



Comparison of Minimum Performance Standards of ETSO-C116 and TSO-C116a

Classification of Judgement

- Editorial Requirement is different in editorial nature only
- Identical Requirement is identical between ETSO-C116 and TSO-C116a
- Similar Requirement is similar between ETSO-C116 and TSO-C116a, i.e. verbiage is different, but intend of requirement is identical
- Detailed Requirement is similar between ETSO-C116 and TSO-C116a, but TSO-C116a requirement is more detailed.
- Add On Requirement is Add On within TSO-C116a and not covered by ETSO-C116
- Headline only This is a Headline only

ETSO-C116 Requirement Corresponding to TSO-C116a	TSO-C116a Requirement (consolidated text from TSO-C116a and AS8047)	Judgement	Remark
1.0 Purpose. This appendix provides minimum standards for crewmembers protective breathing equipment.	1.1 Scope (FAA modified) Disregard.	Similar	
2.0 Scope. These standards apply to protective breathing equipment that provides any crewmember with the ability to locate and combat a fire within the airplane cabin or any other accessible compartment at normal cabin altitudes (up to 8000 feet equivalent).	1.2 Classification (Origin AS 8047) This aerospace standard (AS) defines the requirements of portable protective breathing equipment for use during smoke/fire conditions on board an aircraft. The equipment is required to protect and to be suitable for use by crew during the following scenarios: Class 1) For an in-flight cabin or accessible compartment smoke/fire conditions at	Add On	ETSO-C116 only covers TSO-C116a, Class 1 equipment



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	<p>normal cabin altitude (up to 8,000 ft equivalent).</p> <p>Class 2) In addition to the requirements of Class 1, protection against a subsequent depressurization to +40,000 ft while wearing the unit.</p> <p>Class 3) Emergency ground evacuation of the aircraft during fire/smoke conditions, operating escape systems and assisting passengers.</p> <p>Class 4) In flight emergency and ground evacuation during smoke/fire conditions (as per Class 1 & 3 combined).</p>		
<p>6.0 References. The following may be helpful in developing a PBE design and/or obtaining FAA approval of the basic design, they are not of themselves FAA requirements and may differ from the TSO requirements, which take precedence:</p>	<p>2.1 Applicable Documents (FAA modified)</p>	<p>Similar</p>	
<p>SAE AS 8010 Aviators Breathing Oxygen Purity Standard.</p>	<p>AS 8010C Aviator's Breathing Oxygen Purity Standard</p>	<p>Detailed</p>	
<p>SAE AS 8031 Personal Protective Devices for Toxic and Irritating Atmospheres. Air Transport Crew Member.</p>	<p>AS 8031A Personal Protective Devices for Toxic and Irritating Atmospheres, Air Transport Crew Members</p>	<p>Detailed</p>	
<p>None</p>	<p>14 CFR Part 121 Operating Requirements: Domestic, Flag, and Supplemental Operations</p>	<p>Add On</p>	
<p>None</p>	<p>14 CFR Part 25</p>	<p>Add On</p>	



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	Airworthiness Standards: Transport Category Airplanes		
None	TSO-C99a Protective Breathing Equipment	Add On	
None	TSO-C69c Emergency Evacuation Slides, Ramps and Slide/Ramp Combinations	Add On	
ASTM D1149 Accelerate Ozone Cracking of Vulcanized Rubber	ASTM D1149 Standard Test Method for Rubber Deterioration - Surface Ozone Cracking in a Chamber	Detailed	
ASTM D624 Rubber Property-Tear Resistance	ASTM D624 Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers	Detailed	
ASTM D750 , Rubber Deterioration	ASTM D750, Standard Test Method for Rubber Deterioration Using Artificial Weathering Apparatus ASTM D228, Abrasion Resistance	Detailed	
ASTM D1922-67 Standard Test Method for Propagation Tear Resistance of Plastic Film and Thin Sheeting by Pendulum Method.	ASTM D1922-Rev A Standard Test Method for Propagation Tear Resistance of Plastic Film and Thin Sheeting by Pendulum Method	Identical	
ASTM D1004-86 Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting	ASTM D1004 Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting	Identical	
ASTM D2582-67 Standard Test Method for Puncture-Propagation Tear Resistance of Plastic Film and Thin Sheeting	ASTM D2582 Standard Test Method for Puncture-Propagation Tear Resistance of Plastic Film and Thin Sheeting	Identical	
None	(FAA added) Add the following documents:	Add On	
None	AS 8026A,	Add On	



