being tested shall be adjusted to obtain the required temperature. In most cases the flame plume developed will not expose the complete unit. A segment can be passed through the flame plume to obtain the 5-second exposure period and then the unit can be rotated to the next segment and passed through the flame plume, and so forth, until the complete unit has been tested. Making a visual (videotape) record of this test might be useful documentation, in addition to the measured parameters. 6.2.4 Heat Release and Smoke Density. Exposed panels/surfaces totalling more than one square foot in surface area must meet the heat release and smoke density requirements of CS 25.853, Appendix F, Parts IV and V. Guidance on these test requirements can be found in the Aircraft Materials Fire Test Handbook, DOT/FAA/AR-00/42, at www.fire.tc.faa.gov/handbook.stm. 6.2.5 Battery Qualification. If the equipment uses a lithium battery as a power source, battery must meet the applicable battery standards: 6.2.5.1 ETSO-C142a, Non-Rechargeable Lithium Cells and Batteries (see RTCA, Inc. document RTCA/DO-227, Minimum Operational Performance Standards for Lithium Batteries, dated June 23, 1995), or most current revision. 6.2.5.2 ETSO-C179a, Rechargeable Lithium Cells and Lithium Batteries (see UL 1642, Standard for Safety for Lithium Batteries, fourth edition, dated September 19, 2005).

ETSO-C116a
Appendix 1

MPS FOR CREWMEMBER PORTABLE PBE *(continued)*

SAE AS 8047 section:	Action:
Paragraph 6.3	New paragraph to be added: 6.3 Environmental Qualification 6.3.1 High-Temperature Exposure: The portable PBE shall be soaked for 12 hours at not less than 160 °F (71.1 °C). Then the PBE shall be transferred to 70 °F (21.1 °C) ambient temperature. Within 30 minutes of doing this, the portable PBE shall be tested to the requirements of paragraph 3.2. 6.3.2 Low-Temperature Exposure: The portable PBE device shall be soaked for 2 hours at not greater than – 65 °F (– 54 °C). Then the PBE shall be transferred to 0 °F (– 17.8 °C) for 2 hours to stabilise it. After this, the PBE shall be transferred to 70 °F (21.1 °C) ambient temperature. Within 30 minutes of doing this, the portable PBE shall be tested to the requirements of paragraph 3.2. 6.3.3 Operational Shock: The PBE shall comply with the test requirements in RTCA DO-160 release defined in CS-ETSO, Subpart A, paragraph 2.1, Section 7, paragraph 7.2. 6.3.4 Humidity: The PBE shall comply with the test requirements in RTCA DO-160 release defined in CS-ETSO, Subpart A, paragraph 2.1, Section 6, Category A. 6.3.5 Waterproofness: The PBE shall comply with the test requirements in RTCA DO-160 release defined in CS-ETSO, Subpart A, paragraph 2.1, Section 10, Category R. 6.3.6 Fungus Resistance: The PBE shall comply with the test requirements in RTCA DO-160 release defined in CS-ETSO, Subpart A, paragraph 2.1, Section 13, Category F. 6.3.7 Decompression (Class 2 only): Devices covered by this document must meet the requirements of paragraph 3.2 when subjected to decompression testing.

ETSO-C119d
Date: 5.8.2016

European Aviation Safety Agency

European Technical Standard Order

Subject: AIRBORNE COLLISION AVOIDANCE SYSTEM II (ACAS II) Version 7.1 with Hybrid Surveillance

1 — Applicability

This ETSO provides the requirements which Airborne Collision Avoidance System II (ACAS II) Version 7.1 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 EUROCAE Document ED-143, Minimum Operational Performance Standards for Traffic Alert and Collision Avoidance System II (TCAS II), dated September 2008, as modified by Change 1 dated April 2009, Change 2 (Version 7.1) dated April 2013, and by Appendix 1 to this ETSO and EUROCAE Document ED-221, Minimum Operational Performance Standards for Traffic Alert and Collision Avoidance System II (TCAS II) Hybrid Surveillance, dated April 2013, Sections 2 and 3, as modified by Appendix 2 to this ETSO

3.1.2 — Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1.

3.1.3 — Computer Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 — Electronic Hardware Qualification

See CS-ETSO, Subpart A, paragraph 2.3.

3.2 — Specific resulting in misleading information

None.

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 hazardous 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.

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

TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM II (TCAS II) VERSION 7.1

AMENDMENT TO EUROCAE ED-143 CHANGE 2 REQUIREMENTS

This Appendix lists EASA modification to MPS for Traffic Alert And Collision Avoidance System (TCAS) Airborne Equipment, TCAS II Change 2, dated April 2013.

When own ship is on the ground, clarification is required to allow the system to limit the output of TCAS intruders to the display to those within 3 000 feet of own altitude. In lieu of section '2.2.2 System Performance' of EUROCAE ED-143 Change 2, substitute the following:

2.2.2 System Performance

Note: *When operating within the maximum aircraft transponder population and electromagnetic interference levels defined in subparagraph 2.2.1.2, TCAS II will provide a level of performance for active surveillance of targets-of-interest that will support the requirements for generation of collision advisory information.*

Specifically, TCAS II will generate a surveillance track in range and altitude on a target-of-interest at the range and with the track probability and range accuracy specified below. This is to ensure that a correct resolution advisory can be issued in time for the pilot to maintain adequate vertical separation at closest-point-of-approach.

TCAS II will also generate, whenever possible, a surveillance track in range and altitude on a target-of-interest at the range and with the track probability and range accuracy specified below such that a correct traffic advisory can be issued as a precursor to the resolution advisory.

In addition to the surveillance requirements to support generation of resolution and traffic advisories, TCAS II will display the range and, if available, the altitude and bearing position information on targets that generate advisories. The bearing position information will be generated according to the accuracy requirement specified below.

TCAS II will also generate for display, whenever possible, surveillance range, altitude and bearing position information on Mode C and Mode S aircraft that are within the range specified below and within ± 10 000 ft altitude relative to TCAS II when airborne, and within ± 3 000 ft altitude relative to TCAS II when on the ground.

It is acceptable to limit the output of TCAS intruders to the display to those within 3 000 feet of own altitude when own aircraft is on the ground. This is permitted (but not required) so that the altitude surveillance volume for TCAS Mode C intruders can be consistent with the Mode S surveillance altitude limits modified in EUROCAE ED-143 Change 2 (section 2.2.4.6.2.2.1). This allowance to limit the display to ± 3 000 feet does not modify surveillance altitude volumes which are defined in EUROCAE ED-143, section 2.2.4.6.

The system shall use the definition of on-ground as defined in EUROCAE ED-143, Volume II, 2.1.14. Alternatively, the system may use the definition of 'operating on Surface' in EUROCAE ED-221, section 2.2.8, for on-ground.

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Appendix 2

APPENDIX 2

TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM II (TCAS II) VERSION 7.1

HYBRID SURVEILLANCE

AMENDMENT TO EUROCAE ED-221 REQUIREMENTS

This Appendix lists EASA modification to MPS for Traffic Alert and Collision Avoidance System II (TCAS II) Hybrid Surveillance, dated April 2013.

Text from EUROCAE ED-221 is provided here as needed to provide context. Text to be added is underlined. Text to be removed is lined through.

1 To ensure proper revalidation when own aircraft is operating on the surface, in the first paragraph of EUROCAE ED-221, section 2.2.7.5 'Revalidation', insert the following <u>new underlined text</u>:

An established track that is under hybrid surveillance (per §2.2.7.1) **shall** be subject to revalidation. If a track under hybrid surveillance does not satisfy the first (altitude) condition of §2.2.6.1.4, it **shall** be subject to revalidation every 60th surveillance update interval; <u>if it satisfies the first and second (altitude and range) conditions of §2.2.6.1.4 but not the third (airborne) condition, it shall be subject to revalidation every 10th surveillance update interval;</u> if it satisfies the first condition of §2.2.6.1.4 but not the second (range) condition, it **shall** be subject to revalidation at intervals calculated according to the following procedure. The revalidation interval *t* **shall** be calculated at the time of the initial successful validation and at the time of each successful revalidation. It **shall** be used as the number of surveillance update intervals until the next revalidation attempt.

1.2 Because there is a requirement specifying creation of information which is never used, in EUROCAE ED-221, section 2.2.11 'Interface to the CAS Logic', delete existing ~~lined through~~ text from the first paragraph as follows:

Position data for tracks under passive surveillance may be provided to the CAS logic via the interface specified in Ref. A, §2.2.4.8.1. ~~If this is done, information **shall** be provided in addition to that required in Ref. A, §2.2.4.8.l(a) to distinguish a position report that resulted from a passive reception of an Airborne Position Message from one that resulted from an active interrogation.~~

1.3 Tests 2, 3a and 3b specified in EUROCAE ED-221, section 2.4.2.5 'Verification of Acquisition and Maintenance of Established Tracks Using Active Surveillance' (§2.2.6), do not need to be performed as their expected results are incorrect. Test coverage of the input conditions associated with those tests is provided, in aggregate, by other existing tests in EUROCAE ED-221.

1.4 A new Test 11a is required in addition to the existing Test 11 specified in EUROCAE ED-221, section 2.4.2.6 'Verification of Maintenance of Established Tracks using Passive Surveillance' (§2.2.7). This new test is to verify the revalidation rate when own aircraft is operating on the surface. Perform this new test in addition to the existing Test 11; the new test does not replace Test 11. Insert the following <u>new underlined text</u> after existing Test 11:

Test 11a (Intruder Revalidation Rate when own aircraft is operating on the surface §2.2.7.5)

This test verifies the revalidation rate when own aircraft is operating on the surface based on the altitude and range criteria for active tracking (§2.2.7.5).

(The following tests may be performed using ADS-B reports or directly decoded ADS-B messages. TIS-B and ADS-R data is not permitted.)

Scenario Description

- Intruder 1 shows that when own aircraft is operating on the airport surface and an intruder is within the altitude and range criteria for active surveillance it will be tracked using hybrid surveillance with a 10-second revalidation rate (§2.2.7.5).
- Intruder 2 shows that when own aircraft is operating on the airport surface and an intruder is within the altitude but not the range criteria for active surveillance it will be tracked using hybrid surveillance with a variable revalidation rate according to the requirements in (§2.2.7.5).

TCAS Aircraft
Altitude = 0 ft (Ground Level)
Altitude Rate = 0 FPM
Position = Sydney
Radio altitude input = 0 ft
Ground Speed is valid and at 0 knots and TCAS Air/Ground (OOGROUN) indicates on-ground.

Intruder Aircraft #1
Altitude = 2 000 ft
Altitude Rate = 0 FPM
Range = 2 NM
Relative Speed = 0 kt
At T = 100 the intruder is terminated.

Intruder Aircraft #2
Altitude = 2 000 ft
Altitude Rate = 0 FPM
Range = 8 NM
Relative Speed = 0 kt
At T = 100 the intruder is terminated.

Success Criteria

For the tests in this section, the revalidation rate for each applicable success criteria was identified using the table in §2.2.7.5. If the implementation uses the equation method, then the revalidation interval can be longer by 10 to 20 seconds. Care should be taken to verify that the success criteria matches the value expected based on the implementation.

For each intruder:

The surveillance reports to the CAS logic are present for the duration of the track. Verify that the track is under passive surveillance.

Intruder 1

Verify that revalidation interrogations are transmitted every 10 seconds.

Intruder 2
Verify that revalidation interrogations are transmitted every 30 seconds.

The revalidation rate for each applicable success criteria was identified using the table in §2.2.7.5. If the implementation uses the equation method, then the revalidation interval can be longer by up to 10 to 20 seconds. Care should be taken to verify that the success criteria matches the value expected based on the implementation.

1.5 EUROCAE ED-221 removes a provision which allowed for larger range calculation errors above ± 60 degrees latitude from RTCA/DO-300, Section 2.2.7.6 (from which ED-221 is derived), but the associated tests were not updated accordingly. To account for the removal of that provision, delete the following ~~lined through~~ text from EUROCAE ED-221, sections 2.4.2.8 'Verification of Error Budget in Computing Slant Range from Passive Data' and 2.4.2.10 'Verification of DF17 Decoding', and insert as underlined below a clarifying note in Appendix A 'Conversion of Reported Positions to Slant Range', section A.1 'Overview'.

2.4.2.8 Verification of Error Budget in Computing Slant Range from Passive Data

(…)

If the test method is used to demonstrate compliance with the requirement, then this paragraph describes one potential scenario. Own aircraft and intruder aircraft are travelling towards each other at 600 kt at high latitude ~~(near 60 degrees)~~. If the error between the passive range estimate and active range measurement is less than 145 meters then the intent of the requirement is met. The error in range computation of tests at slower closure rates can be used to extrapolate or predict errors at the 1 200 kt closure rate.

(…)

2.4.2.10 Verification of DF17 Decoding

(…)

Success Criteria

All Intruders.
For all of the Intruders ~~with Latitudes within ±60 degrees~~, verify that the range for each intruder is within 145 m of the calculated range identified in Table 3.
For all of the Intruders ~~with Latitudes within ±60 degrees~~, verify that the bearing for each intruder is within 3 degrees of the calculated bearing identified in Table 3.
Verify that the error in range from the calculated range does not use more of the error budget allowed for range based on the completion of Test §2.4.2.8 (Verification of Error Budget in Computing Slant Range from Passive Data) Test 1.

(…)

A.1 OVERVIEW

This Appendix provides useful guidance on computing range from own and reported position data. This Appendix does not recommend a particular implementation and should be used for reference only.

Firstly, the exact conversion equations from position to slant range are given. The computational requirements for the exact conversion equations are reasonable and could be used as is for modern processors and typical TCAS traffic loads.

Secondly, several approximate conversion equations from position to slant range are presented. For circumstances where hybrid surveillance is implemented as a software upgrade to existing processors, it may be desirable to use approximations to the conversion equations to reduce the computational requirements. The errors in the approximate equations are presented and compared to the computational accuracy requirements of §2.2.7.6, which requires a maximum 145 m processing error when calculating slant range.

Note: The equations in A.2 provide an example of conversion equations which meet the accuracy requirements. The approximation equations provided in the Appendix may not provide the required accuracy.

ETSO-C126b
Date: 5.8.2016

European Aviation Safety Agency

European Technical Standard Order

Subject: 406 and 121.5 MHz Emergency Locator Transmitter

1 — Applicability

This ETSO provides the requirements which 406 and 121.5 MHz Emergency Locator Transmitters that are designed and manufactured on or after the applicability 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-62A, Minimum Operational Performance Specification for Aircraft Emergency Locator Transmitters 406 MHz and 121.5 MHz (Optional 243 MHz), dated February 2009.

Additionally, the use of hook and loop fasteners is not an acceptable means of attachment in complying with the Crash Safety requirements of section 4.5.7.3 of EUROCAE ED-62A for automatic fixed (AF) and automatic portable (AP) ELTs.

The shock and crash safety tests in EUROCAE ED-62A, section 4.5.7.3, require testing coincident with each orthogonal axes individually. Additionally, to better simulate more realistic aircraft crash scenarios, it is recommend that shock and crash safety testing be accomplished with simultaneous longitudinal and vertical cross-axis forces.

3.1.2 — Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1.

3.1.3 — Computer Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 — Electronic Hardware Qualification

See CS-ETSO, Subpart A, paragraph 2.3

3.2 — Specific

The battery used in the Emergency Locator Transmitter authorised under this ETSO must be appropriate for the intended operational environment, not pose a hazard to the aircraft, and meet the requirements of acceptable battery standards.

If non-rechargeable lithium cells and batteries are used to power the Emergency Locator Transmitter, ETSO-C142a 'Non-Rechargeable Lithium Cells And Batteries — Lithium Batteries' provides MPS for such lithium batteries.

If rechargeable lithium cells and batteries are used to power the Emergency Locator Transmitter, ETSO-C179a 'Permanently Installed Rechargeable Lithium Cells, Batteries, and Battery Systems' provides MPS for such batteries.

If nickel-cadmium, nickel metal-hydride or lead acid batteries are used to power the Emergency Locator Transmitter, ETSO-C173a 'Nickel-Cadmium, Nickel Metal-Hydride, and Lead-Acid Batteries' provides MPS for such batteries.

If batteries with a different chemistry are used to power the Emergency Locator Transmitter, the applicant must propose to EASA an appropriate MPS to be used for such batteries.

3.2.1 — Failure Condition Classification

See CS-ETSO, Subpart A, paragraph 2.4.

Failure of the function defined in paragraph 3.1 resulting in signal outputs not meeting the requirements of paragraph 3 is a minor failure condition. Loss of the function defined in paragraph 3.1 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.

ETSO-C127b
Date: 5.8.2016

European Aviation Safety Agency

European Technical Standard Order

Subject: ROTORCRAFT, TRANSPORT AEROPLANE, AND SMALL AEROPLANE SEATING SYSTEMS

1 - Applicability

This ETSO provides the Minimum Performance Standards (MPS) that rotorcraft, transport aeroplane, and small aeroplane seating systems of the following designated types 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's standards apply to equipment intended to be utilised as aircraft seating systems of the following classifications:

(1) Seat Type and applicable Aircraft Category:
- (a) Type A — Airplane. Aircraft Category: Transport
- (b) Type B — Rotorcraft. Aircraft Category: Transport or Normal
- (c) Type C — Small Airplane. Aircraft Category: Normal, Utility, Acrobatic, or Commuter

(2) Seat Subtype:
- (a) Subtype 1 — Passenger
- (b) Subtype 2 — Flight Attendant
- (c) Subtype 3 — Observer
- (d) Subtype 4 — Pilot/Co-pilot

(3) Seat Orientation:
- (a) Forward-Facing
- (b) Rearward-Facing

Note: Seats with installation limitations of angles more than 18 degrees from the aircraft centre line are not addressed by this standard. See Appendix 1 to this ETSO amending SAE AS8049B, subsection 5.3.3.5.i.

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

New models of rotorcraft, transport airplane, and small airplane seating systems identified and manufactured on or after the effective date of this ETSO must meet the requirements in the following: SAE International's Aerospace Standard (AS) 8049B, Performance Standard for Seats in Civil Rotorcraft, Transport Aircraft, and General Aviation Aircraft, dated January 2005, as modified by Appendix 1 to this ETSO; SAE Aerospace Recommended Practice (ARP) 5526C, Aircraft Seat Design Guidance and Clarifications, dated May 2011, as modified by Appendix 1 to this ETSO; and Appendix 2 to this ETSO (for specific elective requirements).

3.1.2 — Environmental Standard

None.

3.1.3 — Computer Software

None.

3.2 — Specific

None.