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	Crewmember Demand Oxygen Mask for Transport Category Aircraft		
None	AS 1303A, Portable Chemical Oxygen	Add On	
None	2.1 Applicable Documents (Origin AS 8047)	Add On	
None	AIR 825 Oxygen Equipment for Aircraft	Add On	
ASTM D1004-86 Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting	ASTM D1048 Rubber Insulating Blankets - Para 19.2.4	Similar	
ASTM D228 Abrasion Resistance.	ASTM D228 Method of Testing Asphalt Roofing, Cap Sheets, and Shingles	Detailed	
None	AMRL Test Report 70-5 Anthropometry of Air Force Women	Add On	
None	WADC Test Report 58-505 Anthropometric sizing	Add On	
None	BS 4667 Part 4 British Standard Specification for Breathing Apparatus	Add On	
None	FAA-RD-77-18 Development of a fire protective overgarment for use by air carrier flight attendants	Add On	
None	ATS 1000.001 Fire - Smoke - Toxicity (FST) Test Specifications	Add On	This is an Airbus document. OEM specific data should not be part of a ETSO
None	I.A.M. A. E. Report 543 A study of Workload and Oxygen Consumption for	Add On	



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	Cabin Crew Members During Smoke/Fire		
None	C.G.A. G-7.1 Grade D Commodity Specification for Air (Moisture content levels as per AS 8010)	Add On	
None	MIL-STD-810 Environmental Test Methods and Engineering Guidelines	Add On	
FAA-AM-78-41 A Study of Workload and Oxygen Consumption for Airline Cabin Crew Member During a Simulated Inflight Smoke/Fire Emergency.	FAA-AM-78-41 FAA Report - Optical Properties of Smoke Protective Devices	Identical	
None	AAM-119-86-4 A Study of Workload and Oxygen Consumption for Airline Cabin Crew Members During a Simulated In-flight Smoke/Fire Emergency	Add On	
None	2.2 Definitions (Origin AS 8047) Headline only	Add On	
None	2.2.1 (Origin AS 8047) For purposes of the document, 'unit' shall be used as a general term to refer to protective breathing equipment described herein.	Add On	
None	2.2.2 (Origin AS 8047) All test measurements to be converted to NTPD ground level conditions.	Add On	
None	2.2.3 (Origin AS 8047) Work loads refer to external work rates and are	Add On	



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	defined as watts per unit Body Weight of the user.		
None	2.2.4 (Origin AS 8047) GL refers to Ground Level conditions.	Add On	
3. Minimum Performance Standards.	3. Technical Requirements	Headline only	
None	3.1 General	Headline only	
3.1 The PBE unit must contain a supply of breathable gas (allows the use of any breathable gas instead of requiring only oxygen and does allow the use of a chemical oxygen generator).	3.1.1 (FAA modified) 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 applicable sections of 14 CFR 25.1439 and 121.337.	Detailed	Requirement already includes reliability focus.
3.1 The PBE unit must contain a supply of breathable gas (allows the use of any breathable gas instead of requiring only oxygen and does allow the use of a chemical oxygen generator).	3.1.1.1 (FAA added) Breathable gas source may be either oxygen or air.	Similar	
3.1 The PBE unit must contain a supply of breathable gas (allows the use of any breathable gas instead of requiring only oxygen and does allow the use of a chemical oxygen generator).	3.1.1.2 (FAA added) Use of a chemical oxygen generator is an acceptable alternative.	Similar	
3.5 The supply of breathable gas shall meet the applicable SAE gas standard for purity.	3.1.1.3 (FAA added) Breathable gas must meet the gas standard for purity, SAE AS8010 Rev C, Aviator's Breathing Oxygen Purity Standard. For air, comply with the purity standards in AS 8010C Table 2, Constituent Maximum Concentrations for Chemical Oxygen. Use	Detailed	Requirement considers already the use of the equipment in emergency case only.



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	Type IV chemically-generated oxygen for emergency-use.		
<p>3.2 The unit shall adequately protect any adult, within the 5th percentile female (neck size circumference 11.1 inches) and 95th percentile male (neck size circumference 16.4 inches) body dimensions (including spectacle users). Any recommendations addressing long hair and/or beards shall be included in the instructions furnished with the manufactured units.</p>	<p>3.1.2 (FAA modified) 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.</p>	Detailed	
<p>3.2 The unit shall adequately protect any adult, within the 5th percentile female (neck size circumference 11.1 inches) and 95th percentile male (neck size circumference 16.4 inches) body dimensions (including spectacle users). Any recommendations addressing long hair and/or beards shall be included in the instructions furnished with the manufactured units.</p>	<p>3.1.2.1 (FAA added) 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</p>	Detailed	
None	<p>3.1.2.2 (FAA added) Include limitations/recommendations for using portable PBE with long hair and/or beards in the IM/CMM (required in paragraph 5.b of this TSO), which is furnished with the manufactured units.</p>	Add On	
<p>5.3 The size of the PBE unit when donned shall allow the wearer to pass through any access appropriate to the airplane type for which approval is requested, to investigate and/or combat an inflight fire. As a generic standard, the wearer must be able to pass</p>	<p>3.1.2.3 (FAA added) Size of the portable PBE unit when donned must allow the wearer to pass through any access opening 18 inches (460 mm) x 18 inches (460 mm) to investigate and/or combat an in-flight fire.</p>	Similar	



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through 460 mm * 460 mm opening			
3.3 The unit shall have a means for any crewmember to determine the serviceability of the unit in its stowed condition.	3.1.3 (Origin AS 8047) The unit shall be supplied with a means to determine serviceability in its stowed condition.	Similar	
3.4 Failure of the unit to operate or to cease operation shall be readily apparent to the user.	3.1.4 (FAA modified) 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	Add On	This requirement asks for additional design feature which have not been requested by the regulations since the first PBE specifications.
<i>None</i>	3.1.5 (FAA modified) Disregard. Reference to gas standard is now in paragraph 3.1.1.3	Editorial	
3.6 The unit shall not result in a hazard when stored, in use, or during an inadvertent operation.	3.1.6 (FAA modified) Unit must not cause a hazard when stored, in use, or during inadvertent operation.	Identical	
3.7 The stowed unit shall not be adversely affected by environmental extremes. The applicable sections of RTCA DO-160C shall be used to demonstrate unit compliance.	3.1.7 (Origin AS 8047) The stowed unit shall not be adversely affected by environmental extremes. Pressurized Containers shall have protection against over temperature/pressure but not cause loss to the user during its normal use.	Detailed	
3.8 The unit shall have a stated reliability with an appropriate confidence level to establish any shelf life, operational limit and/or maintenance interval.	3.1.8 (FAA modified) 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.	Detailed	



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None	3.1.9 (Origin AS 8047) The unit shall have a failure rate of not more than 0.01 per 1000 unit flying hours.	Detailed	
3.9 The unit shall wear comfortably in use leaving both hands free. It shall not be displaced during the normal tasks of locating and combating a fire (i.e., crawling, kneeling, running actions, etc.).	3.1.10 (FAA modified) 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	Similar	
<i>None</i>	3.1.11 Headline only (FAA modified) Hoods, Full Face Masks with Lenses, and/or Integral Goggles	Headline only	
3.10 The unit shall provide adequate vision capability for its intended use, including the consideration of fogging and/or condensation.	3.1.11.1 (FAA added) 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 center point) and in the vertical meridian of at least 60 degrees (40 degrees above and 20 degrees below the center point) when evaluated by standard arc perimeter techniques.	Detailed	
	Fogging: Design the portable PBE to minimize moisture condensation on the inside surface or include a means of preventing or removing any moisture that may condense on surfaces during use.	Detailed	
3.11 The unit must allow intelligible two-way communication, including the use of airplane interphone and megaphone. The user must be able	3.1.12 (FAA modified) Portable PBE must allow intelligible two-way communication, including the use of airplane	Detailed	



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to communicate with a user or nonuser at a distance of at least four meters. A background noise of 65 dB and a user communication sound level of 85 dB or equivalent method is recommended.	interphone (handset or microphone) and megaphone. User must be able to communicate with another user or nonuser at a distance of at least four meters. Use a background noise of 65 dB and a user communication sound level of 85 dB or equivalent method.		
None	3.1.13 (Origin AS 8047) The unit may be a single unit, or a combination of goggle, mask regulator, etc.	Add On	
3.11 The unit shall be capable of being easily donned and activated, after gaining access to the stowed unit within 15 seconds. It must be easy to doff.	3.1.14 (Origin AS 8047) Donning and doffing shall be easily performed.	Similar	The requirement has been relaxed compared to ETSO-C116.
5.4 The material and fabrication of the unit shall cause the unit to be puncture/tear resistant. See ASTM references for suggested methods.	3.1.15 (FAA added) Material used to fabricate the unit must be puncture/tear resistant.	Similar	
4.0 Performance Requirements The following shall apply to the approval of any crewmember PBE design to be identified and manufactured to this TSO: 4.2 The mean inspiratory values shall be within the following limits:	3.2 Performance Requirements	Similar	
4.2.1 The carbon dioxide concentration level at mouth/nose shall not exceed 4 percent at sea level. The concentration may increase to 5 percent at sea level for a period not to exceed 2 minutes.	3.2.1 (FAA modified) Average inspiratory limits must be within the following: Carbon dioxide concentration level at mouth/nose must not exceed 4 percent at sea level. Concentration may increase to 5 percent at sea	Detailed	The requirement has been defined as average now. Basis of average is missing.