4 — Marking

4.1 — General

Marking is detailed in CS-ETSO, Subpart A, paragraph 1.2. In addition, each seating system shall be legibly and permanently marked with the following:

(i) The specific seat MPS complied with as abbreviated by paragraphs 4.a.(1).(a) through 4.a.(1).(e) below. Separate each applicable identifier with a dash. For example, a transport airplane passenger seat that is forward facing, rearward facing, meets the step load on the baggage bar standard, and meets higher static loads shall be marked as: Type A-T-1-FF-RF-a-c.

  (a) The seat type, use: 'Type A' for Airplane, 'Type B' for Rotorcraft, or 'Type C' for Small Airplane.

  (b) The seat type shall be followed by the aircraft category, use: 'T' for Transport, 'N' for Normal, 'U' for Utility, 'A' for Acrobatic, or 'C' for Commuter.

  (c) The aircraft category shall be followed by the appropriate seat subtype, use: '1' for Passenger, '2' for Flight Attendant, '3' for Observer, or '4' for Pilot/Copilot.

  (d) The subtype shall be followed by the appropriate seat facing designation, use: 'FF' for Forward Facing, or 'RF' for Rearward Facing.

  (e) The seat facing designations shall be followed by the applicable paragraph letter of the elective criteria defined in appendix 2 of this ETSO, use: 'a' for Step Load on Baggage Bars, 'b' for Flight Attendant Step Load, 'c' for Testing to Higher Static Loads, 'd' for Hand Holds, 'e' for Flammability –Large Exposed Non-metallic Parts.

(ii) The seating system, safety belt restraint system, and seat cushion part numbers.

(iii) The document reference that contains installation instructions and limitations.

(iv) For Type A and Type B-Transport passenger, flight attendant and observer seating systems, mark each seat cushion to be qualified with 'Complies with CS 25.853(c)', or 'Complies with CS 29.853(b)', as applicable when tested in accordance with the requirements of Section 3.4.2 of SAE AS8049A, as revised by subparagraph 2.2.3 of Appendix 1 of this ETSO.

(v) Each separate component that is easily removable (without hand tools, except those components that are ETSO articles), each interchangeable element, and each separate sub-assembly of the article that the manufacturer determines may be interchangeable with other seating systems must be permanently and legibly marked with at least the name of the manufacturer, manufacturer's sub-assembly part number, and the ETSO number.

4.2 — Specific

None.

5 — Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

ETSO-C127b
Appendix 1

APPENDIX 1

MPS FOR ROTORCRAFT, TRANSPORT AEROPLANE, AND SMALL AEROPLANE SEATING SYSTEMS

1.0. This Appendix prescribes MPS for SAE International's Aerospace Standard (AS) 8049B, *Performance Standard for Seats in Civil Rotorcraft, Transport Aircraft, and General Aviation Aircraft*, dated January 2005. When the SAE section *recommends (or suggests, advises, etc.)* something, and it is part of the MPS, the recommendation becomes a *requirement*. In addition, modify AS8049B as follows:

Table 1 — SAE AS8049B

When reading AS8049B…	**Do the following:**
Section 1	Disregard
Section 2	Disregard
Section 3	Apply all subsections unless disregarded or modified below: --- Page 5, disregard subsection 3.1. --- Page 6, replace subsection 3.2.7 to read as follows: 3.2.7 When an under-seat baggage restraint is incorporated in a passenger seat, it shall be designed to restrain at least 9.1 kg (20 lb) or its placarded weight of stowed items per passenger place under the *dynamic* and *static (forward and sideward directions only)* test conditions of this document in a manner that will not significantly impede rapid egress from the seat. --- Page 6, replace subsection 3.2.15 to read as follows: 3.2.15 Except for rearward facing seats *and seats equipped with multiple anchorage point pelvic restraints (e.g. Y-belts)*, the pelvic restraint system shall be designed such that the vertical angle *between the pelvic restraint centerline and the seat reference point (SRP) waterline shall range from 35° to 55°*. The SRP water line is a line/plane passing through the SRP parallel to the floor waterline. The pelvic restraint centerline is formed by a line from the pelvic restraint anchorage to a point located 250 mm (9.75 in) forward of the SRP and 180 mm (7.0 in) above the SRP water line. *In addition, the pelvic restraint anchorage point(s) must be located no further than 2.0 inches forward of the SRP (ref Figure 1A). See the FAA AC 21-34 for additional guidance for acceptable seat belt geometry.* --- Page 6, add subsection 3.2.16 to read as follows: *3.2.16 All hinged armrest caps installed along an aisle must close as a result of normal*

When reading AS8049B…	Do the following:
	movement along the aisle. Caps must not snag clothing or present any other impediment to egress when contacted by a person moving in either direction along the aisle. --- Page 6, add subsection 3.2.17, to read as follows: *3.2.17 Safety belt restraint systems must be equipped with a metal-to-metal latching device.* --- Page 6, add subsection 3.2.18 to read as follows: *3.2.18 Design seat stowage compartments to prevent the contents becoming a hazard by shifting under the load conditions identified in Table 4 and subsection 5.3.1. Specify the maximum weight of the contents allowed in each stowage compartment.* --- Page 6, add subsection 3.2.19 to read as follows: *3.2.19 The seat reference point (SRP) must be determined using only one of the methods described in Figure 1B. The selected method shall be documented, and must be used consistently when evaluating all variations of the seat ETSOA model or future changes to the seat ETSOA model design.* --- Page 10, replace subsection 3.4.1 to read as follows: *3.4.1 Test the materials in Type A Transport and Type B Transport seating systems, ensuring they meet the fire protection properties specified in CS-25, Appendix F, Part I, paragraph (a)(1). The material's fire protection properties may be demonstrated using the methods provided in the FAA policy statement, PS-ANM-25.853-01-R2, Flammability Testing of Interior Materials, which may permit substantiation based on previously tested materials. The definition and use of parts that are considered small parts that would not contribute significantly to the propagation of a fire must be approved in advance by EASA. When inflatable restraints are included, the airbag material shall meet the flammability requirements of CS-25, Appendix F, Part I(a)(iv).* *Note: Inflatable restraints are a new and novel technology that may be subject to significant additional special conditions and certification requirements for installation approval.* *Materials in Normal, Utility and Acrobatic category Type C seating systems must have flame-resistant properties as defined in* ***14 CFR Part 1****. Test the materials to meet the requirements of paragraph 8.b of the FAA Advisory Circular (AC) 23-2A, Change 1, Flammability Tests. Commuter category Type C seating systems shall meet the flammability performance requirements defined in CS 23.853(d)(3), and*

When reading AS8049B…	Do the following:
	tested as prescribed in CS-23, Appendix F, Part I. *Materials in Type B Normal Rotorcraft seating systems must have flame-resistant properties as defined in* ***14 CFR Part 1****. Test the materials to meet the requirements of paragraph 8.b of the FAA Advisory Circular 23-2A 'Flammability Test', dated May 11, 2007. The material's fire protection properties may also be demonstrated by analysis (similarity) to provide equivalent protection.* *Type A — Transport airplane insulation on electrical wire and electrical cable, and materials used to provide additional protection for the wire and cable, must be self-extinguishing when tested in accordance with the applicable portions of Appendix F, Part I of CS-25.* *Type B — Rotorcraft insulation on electrical wire and cable must be self-extinguishing when tested in accordance with Appendix F, Part I(a)(3), to CS-25.* *Type C seats with insulation on electrical wire and electrical cable must be self-extinguishing when tested at an angle of 60 degrees in accordance with the applicable portions of Appendix F to CS-23. The average burn length must not exceed 3 inches (76 mm) and the average flame time after removal of the flame source must not exceed 30 seconds. Drippings from the test specimen must not continue to flame for more than an average of 3 seconds after falling.* --- Page 10, replace subsection 3.4.2 to read as follows: Type A *Transport and Type B Transport* — passenger, flight attendant, and observer seat cushion systems shall be tested to and shall meet the fire protection provisions of CS-25 Appendix F, Part II. *The material's fire protection may also be demonstrated by following the FAA AC 25.853-1 'Flammability Requirements for Aircraft Seat Cushions' and, where applicable, the FAA Policy Statement ANM-115-07-002 on certification for flammability of lightweight seat cushions.* --- Page 12, replace subsection 3.5.7 to read as follows: 3.5.7 Deployable Items: Certain items on the seat, such as food trays, legrests, arm caps over in-arm tray tables, etc., are used by passengers in flight and are required to be stowed for taxi, takeoff and landing. Deployment of such items should be treated as 'permanent deformation' if the item deploys into an area that must be used by multiple passengers (in addition to the occupant of the seat) for egress. The location of the measuring point used for determining the deformation of the deployed item shall be either at the point of full deployment or at the point of the actual deployment if a partially deployed item resists further deployment upon application of a static load of 45 N (10 lb) along the

When reading AS8049B…	Do the following:
	direction of the inertial load path. Such deployments can be considered acceptable, even if they exceed the provisions of 3.5 and its subparagraphs, if they are readily pushed out of the way by normal passenger movement, and remain in a position that does not affect egress (i.e., when pushed out of the way it remains in that position). Normal passenger movement is the act of the seated occupant getting up out of the seat and moving to egress the airplane (i.e., unbuckling their restraint, standing, turning towards the aisle and moving into the aisle). It does not include additional movements to lift or stow items, or latching an item in place. Any items that remain in a position that would affect egress shall be reported as permanent deformation. *If the food tray table deploys as a result of being struck by the ATD head during a row-to-row HIC test and the food tray table is easily pushed out of the way, the deployment is acceptable and does not need to be considered as permanent deformation (except for seats installed where deployment may affect egress through a required exit path — see below). It is not required for the food tray table to remain in a position that does not affect egress. 'Easily pushed out of the way' is not required to be by normal passenger movement. Determination of the food tray deploying as a result of being struck by the ATD head during the test shall be made by evaluation of the high-speed film/video.* *If the food tray table deploys as a result of being struck by the ATD head during the test and the food tray table is not easily pushed out of the way, the deployment shall be treated as permanent deformation.* *Any food tray deployment on a seat that will be installed where deployment may affect egress through a required exit path, regardless of being struck by the ATD head, shall be treated as permanent deformation.*
Section 4	Apply all subsections unless disregarded or modified below: -- Page 16, replace note (1) in Table 4 to read as follows: (1) *The 4.0 ultimate load factor applies to the seat assembly (except for the fittings). The highest special factor of safety (e.g. casting) applicable to any part (except for the fittings) shall be applied to the 4.0 ultimate load factor. Fittings (as defined in paragraph 4.1.3) must meet a minimum applied load factor of 4.0 g. The 4.0 applied load factor for the fittings includes the 1.33 fitting factor. If multiple special factors of safety are applicable to the fittings (e.g. fitting factor and casting factor), then as indicated in paragraph 4.1.4, the fitting shall be tested statically to the highest applicable special factor of safety. Since for the fittings the 4.0 g applied load factor already includes the 1.33 fitting factor, the 1.33 fitting factor is divided out before the highest special factor of safety is applied.* --

<table>
<tr><th>When reading AS8049B…</th><th>Do the following:</th></tr>
<tr><td></td><td>Page 16, replace note (2) in Table 4 to read as follows:

(2) Elective: Increase these load factors as necessary for reduced weight gust/flight loads or landing requirements. Loads at angles other than those prescribed by Table 4 may be tested. All seat adjustment positions and occupancy variations, including those used in flight, must be evaluated when using these increased load factors. Document the increased load factors. They must also be marked on the ETSO placard (see Appendix 2).

Page 16, replace note (4) in Table 4 to read as follows:

(4) Normal, Utility, Acrobatic and Commuter Category.

Page 16, delete note (7) in Table 4.

Explanation: The seating system’s manufacturer doesn’t control the CS-23 requirements applying to the seat installation. The manufacturer may test to load factors higher than required in Table 4 under the provisions of Appendix 2, paragraph c, to this ETSO.

Page 16, add a reference of note (8) to be applicable to the Upward load direction for Type C Seat in Table 4. Add note (8) to Table 4 to read as follows:

(8) Use a factor of 4.5 for Acrobatic Category seats.</td></tr>
<tr><td>Section 5</td><td>Apply all subsections unless disregarded or modified below:

Page 21, replace subsection 5.1.9 to read as follows:

5.1.9 The load due to any item of mass, including the seat that is not restrained by the occupant restraint system, must be applied in a representative manner at the c.g. of the mass, or with a corrective factor applied in a conservative manner relative to the c.g. of the item of mass.

Note: If the retention of an item of mass attached to the seat is demonstrated (by the dynamic qualification tests of subsection 5.3), the static retention for the forward and down static conditions doesn’t need to further be demonstrated. However, the retention of items of mass for the side, up and aft static conditions must still be demonstrated.

Page 23, replace subsection 5.2.2 to read as follows:

5.2.2 The seat structure must be able to support ultimate loads without failure for at</td></tr>
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When reading AS8049B…	Do the following:
	least *3 seconds*. If it can be shown that failure of an armrest on a seat assembly does not reduce the degree of safety afforded the occupant(s) or become a hazard, such failure will not be cause for rejection. *Note: If the retention of an item of mass attached to the seat is demonstrated by the dynamic qualification tests of subsection 5.3, the static retention for the forward and down static conditions don't need to further be demonstrated. However, the retention of items of mass for the side**, up** and aft static conditions must still be demonstrated.* -- Page 23, replace 5.3 to read as follows: 5.3 Dynamic Qualification Tests: This section specifies the dynamic tests to satisfy the requirements of this document. *For Type A Seats: it may be demonstrated the compliance with the dynamic test procedures and documentation of subsections 5.3.1 'Dynamic Impact Test Parameters' through subsection 5.3.9.2 'Impact Pulse Shape' of SAE AS 8049B by the equivalent procedures of the FAA AC 25.562-1B. The equivalent method shall be documented in the document that contains installation instructions and limitations, and must be used consistently when evaluating all variations of the seat or future changes to the seat design.* *For Type A Seats: the simplified procedures for head injury criteria (HIC) outlined in the FAA AC 25.562-1B can also be used instead of the test conditions in AS8049B subsection 5.3.6.2.* *Except for Hybrid III ATDs (**49 CFR Part 572, Subpart E**) modified in accordance with SAE Technical Paper 1999-01-1609, use of an equivalent ATD must be established by the applicant and accepted by EASA.* -- Page 23, replace subsection 5.3.1.2 to read as follows: 5.3.1.2 Test 2 (Figures 6, 7A, and 7B), as a single row seat test, determines the performance of a system in a test condition where the predominant impact force component is along the aircraft longitudinal axis and is combined with a lateral impact force component. This test evaluates the structural adequacy of the seat, permanent deformation of the structure, the pelvic restraint and upper torso restraint (if applicable) behaviour and loads, and may yield data on ATD head displacement, velocity, and acceleration time histories and the seat leg loads imposed on the seat tracks or attachment fittings. *For seats intended to be installed at an angle relative to the longitudinal axis of*

When reading AS8049B…	Do the following:
	the aircraft that is greater than 2° (but less than 18°), the test yaw angle for the test that substantiates those seats shall be 10° plus or minus the intended installation angle (if more critical) depending on which yaw angle results in the most critical attachment fitting resultant loads. --- Page 37, replace subsection 5.3.3.5.i to read as follows: i. Side-Facing Seats: *Seats with installation limitations of angles more than 18° from aircraft centerline are not addressed by this standard.* --- Page 37, replace subsection 5.3.3.6 to read as follows: 5.3.3.6 Multiple Row Test Fixtures: In tests of passenger seats that are normally installed in repetitive rows in the aircraft, head and knee impact conditions are best evaluated through tests that use at least two rows of seats. These conditions are usually critical only in Test 2. This test allows direct measurements of the head and femur injury data. a. The fixture shall be capable of setting the aircraft longitudinal axis at a yaw angle of – 10° and + 10°. The fixture should also allow adjustment of the seat pitch. b. To allow direct measurement of head acceleration for head injury assessment for a seat installation where the head of the occupant is within striking distance of structure, a representative impact surface may be attached to the test fixture in front of the front row seat at the orientation and distance from the seat representing the aircraft installation. c. *Test 2 (Figures 6, 7A, & 7B) conducted solely to collect head/knee path data should be conducted with 0° yaw and without floor deformation. The test must be conducted on the seat with the greatest overhang among the seats selected for the applicable forward longitudinal dynamic structural test. It is acceptable to use the opposite-hand part for this seat. The occupancy used in the applicable forward longitudinal dynamic structural test must be used for this test. For consistency, a floor should be used for tests used to gather head path data. It is acceptable to collect ATD head path data in the applicable forward longitudinal dynamic structural test.* d. *Seats designed for seat tracks that are not in-line and parallel (track-break seats) typically require special floor attachment fittings. The installation of the seat tracks on the test fixture for these seats is unique, and depends on the intended seat location in the airplane. The test setup must represent the seat track orientation on the airplane (that is, angles, offsets, forward/aft distance, and so forth) of seat tracks under the aft attachments vs. the forward attachments).* --- Page 43, replace subsection 5.3.5 to read as follows:

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5.3.5 Selection of Test Articles: Many seat designs comprise a family of seats that have the same basic structural design but differ in detail. For example, a basic seat frame configuration can allow for several different seat leg locations to permit installation in different aircraft. If these differences are of a nature that their effect can be determined by rational analysis, then the analysis can determine the most critical configuration. As a minimum, the most critically stressed configuration shall be selected for the dynamic tests so that the other configurations could be accepted by comparison with that configuration.
There are two factors that must be considered in selecting the critical structural test configurations. First, the seat to aircraft interface loads (undeformed seat) can be determined by rational analysis for the seat design and load configurations. The rational analysis can be based on static or dynamic seat/occupant analytical methods. The rational analysis can form the basis for selecting the most highly stressed critical configuration based on load. Additionally, the effects of seat deformation should be considered. As noted, a family of seats typically includes seat models with varied seat leg locations. The effects of floor deformation are more critical for narrowly spaced legs. Thus, a test or rational analysis of the seat model with the minimum seat leg spacing must be conducted to evaluate the most highly stressed critical configuration based on deformation.