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	level for a period not to exceed 2 minutes.		
4.2.2 The carbon monoxide level shall not exceed 50 ppm, time weighted average.	Carbon monoxide level must not exceed 50 ppm, time weighted average.	Identical	
4.2.3 The chloride level shall not exceed 1 ppm, time weighted average.	Chloride level must not exceed 1 ppm, time weighted average	Identical	
4.3 Upon donning, the unit shall be self purging by a sufficient supply of breathable gas to ensure one complete dead volume displacement within 20 seconds of initial operation.	3.2.2 (FAA modified) When a user puts on portable PBE, the unit must be selfpurging by enough breathable gas to ensure one complete dead volume displacement within 20 seconds of initial operation.	Similar	
4.4 The unit shall protect the user against toxic fumes and smoke. The eyes, nose, and mouth must be protected to 0.05 mean contaminant protection factor during the work profile stated as item 1 of this paragraph. Aerospace Standards (AS) 8031 and 8047 (Class 1) may be used as references, as applicable. AS 8031, states that the test contaminant must be n-pentane or similar gas having a molecular weight less than 100. The use of sulphur hexafluoride (SF6) is an acceptable alternative. The use of aerosols such as sodium chloride (NaCl) or corn oil are not considered acceptable as an alternative for a challenge gas. Component sensitivity to particle size and the potential to precipitate on the unit surface are considerations that make aerosols unacceptable to measure a contaminant protection factor.	3.2.3 (FAA modified) Portable PBE must protect the user against toxic fumes and smoke. Use the test procedures in AS 8031A. You may use an alternative challenge gas. We don't accept aerosols, such as sodium chloride (NaCl) or corn oil 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.	Add On	The use of sodium chloride (NaCl) is not accepted anymore by TSO-C116a
<i>None</i>	3.2.4 (FAA modified)	Similar	



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	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)		
4.1 The unit shall provide the required protection for the following work load profile, at an ambient temperature of 21 °C for adults within the 5 th percentile female (107 lbs) and 95 th percentile male (220 lbs) body weight, at sea level and 8000 feet altitude: 0 to 5 minutes at 0.33 watts per lb. body weight. 5 to 7 minutes at 0.66 watts per lb. body weight. 7 to 12 minutes at 0.50 watts per lb. body weight. 12 to 14 minutes at 0.66 watts per lb. body weight. 14 to 15 minutes at 0.33 watts per lb. body weight.	Class 1 to be performed at GL and 8000 ft 0 - 5 minutes at 0.33 watts/lb work load 5 - 7 minutes at 0.66 watts/lb work load 7 - 12 minutes at 0.50 watts/lb work load 12 - 14 minutes at 0.66 watts/lb work load 14 - 15 minutes at 0.33 watts/lb work load	Similar	
<i>None</i>	Class 2 In addition to the requirements of Class 1, it must be an oxygen device and be tested at 40,000 ft for adequate decompression 'protection, 2 minutes after donning the unit.	Add On	
<i>None</i>	Class 3 to be performed at GL 0 - 3 minutes at 1.07 watts/lb work load 3 - 4 minutes at 0.36 watts/lb work load	Add On	
<i>None</i>	Class 4 to be performed at GL and 8,000 ft 0 - 5 minutes at 0.33 watts/lb work load 5 - 10 minutes at 0.66 watts/lb work load 10 - 13 minutes at 0.33 watts/lb work load 13 - 15 minutes at 1.07 watts/lb work load	Add On	
4.5 The internal temperature of the unit shall not exceed 40°C wet bulb at an ambient temperature of 21°C.	3.2.5 (FAA modified) Internal temperature of the portable PBE must not exceed 104°F (40°C) wet bulb at an ambient	Similar	



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	temperature of +70 °F (21.1 °C).		
4.6 The internal temperature of the unit shall not exceed 50 °C wet bulb. for a 2 minute exposure, at an ambient temperature of 100 °C.	3.2.6 (FAA modified) 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.	Detailed	
None	3.2.7 (Origin AS 8047) The unit must perform satisfactorily when donned at any time in the breathing cycle.	Add On	
4.7 Breathing inspiration/expiration resistance shall not exceed 3 1/2 inches of water from sea level to 8000 feet altitude, as measured at the mouth.	3.2.8 (Origin AS 8047) Breathing (inspiration/expiration) resistance (as measured at the mouth shall not exceed ± 3.5 inches of water, throughout the specified altitude range.	Similar	
4.8 The unit shall operate at a mean positive pressure and shall incorporate relief valve(s) to prevent overpressure of the unit.	3.2.9 (FAA modified) The unit must operate at a mean positive pressure and incorporate a relief valve(s) to prevent over-pressurization.	Similar	
4.9 The unit shall be designed for peak breathing flows of 250 liters per minutes (LPM) and shall be capable of 80 liter-minute volume for a 30 second period at any time throughout its operation.	3.2.10 (FAA modified) 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 liters for a 30 second period at any time throughout its operation.	Similar	
3.12 The unit shall be capable of being easily donned and activated, after gaining access to the stowed	3.2.10 (FAA modified) Portable PBE must be easily put on and activated,	Detailed	