Page 44, replace subsection 5.3.5.1 to read as follows:
5.3.5.1 In all cases, the test article must be representative of the final production article in all structural elements, and shall include the seat, seat cushions, restraints and armrests. It must also include a functioning position adjustment mechanism and correctly adjusted break over (if present).
Weights simulating luggage carried by luggage restraint bars (9.1 kg (20 lb) per passenger place) need only be representative masses.
Items 0.15 kg (0.33 lb) or greater that are part of the seat and affect the dynamic performance of the seat, including occupant injury and egress, must be representative of the production item and production means of attachment on the test article.
Items 0.15 kg (0.33 lb) or greater that are part of the seat but do not affect the dynamic performance of the seat, including occupant injury and egress, may be representative masses, but the production means of attachment must be on the test article.
Items less than 0.15 kg (0.33 lb) and their means of attachment are not required to be on the test article. However, the mass of the item must be included on the test article as ballast.
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When reading AS8049B…	Do the following:
	Wiring harnesses, regardless of weight, may be represented on the test article by ballast weights. The production means of attachment need not be included in the test. Life vests must be installed on the test article, if provisions are provided, but are not required to be the production life vest. Any life vest of equivalent weight, or greater, may be included on the test article. The life vest may be ballasted to substantiate heavier life vests. *The life vest must represent the size and configuration of the production life vest if its size or configuration could affect retention of the life vest.* ***For Type A seats,*** *if an item of mass that does* ***not*** *affect the dynamic performance of the seat fails during a test that is otherwise acceptable, then the design may be validated by a 24g static test. The failed test article must be redesigned unless the failure is attributable to test setup or non-representative test article. The certified gross weight of the test article must be adjusted to account for any separation of mass due to failure. Apply the load for the 24g test in the same direction as the load vector in the dynamic test where the failure occurred. Any preload, such as due to floor warpage, of the failed article must be represented in the static 24g test.* In any case, the separation of an item of mass should not leave any sharp or injurious edges. Function of equipment or subsystems after the test is not required. Once it has been demonstrated that an item of mass can be retained in its critical loading case, subsequent tests may be conducted with the item secured for test purposes. --- Page 45, replace subsection 5.3.6.3 to read as follows: 5.3.6.3 If a non-symmetrical upper torso restraint system (such as a single diagonal shoulder belt) is used in a system, it shall be installed on the test fixture in a position representative of that in the aircraft. For a forward-facing seat equipped with a single diagonal shoulder belt, the Test 2 yaw direction should be selected such that the belt passes over the *leading* shoulder. *Note:* ~~***For a Type A seat,***~~ *additional tests may be required with the single diagonal shoulder belt passing over the trailing shoulder in order to evaluate retention of the harness on the occupant shoulder. As applicable, test per the FAA AC-25.562-1B, paragraph 3.b.(3).* --- Page 50, replace subsection 5.3.9.2 to read as follows: 5.3.9.2 Impact Pulse Shape: Data for evaluating the impact pulse shape are obtained from an accelerometer that measures the acceleration in the direction parallel to

When reading AS8049B…	Do the following:
	the inertial response shown in Figures 6, 7A, and 7B. The impact pulses intended for the tests discussed in this document have an isosceles triangle shape. These ideal pulses are considered minimum test conditions. Since the actual acquired test pulses will differ from the ideal, it is necessary to evaluate the acquired test pulses to ensure the minimum requirements are satisfied. The five properties of the ideal pulse that must be satisfied by the acquired test pulse are (referring to Figures 6, 7A, and 7B, and as discussed in Appendix A): Pulse shape: isosceles triangle Greq: peak deceleration required by test condition Treq: rise time required by test condition V: total velocity change required by test condition Vtr: velocity change required during Treq (Vtr = V/2) A graphical technique can be used to evaluate pulse shapes that are not precise isosceles triangles. Appendix A presents the graphical method of evaluating the acquired pulse (the recorded test sled acceleration versus time). For the acquired pulse to be acceptable*, the requirements of Appendix A shall be met.* --- Page 54, replace subsection 5.3.9.9 to read as follows: 5.3.9.9 Femur Load (Type A Seats): Data for measuring femur loads can be collected in the tests discussed in this document if the ATD's legs contact seats or other structure. The maximum compressive load in the femur can be obtained directly from a plot or listing of each femur load transducer output. If the value of peak acceleration measured in the test exceeds the level given in Figure 6, 7A, or 7B, the femur load measured in the test may be adjusted by no more than 10 % by multiplying the measured values by the ratio of the peak acceleration given in Figure 6, 7A, or 7B, divided by the measured peak acceleration, if necessary. Data need not be recorded in each individual test if rational comparative analysis is available for showing compliance. For large clearance installations (distance from seat SRP to strike target is greater than 100 cm (40 in.) nominally), no data is necessary to substantiate femur loads. *However, appropriate limitations must be documented.* *Extensive seat testing has shown that the femur loading criterion is not usually exceeded therefore, recording femur loads may not be necessary during the test if it can be shown compliance by rational comparative analysis using data from previous tests. However, the rational analysis must show that the testing applies to the seat design, and must include appropriate limitations which must be documented.* ---

When reading AS8049B…	Do the following:
	Page 54, replace subsection 5.3.9.11 to read as follows: 5.3.9.11 Seat Deformation: The permanent deformations affecting aircraft evacuation shall be evaluated and documented. The floor deformation fixture may be returned to the flat floor condition for documenting seat deformation. This documentation can take the form of dimensioned scale drawings that show the seat in its deformed condition relative to a reference origin, such as a floor track fitting which can be related to the aircraft interior. If the seat deformation is not critical, still photographs of the seat (with dimensional targets or grids in place so that measurements can be made) will provide adequate documentation. Any actions necessary for proper seat functions, such as stowage of the seat when the ATD is removed, shall be observed and documented. *Safety belt restraint systems must not yield to the extent they would impede rapid evacuation of the occupant.* --- Page 56, replace subsections 5.3.10.1.1.e ~~**and 5.3.10.1.1.f**~~ to read as follows: e. A statement confirming that the data collection was done in accordance with the *requirements* of this document, or a detailed description of the actual procedure used and technical analysis showing equivalence to the *requirements* of this document. ~~**f. Manufacturer, governing specification, serial number, and test weight of ATDs used in the tests, and a description of any modifications or repairs performed on the ATDs that could cause them to deviate from the specification.**~~
Section 6	Disregard and refer to paragraph **4** of this ETSO.
Section 7	Disregard
Appendix A	No Changes

2.0. This paragraph prescribes the MPS for SAE International ARP5526C 'Aircraft Seat Design Guidance and Clarifications', dated May 2011. When the SAE section *recommends (or suggests, advises, etc.)* something, and it is part of the MPS, the recommendation becomes a *requirement*. In addition, modify ARP5526C as follows:

Table 2 — SAE ARP5526C

When reading ARP5526C…	**Do the following:**
Section 1	Disregard
Section 2	Disregard
Section 3	Disregard all subsections in Section 3 not listed below. The following subsections apply as modified: Page 5, replace subsection 3.2.2 to read as follows: 3.2.2 Definition and Criteria: Seatbelt misalignment is a condition where the seatbelt and/or shackle is positioned to give the impression that the belt has been properly tightened, when in fact there is slack in the system or the shackle is positioned so that it will not carry the force generated in an emergency landing or turbulence condition. *Restraint system anchorages should provide self-aligning features. If self-aligning features are not provided, the static and dynamic tests in this document should be conducted with the restraints and anchorages positioned in the most adverse configuration allowed by the design. The anchorage system shall minimise the possibility of incorrect installation or inadvertent disconnection of the restraints.* The seat belt installation should not appear to the belted occupant to be properly adjusted (snug) while there is significant (2.54 cm (one inch) or more) slack in the system which may pay out in an emergency landing situation. For example, the belt installation should not be able to be caught between seat features such that the occupant would not know there was slack in the belt which may allow the occupant to slide forward during emergency landing or turbulence. To test the installed seat belt for misalignment, the seat should be positioned in its taxi, take-off and landing condition. Installations on seats having bottom cushions that can be removed or incorrectly repositioned without tools should be evaluated with the cushions installed, removed and incorrectly repositioned. The belt and shackle combination should be manipulated with one hand in an attempt to place the restraint in a non-design configuration where it could carry the seatbelt adjustment forces. Particular effort should be made to place the restraint in a position that the restraint forces would not be applied to the hook of the shackle in the same manner as they would be applied in a straight tension pull on the belt. Attempts should be made with the restraint in its normal shape, a single twist of the webbing and/or a single fold of the webbing. Typical areas around the restraint shackle that should be checked are the plastic shrouding around the armrest, the

When reading ARP5526C…	Do the following:
	hydraulic seat recline device, the seat pan, anti-rotation brackets/stops, seat pan supports and exposed fasteners. If a condition of potential misalignment is identified, the seatbelt and shackle, in that condition, should be loaded by a restorative force of 22.2 N (five pounds) applied through the belt in the direction that it would be loaded in the emergency landing or turbulence situation. If the load is carried in the misaligned condition, the design is unacceptable. The examples in Section 3.2.3 illustrate various misalignment conditions that have been found to be unacceptable, as indicated. These examples are not intended to be all-inclusive. To test the belt for inadvertent disengagement, where disengagement is defined as the separation of the restraint's attachment fitting from the seat structure, the belt should be tested in all orientations with the seat in the taxi, take-off and landing conditions with the seat cushions installed. Interaction of belts in adjacent seats, where the belts could be inadvertently crossed and used by occupants in those adjacent seats, must be evaluated for the possibility of disengagement. --- Page 9, replace subsection 3.3.2 to read as follows: *3.3.2 Definition and Criteria: The terms 'life preserver', 'life vest' and 'life jacket' may be used interchangeably. When life preserver stowage provisions are included as part of the seat design, the stowage provisions shall provide access to a life preserver for each seating position. The life preserver stowage shall be designed and located such that the requirements of this section are met. The installation, operating and maintenance instructions shall also reflect the requirements of this section. For example, installation instructions shall account for the allowable life preserver weight and size, marking requirements, as well as the required unobstructed area to remove the life preserver from the container. Furthermore, the operating instructions must report the detailed content of the simulated preflight briefing and any special instructions for unique aspects of the design operation that should be considered for operational use and continued performance.* *a. The life preserver shall be restrained under all applicable loading conditions, i.e. the retention device shall not allow the life preserver to come free during emergency landing static and dynamic conditions, taxi, take-off, landing, turbulence, and during stowage and removal of underseat baggage.* *b. Any life preserver locating placard installed on the seat shall accurately state the location of the life preserver and be adequately marked per 3.8.2 of this ARP5526 Revision C document (e.g. "Life preserver under center armrest"). For life preserver locations other than under the seat or under a console between the seats, mark "Life preserver" or "Life preserver inside" on the container or compartment, unless the location is identified with a pull strap. Pull straps shall be red or labelled "PULL" or "PULL FOR LIFE PRESERVER" in contrasting colour. A symbolic placard may be used in lieu of text.* *For seats intended to be installed in sequential rows, a placard may be on the*

When reading ARP5526C…	Do the following:
	seat back stating the location of the life preserver for the occupant seated behind. c. *The retrieval path of the life preserver shall be free of obstructions due to life preserver container movement and/or seat or aircraft components (e.g. seat legs, cushions, baggage bars, shrouds, etc.) when the seat is in the configuration for taxi, take-off and landing.* d. *The life preserver stowage shall not present any sharp edges or points that could damage the life preserver or cause injury.* e. *For underseat pan storage on passenger seats (excluding center console storage):* *1) A pull strap shall be connected to the life preserver, or a pull strap or latch shall be on the compartment opening, such that when the strap or latch is pulled, the preserver is presented on the strap or the occupant can reach into the compartment to retrieve the preserver (i.e. one or two motions of the occupant result in retrieval of the life preserver).* *2) The life preserver shall be located no more than 3 inches aft of the front edge of the seat bottom, i.e. the seat frame or cushion, whichever is further forward.* *3) Unless limited by seat cushions or structure (e.g. seat leg, floor, etc.), designs utilising a pull strap shall permit life preserver retrieval when pulled from any angle between:* *a) 45 degrees up and 50 degrees down from the horizontal,* *b) 45 degrees left and 45 degrees right from the container centerline.* *4) For designs utilising a pull strap, normal seat operation or underseat baggage storage activities shall not sweep the pull strap into an unreachable location.* *5) The life preserver container, or compartment, as installed on the seat shall protect the life preserver from inadvertent damage from normal passenger movement such as the stowage and removal of underseat baggage.* f. *Demonstrate that the life preserver shall be within easy reach of, and shall be readily removed by a seated and belted occupant (shoulder strap(s) may be removed prior to demonstration), for all seat orientations and installations that are intended for use during taxi, take-off and landing. In lieu of an actual life preserver, a representative object (e.g. size and weight) may be utilised for testing. The evaluation to quickly retrieve the preserver is to begin with the occupant moving their hand(s) from the seated position to reach for the preserver and to end with the occupant having the preserver in their hand(s) and fully removed from the stowage container. It does not include the time for the occupant to return to the upright position, to remove a pull strap from the preserver (if used) or to open the preserver package provided by the preserver manufacturer. Test the critical configuration(s) to demonstrate retrieval in less than 10 seconds by a minimum of 5 test subjects with a success rate of no less than 75 %. The test shall evaluate three anticipated occupant test subject size categories: 5th, 50th and 95th percentile. At least one occupant from each size category shall demonstrate successful retrieval within 10 seconds. Test subjects for either the 5th or 95th percentile occupant category shall not exceed 40 % of*

When reading ARP5526C…	Do the following:
	the overall test subject population. *1) For passenger seats, the test subjects shall be naïve. For the purpose of this test, naïve test subjects shall be defined as: they shall have had no experience within the prior 24 months in retrieving a life preserver. Subjects must receive no retrieval information other than a typical preflight briefing. The occupant size categories to be evaluated shall be defined as:* *a. A 5th percentile is no more than 60 in. (1.5 m) tall.* *b. A 50th percentile is at least 63 in. (1.6 m) tall but no more than 70 in. (1.8 m) tall.* *c. A 95th percentile weighs at least 244 lb (110.7 kg).* *2) For flight attendant and observer seats, the test subjects do not need to be naïve. The occupant size categories to be evaluated shall be defined as:* *a. A 5th percentile is no more than 60 in. (1.5 m) tall.* *b. A 50th percentile is at least 63 in. (1.6 m) tall but no more than 70 in. (1.8 m) tall.* *c. A 95th percentile weighs at least 244 lb (110.7 kg).* *3) For pilot/co-pilot seats, the test subjects do not need to be naïve. The occupant size categories to be evaluated shall be defined as:* *a. A 5th percentile is no more than 62 in. (1.57 m) tall.* *b. A 50th percentile is at least 63 in. (1.6m) tall but no more than 70 in. (1.8 m) tall.* *c. A 95th percentile weighs at least 244 lb (110.7 kg).* --- 3.6.2 For Type A seats, apply as written. 3.7.2 For Type A seats, apply as written. --- Page 13, replace subsection 3.8.2 to read as follows: 3.8.2 Definition and Criteria: Safety placards on occupant seats should be permanently affixed, located such that they cannot be easily obscured and of a type that cannot be easily erased. The lettering height and colour contrast should be sufficient to allow the placard to be read by the intended occupant (e.g. placards located on the back of the seat should be designed to allow the occupant seated behind to easily read it at the anticipated installed pitch.) --- 3.9.2 Apply as written. 3.10.2 Apply as written. 3.11.2 Apply as written. --- Page 20, replace subsection 3.12.2 to read as follows: 3.12.2 Definition and Criteria: Edges that could cut skin during normal use *(including in edges on electrical equipment)* should be eliminated and for maintenance

When reading ARP5526C…	Do the following:
	should be minimised. *To be considered non-injurious, edges that are accessible (as defined in section 3.11.2.1) and could cut skin during normal use shall meet either of the standards listed below:* *1. NASA Standard 3000 Volume I (NASA–STD-3000 Vol. I), Man-Systems Integration Standards, Revision B, July 1995, Section 6.3.3, or* *2. UL 1439, Standard for Tests for Sharpness of Edges on Equipment, Edition 4, February 26, 1998, with revisions through 6/1/2004*. In addition, the seat should not have any feature whose edges or corners are exposed when deployed, that presents an impediment to an occupant's egress (e.g. cocktail table, seat back and in-arm video, flip-out PCU, ashtray, etc.). --- 3.13.2 Apply as written. 3.14.2 Apply as written. 3.15.2 Apply as written. 3.17.2 For Type A passenger seats, apply as written. 3.20.2 Apply as written.
Appendix A	Apply Appendix A as necessary to comply with the requirements of this ETSO.
Appendix B	Disregard all subsections in Appendix B not listed below. The following subsections apply as modified: --- B.1.1.14 Apply as written. B.1.1.26 Apply as written. --- Page 46, replace subsection B.1.1.28 to read as follows: B.1.1.28 Where seat recline could adversely affect emergency evacuation, passenger seat recline and control mechanisms should have an override feature so that the reclined seat back may be moved to the upright position without releasing the recline control button.

APPENDIX 2

ELECTIVE MPS FOR ROTORCRAFT, TRANSPORT AEROPLANE, AND SMALL AEROPLANE SEATING SYSTEMS

Complying with the MPS in these paragraphs is elective. However, the MPS must be followed for the one(s) elected to comply.
Per ETSO paragraph **3.1.1**, elective MPS subparagraphs complied with must be documented and reported to receive credit under this ETSO.
In addition, see ETSO paragraph **4.1.(i).(e)** for marking requirements.

a. Step Load on Baggage Bars: For seats where the baggage restraint allows application of a foot step load, apply the test criteria of ARP5526C, subsection 3.7.2. The testing must not degrade either the basic forward or side load carrying capabilities noted in AS8049B, Table 4, or result in deformation, posing a tripping hazard.

b. Flight Attendant Step Load: For seats that include a built-in flight attendant step in the seat design, demonstrate that such a step design meets expected service loads. Apply ARP5526C, Appendix B, subsection B.1.1.29, Table B1, to qualify the design.

c. Testing to Higher Static Loads: To substantiate the seat to load factors higher than those specified in Table 4 of AS8049B, or to combine load factors, the higher load factors must be reported. The higher load factors must be marked on the ETSO placard.

d. Hand Holds: For seats designed to provide a handhold for passengers moving about the airplane, apply ARP5526C, Section 3.1.2.

e. Flammability — Large Exposed Non-metallic Parts: For Type A seats incorporating large non-metallic panels in their design, test and meet the fire protection provisions of Appendix F, parts IV and part V (heat release and smoke emission) of CS-25. The material's fire protection properties may be demonstrated using the methods provided in the FAA policy statement, PS-ANM-25.853-01-R2 'Flammability Testing of Interior Materials', which may permit substantiation based on previously tested materials.

ETSO-C139a
Date: 5.8.2016

European Aviation Safety Agency

European Technical Standard Order

Subject: Audio Systems and Equipment

1 — Applicability

This ETSO provides the requirements which Audio Systems and 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-214A, Audio Systems Characteristics and Minimum Performance Standards for Aircraft Audio Systems and Equipment, dated 18 December 2013.

3.1.2 — Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1.

3.1.3 — Computer Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 — Electronic Hardware Qualification

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 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.