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unit within 15 seconds. It must be easy to doff.	after the user gains access to the stowed unit within 15 seconds. Design unit 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.		
<i>None</i>	4. Construction Disregard entire section. Paragraphs have been incorporated in paragraph 3, technical requirements, and paragraph 6.2 below, : flammability	Add On	
<i>None</i>	5. Training	Headline Only	
<i>None</i>	5.1 Requirements 1 Any unit available for crew training shall simulate the characteristics of accessibility, donning, function and communication. 2) The unit should offer protection against non-toxic smoke.	Add On	
<i>None</i>	6. TESTING PROCEDURES (FAA modified)	Headline Only	
<i>None</i>	6.1 (FAA modified) Manufacturer of the portable PBE is responsible for performing the required tests in paragraph 3.2 to verify its performance.	Add On	
NOTE The test protocol to establish the combined performance requirement of the work load profile and contaminant levels shall be based upon the	The test protocol to establish the combined performance requirements of unitized work load and contaminant levels of para 3.2 shall be based upon the testing of 24 persons representative of the	Similar	



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testing of 24 persons representative of the stated population range.	intended population weight range.		
None	6.2 (FAA modified) Disregard. Find marking requirements in paragraph 4 of this TSO.	Add On	
5.1 The unit and any stowage container/case shall be constructed of materials that are flame resistant that satisfy the requirements of FAR Section 25.853 and tested in accordance with Appendix F Part I (a) through (d) Vertical Test.	6.2. FLAMMABILITY (FAA added) All materials used in the portable PBE and any stowage container/case (including insulation on electrical wires) in a typical installed arrangement must be selfextinguishing. Materials must comply with 14 CFR 25.853(a) specifically Appendix F Part I (a)(1)(iv) in effect on October 27, 2004.	Detailed	
5.2 (first sentence) Any exposed portions of the unit and stowage case shall withstand and remain functional when exposed to a radiant heat flux of 1.0 BTU/ft per second for 60 seconds. ...	6.2.1 (FAA added) 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.	Identical	
Note (1) The 1.0 BTU/ft per second for 60 seconds criteria. A radiant heat source of sufficient size to expose the stowage case containing a PBE unit and any exposed portions of the unit in a manner to obtain the stated heat flux at the case surfaces, in a typical as installed arrangement, will be acceptable.	6.2.2 (FAA added) 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.	Similar	
5.2 (second and third sentence) The unit shall also protect the head and neck of the user from dripping 200°C plastic materials and withstand a 1000°C flame for 5 seconds without material penetration while operational	6.2.3 (FAA added) Portable PBE must protect the user's head and neck from dripping 392°F (200°C) plastic materials and withstand an 1832°F (1000°C) flame for 5	Similar	



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	seconds without material penetration while operating.		
<p>Note (2) Protection from dripping 200 °C plastic material may be accomplished by a number of methods. One method is to ignite a polypropylene rod and allow the drops to impinge on the various external materials, seams, transparency, etc. The drop height should be adjusted so that the drop contact temperature is at least 200 °C.</p>	<p>6.2.3.1 (FAA added) 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).</p>	Similar	
<p>Note (3) The 5 second 1000 °C test. This test is meant to protect a crewmember wearing the PBE from an unexpected flame lick. The two main concerns are failure of the unit that would injure the wearer and any leakage of the breathable atmosphere that could produce an explosion or hazard. The test rig shall expose the unit, while operating, to a 1000 °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 will need to be adjusted to obtain the required temperature. In most cases the flame plume developed will not expose the complete unit. A segment may be passed through the flame plume to obtain the 5 seconds exposure period and then rotated to the next segment and passed through the flame plume, etc., until the complete unit has been tested. A visual (i.e., videotape) record to this test might be useful documentation, in addition to the measured parameters.</p>	<p>6.2.3.2 (FAA added) The 5-second 1832 °F (1000 °C) test is meant to protect a crewmember 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 an 1832 °F (1000 °C) flame envelope. One company has used German Teklu burners with a flow rate of about 21 liters per minute. Adjust the flow rate and distance of the burner to the surface of the PBE unit being tested to obtain the required temperature. In most cases the flame plume developed will not expose the complete unit. You can pass a segment through the flame plume to obtain the 5-second exposure period and then rotate it to the next segment and pass it 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.</p>	Similar-	



Comparison of Minimum Performance Standards of ETSO-C116 and TSO-C116a

ETSO-C116 Requirement Corresponding to TSO-C116a	TSO-C116a Requirement (consolidated text from TSO-C116a and AS8047)	Judgement	Remark
None	6.2.4 (FAA added) Heat Release and Smoke Density. Exposed panels/surfaces totaling more than one square foot in surface area must meet the heat release and smoke density requirements of 14 CFR 25.853 and 14 CFR part 25, Appendix F, Parts IV and V. Find guidance on these test requirements in the Materials Fire Test Handbook, DOT/FAA/AR-00/42, at www.fire.tc.faa.gov/handbook.stm .	Add On	The requirement now calls for compliance with FAR 25 heat release and density requirements
None	6.2.5 (FAA added) Battery Qualification. If the equipment uses a lithium battery as a power source, battery must meet the applicable battery standards:	Add On	It seems that this requirement has been added to provide guidance for compliance demonstration for specific design solutions to comply with TSCO-C116a, § 3.1.4
None	6.2.5.1 (FAA added) TSO-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.	Add On	It seems that this requirement has been added to provide guidance for compliance demonstration for specific design solutions to comply with TSCO-C116a, § 3.1.4
None	6.2.5.2 (FAA added) TSO-C179, Rechargeable Lithium Cells and Lithium Batteries (see UL 1642, Standard for Safety for Lithium Batteries, fourth edition, dated September 19, 2005	Add On	It seems that this requirement has been added to provide guidance for compliance demonstration for specific design solutions to comply with TSCO-C116a, § 3.1.4
3.7 The stowed unit shall not be adversely affected by environmental extremes. The applicable sections of RTCA DO-160C shall be used to demonstrate unit compliance.	6.3 Environmental Qualification (FAA added)	Headline Only	



Comparison of Minimum Performance Standards of ETSO-C116 and TSO-C116a

ETSO-C116 Requirement Corresponding to TSO-C116a	TSO-C116a Requirement (consolidated text from TSO-C116a and AS8047)	Judgement	Remark
RTCA-DO 160, Section 4 Temperature / Altitude Temperature / Altitude	6.3.1 (FAA added) High Temperature Exposure: Soak the portable PBE for 12 hours at not less than 160° F (71.1° C). Then transfer the PBE to 70°F (21.1°C), ambient temperature. Within 30 minutes of doing this, test the portable PBE to the requirements of paragraph 3.2.	Detailed	The requirement is more detailed than the initial TSO. The requirement and durations seem to be based on a Boeing specification and not RTCA-DO 160.
RTCA-DO 160, Section 4 Temperature / Altitude	6.3.2 (FAA added) Low Temperature Exposure: Soak the portable PBE device for 2 hours at not greater than -65°F (-54°C). Then transfer the PBE to 0°F (-17.8°C) for 2 hours to stabilize it. After this, transfer the PBE to 70°F (21.1°C), ambient temperature. Within 30 minutes of doing this, test the portable PBE to the requirements of paragraph 3.2.	Detailed	The requirement is more detailed than the initial TSO. The requirement and durations seem to be based on a Boeing specification and not RTCA-DO 160.
RTCA-DO 160, Section 7 Operational Shocks and Crash Safety	6.3.3 (FAA added) Operational Shock: Comply with the test requirements in RTCA DO-160F, Section 7, paragraph 7.2.	Detailed	The requirement is more detailed than the initial TSO.
RTCA-DO 160, Section 6 Humidity	6.3.4 (FAA added) Humidity: Comply with the test requirements in RTCA DO160F, Section 6, Category A.	Detailed	The requirement is more detailed than the initial TSO.
RTCA-DO 160, Section 10 Water Proofness	6.3.5 (FAA added) Waterproofness: Comply with the test requirements in RTCA DO-160F, Section 10, Category R.	Detailed	The requirement is more detailed than the initial TSO.
RTCA-DO 160, Section 15 Fungus	6.3.6 (FAA added) Fungus Resistance: Comply with the test	Detailed	The requirement is more detailed than the initial TSO.



Comparison of Minimum Performance Standards of ETSO-C116 and TSO-C116a

ETSO-C116 Requirement Corresponding to TSO-C116a	TSO-C116a Requirement (consolidated text from TSO-C116a and AS8047)	Judgement	Remark
	requirements in RTCA DO-160F, Section 13, Category F.		
<i>None</i>	Decompression (Class 2 only): Devices 6.3.7 (FAA added) covered by this document must meet the requirements of paragraph 3.2 when subjected to decompression testing.	Add On	
<i>None</i>	FAR 25.1439 Protective breathing equipment.	Headline only	Why does a MPS copy FAR 25 requirements ?
<i>None</i>	a) Fixed (stationary, or built in) protective breathing equipment must be installed for the use of the flightcrew, and at least one portable protective breathing equipment shall be located at or near the flight deck for use by a flight crewmember. In addition, portable protective breathing equipment must be installed for the use of appropriate crewmembers for fighting fires in compartments accessible in flight other than the flight deck. This includes isolated compartments and upper and lower lobe galleys, in which crewmember occupancy is permitted during flight. Equipment must be installed for the maximum number of crewmembers expected to be in the area during any operation.	Add On	This is an installation requirement.
<i>None</i>	(b) For protective breathing equipment required by paragraph (a) of this section or by the applicable Operating Regulations:	Add On	
<i>None</i>	(1) The equipment must be designed to protect the appropriate crewmember from smoke, carbon dioxide, and other harmful gases while on flight deck duty or while combating fires.	Add On	Requirement covered already by MPS
<i>None</i>	(2) The equipment must include-- (i) Masks covering the eyes, nose and mouth, or (ii) Masks covering the nose and mouth, plus	Add On	Requirement covered already by MPS