ETSO-C151c
Date: 5.8.2016

European Aviation Safety Agency

European Technical Standard Order

Subject: Terrain Awareness and Warning System (TAWS)

1 — Applicability

This ETSO provides the requirements which Terrain Awareness and Warning System (TAWS) 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 attached Appendix 1 "Minimum Performance Standard for a Terrain Awareness and Warning System for Classes A and B" and in Appendix 3 "Minimum Performance Standard for a Terrain Awareness and Warning System for Class C".

This equipment is intended for fixed-wing aircraft only

3.1.2 — Environmental Standard

See CS-ETSO, Subpart A, paragraph 2.1.

3.1.3 — Computer Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 — Electronic Hardware Qualification

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.

Failure of the function defined in paragraph 3.1.1 due to a TAWS computer malfunction resulting in false terrain warnings, un-annunciated loss of function, or presentation of hazardously misleading information as defined in paragraph 2.12 of Appendix 1 is a major failure condition. Loss of the function defined in paragraph 3.1.1 is a minor failure condition.

3.2.2 — Functional Qualification~~s~~

The required performance shall be demonstrated under the test conditions specified in Appendix 2 of this ETSO for Class A and B equipment, or Appendix 3 of this ETSO for Class C equipment.

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

MINIMUM PERFORMANCE STANDARD FOR A TERRAIN AWARENESS AND WARNING SYSTEM FOR CLASSES A AND B

1.0 INTRODUCTION

1.1 PURPOSE. This standard provides the MPS for a Terrain Awareness and Warning System (TAWS).

1.2 SCOPE. This Appendix sets forth the standard for two classes of TAWS equipment: Class A and Class B.

1.3 SYSTEM FUNCTION AND OVERVIEW. The system must provide the flight crew with sufficient information and appropriate alerts to detect a potentially hazardous terrain situation that, in turn, prevents a CFIT event. The basic TAWS functions for all TAWS systems approved under this ETSO include the following:

a. A forward looking terrain avoidance (FLTA) function. The FLTA function looks ahead of the aeroplane along and below the aeroplane's lateral and vertical flight path and provides suitable alerts if a potential CFIT threat exists.

b. A premature descent alert (PDA) function. The PDA function of the TAWS uses the aeroplane's current position and flight path information, as determined from a suitable navigation source and airport database, to determine if the aeroplane is hazardously below the normal (typically three-degree) approach path for the nearest runway as defined by the alerting algorithm.

c. An appropriate visual and aural discrete signal for both caution and warning alerts.

d. Class A TAWS equipment must provide terrain information, which is presented on a display system.

e. Class A TAWS equipment must provide indications of imminent contact with the ground for the following conditions as further defined in RCTA/DO-161A, Minimum Performance Standards -Airborne Ground Proximity Warning Equipment, dated May 27, 1976, and section 3.3 of this Appendix. Deviations from RTCA/DO-161A are acceptable providing the nuisance alert rate is minimised, the deviation is approved under the provision of Part-21, 21.A.610, and an equivalent level of safety for the following conditions is provided.

— **Mode 1:** Excessive rates of descent

— **Mode 2:** Excessive closure rate to terrain

— **Mode 3:** Negative climb rate or altitude loss after takeoff

— **Mode 4:** Flight into terrain when not in landing configuration

— **Mode 5:** Excessive downward deviation from an Instrument Landing System (ILS) glideslope, Localizer Performance and Vertical Guidance (LPV), or Global Navigation Satellite System (GNSS) Landing System (GLS) glidepath.

Note: RTCA/DO-161A glideslope requirements are incorporated for GLS and LPV glidepaths for TAWS Class A systems, reference paragraph 3.3f. It is desirable to provide a glidepath/glideslope warning function on any approach with vertical guidance.

— **Altitude Callout:** A voice callout ('Five Hundred') when the aeroplane descends to 500 feet above terrain or nearest runway elevation. All TAWS equipment must provide a 500 foot voice call out.

Note: The altitude callout is not defined in RTCA/DO-161A but is a requirement for the TAWS system. The altitude callout requirements are defined in paragraph **3.3.c.** of this Appendix.

f. Class B equipment basic TAWS functions include functions listed in paragraphs 1.3.a through 1.3.c and it must provide indications of imminent contact with the ground during the following aeroplane operations as defined in paragraph **3.4** of this Appendix:

— **Mode 1:** Excessive rates of descent

— **Mode 3:** Negative climb rate or altitude loss after takeoff

— **Altitude Callout:** A voice callout ('Five Hundred') when the aeroplane descends to 500 feet above the nearest runway elevation. All TAWS equipment must provide the 500 foot voice call out.

1.4 <u>ADDED FEATURES</u>. If the manufacturer elects to add features to the TAWS equipment, those features must at least meet the same qualification testing, software verification, and validation requirements as provided under this ETSO. Additional information, such as human-made obstacles, may be added as long as they do not adversely alter the terrain functions.

1.5 <u>OTHER TECHNOLOGIES</u>. Although this ETSO envisions a TAWS based on the use of on-board terrain and airport databases, other technologies such as the use of radar are not excluded. Other concepts and technologies may be approved under this ETSO's provisions for non-ETSO functionality.

2.0 DEFINITIONS

2.1 Advisory Alerts. The level or category of alert for conditions that require flight crew awareness and may require subsequent flight crew response.

2.2 Alert. A visual, aural, or tactile stimulus presented to attract attention and convey information regarding system status or condition.

2.3 Aural Alert. A discrete sound, tone, or verbal statement used to annunciate a condition, situation, or event.

2.4 Caution Alert. The level or category of alert for conditions that require immediate flight crew awareness and subsequent flight crew response.

2.5 Controlled Flight Into Terrain (CFIT). An accident or incident in which an aircraft, under the full control of the pilot, is flown into terrain, obstacles, or water.

2.6 Failure. The inability of the equipment or any sub-part of that equipment to perform within previously specified limits.

2.7 False Alert. An inappropriate alert that occurs as result of a failure within the TAWS or when the design alerting thresholds of the TAWS are not exceeded.

2.8 Forward-Looking Terrain Avoidance (FLTA). Looks ahead of the aeroplane along and below the aeroplane's lateral and vertical flight path and provides suitable alerts if a potential CFIT exists.

2.9 Global Navigation Satellite System (GNSS). A world-wide position, velocity, and time determination system that includes one or more satellite constellations, receivers, and system integrity monitoring, augmented as necessary to support the required navigation performance for the actual phase of operation.

2.10 Ground Based Augmentation System (GBAS) Landing System (GLS). GLS provides precision navigation guidance for exact alignment and descent of aircraft on approach to a runway. GLS uses the Ground Based Augmentation System (GBAS) to augment the Global Navigation Satellite System(s) and to provide locally relevant information to the aircraft, including the definition of the approach path.

2.11 Hazard. A state or set of conditions that together with other conditions in the environment can lead to an accident.

2.12 Hazardously Misleading Information (HMI). An incorrect depiction of the terrain threat relative to the aeroplane during an alert condition (excluding source data).

2.13 Localizer Performance with Vertical Guidance (LPV). A wide area augmentation system (WAAS) approach that provides vertical guidance to as low as 200 feet above ground level (AGL).

2.14 Nuisance Alert. An inappropriate alert, occurring during normal safe procedures, which is the result of a design performance limitation of TAWS.

2.15 Required Obstacle Clearance (ROC). Required vertical clearance expressed in feet between an aircraft and an obstruction. (Per Order 8260.3B, Change 20)

2.16 Search Volume. A volume of airspace around the aeroplane's current and projected path that is used to define a TAWS alert condition.

2.17 Terrain Cell. A grid of terrain provided by the TAWS database which identifies the highest terrain elevation within a defined geographical area. Terrain cell dimensions and resolution can vary depending on the needs of the TAWS system and availability of data. If a supplier desires, obstacle height can be included in the terrain elevation.

2.18 Visual Alert. The use of projected or displayed information to present a condition, situation, or event.

2.19 Warning Alert. The level or category of alert for conditions that require immediate flight crew awareness and immediate flight crew response.

3.0 REQUIRED TAWS FUNCTIONS

3.1 Class A and Class B Requirements for FLTA. The majority of CFIT accidents occur because flight crews do not have adequate situational information regarding the terrain in the vicinity of the aeroplane and its projected flight path. Class A and Class B equipment is required to look ahead of the aeroplane, within the design search volume, and provide timely alerts in the event terrain is predicted to penetrate the search volume. The FLTA function should be available during all airborne phases of flight including turning flight. The search volume consists of a computed look ahead distance, a lateral distance on both sides of the aeroplane's flight path, and a specified look down distance based upon the aeroplane's vertical flight path. This search volume should vary as a function of phase flight, distance from runway, and the required obstacle clearance (ROC) in order to perform its intended function and to minimise nuisance alerts. The lateral search volume should expand as necessary to accommodate turning flight. The TAWS search volumes should consider the accuracy of the TAWS navigation source. The TAWS lateral search area should be less than the protected area defined by the United States Standard for Terminal Instrument Procedures (TERPS), FAA Order 8260.3B and International Civil Aviation Organization (ICAO) Procedures for Air Navigation Services — Aircraft Operations (PAN-OPS) 8168, volume 2, in order to prevent nuisance alerts.

3.1.1 Reduced Required Terrain Clearance (RTC). Class A and Class B equipment must provide suitable alerts when the aeroplane is above the terrain in the aeroplane's projected flight path, but the projected amount of terrain clearance is considered unsafe for the particular phase of flight. The required obstacle (terrain) clearance (ROC), as specified in TERPS and the Aeronautical Information Manual (AIM), has been used to define the minimum requirements for obstacle/terrain clearance (ROC) appropriate to the FLTA function. These requirements are specified in Table **3.1.1.** The FLTA function must be tested to verify that the alerting algorithms meet the test conditions specified in Appendix 2, Tables **A, B, C, D, E, and F.**

Table 3.1.1 — TAWS REQUIRED TERRAIN CLEARANCE (RTC) BY PHASE OF FLIGHT

Phase of Flight	TERPS (ROC)	TAWS (RTC) Level Flight	TAWS (RTC) Descending
Enroute	1 000 feet	700 feet	500 feet
Terminal (Intermediate Segment)	500 feet	350 feet	300 feet
Approach	250 feet	150 feet	100 feet
Departure (See Note 1)	48 feet/nautical mile (NM)	100 feet	100 feet

Note 1: During the departure phase of flight, the FLTA function of Class A and B equipment must alert if the aeroplane is projected to be within 100 feet vertically of terrain. However, Class A and Class B equipment should not alert if the aeroplane is projected to be more than 400 feet above the terrain.

Note 2: As an alternate to the stepped down reduction from the terminal to approach phase as shown in Table 3.1.1, a linear reduction of the RTC as the aircraft comes closer to the nearest runway is allowed, provided the requirements of Table 3.1.1 are met.

Note 3: During the visual segment of a normal instrument approach (typically about 1 NM from the runway threshold), the RTC should be defined/reduced to minimise nuisance alerts. Below a certain altitude or distance from the runway threshold, logic may be incorporated in order to inhibit the FLTA function. Typical operations below minimum descent altitude (MDA), decision altitude (DA), decision height (DH), or the visual descent point (VDP) should not generate nuisance alerts.

Note 4: The specific RTC values are reduced slightly for descending flight conditions to accommodate the dynamic conditions and pilot response times.

3.1.2 Imminent Terrain Impact. Class A and Class B equipment must provide suitable alerts when the aeroplane is below the elevation of a terrain cell along the aeroplane's lateral projected flight path and, based upon the vertical projected flight path, the equipment predicts that the terrain clearance will be less than the value given in the RTC column of Table 3.1.1. See **Appendix 2** for test conditions that must be conducted (Table G).

3.1.3 FLTA Turning Flight. Class A and Class B equipment must provide suitable alerts for the functions specified in paragraphs 3.1.1 and 3.1.2 when the aeroplane is in turning flight.

3.2 Class A and Class B Equipment Requirements for Detection and Alerting for Premature Descent Along the Final Approach Segment. Class A and Class B equipment must provide a suitable alert when it determines that the aeroplane is significantly below the normal approach flight path to a runway. Approximately one-third of all CFIT accidents occur during the final approach phase of flight, when the aeroplane is properly configured for landing and descending at a normal rate. For a variety of reasons, which include poor visibility, night time operations, loss of situational awareness, operating below minimums without adequate visual references, and deviations from the published approach procedures, many aeroplanes have crashed into the ground short of the runway. Detection of this condition and alerting the flight crew is an essential safety requirement of this ETSO, and there are numerous ways to accomplish these overall objectives. Alerting criteria may be based upon height above runway elevation and distance to runway. It may be based upon height above the terrain and distance to runway or other suitable means. This ETSO will not define the surfaces for which alerting is required. Instead, it specifies some general requirements for alerting and some cases when alerting is inappropriate. See Appendix 2, Table **H**, for test requirements.

a. The PDA function must be available for all types of instrument approaches. This includes both straight-in approaches and circling approaches.

b. The TAWS equipment must not generate PDA alerts for normal visual flight rules (VFR) operations in the airport area. Aeroplanes routinely operate at traffic pattern altitudes of 800 feet above field/runway elevation when within 5 NM of the airport.

c. Aeroplanes routinely operate in VFR conditions at 1 000 feet above ground level (AGL) within 10–15 NM of the nearest airport, and these operations must not generate alerts.

d. Aeroplanes routinely operate in the visual segment of a circling approach within 2 NM of the airport/runway of intended landing, with 300 feet of obstacle clearance. Operations at circling minimums must not cause PDA or FLTA alerts.

3.3 Class A Requirements for Ground Proximity Warning System (GPWS) Alerting. In addition to the TAWS FLTA and PDA functions, the equipment must provide the Mode 1 through Mode 5 GPWS functions listed below in accordance with ETSO-C92c and the altitude callout function in accordance with paragraph **3.3.c.** of this Appendix. However, it is essential to retain the independent protective features provided by both the GPWS and FLTA functions. In each case, all of the following modes must be covered. Some GPWS alerting thresholds may be adjusted or modified to be more compatible with the FLTA alerting function and to minimise GPWS nuisance alerts. Modifications to the GPWS requirements require an approved deviation in accordance with Part-21, 21.A.610. The failure of the ETSO-C92c equipment functions, except for power supply failure, input sensor failure, or failure of other common portions of the equipment, must not cause a loss of the FLTA, PDA, or terrain display.

— **Mode 1:** Excessive rate of descent

— **Mode 2:** Excessive closure rate to terrain

— **Mode 3:** Negative climb rate or altitude loss after takeoff

— **Mode 4:** Flight into terrain when not in landing configuration

— **Mode 5:** Excessive downward deviation from an ILS glideslope, LPV, and/or GLS glidepath

— **Altitude Callout:** Five Hundred Foot Voice Callout

a. **Flap Alerting Inhibition.** A separate, guarded control may be provided to inhibit Mode 4 alerts based on flaps being other than landing configuration.

b. **Speed.** Airspeed or groundspeed must be included in the logic that determines basic GPWS alerting time for 'excessive closure rate to terrain' and 'flight into terrain when not in landing configuration' to allow maximum time for the flight crew to react and take corrective action.

c. **Altitude Callouts.** Class A equipment must provide a voice callout of 'five hundred' or equivalent when descending through 500 feet above terrain or 500 feet above the nearest runway elevation during nonprecision approaches, but are recommended for all approaches. Additional altitude callouts, such as 'one hundred' or 'two hundred' are acceptable, but not required. This voice callout will not be made at ascent, for example on a missed approach or departure.

d. **Sweep Tones 'Whoop-Whoop'.** If a two-tone sweep is used to comply with RTCA/DO-161A, paragraph 2.3, the complete cycle of two-tone sweeps plus annunciation may be extended from '1.4' to '2' seconds.

e. **Mode 5 Glidepath Deviation Alerting.** Class A TAWS equipment must provide Mode 5 alerting for localizer performance with vertical guidance (LPV) glidepath and GNSS landing system (GLS) glidepath, as well as the ILS glideslope. The LPV and GLS envelope, deactivation, reactivation, arming, disarming, alert requirements must follow the Mode 5 requirements in RTCA/DO-161A. The FAA recommends that the glidepath aural alert for LPV and GLS approaches say 'glidepath' or equivalent, but the use of "glideslope" is also acceptable. Follow test guidance in RTCA/DO-161A.

3.4 Class B Requirements for GPWS Alerting

a. Class B equipment must provide alerts for excessive descent rates. The Mode 1 alerting envelope of RTCA/DO-161A was modified to accommodate a larger envelope for both caution and warning alerts. Height above terrain may be determined by using the terrain database elevation and subtracting it from the QNH (corrected) barometric altitude, or GNSS altitude (or equivalent). In addition, since the envelopes are not limited by a radio altitude measurement to a maximum of 2 500 feet AGL, the envelopes are expanded to include higher vertical speeds. The equipment must meet either the requirements set forth in Appendix **2**, paragraph **7.0**, or those specified in RTCA/DO-161A.

b. Class B equipment must provide alerts for 'negative climb rate after takeoff or missed approach' or 'altitude loss after takeoff,' as specified in RTCA/DO-161A. The alerting envelopes are identical to the Mode 3 alerting envelopes in RTCA/DO-161A. Height above terrain may be determined by comparison of aircraft altitude (GNSS or barometric) with runway threshold elevation or by radio altimeter.

c. This feature also has an important CFIT protection function. In the event the aeroplane is operated unintentionally close to terrain when not in the airport area or the area for which PDA protection is provided, this voice callout will alert the flight crew to hazardous conditions. The equipment must meet the requirements specified in Appendix **2**, section **9.0**. Class B TAWS equipment must provide a 500 foot voice call out when descending through 500 feet above the runway threshold elevation for landing. This feature is primarily intended to provide situational awareness to the flight crew when the aeroplane is being operated properly, per normal procedures. During a normal approach, it is useful to provide the flight crew with a voice callout at 500 feet, relative to the runway threshold elevation for the runway of intended landing. The Class B TAWS equipment must also provide a 500 foot voice call out above terrain when not landing. This 500 foot voice call out above terrain when not landing is an important CFIT protection function. In the event the aeroplane is operated unintentionally close to terrain when not in the airport area or the area for which PDA protection is provided, this voice callout will indicate hazardous conditions to the flight crew.