Comparison of Minimum Performance Standards of ETSO-C116 and TSO-C116a

ETSO-C116 Requirement Corresponding to TSO-C116a	TSO-C116a Requirement (consolidated text from TSO-C116a and AS8047)	Judgement	Remark
	accessory equipment to cover the eyes.		
None	3) Equipment, including portable equipment, must allow communication with other crewmembers while in use. Equipment available at flightcrew assigned duty stations must also enable the flightcrew to use radio equipment.	Add On	Requirement covered already by MPS
None	4) The part of the equipment protecting the eyes shall not cause any appreciable adverse effect on vision and must allow corrective glasses to be worn.	Add On	Requirement covered already by MPS
None	(5) The equipment must supply protective oxygen of 15 minutes duration per crewmember at a pressure altitude of 8,000 feet with a respiratory minute volume of 30 liters per minute BTPD. The equipment and system must be designed to prevent any inward leakage to the inside of the device and prevent any outward leakage causing significant increase in the oxygen content of the local ambient atmosphere. If a demand oxygen system is used, a supply of 300 liters of free oxygen at 70[deg] F. and 760 mm. Hg. pressure is considered to be of 15-minute duration at the prescribed altitude and minute volume. If a continuous flow open circuit protective breathing system is used, a flow rate of 60 liters per minute at 8,000 feet (45 liters per minute at sea level) and a supply of 600 liters of free oxygen at 70[deg] F. and 760 mm. Hg. pressure is considered to be of 15-minute duration at the prescribed altitude and minute volume. Continuous flow systems must not increase the ambient oxygen content of the local atmosphere above that of demand systems. BTPD refers to body temperature conditions (that is, 37[deg] C., at ambient pressure, dry).	Add On	Requirement covered already by MPS



Comparison of Minimum Performance Standards of ETSO-C116 and TSO-C116a

ETSO-C116 Requirement Corresponding to TSO-C116a	TSO-C116a Requirement (consolidated text from TSO-C116a and AS8047)	Judgement	Remark
None	(6) The equipment must meet the requirements of Sec. 25.1441.	Add On	Why does a MPS copy FAR 25 requirements ?
None	FAR 25.1441 — Oxygen equipment and supply.	Headline only	Why does a MPS copy FAR 25 requirements ?
None	(a) If certification with supplemental oxygen equipment is requested, the equipment must meet the requirements of this section and §§25.1443 through 25.1453.	Add On	
None	(b) The oxygen system must be free from hazards in itself, in its method of operation, and in its effect upon other components	Add On	
None	(c) There must be a means to allow the crew to readily determine, during flight, the quantity of oxygen available in each source of supply.	Add On	This requirement would exclude design solutions without a pressure gauge, or equivalent level of safety must be demonstrated.
None	(d) The oxygen flow rate and the oxygen equipment for airplanes for which certification for operation above 40,000 feet is requested must be approved.	Add On	This requirement is in contradiction to the MPS
None	FAR 121,337 — Protective breathing equipment	Headline only	Why does a MPS copy FAR 25 requirements ?
None	(a) The certificate holder shall furnish approved protective breathing equipment (PBE) meeting the equipment, breathing gas, and communication requirements contained in paragraph (b) of this section.	Add On	This is an installation and operation requirement
None	(b) <i>Pressurized and nonpressurized cabin airplanes.</i> Except as provided in paragraph (f) of this section, no person may operate an airplane unless protective breathing equipment meeting the requirements of this section is provided as follows:	Add On	This is an installation and operation requirement.
None	(1) <i>General.</i> The equipment must protect the	Add On	Requirement covered already by MPS



Comparison of Minimum Performance Standards of ETSO-C116 and TSO-C116a

ETSO-C116 Requirement Corresponding to TSO-C116a	TSO-C116a Requirement (consolidated text from TSO-C116a and AS8047)	Judgement	Remark
	flightcrew from the effects of smoke, carbon dioxide or other harmful gases or an oxygen deficient environment caused by other than an airplane depressurization while on flight deck duty and must protect crewmembers from the above effects while combatting fires on board the airplane.		
<i>None</i>	(2) The equipment must be inspected regularly in accordance with inspection guidelines and the inspection periods established by the equipment manufacturer to ensure its condition for continued serviceability and immediate readiness to perform its intended emergency purposes. The inspection periods may be changed upon a showing by the certificate holder that the changes would provide an equivalent level of safety.	Add On	This is an installation and operation requirement.
<i>None</i>	(3) That part of the equipment protecting the eyes must not impair the wearer's vision to the extent that a crewmember's duties cannot be accomplished and must allow corrective glasses to be worn without impairment of vision or loss of the protection required by paragraph (b)(1) of this section.	Add On	Requirement covered already by MPS
<i>None</i>	(4) The equipment, while in use, must allow the flightcrew to communicate using the airplane radio equipment and to communicate by interphone with each other while at their assigned duty stations. The equipment, while in use, must also allow crewmember interphone communications between each of two flight crewmember stations in the pilot compartment and at least one normal flight attendant station in each passenger compartment.	Add On	Requirement covered already by MPS
<i>None</i>	(5) The equipment, while in use, must allow any crewmember to use the airplane interphone system at any of the flight attendant stations referred to in	Add On	Requirement covered already by MPS



Comparison of Minimum Performance Standards of ETSO-C116 and TSO-C116a

ETSO-C116 Requirement Corresponding to TSO-C116a	TSO-C116a Requirement (consolidated text from TSO-C116a and AS8047)	Judgement	Remark
	paragraph (b)(4) of this section.		
None	(6) The equipment may also be used to meet the supplemental oxygen requirements of this part provided it meets the oxygen equipment standards of §121.335 of this part.	Add On	This is an installation and operation requirement.
None	(7) Protective breathing gas duration and supply system equipment requirements are as follows: (i) The equipment must supply breathing gas for 15 minutes at a pressure altitude of 8,000 feet for the following: (A) Flight crewmembers while performing flight deck duties; and (B) Crewmembers while combatting an in-flight fire.	Add On	Requirement covered already by MPS
None	(ii) The breathing gas system must be free from hazards in itself, in its method of operation, and in its effect upon other components.	Add On	Requirement covered already by MPS
None	(iii) For breathing gas systems other than chemical oxygen generators, there must be a means to allow the crew to readily determine, during the equipment preflight described in paragraph (c) of this section, that the gas supply is fully charged.	Add On	This requirement is in contradiction to 25.1141 (c)
None	(iv) For each chemical oxygen generator, the supply system equipment must meet the requirements of §25.1450 (b) and (c) of this chapter.	Add On	Not applicable to OXYCREW E28180-20-Series
None	(8) <i>Smoke and fume protection.</i> Protective breathing equipment with a fixed or portable breathing gas supply meeting the requirements of this section must be conveniently located on the flight deck and be easily accessible for immediate use by each required flight crewmember at his or her assigned duty station.	Add On	This is an installation and operation requirement.



Comparison of Minimum Performance Standards of ETSO-C116 and TSO-C116a

ETSO-C116 Requirement Corresponding to TSO-C116a	TSO-C116a Requirement (consolidated text from TSO-C116a and AS8047)	Judgement	Remark
None	<p>(9) Fire combatting. Except for nontransport category airplanes type certificated after December 31, 1964, protective breathing equipment with a portable breathing gas supply meeting the requirements of this section must be easily accessible and conveniently located for immediate use by crewmembers in combatting fires as follows:</p> <p>(i) One PBE is required for each hand fire extinguisher located for use in a galley other than a galley located in a passenger, cargo, or crew compartment.</p> <p>(ii) One on the flight deck, except that the Administrator may authorize another location for this PBE if special circumstances exist that make compliance impractical and the proposed deviation would provide an equivalent level of safety.</p> <p>(iii) In each passenger compartment, one for each hand fire extinguisher required by §121.309 of this part, to be located within 3 feet of each required hand fire extinguisher, except that the Administrator may authorize a deviation allowing locations of PBE more than 3 feet from required hand fire extinguisher locations if special circumstances exist that make compliance impractical and if the proposed deviation provides an equivalent level of safety.</p>	Add On	This is an installation and operation requirement.
None	<p>(c) <i>Equipment preflight.</i> (1) Before each flight, each item of PBE at flight crewmember duty stations must be checked by the flight crewmember who will use the equipment to ensure that the equipment—</p> <p>(i) For other than chemical oxygen generator systems, is functioning, is serviceable, fits properly (unless a universal-fit type), and is connected to</p>	Add On	This is an installation and operation requirement.



Comparison of Minimum Performance Standards of ETSO-C116 and TSO-C116a

ETSO-C116 Requirement Corresponding to TSO-C116a	TSO-C116a Requirement (consolidated text from TSO-C116a and AS8047)	Judgement	Remark
	<p>supply terminals and that the breathing gas supply and pressure are adequate for use; and</p> <p>(ii) For chemical oxygen generator systems, is serviceable and fits properly (unless a universal-fit type).</p>		
None	<p>(2) Each item of PBE located at other than a flight crewmember duty station must be checked by a designated crewmember to ensure that each is properly stowed and serviceable, and, for other than chemical oxygen generator systems, the breathing gas supply is fully charged. Each certificate holder, in its operations manual, must designate at least one crewmember to perform those checks before he or she takes off in that airplane for his or her first flight of the day.</p>	Add On	This is an installation and operation requirement.