3.5 Class A Equipment Requirements for a Terrain Display. Class A equipment must be designed to interface with a colour terrain display, and may be designed to also interface to a monochromatic terrain display. Class A equipment for TAWS must also be capable of providing the following terrain-related information to a display system:

a. The terrain must be depicted relative to the aeroplane's position such that the pilot can estimate the relative bearing to the terrain of interest.

b. The terrain must be depicted relative to the aeroplane's position such that the pilot may estimate the distance to the terrain of interest.

c. The terrain depicted must be oriented to either the heading or the track of the aeroplane. In addition, a north-up orientation may be added as a selectable format.

d. Variations in terrain elevation must be depicted relative to the aeroplane's current or projected elevation (above and below) and be visually distinct. Terrain that is more than 2 000 feet below the aeroplane's elevation can be excluded.

e. Terrain that generates alerts must be displayed in a manner to distinguish it from non-hazardous terrain, consistent with the caution and warning alert level.

3.6 Class B Equipment Requirements for a Terrain Display. Operators required to install Class B equipment are not required to include a terrain display. However, Class B TAWS equipment must be capable of driving a terrain display function in the event the installer wants to include the terrain display function.

4.0 AURAL AND VISUAL ALERTS

4.1 The TAWS is required to provide aural and visual alerts for each of the functions described in section **3.0** of this Appendix.

4.2 The TAWS must provide the required aural and visual alerts in a manner that clearly indicates to the flight crew that they represent a single event. The TAWS may accomplish the entire alerting function, or provide alert inputs to an external aircraft alerting system. Exceptions to this requirement are allowed when suppression of aural alerts is necessary to protect pilots from nuisance aural alerting, but a visual alert is still appropriate.

4.3 Each aural alert must identify the reason for the alert, such as 'too low terrain',- 'glideslope', or another acceptable annunciation.

4.4 The system must remove the visual and aural alert once the situation has been resolved.

4.5 The system must be capable of accepting and processing aeroplane performance-related data or aeroplane dynamic data and providing the capability to update aural and visual alerts at least once per second.

4.6 The aural and visual outputs as defined in Table **4-1** must be compatible with the standard cockpit displays and auditory systems.

4.7 The aural and visual alerts should be selectable to accommodate operational commonality among aeroplane fleets.

4.8 The visual display of alerting information must be immediately and continuously displayed until the situation is resolved or no longer valid.

4.9 At a minimum, the TAWS must be capable of providing aural alert messages described in Table **4-1**. In addition to this minimum set, other voice alerts may be provided.

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Table 4-1

STANDARD SET OF VISUAL AND AURAL ALERTS		
Alert Condition	**Caution**	**Warning**
FLTA Functions Reduced Required Terrain Clearance and Imminent Impact with Terrain Class A & Class B	**Visual Alert** Amber text message that is obvious, concise, and must be consistent with the aural message. **Aural Alerts** Minimum selectable voice alerts: 'Caution, Terrain; Caution, Terrain' **and** 'Terrain Ahead; Terrain Ahead'	**Visual Alert** Red text message that is obvious, concise and must be consistent with the aural message. **Aural Alerts** Minimum selectable voice alerts: 'Terrain, Terrain; Pull-Up, Pull-Up' **and** 'Terrain Ahead, Pull-Up; Terrain Ahead, Pull-Up'
Premature Descent Alert (PDA) Class A & Class B	**Visual Alert** Amber text message that is obvious, concise, and must be consistent with the aural message. **Aural Alert** 'Too Low Terrain'	**Visual Alert** None Required **Aural Alert** None Required
Ground Proximity Envelope 1, 2, or 3 Excessive Descent Rate Mode 1 Class A & Class B	**Visual Alert** Amber text message that is obvious, concise, and must be consistent with the aural message. **Aural Alert** 'Sink Rate'	**Visual Alert** Red text message that is obvious, concise, and must be consistent with the Aural message. **Aural Alert** 'Pull-Up'
Ground Proximity Excessive Closure Rate (Flaps not in Landing Configuration) Mode 2A Class A	**Visual Alert** Amber text message that is obvious, concise, and must be consistent with the aural message. **Aural Alert** 'Terrain, Terrain'	**Visual Alert** Red text message that is obvious, concise, and must be consistent with the aural message. **Aural Alert** 'Pull-Up'

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STANDARD SET OF VISUAL AND AURAL ALERTS		
Alert Condition	**Caution**	**Warning**
Ground Proximity Excessive Closure Rate (Landing Configuration) Mode 2B Class A	**Visual Alert** Amber text message that is obvious, concise, and must be consistent with the aural message. **Aural Alert** 'Terrain, Terrain'	**Visual Alert** Red text message that is obvious, concise, and must be consistent with the aural message for gear up. **Aural Alert** 'Pull-Up'—for gear up None Required—for gear down
Ground Proximity Altitude Loss after Takeoff Mode 3 Class A & Class B	**Visual Alert** Amber text message that is obvious, concise, and must be consistent with the aural message. **Aural Alerts** 'Don't Sink' and 'Too Low Terrain'	**Visual Alert** None Required **Aural Alert** None Required
Ground Proximity Envelope 1 (Gear and/or flaps other than landing configuration) Mode 4 Class A	**Visual Alert** Amber text message that is obvious, concise, and must be consistent with the aural message. **Aural Alerts** 'Too Low Terrain' **and** 'Too Low Gear'	**Visual Alert** None Required **Aural Alert** None Required
Ground Proximity Envelope 2 Insufficient Terrain Clearance (Gear and/or flaps other than landing configuration) Mode 4 Class A	**Visual Alert** Amber text message that is obvious, concise, and must be consistent with the aural message. **Aural Alerts** 'Too Low Terrain' **and** 'Too Low Flaps'	**Visual Alert** None Required **Aural Alert** None Required
Ground Proximity Envelope 3 Insufficient Terrain Clearance (Gear and/or flaps other than landing configuration) Mode 4 Class A	**Visual Alert** Amber text message that is obvious, concise, and must be consistent with the aural message. **Aural Alert** 'Too Low Terrain'	**Visual Alert** None Required **Aural Alert** None Required

STANDARD SET OF VISUAL AND AURAL ALERTS		
Alert Condition	**Caution**	**Warning**
Ground Proximity Excessive Glideslope or Glidepath Deviation Mode 5 Class A	**Visual Alert** Amber text message that is obvious, concise, and must be consistent with the aural message. **Aural Alert** ‘Glideslope’ or ‘Glidepath’	**Visual Alert** None Required **Aural Alert** None Required
Ground Proximity Altitude Callout (See Note 1)	**Visual Alert** None Required	**Visual Alert** None Required
Class A & Class B (See Note 3)	**Aural Alert** ‘Five Hundred’	**Aural Alert** None Required

Note 1: The call out for ground proximity altitude is considered advisory.

Note 2: Visual alerts may be put on the terrain situational awareness display, if doing so fits with the overall human factors alerting scheme for the flight deck. This does not eliminate the visual alert color requirements, even in the case of a monochromatic display. Typically in such a scenario, adjacent colored annunciator lamps meet the alerting color requirements.

Note 3: Additional callouts can be made by the system, but the system is required to make the 500 foot voice callout.

4.10 Prioritisation

a. **Class A Equipment.** Class A Equipment must have an interactive capability with other external alerting systems so that an alerting priority can be executed automatically. This prevents confusion or chaos on the flight deck during multiple alerts from different alerting systems. Typical alerting systems that may be interactive with TAWS include predictive windshear (PWS), reactive windshear (RWS), and traffic alert collision and avoidance system (TCAS). The TAWS system must include an alert prioritisation scheme for Class A equipment. Table **4-2** provides an example prioritisation scheme for Class A equipment. If the PWS, RWS, or TCAS functions are provided within TAWS, the alert prioritisation scheme in Table **4-2** also applies. The FAA will consider alert prioritisation schemes other than the one included in Table **4-2**.

b. **Class B Equipment**

1. Class B Equipment does not require prioritisation with external systems such as TCAS, RWS, and PWS. If prioritisation with those functions is provided, the prioritisation scheme should be in accordance with the scheme in Table **4-2**.

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2. Class B Equipment must establish an internal priority alerting system (scheme) for each of the functions. The priority scheme must ensure that the more critical alerts override alerts of lesser priority. Table **4-3** provides a example internal priority scheme for Class B equipment. Class B Equipment need only consider the TAWS functions required for Class B Equipment.

Table 4-2

Legend: W = Warning, C = Caution, I = Non-Alert Information

ALERT PRIORITISATION SCHEME			
Priority	**Description**	**Level**	**Comments**
1	Reactive Windshear Warning	W	
2	Sink Rate Pull-Up Warning	W	Continuous
3	Excessive Closure Pull-Up Warning	W	Continuous
4	RTC Terrain Warning	W	
5	V_1 Callout	I	
6	Engine Fail Callout	W	
7	FLTA Pull-up Warning	W	Continuous
8	PWS Warning	W	
9	RTC Terrain Caution	C	Continuous
10	Minimums	I	
11	FLTA Caution	C	7 s period
12	Too Low Terrain	C	
13	PDA (‘Too Low Terrain’) Caution	C	
14	Altitude Callouts	I	
15	Too Low Gear	C	
16	Too Low Flaps	C	
17	Sink Rate	C	
18	Don’t Sink	C	
19	“Glideslope” or “Glidepath”	C	3 s period
20	PWS Caution	C	
21	Approaching Minimums	I	
22	Bank Angle	C	
23	Reactive Windshear Caution	C	
Mode 6	TCAS RA *(‘Climb’, ‘Descend’, etc.*)	W	Continuous
Mode 6	TCAS TA (‘*Traffic, Traffic*’)	C	Continuous

Note: These alerts can occur simultaneously with TAWS voice callout alerts.

Table 4-3

TAWS INTERNAL ALERT PRIORITIZATION SCHEME	
Priority	**Description**
1	Sink Rate Pull-Up Warning
2	Terrain Awareness Pull-Up Warning
3	Terrain Awareness Caution
4	PDA (‘*Too Low Terrain*’) Caution
5	Altitude Callout ‘500’
6	Sink Rate
7	Don’t Sink (Mode 3)

4.11 During ILS glideslope, LPV, GLS glidepath, or other localizer-based approach operations, TAWS should not cause an alert for a terrain/obstacle located outside the TERPS-protected airspace. Special design considerations may be necessary to address this issue.

5.0 TAWS Position Requirements. TAWS relies on horizontal position, vertical position, velocity, and vertical rate information. This information can be generated internally to the TAWS, or acquired by interfacing to other installed avionics on the aircraft.

5.1 External Sources. When the TAWS interfaces to external sources for position, velocity, or rate information, the TAWS installation manual must define the performance requirements for the interface.

5.2 Internal Sources. When the TAWS includes internal sources for position, velocity, or rate information, these sources must meet the performance requirements in the applicable ETSO, if an applicable ETSO exists. The performance of the internal source must be sufficient for the TAWS to meet its intended function. Examples of applicable ETSOs include:

a. GNSS equipment: ETSO-C129a *Airborne Supplemental Navigation Equipment Using the Global Positioning System* (or subsequent), or any revision of ETSO-C145 *Airborne Navigation Sensors Using the Global Positioning System Augmented by the Satellite-Based Augmentation System*, ETSO-C146 *Stand-Alone Airborne Navigation Equipment Using the Global Positioning System Augmented by the Satellite-Based Augmentation System*, or ETSO-C196 *Airborne Supplemental Navigation Sensors for Global Positioning System Equipment Using Aircraft-Based Augmentation*.

b. Barometric altitude equipment: ETSO-C10b *Altimeter, Pressure Actuated, Sensitive Type*, or ETSO-C106 *Air Data Computer*.

c. Radio altimeter equipment: ETSO-C87a *Airborne Low-Range Radio Altimeter* (or subsequent), ETSO-2C87 *Low Range Radio Altimeters*, or RTCA/DO-155 *Minimum Performance Standards Airborne Low-Range Radar Altimeters*.

d. Vertical velocity equipment: ETSO-C8 *Vertical Velocity Instruments* (or subsequent), or ETSO-C106 *Air Data Computer* (or subsequent).

5.3 Primary Horizontal Position Sources. Horizontal position for TAWS must come from a GNSS source meeting ETSO-C129a or any revision of ETSO-C145, ETSO-C146, or ETSO-C196 (or subsequent). As an exception, TAWS equipment limited to installation in aircraft where the EU Regulation on Air Operations does not require such equipment may be configurable to operate solely on a non-GNSS position source.

5.4 Alternate Horizontal Position Sources. Retaining TAWS functionality during GNSS outage or unavailability provides a safety benefit. It is acceptable and recommended to incorporate a secondary, non GNSS position source, to provide horizontal position when the GNSS is not available or reliable.

5.5 Vertical Position Sources. Vertical position for TAWS may come from a barometric source, such as an altimeter or an air data computer, or from a geometric source, such as GNSS. GNSS vertical accuracy, at a minimum, must meet RTCA/DO-229D, section 2.2.3.3.4. Designs that cross check barometric and geometric altitude are recommended. Class A TAWS also requires a radio altimeter.

5.6 Position Source Faults. If a position source generates a fault indication or any flag indicating the position is invalid or does not meet performance requirements, the TAWS must stop utilizing that position source. The TAWS may revert to an alternate position source, and must provide indications, as appropriate, regarding loss of function associated with the loss of the position source. The TAWS must inhibit FLTA and PDA alerts when the position source in use is faulted or invalid.

6.0 CLASS A AND CLASS B REQUIREMENTS FOR A TERRAIN AND AIRPORT DATABASE

6.1 Minimum Geographical Consideration. At a minimum, terrain and airport information must be provided for the expected areas of operation, airports, and routes flown.

6.2 Development and Methodology. The manufacturer must present the development methodology used to validate and verify the terrain and airport information.
RTCA/DO-200A/ED-76 *Standards for Processing Aeronautical Data* should be used as a guideline.

6.3 Resolution. Terrain and airport information must be accurate and of acceptable resolution in order for the system to perform its intended function. Terrain data should be gridded at 30 arc seconds with 100-foot resolution within 30 NM of all airports with runway lengths of 3 500 feet or greater, and whenever necessary (particularly in mountainous environments), 15 arc seconds with 100-foot resolution (or even 6 arc seconds) within 6 NM of the closest runway. It is acceptable to have terrain data gridded in larger segments over oceanic and remote areas around the world.

Note: Class B equipment may require information relative to airports with runways less than 3 500 feet whether public or private. Small aeroplane owners and operators will likely be the largest market for Class B equipment and they frequently use airports of less than 3 500 feet. Those TAWS manufacturers who desire to sell to this market must be willing to customize their terrain databases to include selected airports used by their customers.

6.4 Continued Airworthiness Updates. The system must be capable of accepting updated terrain and airport information. Updating of terrain, obstacle, and airport databases does not require a change to the ETSO authorization.

7.0 CLASS A AND CLASS B FAILURE INDICATION. Class A and Class B equipment must include a failure monitor function that provides reliable indications of equipment condition during operation. It must monitor the equipment itself, input power, input signals, and aural and visual outputs. A means to inform the flight crew whenever the system has failed or can no longer perform the intended function must be provided.

8.0 CLASS A AND CLASS B REQUIREMENTS FOR SELF-TEST. Class A and Class B equipment must have a self-test function to verify system operation and integrity. It must monitor the equipment itself, input power, input signals, and aural and visual outputs. Failure of the system to successfully pass the self-test must be annunciated.

Note: Flight crew verification of the aural and visual outputs during a self-test is an acceptable method for monitoring aural and visual outputs.

9.0 CLASS A EQUIPMENT REQUIREMENTS FOR INHIBITING THE FLTA FUNCTION, THE PREMATURE DESCENT ALERT FUNCTION, AND THE TERRAIN DISPLAY

9.1 Manual Inhibit. The TAWS system must have a capability (e.g. a control switch to the flight crew) to manually inhibit the TAWS (FLTA/PDA) aural alerts, visual alerts, and the terrain display. The switch must not inhibit any of the GPWS alerts defined in section 1.3.e. If the TAWS system incorporates an automatic inhibit function that automatically inhibits TAWS (FLTA/PDA) aural alerts, visual alerts, and terrain display when a position source is faulted or unavailable, then the manual inhibit may be designed to only inhibit aural and visual alerts. This alternate manual inhibit functionality will allow pilots to disable the TAWS (FLTA/PDA) alerting without removing the terrain display when landing at a site not included in the database or landing at a site that generates known nuisance alerts. Inhibit status must be annunciated to the flight crew.

9.2 Automatic Inhibit. The capability of automatically inhibiting Class A functions within TAWS equipment is acceptable when utilizing the conditions described in paragraph **7.0**. If auto inhibit capability is provided, the "inhibit status" must be annunciated to the flight crew.

10.0 CLASS A and B PHASE OF FLIGHT DEFINITIONS. The TAWS equipment search volumes and alerting thresholds should vary as necessary in order to be compatible with TERPS and other operational considerations. For this reason, a set of definitions is offered for enroute, terminal, approach and departure phases of flight. Other definitions for enroute, terminal, and approach may be used by TAWS provided they are compatible with TERPS and standard instrument approach procedures and comply with the test criteria specified in Appendix **2**. If other definitions for enroute, terminal, and approach are used by TAWS, they must be submitted to EASA in the form of a deviation as per Part 21 21.A.610.

10.1 Enroute Phase. The enroute phase exists when the aeroplane is more than 15 NM from the nearest airport or whenever the conditions for terminal, approach, and departure phases are not met.

10.2 Terminal Phase. The terminal phase exists when the aeroplane is 15 NM or less from the nearest runway while the range to the nearest runway threshold is decreasing and the aeroplane is at or lower than a straight line drawn between the two points specified in Table **10** relative to the nearest runway.

Note: If the aircraft is accomplishing a procedure turn as part of an instrument approach procedure, the system may remain in the terminal phase, even though the distance to the runway threshold may be temporarily increasing and the conditions for the approach phase may be temporarily met.

Table 10

HEIGHT ABOVE RUNWAY VERSUS DISTANCE TO RUNWAY	
Distance to Runway	**Height above Runway**
15 NM	3 500 Feet
5 NM	1 900 Feet

10.3 Approach Phase. The approach phase exists when the distance to the nearest runway threshold is equal to or less than 5 NM; and the height above the nearest runway threshold location and elevation is equal to or less than 1900 feet; and the distance to the nearest runway threshold is decreasing.

10.4 Departure Phase. The departure phase should be defined by some reliable parameter that initially determines that the aeroplane is on the ground upon initial power-up. If, for example, the equipment can determine that the aeroplane is 'on the ground' by using some logic such as ground speed less than 35 knots and altitude within ± 75 feet of field elevation or nearest runway elevation and 'airborne' by using some logic such as ground speed greater than 50 knots and altitude 100 feet greater than field elevation, then the equipment can reliably determine that it is in the 'Departure Phase'. Other parameters to consider are climb state and distance from departure runway. Once the aeroplane reaches 1 500 feet above the departure runway, the departure phase is ended.

10.5 Nearest Airport or Runway. The enroute phase considers distance to the nearest airport, and the terminal and approach phases consider distance to the nearest runway in determining the appropriate phase of flight, and thus the appropriate terrain alerting requirements. The phase of flight may also be determined by basing the phase of flight on the intended landing airport or runway, if the TAWS has the intended landing airport or runway information available. The phase of flight determination may also exclude airports or runways which are unsuitable for landing of a particular type of aircraft. For example, the TAWS could be configurable at installation on a large transport category aircraft to only change the phase of flight based on runways of a certain minimum length.

11.0 CLASS A AND CLASS B SUMMARY REQUIREMENTS
(Reserved)

Table 11
(reserved)

APPENDIX 2

TEST CONDITIONS

1.0 FORWARD-LOOKING TERRAIN AVOIDANCE — REDUCED REQUIRED TERRAIN CLEARANCE (RTC) TEST CONDITIONS. These conditions exist when the aeroplane is currently above the terrain, but the combination of current altitude, height above terrain, and projected flight path indicates that there is a significant reduction in the RTC.

1.1 Phase of Flight Definitions. For the following test conditions, refer to Appendix **1**, paragraph **10.0**, for an expanded explanation of the definitions of the phases of flight.

1.2 En route Descent Requirement. A terrain alert must be provided in time to ensure that the aeroplane can level off (L/O) with a minimum of 500 feet altitude clearance over the terrain/obstacle when descending toward the terrain/obstacle at any speed within the operational flight envelope of the aeroplane. The test conditions assume a descent along a flight path with terrain that is 1 000 feet below the expected L/O altitude. If the pilot initiates the L/O at the proper altitude, no TAWS alert is expected. However, if the pilot is distracted or otherwise delays the L/O, a TAWS alert is required to permit the pilot to recover to level flight in a safe manner.

Note: The L/O initiation height of 20 % of the vertical speed was chosen (as a minimum standard for nuisance alarm-free operations) because it is similar to typical autopilot or flight director L/O (altitude capture) algorithms. In contrast, the technique of using 10 %of the existing vertical speed as a L/O initiation point is usually considered a minimum, appropriate only to manual operations of smaller general aviation (GA) aeroplanes. With high rates of descent, experienced pilots often use a manual technique of reducing the vertical speed by one half when reaching 1 000 feet above/below the L/O altitude. This technique will significantly reduce the likelihood of nuisance alerts. In the event that using 20 %of the vertical speed as a minimum standard for nuisance-free operations is shown not to be compatible with the installed autopilot or flight director L/O (altitude capture) algorithms, consideration should be given to setting the alert logic closer to the 10 %vertical speed criteria to minimize nuisance alerts.

a. Table A, column A, represents the test condition. Columns B, C, and D are for information purposes only. Column E represents the minimum altitude for which TAWS alerts must be posted to perform their intended function. Column F represents the maximum altitude for which TAWS alerts may be provided in order to meet the nuisance alert criteria. See Appendix **2**, paragraph **4.0**.

b. For each of the descent rates specified below, recovery to level flight at or above 500 feet terrain clearance is required.

c. Test conditions for enroute descent requirement:

Assumed pilot response time	3.0 seconds (minimum)
Assumed constant G pull-up	0.25 g's
Minimum allowed terrain clearance	500 feet AGL
Descent rates	1 000, 2 000, 4 000, and 6 000 feet per minute (FPM)
Assumed pilot task for column F	L/O at 1 000 feet above the terrain per TERPS ROC

Note1: The actual values for the aeroplane altitude, distance, and time from the terrain cell when caution and warning alerts are posted and the minimum terrain clearance altitude must be recorded.

Note 2: Enroute operations are considered to exist beyond 15 NM from the departure runway until 15 NM from the destination airport. Use of the nearest runway logic is permissible provided suitable logic is incorporated to ensure that the transitions to the terminal logic will typically occur only when the aeroplane is in terminal airspace.

Note 3: The values shown in column E may be reduced by 100 feet (to permit a L/O to occur at 400 feet above the obstacle) provided that it can be demonstrated that the basic TAWS Mode 1 alert (sink rate) is issued at or above the altitude specified in column E for typical terrain topographies.

Note 4: **Class B Equipment Considerations.** The values shown in Column F are appropriate for autopilot or flight director operations with an altitude capture function typical of many CS-25-certified aeroplanes (Transport Category Aircraft). The values are based upon 20 %of the aeroplane's vertical velocity. If TAWS is installed on an aeroplane without such an autopilot or flight director function, consideration should be given to computing the alerts based upon 10 %of the vertical velocity, which is more appropriate to manual flight and small, GA aeroplane operations.

TABLE A

ENROUTE DESCENT ALERTING CRITERIA					
A	B	C	D	E	F
VERT SPEED (FPM)	ALT LOST WITH 3-SEC PILOT DELAY	ALT REQ'D TO L/O WITH 0.25G	TOTAL ALT LOST DUE TO RECOVERY MANEUVER	MINIMUM TAWS WARNING ALERT HEIGHT (ABOVE TERRAIN)	MAXIMUM TAWS CAUTION ALERT HEIGHT (ABOVE TERRAIN)
1 000	50	17	67	567	1 200
2 000	100	69	169	669	1 400
4 000	200	278	478	978	1 800

1.3 Enroute Level Flight Requirement. During level flight operations (vertical speed is ± 500 FPM), a terrain alert should be posted when the aeroplane is within 700 feet of the terrain and is predicted to be equal to or less than 700 feet within the prescribed alerting time or distance. See Table B for test criteria.

Note: The actual values for the aeroplane altitude, distance and time from the terrain cell when caution and warning alerts are posted must be recorded.

TABLE B

ENROUTE LEVEL FLIGHT ALERTING CRITERIA			
GROUND SPEED (KT)	HEIGHT OF TERRAIN CELL MEAN SEA LEVEL (MSL)	TEST RUN ALTITUDE (MSL)	ALERT CRITERIA
200	5 000	6 000	NO ALERT
250	5 000	5 800	NO ALERT
300	5 000	5 800	NO ALERT
200	5 000	5 700 (+ 0/– 100)	MUST ALERT
250	5 000	5 700 (+ 0/– 100)	MUST ALERT
300	5 000	5 700 (+ 0/– 100)	MUST ALERT
400	5 000	5 700 (+ 0/– 100)	MUST ALERT
500	5 000	5 700 (+ 0/– 100)	MUST ALERT

1.4 Terminal Area (Intermediate Segment) Descent Requirement. A terrain alert must be provided in time to ensure that the aeroplane can L/O with a minimum of 300 feet altitude clearance over the terrain/obstacle when descending toward the terrain/obstacle at any speed within the operational flight envelope of the aeroplane. The test conditions assume a descent along a flight path with terrain that is 500 feet below the expected L/O altitude. If the pilot initiates the L/O at the proper altitude, no TAWS alert is expected. However, if the pilot is distracted or otherwise delays the L/O, a TAWS alert is required to permit the pilot to recover to level flight in a safe manner.

a. Table C, column A, represents the test condition. Columns B, C, and D are for information purposes only. Column E represents the minimum altitude for which TAWS alerts must be posted to perform their intended function. Column F represents the maximum altitude for which TAWS alerts may be provided in order to meet the nuisance alert criteria. See Appendix **2**, paragraph **4.0**.

b. For each of the descent rates specified below, recovery to level flight at or above 300 feet terrain clearance is required.

c. Test conditions for terminal area descent requirement:

Assumed pilot response time	1.0 second (minimum)
Assumed constant G pull-up	0.25 g's
Minimum allowed terrain clearance	300 feet AGL
Descent rates	1 000, 2 000, and 3 000 FPM
Assumed pilot task for column F	L/O at 500 feet above the terrain per TERPS ROC

Note 1: The actual values for the aeroplane altitude, distance, and time from the terrain cell when caution and warning alerts are posted and the minimum terrain clearance altitude must be recorded.

Note 2: **For Class B Equipment Considerations.** The values shown in Column F are appropriate for autopilot or flight director operations with an altitude capture function typical of many CS-25-certificated aeroplanes (Transport Category Aircraft). The values are based upon 20 %of the aeroplanes vertical velocity. If TAWS is installed on an aeroplane without such an autopilot or flight director function, consideration should be given to computing the alerts upon 10 %of the vertical velocity, which is more appropriate to manual flight and small, GA aeroplane operations.

Table C

TERMINAL DESCENT AREA ALERTING CRITERIA					
A	**B**	**C**	**D**	**E**	**F**
VERT SPEED (FPM)	ALT LOST WITH 1SEC PILOT DELAY	ALT REQ'D TO L/O WITH 0.25G	TOTAL ALT LOST DUE TO RECOVERY MANEUVER	MINIMUM TAWS WARNING ALERT HEIGHT (ABOVE TERRAIN)	MAXIMUM TAWS CAUTION ALERT HEIGHT (ABOVE TERRAIN)
1 000	17	17	34	334	700
2 000	33	69	102	402	900
3 000	50	156	206	506	1 100

1.5 Terminal Area (Intermediate Segment) Level Flight Requirement. During level flight operations (vertical speed less than ± 500 feet per minute), a terrain alert should be posted when the aeroplane is less than 350 feet above the terrain and is predicted to be within less than 350 feet within the prescribed alerting time or distance. See Table D for test criteria.

Note: The actual values for the aeroplane altitude, distance, and time from the terrain cell when caution and warning alerts are posted must be recorded.

Table D

TERMINAL AREA LEVEL FLIGHT ALERTING CRITERIA			
GROUND SPEED (KT)	HEIGHT OF TERRAIN CELL (MSL)	TEST RUN ALTITUDE (MSL)	ALERT CRITERIA
150	1 000	1 500	NO ALERT
200	1 000	1 500	NO ALERT
250	1 000	1 500	NO ALERT
100	1 000	1 350	MUST ALERT
150	1 000	1 350	MUST ALERT
200	1 000	1 350	MUST ALERT
250	1 000	1 350	MUST ALERT

1.6 Final Approach Segment Descent Requirement. A terrain alert must be provided in time to ensure that the aeroplane can L/O with a minimum of 100 feet altitude clearance over the terrain/obstacle when descending toward the terrain/obstacle at any speed within the operational flight envelope of the aeroplane.

a. Table E, column A, represents the test condition. Columns B, C, and D are for information purposes only. Column E represents the minimum altitude for which TAWS alerts must be posted to perform their intended function. Column F represents the maximum altitude for which TAWS alerts may be provided in order to meet the nuisance alert criteria. See appendix **2**, paragraph **4.0**.

b. For each of the descent rates specified below, recovery to level flight at or above 100 feet terrain clearance is required.

c. Test conditions for final approach segment descent requirement:

Assumed pilot response time	1.0 seconds (minimum)
Assumed constant G pull-up	0.25 g's
Minimum allowed terrain clearance	100 feet AGL
Descent rates	500, 750, 1 000, and 1 500 FPM
Assumed pilot task for column F	L/O at 250 feet above the terrain per TERPS ROC

Note: 1: The actual values for the aeroplane altitude, distance, and time from the terrain cell when caution and warning alerts are posted and the minimum terrain clearance altitude must be recorded.

Note: 2: **For Class B Equipment Considerations.** The values shown in column F are appropriate for autopilot or flight director operations with an altitude capture function typical of many CS-25-certificated aeroplanes (Large Aeroplanes). The values are based upon 20 %of the aeroplanes vertical velocity. If TAWS is installed on an aeroplane without such an autopilot or flight director function, consideration should be given to computing the alerts based upon 10 %of the vertical velocity, which is more appropriate to manual flight and small, GA aeroplane operations.

Table E

A	**B**	**C**	**D**	**E**	**F**
VERT SPEED (FPM)	ALT LOST WITH 1SEC PILOT DELAY	ALT REQ'D TO L/O WITH 0.25G	TOTAL ALT LOST DUE TO RECOVERY MANEUVER	MINIMUM TAWS WARNING ALERT HEIGHT (ABOVE TERRAIN)	MAXIMUM TAWS CAUTION ALERT HEIGHT (ABOVE TERRAIN)
500	8	4	12	112	350
750	12	10	22	122	400
1 000	17	18	35	135	450
1 500	25	39	64	164	550

1.7 Final Approach Level Flight Requirement. During level flight operations at the minimum descent altitude (MDA), a terrain alert should be posted when the aeroplane is within 150 feet of the terrain and is predicted to be within less than 150 feet within the prescribed alerting time or distance.

See Table F for test criteria.

Note: The actual values for the aeroplane altitude, distance, and time from the terrain cell when caution and warning alerts are posted must be recorded.

Table F

FINAL APPROACH LEVEL FLIGHT ALERT CRITERIA				
GROUND SPEED (KT)	HEIGHT OF TERRAIN CELL (MSL)	DISTANCE TERRAIN FROM RWY (NM)	TEST RUN ALTITUDE (MSL)	ALERT CRITERIA
120	400	2.0	650	NO ALERT
140	400	2.0	650	NO ALERT
160	400	2.0	650	NO ALERT
120	400	2.0	600	MAY ALERT
140	400	2.0	600	MAY ALERT
160	400	2.0	600	MAY ALERT
100	400	2.0	550	MUST ALERT
120	400	2.0	550	MUST ALERT
140	400	2.0	550	MUST ALERT
160	400	2.0	550	MUST ALERT

2.0 FORWARD-LOOKING TERRAIN AVOIDANCE IMMINENT TERRAIN IMPACT TEST CONDITIONS. The following test conditions must be conducted to evaluate level flight performance during all phases of flight:

Note: 1: The actual values for the aeroplane altitude, distance and time from the terrain cell when caution and warning alerts are posted must be recorded.

Note: 2: Based upon a one-second pilot delay and a 0.25g incremental pull to constant 6.0-degree climb gradient, compute and record the aeroplane altitude at the terrain cell, the positive (or negative) clearance altitude, and the aeroplane position and time (after the alert), when the alert envelope is cleared.

2.1 Test Criteria. For each of the test cases below, a positive clearance of the terrain cell of interest is required.

2.2 Additional Test Criteria. Repeat each of the test cases below with the altitude error of – 200 feet). A positive clearance of the terrain cell of interest is required.

Table G

IMMINENT TERRAIN IMPACT ALERTING CRITERIA				
GROUND SPEED (KT)	HEIGHT OF TERRAIN CELL (MSL)	DISTANCE TERRAIN FROM RWY (NM)	TEST RUN ALTITUDE (MSL)	ALERT CRITERIA
200	10 000	30	9 000	MUST ALERT

250	10 000	30	9 000	MUST ALERT
300	10 000	30	9 000	MUST ALERT
400	10 000	30	8 000	MUST ALERT
500	10 000	30	8 000	MUST ALERT
150	2 000	10	1 500	MUST ALERT
200	2 000	10	1 500	MUST ALERT
250	2 000	10	1 500	MUST ALERT
100	600	5	500	MUST ALERT
120	600	5	500	MUST ALERT
140	600	5	500	MUST ALERT
100	600	4	200	MUST ALERT
120	600	4	200	MUST ALERT
140	600	4	200	MUST ALERT
160	600	4	200	MUST ALERT
160	600	5	500	MUST ALERT

3.0 PDA TEST CONDITIONS. The purpose of this test is to verify that the pilot will be alerted to a 'low altitude condition' at an altitude defined by the specific design PDA alert surface. This ETSO does not define specific pass/fail criteria since, as stated in paragraph **3.2** of appendix **1**, it does not define the surface for which alerting is required. The applicant must provide the proposed pass/fail criteria along with the proposed recovery procedures for the specific alerting criteria proposed by the applicant. In developing the test plan, the applicant should refer to paragraph **3.2** of appendix **1** for general requirements for alerting (if alerting is applicable). The applicant may also want to consider the recovery procedures specified in paragraphs **1.2**, **1.4**, and **1.6** of paragraph **1** of appendix **2**. The following test conditions must be conducted to evaluate PDA performance:

Descent rates (FPM)	750, 1 500, and 2 000, 3 000
Assumed runway elevation	Sea level, Level terrain

Note: For each test condition listed in table **H**, compute and record the PDA alert altitude and the recovery altitude to level flight.

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Table H

PREMATURE DESCENT ALERTING CRITERIA				
GROUND SPEED (KT)	VERT. SPEED (FPM)	DISTANCE FROM RWY THRESHOLD (TOUCHDOWN) (NM)	PDA ALERT HEIGHT (MSL)	RECOVERY ALTITUDE (MSL)
80	750	15		
100	1 500	15		
120	750	15		
140	1 500	15		
160	750	15		
200	1 500	15		
250	2 000	15		
80	750	12		
100	1 500	12		
120	750	12		
140	1 500	12		
160	750	12		
80	750	4		
100	1 500	4		
120	750	4		
140	1 500	4		
80	750	2		
100	1 500	2		
120	750	2		
140	1 500	2		

4.0 NUISANCE ALERT TEST CONDITIONS — GENERAL. The following test conditions must be conducted to evaluate TAWS performance during all phases of flight. The following general criteria apply:

4.1 4 000 FPM. Descent must be possible at 4 000 FPM in the enroute airspace and pilots must be able to L/O 1 000 feet above the terrain using a normal L/O procedure (leading by 20 %of the vertical speed) without a caution or warning alert. See Table A.

4.2 2 000 FPM. Descent must be possible at 2 000 FPM in the terminal area and pilots must be able to L/O 500 feet above the terrain using the normal L/O procedure described in paragraph **4.1** above, without a caution or warning alert. See Table C.

4.3 1 000 FPM. Descent must be possible at 1 000 FPM in the final approach segment and pilots must be able to L/O at the MDA using the normal L/O procedure described in paragraph **4.1** above, without a caution or warning alert. See Table E.

5.0 NUISANCE TEST CONDITIONS FOR HORIZONTAL AND VERTICAL FLIGHT TECHNICAL ERRORS. It must be shown by analysis, simulation, or flight testing, that the system will not produce nuisance alerts when the aeroplane is conducting normal flight operations in accordance with published instrument approach procedures. This assumes the normal range in variation of input parameters.

5.1 Test Cases. At a minimum, the following cases listed in Table **I** must be tested twice: one set of runs conducted with no lateral or vertical errors while another set is conducted with both lateral and vertical flight technical errors (FTE). Certain conditions must be simulated, such as: a lateral FTE of 0.3 NM and a vertical FTE of – 100 feet (such as when the aircraft is closer to terrain) up to the final approach fix (FAF), as well as a lateral FTE of 0.3 NM and a vertical FTE of – 50 feet from the FAF to the missed approach point (MAP). For all listed VHF omni- directional range navigation system (VOR), VOR/distance measuring equipment (DME) and localizer-based approaches, from the FAF to the MAP, the aeroplane descends at 1 000 FPM until reaching either MDA (run #1) or MDA – 50 feet (run #2). The aeroplane then levels off and flies level until reaching the MAP. Localizer updating of lateral position errors (if provided) may be simulated.

Table I

NUISANCE ALERT TEST CONDITIONS FOR HORIZONTAL AND VERTICAL FLIGHT TECHNICAL ERRORS		
Case	**Location**	**Operation**
1	Quito, Ecuador	VOR ‘QIT’-ILS Rwy 35
2	Katmandu, Nepal	VOR-DME Rwy 2
3	Windsor Locks, CT	VOR Rwy 15
4	Calvi, France	LOC DME Rwy 18/Circle
5	Tegucigalpa, Honduras	VOR DME Rwy 1/Circle
6	Eagle, CO	LOC DME-C
7	Monterey, CA	LOC DME Rwy 28L
8	Juneau, AK	LDA-1 Rwy 8
9	Chambery, France	ILS Rwy 18

6.0 TEST CONDITIONS USING KNOWN ACCIDENT CASES. The aircraft configuration and flight trajectory for each case may be obtained from the FAA Regulatory and Guidance Library site. Click ‘Technical Standards and Orders and Index’, click ‘Current’, and then click ‘TSO-C151c’.

6.1 Test Report. The test report should include as many of the following parameters as possible used to recreate the events: (1) latitude; (2) longitude; (3) altitude; (4) time from terrain at caution and warning alerts; (5) distance from terrain at caution and warning alerts; (6) ground speed; (7) true track; (8) true heading; (9) radio altitude (height above terrain); (10) gear position; and (11) flap position.

6.2 Computation and Recording. In addition to the parameters above, when the warning is posted for each test case, based upon a one second pilot delay and a 0.25 g incremental pull to a constant 6.0 degree climb gradient, do the following: compute and record the aeroplane altitude at the terrain cell, the positive (or negative) clearance altitude, and the aeroplane position and time (after the alert) when the alert envelope is cleared.

Note: The terrain cell of interest is the one associated with the accident and not necessarily the terrain cell that caused the warning.

6.3 Test Criteria. For each of the test cases below in **table J**, demonstrate that the aeroplane profile clears the terrain of interest.

Table J

LOCATION	DATE	AIRCRAFT REGISTRATION NUMBER
La Paz, Bolivia	1/1/1985	N819EA
Flat Rock, NC	8/23/1985	N600CM
Windsor, MA	12/10/1986	N65TD
Eagle, CO	3/27/1987	N31SK
Tegucigalpa, Honduras	10/21/1989	N88705
Halawa Point, HI	10/28/1989	N707PV
San Diego, CA	3/16/1991	N831LC
Rome, GA	12/11/1991	N25BR
Gabriels, NY	1/3/1992	N55000
Alamogordo, NM	6/24/1992	N108SC
E. Granby, CT	11/12/1995	N566AA
Buga, Columbia	12/20/1995	N651AA
Nimitz Hill, Guam	8/6/1997	H7468

7.0 CLASS B EQUIPMENT TEST REQUIREMENTS FOR EXCESSIVE DESCENT RATE. Use the following performance envelopes down to a 'height above terrain' value of 100 feet. If a radar altimeter input is unavailable, determine the height of terrain by subtracting the terrain elevation (as obtained from the terrain database) from the current QNH (corrected) barometric altitude, the GNSS altitude, or an equivalent source. GNSS vertical accuracy must meet RTCA/DO-229D Section 2.2.3.3.4. The curve in figure 1 represents the minimum heights at which alerting must occur.

Note: Class B equipment may be designed to meet the requirements of RTCA/DO-161A, Mode 1, for excessive descent rate in lieu of the requirements of paragraph **7.0**.

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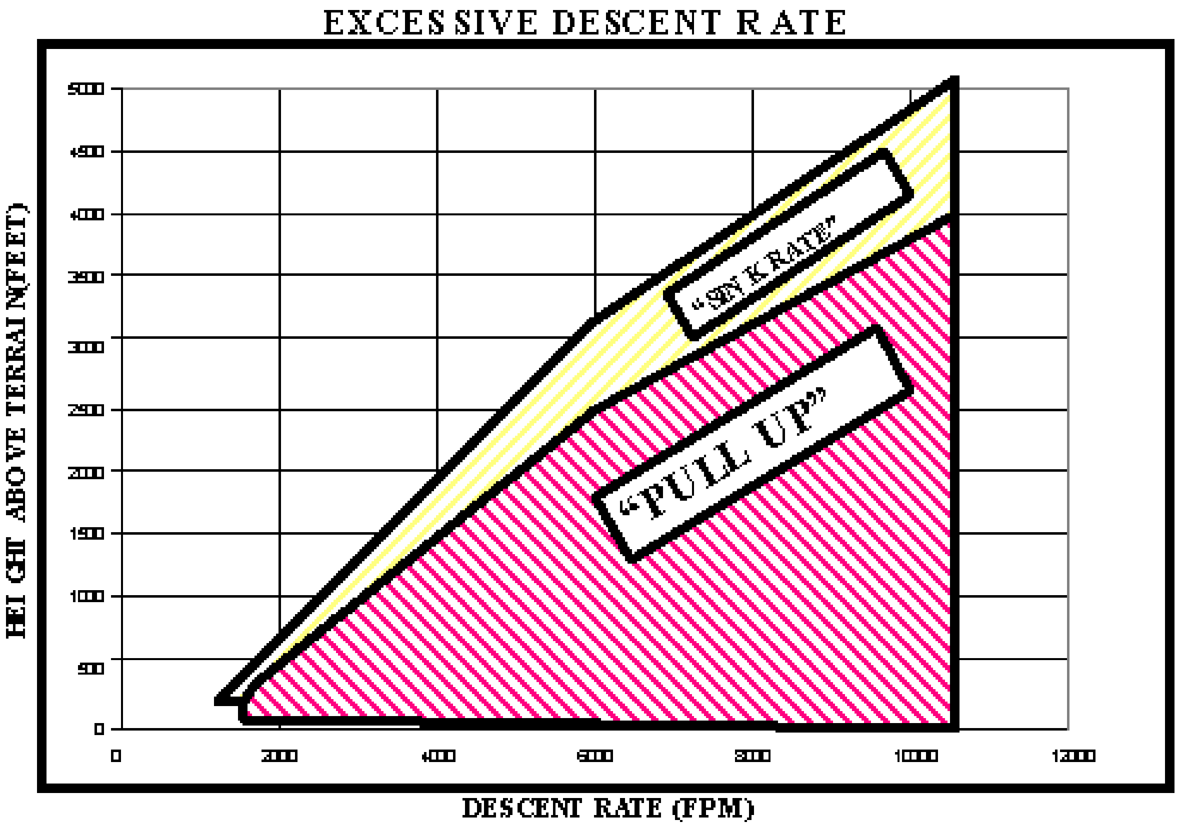
Figure 1



8.0 CLASS B EQUIPMENT TEST REQUIREMENTS FOR NEGATIVE CLIMB RATE OR ALTITUDE LOSS AFTER TAKEOFF. Use the existing performance envelopes specified in RTCA/DO-161A based upon a 'height above runway' using barometric altitude, GNSS altitude, or equivalent, and runway elevation in lieu of radio altimeter inputs, if radio altimeter inputs are unavailable.

9.0 ALTITUDE CALLOUT TEST REQUIREMENTS

9.1 CLASS A EQUIPMENT ALTITUDE CALLOUT TEST REQUIREMENTS. With the landing gear in landing configuration test for approach to an airport with a 1 500 FPM descent rate. Ensure the TAWS provides a single aural callout of 'Five Hundred' or equivalent within one second of the aircraft descending through 500 feet above terrain or the runway threshold elevation (when comparing the aircraft's barometric or geometric altitude against the database runway elevation).

9.2 CLASS B EQUIPMENT ALTITUDE CALLOUT TEST REQUIREMENTS. Instead of using height of terrain as determined by a radio altimeter, determine height above runway by subtracting the runway elevation (from the airport database) from the current barometric altitude, GNSS altitude, or equivalent, if a radio altimeter input is unavailable. When the height above the runway value first reaches 500 feet, a single voice callout ('Five Hundred') or equivalent must be provided.

APPENDIX 3

MINIMUM PERFORMANCE STANDARD (MPS) FOR A TERRAIN AWARENESS AND WARNING SYSTEM FOR CLASS C

1.0 INTRODUCTION

1.1 This Appendix describes modifications to this ETSO for the GA category of aircraft that is not required to have TAWS equipment installed. Class C equipment is intended for small GA aeroplanes that are not required to install Class B equipment.

1.2 This Appendix contains only modifications to existing requirements in this ETSO. It is intended that Class C meet all Class B requirements that are not modified or addressed here. The paragraph numbers below relate directly to the paragraphs in **Appendices 1** and **2.**

2.0 Class C TAWS equipment must meet all of the requirements of a Class B TAWS with the modifications described herein. If the equipment is designed only to function as Class C, per these modifications, it should be appropriately marked as Class C so that it can be uniquely distinguished from the Class A and Class B TAWS required by the EU Regulation on Air Operations.

MODIFICATIONS TO APPENDIX 1 FOR CLASS C TAWS.

Minimum Performance Standards, MPS

1.1 Phase of Flight Definitions. For **Appendix 3**, the terms 'takeoff', 'cruise', and 'landing' are used instead of 'departure', 'enroute', and 'approach' because they are more suitable to the GA environment.

— *Takeoff*—positive ROC, inside traffic area, distance to nearest runway threshold is increasing, and aeroplane is below 1 000 feet.

— *Cruise* — anytime the aeroplane is outside the airport traffic control area.

— *Landing* — inside traffic area and distance to nearest runway threshold is decreasing, and aeroplane is below 1 000 feet.

1.2 Altitude Accuracy and Display. A means must be provided to compute an actual MSL aircraft altitude value that is immune to temperature errors and manual correction mis-sets that would otherwise prevent the TAWS from performing its intended function. This type of altitude is derived primarily from geometric sources such as GPS, and referenced to MSL typically via a database correction. If the TAWS includes a terrain display, this reference altitude value used for the TAWS alerts should also be indicated to the pilot on the display. The altitude value should be labelled according to AC 20-163, *Displaying Geometric Altitude Relative to Mean Sea Level*, which recommends 'GSL'.

1.3 (f)(3) System Function and Overview. This data is pilot selectable for both 'altitude' and 'inhibit'.

3.1.1 Reduced Required Terrain Clearance (RTC). The required terrain clearance in the alternate **table 3.1.1** applies to small aircraft flying visually, and the TERPS criteria need not apply to TAWS. Thus, ROC numbers that are more appropriate to low level flight have been chosen.

Alternate Table 3.1.1

TAWS REQUIRED TERRAIN CLEARANCE (RTC) BY PHASE OF FLIGHT			
Phase of Flight	**Small Aircraft ROC**	**TAWS (RTC) Level Flight**	**TAWS (RTC) Descending**
Cruise	500 Feet	250 Feet	200 Feet
Takeoff	48 Feet/NM	100 Feet	100 Feet
Landing (See Note 1)	250 Feet	150 Feet	100 Feet

Note: 1: During the takeoff phase of flight, the FLTA function must alert if the aircraft is projected to be within 100 feet vertically of terrain. However, the equipment should not alert if the aircraft is projected to be more than 250 feet above the terrain.

3.3.c Voice Callouts. This data is pilot selectable for both ‘altitude’ and ‘inhibit’.

4.0 Aural and Visual Alerts

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Table 4-1

STANDARD SET OF VISUAL AND AURAL ALERTS		
Alert Condition	**Caution**	**Warning**
FLTA Functions Terrain Awareness Reduced Required Terrain Clearance and Terrain Awareness Imminent Impact with Terrain	**Visual Alert** Amber text message that is obvious, concise, and consistent with the aural message. **Aural Alert** Minimum selectable voice alert: 'Caution, Terrain; Caution, Terrain'	**Visual Alert** Red text message that is obvious, concise, and consistent with the aural message. **Aural Alert** Minimum selectable voice alert: 'Terrain; Terrain'
Terrain Awareness Premature Descent Alert (PDA)	**Visual Alert** Amber text message that is obvious, concise, and must be consistent with the aural message. **Aural Alert** 'Too Low; Too Low'	**Visual Alert** None Required **Aural Alert** None Required
Ground Proximity Excessive Descent Rate	**Visual Alert** Amber text message that is obvious, concise, and must be consistent with the aural message. **Aural Alert** 'Sink Rate'	**Visual Alert** Red text message that is obvious, concise, and must be consistent with the aural message. **Aural Alert** 'Pull-Up'
Ground Proximity Altitude Loss after Takeoff	**Visual Alert** Amber text message that is obvious, concise, and must be consistent with the aural message. **Aural Alert** 'Don't Sink'	**Visual Alert** None Required **Aural Alert** None Required
Ground Proximity Voice Callout (See Note 1)	**Visual Alert** None Required **Aural Alert** 'Five Hundred' or selected altitude	**Visual Alert** None Required **Aural Alert** None Required

Note: 1: The aural alert for ground proximity voice callout is considered advisory.

Note: 2: Visual alerts may be put on the terrain situational awareness display, if this fits with the overall human factors alerting scheme for the flight deck. This does not eliminate the visual alert color requirements, even in the case of a monochromatic display. Typically in such a scenario, adjacent colored enunciator lamps meet the alerting color requirements. Audio alerts are still required regardless of terrain display visual alerts.

MODIFICATIONS TO APPENDIX 2 , TEST CONDITIONS.

Note: 1: **Paragraph 1.1** of this ETSO is not applicable; for small aircraft, only the 'takeoff,' 'cruise,' and 'final approach to landing' phases of flight are considered.

Note: 2: **Paragraph 1.2** of this ETSO is changed to specify altitude levels, test speeds, and pull-ups more appropriate for small aircraft.

1.2 Cruise Descent Requirements. A terrain alert must be provided in time to ensure that the aeroplane can L/O with a minimum of 200 feet altitude clearance over the terrain/obstacle when descending toward the terrain/obstacle at any speed within the operational flight envelope of the aeroplane. The test conditions assume a descent along a flight path with terrain that is 500 feet below the expected L/O altitude. If the pilot initiates the L/O at the proper altitude, no TAWS alert is expected. However, if the pilot is distracted or otherwise delays the L/O, a TAWS alert is required to permit the pilot to recover to level flight in a safe manner.

a. Table A, column A, represents the test condition. Columns B, C, and D are for information purposes only. Column E represents the minimum altitude for which TAWS alerts must be posted in order to perform their intended function. Column F represents the maximum altitude for which TAWS alerts may be provided in order to meet the nuisance alert criteria. See **Appendix 2, paragraph 4.0.**

b. For each of the descent rates specified below, recovery to level flight at or above 200 feet terrain clearance is required.

c. Test Conditions for cruise descent requirements:

Assumed pilot response time	3.0 seconds (minimum)
Assumed constant G pull-up	1.0 g
Minimum allowed terrain clearance	200 feet AGL
Descent rates	500, 1 000, and 2 000 FPM
Assumed pilot task for column F	L/O at 500 feet above the terrain per appendix 3, table 3.1.1 (ROC Column)

Note: 1: The actual values for the aeroplane altitude, distance and time from the terrain cell when caution and warning alerts are posted, and the minimum terrain clearance altitude must be recorded.

Note: 2: Cruise operations are considered to exist beyond the airport control area until inside the destination airport control area for VFR operations. Distances may extend to 10 NM from the airport (takeoff and landing) for IFR operations. Use of the nearest runway logic is permissible provided suitable logic is incorporated to ensure that the transitions to the terminal logic will typically occur only when the aeroplane is in terminal airspace.

Note: 3: The values shown in column E may be reduced by 50 feet (to permit a L/O at 150 feet above the obstacle) provided that it demonstrates that the basic TAWS Mode 1 alert (sink rate) is issued at or above the altitude specified in column E for typical terrain topographies.

Note: 4: The values shown in column F are appropriate for an aeroplane without an autopilot or flight director function, and are based upon 10–15 %of the vertical velocity, which is appropriate to manual flight and small, GA aeroplane operations.

Table A

ENROUTE DESCENT ALERTING CRITERIA

Alerting for Premature Descent during Cruise					
A	**B**	**C**	**D**	**E**	**F**
VERT SPEED (FPM)	ALT LOST WITH 3SEC PILOT DELAY	ALT REQ'D TO L/O WITH 1 G PULLUP	TOTAL ALT LOST DUE TO RECOVERY MANEUVER	MINIMUM TAWS WARNING ALERT HEIGHT (ABOVE TERRAIN)	MAXIMUM CAUTION ALERT HEIGHT (ABOVE TERRAIN)
500	25	1	26	226	550
1 000	50	4	54	254	600
2 000	100	17	117	317	800

Note: Paragraph 1.3 in this ETSO is changed to specify altitude levels, test speeds, and pull-ups more appropriate to small aircraft.

1.3 Cruise Level Flight Requirement. During level flight operations (vertical speed is ± 200 feet per minute), a terrain alert should be posted when the aeroplane is within 250 feet of the terrain and is predicted to be equal to or less than 200 feet within the prescribed test criteria. See Table B for test criteria.

Note: The actual values for the aeroplane altitude, distance, and time from the terrain cell when caution and warning alerts are posted must be recorded.

Table B

LEVEL CRUISE FLIGHT ALERTING CRITERIA			
GROUND SPEED (KT)	HEIGHT OF TERRAIN CELL (MSL)	TEST RUN ALTITUDE (MSL)	ALERT CRITERIA
100	5 000	5 340 (+ 0/– 50)	NO ALERT
150	5 000	5 340 (+ 0/– 50)	NO ALERT
200	5 000	5 340 (+ 0/– 50)	NO ALERT
100	5 000	5 240 (+ 0/– 50)	MUST ALERT
150	5 000	5 240 (+ 0/– 50)	MUST ALERT
200	5 000	5 240 (+ 0/– 50)	MUST ALERT

1.4 Terminal Area (Intermediate Segment) Descent Requirement. Not applicable.

1.5 Terminal Area (Intermediate Segment) Level Flight Requirement. Not applicable.

1.6 Final Approach Descent Requirements. Revised to specify altitude levels, test speeds, and pull-ups more appropriate to small aircraft:

a. Table E, column A, represents the test conditions. Columns B, C, and D are for information purposes only. Column E represents the minimum altitude for which TAWS alerts must be posted in order to perform their intended function. Column F represents the maximum altitude for which TAWS alerts may be provided in order to meet the nuisance alert criteria. See **Appendix 2, paragraph 4.0.**

b. For each of the descent rates specified below, recovery to level flight at or above 100 feet terrain clearance is required.

c. Test conditions for 1.6:

Assumed pilot response time	1.0 seconds (minimum)
Assumed constant G pull-up	1.0 g
Minimum allowed terrain clearance	100 feet AGL
Descent rates	500, 750, and 1 000 FPM
Assumed pilot task for column F	L/O at 250 feet above the terrain per appendix 3, table 3.1.1 (ROC Column)

Note 1: The actual values for the aeroplane altitude, distance and time from the terrain cell when caution and warning alerts are posted, and the minimum terrain clearance altitude must be recorded.

Note 2: The values shown in column F are appropriate for an aeroplane without an autopilot or flight director function, and are based upon 10 %of the vertical velocity that is appropriate for manual flight and small, GA aeroplane operations.

Table E

APPROACH DESCENT ALERTING CRITERIA					
A	**B**	**C**	**D**	**E**	**F**
VERT SPEED (FPM)	ALT LOST WITH 1SEC PILOT DELAY	ALT REQ'D TO L/O WITH 1 G PULLUP	TOTAL ALT LOST DUE TO RECOVERY MANEUVER	MINIMUM TAWS WARNING ALERT HEIGHT (ABOVE TERRAIN)	MAXIMUM TAWS CAUTION ALERT HEIGHT (ABOVE TERRAIN)
500	8	1	9	109	300
750	12	2	14	114	325
1 000	17	4	21	121	350

1.7 Landing Flight Requirements. Applies as written.

2.0 through 2.2 FORWARD-LOOKING TERRAIN AVOIDANCE IMMINENT INPACT TEST CONDITIONS. Apply using Table G for speed cases of 100 through 250 knots; however, change the incremental pull from 0.25g to 1.0g as described in note 2.

3.0 through 3.1 PREMATURE DESCENT ALERT TEST CONDITIONS. Apply as written.

4.0 NUISANCE ALERT TEST CONDITIONS — GENERAL. Apply as written.

4.1 4 000 FPM. Not applicable.

4.2 2 000 FPM. Descent must be possible at 2 000 FPM and pilots must be able to L/O at 500 feet above the terrain using a normal L/O procedure (leading by 10 %of the vertical speed), without a caution or warning alert.

4.3 1 000 FPM. Descent must be possible at 1 000 FPM in a final approach segment and pilots must be able to L/O at 250 feet using the normal L/O procedure described in 4.2 above, without a caution or warning alert.

5.0 NUISANCE TEST CONDITIONS FOR HORIZONTAL AND VERTICAL FLIGHT TECHNICAL ERRORS. Applicable as written.

5.1 Test Cases. Is applicable as written; however, test cases are limited to locations 3, 6, 7, and 8 in **table I.**

6.0 TEST CONDITIONS USING KNOWN ACCIDENT CASES. Paragraphs 6.0 through 6.3 of Appendix 2 are to be determined by the applicant using actual National Transportation Safety Board (NTSB) or national equivalent entity GA accidents. Since detailed data is usually not available, reasonable constructed scenarios matching the actual known accident data may be demonstrated. Pulls of up to 1.0g may be used instead of the 0.25g as specified in **paragraph 6.2**, *computation and recording*.

7.0 CLASS C EQUIPMENT TEST REQUIREMENTS FOR EXCESSIVE DESCENT RATE. Apply Class B as written.

8.0 CLASS C EQUIPMENT TEST REQUIREMENTS FOR NEGATIVE CLIMB RATE OR ALTITUDE LOSS AFTER TAKEOFF. Apply Class B as written.

9.0 CLASS C EQUIPMENT TEST REQUIREMENTS FOR THE ALTITUDE CALLOUTS. Apply Class B as written.

ETSO-C159b
Date: 5.8.2016

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 is 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 the article is not required to meet any requirement of RTCA DO-326, ' Airworthiness Security Process Specification', in Normative Appendix D or E (as applicable) of RTCA DO-262B where referenced.

***Note**: There are no MPS security requirements for the 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 — Computer Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 — Electronic Hardware Qualification

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 RTCA DO-262B 'Minimum Operational Performance Standards (MOPS)' as identified in Tables 1 and 2 of Appendix 1 to 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 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 resulting in an erroneous behaviour of the function defined in paragraph 3.1.1 of this ETSO is a minor failure condition. Loss of the function as 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

The NGSS class and subclass markings should include the complete equipment identifier reference (such as AES1, AES4, or AES7). An example subclass component (such as HGA, Transceiver, or 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 marking, see Table 3 of Appendix 1 to this ETSO.

5 — Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

Appendix 1

Tables

Table 1: Equipment Class Identifiers

Equipment Class Identifier	Description	Requirement
AES1	AES using a single channel Satellite Data Unit (SDU) that contains one transceiver for data only applications. AES1 is a Short Burst Data (SBD)-only transceiver and cannot support voice calling. A passive Low Gain Antenna (LGA) is required for use with the AES1.	Appendix D, Section 2.2.1.1
AES2	AES2 is capable of multiple services using a single or dual channel SDU that contains one or two transceivers for data and/or voice applications. A passive LGA is required for use with the AES2.	Appendix D, Section 2.2.1.2
AES3	AES using two or more transceivers for multiple data and/or voice applications. Passive or active (powered) antennas may be configured such as an LGA Omni, Intermediate Gain Antenna (IGA) switched beam or IGA/High Gain Antenna (HGA) phased steering array.	Appendix D, Section 2.2.1.3
AES4	AES using an Enhanced Low Gain Antenna (ELGA). AES4 is configured as a complete system.	Appendix E, Section 2.2.1.1.1
AES6	AES using an HGA, transceiver, and Diplexer Low Noise Amplifier (DLNA).	Appendix E, Section 2.2.1.1.2

Table 2: Equipment Sub-Class Identifiers

Sub-Class Identifier	Description	Requirement
LGA	Passive LGA for use with AES1, AES2 or AES3.	Appendix D, Section 2.2.3.1.1
IGA	Active IGA for AES3.	Appendix D, Section 2.2.3.1.1
HGA	Active HGA for AES3.	Appendix D, Section 2.2.3.1.1
HGA	HGA for AES6.	Appendix E, Section 2.2.3.1.2
IGA	IGA for AES7.	Appendix E, Section 2.2.3.1.2
6MA	Transceiver, SDU Configuration Module (SCM), SDU, Modified Type A (DMA) DLNA, and HGA for use with AES6.	Appendix E, Section 2.2.1.1.5
7MA	Transceiver, SDU, SCM, DMA DLNA, and IGA for use with AES7.	Appendix E, Section 2.2.1.1.7
6D	Transceiver and DLNA combination includes SDU, High Power Amplifier (HPA), DLNA, SCM, and HGA functions for use with AES6.	Appendix E, Section 2.2.1.1.9
7D	Transceiver and DLNA combination includes SDU, HPA, DLNA, SCM, and IGA functions for use with AES7.	Appendix E, Section 2.2.1.1.10
6F	Transceiver and Type F (DF) DLNA includes SDU, HPA, SCM, and HGA functions for use with AES6.	Appendix E, Section 2.2.1.1.6
7F	Transceiver and DF DLNA includes SDU, HPA, SCM, and IGA functions for use with AES7.	Appendix E, Section 2.2.1.1.8
DMA	DLNA with standard Transmitter (Tx) filter configures with 6MA transceiver and HGA for use with AES6, or 7MA transceiver and IGA for use with AES7.	Appendix E, Section 2.2.1.1.11
DF	DLNA with enhanced Tx filter configures with 6MA or 6F transceiver and HGA for use with AES6, or with 7MA or 7F transceiver and IGA for use with AES7.	Appendix E, Section 2.2.1.1.12

ETSO-C159b
Appendix 1

Table 3: Valid Combinations of System Components

Valid Combi-nations		System	Transceiver						Trans-ceiver & DLNA		DLNA		Antenna					Complete System
			SBD	LBT	6MA	6F	7MA	7F	6D	7D	DMA	DF	LGA (passive)	IGA switched beam	IGA/HGA phased steering array	HGA	IGA	
AES1	1	Appendix D																X
	2	Appendix D	X										X					
AES2	3	Appendix D																X
	4	Appendix D		X									X					
AES3	5	Appendix D																X
	6	Appendix D	X	X									X					
	7	Appendix D	X	X										X				
	8	Appendix D	X	X											X			
AES 4	1	Appendix E																X
AES 6	2	Appendix E			X						X					X		
	3	Appendix E				X						X				X		
	4	Appendix E							X							X		
	5	Appendix E			X							X				X		
	6	Appendix E																X
AES 7	7	Appendix E					X				X						X	
	8	Appendix E						X				X					X	
	9	Appendix E								X							X	
	10	Appendix E					X					X					X	
	11	Appendix E																X

ETSO-C166b A2
Date: 5.8.2016

**European
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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 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.

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 hazardous failure condition.

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

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

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.

If component can:	***Mark it with:***	***Sample marking pattern:***
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.

ETSO-C173a
Date: 5.8.2016

**European
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European Technical Standard Order

Subject: Nickel-Cadmium, Nickel Metal-Hydride, and Lead-Acid Batteries

1 — Applicability

This ETSO provides the requirements which Nickel-Cadmium, Nickel Metal-Hydride, and Lead-Acid Batteries that are designed and manufactured on or after the applicability 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-293A, Minimum Operational Performance Standards (MPS) for Nickel-Cadmium, Nickel Metal-Hydride, and Lead-Acid Batteries, dated 12/2/2009, as amended according to Appendix 1 to this ETSO.

3.1.2 — Environmental Standard

Nickel-Cadmium, Nickel Metal-Hydride, and Lead-Acid Batteries shall be tested according to the conditions specified in RTCA DO-293A.

Where the RTCA DO-293A quotes the RTCA DO-160 standard, the applicable DO-160 standard revision is defined in CS-ETSO, Subpart A, paragraph 2.1.

3.1.3 — Computer Software

See CS-ETSO, Subpart A, paragraph 2.2.

3.1.4 — Electronic Hardware Qualification

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

4.2 — Specific

At least one major component shall be marked permanently and legibly with all the information in RTCA DO-293A, section 1.10, as modified by Appendix 1.

5 — Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

APPENDIX 1

MINIMUM PERFORMANCE STANDARD FOR NICKEL-CADMIUM, NICKEL METAL-HYDRIDE, AND LEAD-ACID BATTERIES

AMENDMENT TO RTCA DO-293A REQUIREMENTS

RTCA/DO-293A section and title:	*Amendment:*
1.10.1, Battery Marking	**It shall be added to the bottom of the list of Manufacturer's markings:** 11. End Point Voltage (EPV)
2.3.1, Rapid Discharge Capacity at 23 °C	**It shall be deleted at the end of the paragraph and the Test Method:** 'or the manufacturer recommended cutoff voltage'
2.3.2, Rapid Discharge Capacity at – 30 °C	**It shall be deleted at the end of the paragraph and the Test Method:** 'or the manufacturer recommended cutoff voltage'
3.12, Electrolyte Resistance	**It shall be applied ONLY to heater blankets of this section the following:** Testing method and evaluation criteria of MIL-PRF-8565 can be utilised in lieu of the testing method and evaluation criteria stipulated in paragraph 3.12 of RTCA /DO-293A.

ETSO-C201
Date: 5.8.2016

European Aviation Safety Agency

European Technical Standard Order

Subject: Attitude and Heading Reference Systems (AHRS)

1 — Applicability

This ETSO provides the requirements which Attitude and Heading Reference Systems (AHRSs) 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 Document No RTCA/DO-334 'Minimum Operational Performance Standards (MOPS) for Solid-State Strap-Down Attitude and Heading Reference Systems (AHRS)', dated 21.3.2012.

This ETSO applies to solid state strap-down AHRS intended to output pitch and roll attitude that does not use gimbaled sensors. It also addresses the optional functions of heading, turn, slip and the display of information provided by an AHRS.
When the article provides heading, turn and slip, degraded mode, uses aiding, includes a display, or provides information generated by the AHRS to a stand-alone display, it must, in particular, meet the requirements as listed in the table below.

Optional Functions/Mode/Source	Requirement
Heading	2.2.3
Turn and Slip	2.2.5
Degraded Mode	2.2.4
Aiding	2.2.6
Display	2.5

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 Qualification

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 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.

ETSO-C202
Date: 5.8.2016

European Aviation Safety Agency

European Technical Standard Order

Subject: Cargo Stopper Devices

1 — Applicability

This ETSO provides the requirements which Cargo Stopper Devices 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 Document No AS6554 'Cargo Stopper Devices', dated 6.7.2011 except as modified by Appendix 1 of this ETSO

3.1.2 — Environmental Standard

See Section 3.8 of AS6554.

3.1.2.1 Specific:

Consideration shall be given to available data regarding potential environmental degradation for the component straps and filling materials.

(1) Environmental degradation due to aging, ultra-violet (UV)-exposure, weathering, etc., for any materials used in the construction of cargo stopper devices shall be considered.

(2) Textile Performance: See SAE Aerospace Information Report (AIR) 1490B, Environmental Degradation of Textiles, dated December 2007, for available data for textile performance when exposed to environmental factors. These data shall be taken into account for consideration of the

effects of environmental degradation on cargo stopper devices with the expected storage and service life.

Note: Environmental degradation data other than that documented in AIR 1490B may be used if substantiated by the applicant and approved by EASA.

3.1.3 — Software

n/a

3.1.4 — Electronic Hardware Qualification

n/a

3.2 — Specific

None.

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

In addition the following marking shall be applied:

- The rated ultimate load in daN and lbf;
- The Expiration date in the format 'EXP YYYY-MM'

5 — Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

ETSO-C202

APPENDIX 1

The applicable standard is SAE AS6554 'Cargo Stopper Devices', dated 6.7.2011
It shall be modified as follows:

AS6554 section:	**Action:**
Section 1	To be disregarded.
Section 3.7	To be replaced: Fire Protection. The materials used in the cargo stoppers shall not have an average burn rate greater than 2.5 inches per minute when tested horizontally in accordance with the applicable portions of CS-25, Appendix F, part I, paragraph (b).
Section 4.3	To be disregarded.
Section 5	To be disregarded.
Section 6	To be disregarded.

ETSO-2C515
Date: 5.8.2016

European Aviation Safety Agency

European Technical Standard Order

Subject: Aircraft Halocarbon Clean Agent Hand-Held Fire Extinguisher

1 — Applicability

This ETSO provides the requirements which an Aircraft Halocarbon Clean Agent Hand-Held Fire Extinguisher 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.

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 (SAE) Aerospace Standard AS6271 'Halocarbon Clean Agent Hand-Held Fire Extinguisher', issued in January 2013, as modified by Appendix 1 to this ETSO.

3.1.2 — Environmental Standard

Refer to the environmental qualification requirements specified in ANSI/UL2129.

3.1.3 — Computer Software

None

3.1.4 — Electronic Hardware Qualification

None

3.2 — Specific

3.2.1 — Failure Condition Classification

Failure of the function defined in paragraph 3.1.1 of this ETSO has been determined to be a minor failure condition.

4 — Marking

4.1 — General

Marking as detailed in CS-ETSO, Subpart A, paragraph 1.2.4.2 — Specific

The fire extinguisher type, as specified in paragraph 3.1 of AS6271, shall be marked on the article.

In addition, the fire extinguisher rating, as specified in ANSI/UL 711, shall be marked on the article.

5 — Availability of Referenced Document

See CS-ETSO, Subpart A, paragraph 3.

ETSO-2C515
APPENDIX 1

APPENDIX 1

Halocarbon Clean Agent Hand-Held Fire Extinguisher

This Appendix prescribes the Minimum Performance Standards (MPS) for aircraft handheld fire extinguishers. The applicable standard is SAE AS6271 'Halocarbon Clean Agent Hand-Held Fire Extinguisher', issued in January 2013. EASA did revise it as follows:

1. On page 4, replace paragraph 3.2 with the following:

Halocarbon clean agents shall be registered according to REACH[1] for use in a fire extinguisher to be sold in the European Union (EU). REACH is the EU Regulation on chemicals and their safe use. REACH applies to substances manufactured or imported into the EU in quantities of 1 ton or more per year (see 2.1.7).

2. On page 5, replace paragraph 4.1.1 with the following:

The fire extinguisher/mounting bracket assembly shall be shown to withstand without failure the highest ultimate inertia force/load, applied to all on-axis (X, Y, Z) orientations, specified in the Certification Specifications (CS) applicable to the specific aircraft type or types on which the fire extinguisher is suitable to be installed. The ultimate inertia forces/loads shall be increased, if necessary, to meet the aircraft manufacturer's specifications for flight and ground loads accordingly. A fitting factor of 1.33 as specified in C2X.561 shall be included to address wear and tear through frequent removal of the fire extinguisher from its mounting bracket. In addition, the manufacturer shall provide an Interface Control Drawing (ICD) specifying for the fire extinguisher/mounting bracket assembly:

- the ultimate inertia force/loads shown during qualification,
- the mounting orientations (X, Y, Z) for installation,
- the interface loads and the specified means of attachment for installation,
- the Certification Specification(s) (e.g. CS 25.561) including the amendment for which the assembly is demonstrated to be compliant.

3. Page 5, add a note to paragraph 5.2.2:

Note: If the proposed agent was already proven to pass the seat/toxicity test of the MPS in combination with another fire extinguisher, that test would not need to be repeated for the proposed fire extinguisher/agent combination.

[1] Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC (OJ L 396, 30.12.2006, p. 1).

APPENDIX 2

Halocarbon Clean Agent Hand-Held Fire Extinguisher

This Appendix prescribes the Minimum Performance Standards (MPS) for aircraft handheld fire extinguishers. As referred to in SAE AS6271, the applicable standard is ANSI/UL 2129 'Halocarbon Clean Agent Hand-Held Fire Extinguisher', issued in February 2005. EASA did revise it as follows:

1 . Page 9, replace paragraph 6.8 with:

An extinguisher shall operate as intended at temperatures from -40°C to 49°C as required per UL2129. Ground survival temperature of the unit shall be -54°C up to 85°C (refer to RTCA DO-160 release defined in CS-ETSO, Subpart A, paragraph 2.1, ground survival temperature).

2 . Page 12, replace the first phrase of paragraph 12.4 with:

The maximum indicated gauge pressure shall be between 150 and 250 per cent of the indicated charging pressure specified by the manufacturer (at either 20° C or at 21° C).

3 . Page 12, replace paragraph 12.5 with:

The mark used to indicate the charging pressure at the charging temperature (at either 20°C or at 21°C) as specified by the manufacturer shall be a minimum 0.6 mm and not more than 1.0 mm wide.

4 . Page 12, disregard paragraph 12.6 and 12.7