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Standard Specification for Environmental Systems in Aircraft[1]

This standard is issued under the fixed designation F3227/F3227M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers international standards for the environmental system aspects of airworthiness and design for "small" aircraft.

1.2 The applicant for a design approval must seek the individual guidance of their respective CAA body concerning the use of this specification as part of a certification plan. For information on which CAA regulatory bodies have accepted this specification (in whole or in part) as a means of compliance to their Small Aircraft Airworthiness regulations (hereinafter referred to as "the Rules"), refer to the ASTM F44 webpage (www.ASTM.org/COMMITTEE/F44.htm) which includes CAA website links.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 Following is a list of external standards referenced throughout this specification; the earliest revision acceptable for use is indicated. In all cases later document revisions are acceptable if shown to be equivalent to the listed revision, or if otherwise formally accepted by the governing civil aviation authority; earlier revisions are not acceptable.

2.2 *ASTM Standards:*[2]

F3060 Terminology for Aircraft
F3061/F3061M Specification for Systems and Equipment in Small Aircraft
F3083/F3083M Specification for Emergency Conditions, Occupant Safety and Accommodations
F3117/F3117M Specification for Crew Interface in Aircraft
F3230 Practice for Safety Assessment of Systems and Equipment in Small Aircraft

[1] This specification is under the jurisdiction of ASTM Committee F44 on General Aviation Aircraft and is the direct responsibility of Subcommittee F44.50 on Systems and Equipment.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

F3233/F3233M Specification for Flight and Navigation Instrumentation in Aircraft

2.3 *SAE Standard:*[3]

SAE AIR825/4, Rev A Chemical Oxygen Systems

3. Terminology

3.1 Terminology specific to this specification is provided below. For general terminology, refer to Terminology F3060.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *aircraft type code, n*—an aircraft type code (ATC) is defined by considering both the technical considerations regarding the design of the aircraft and the airworthiness level established based upon risk-based criteria; the method of defining an ATC applicable to this specification is defined in Specification F3061/F3061M.

3.2.2 *BTPS, n*—BTPS stands for "Body Temperature and Pressure, Saturated;" this is defined to be a temperature of 37 °C and a pressure equal to the ambient pressure to which the body is exposed minus 6.27 kPa [47 mmHg]; this is the tracheal pressure displaced by water vapor pressure when the breathed air becomes saturated with water vapor at 37 °C.

3.2.3 *chemical oxygen generator, n*—a chemical oxygen generator is defined as a device which produces oxygen by chemical reaction; for more detailed information, refer to SAE AIR825/4.

3.2.4 *continued safe flight and landing, n*—continued safe flight and landing as applicable to this specification is defined in Specification F3061/F3061M.

3.2.5 *probable, adj*—probable means that the event is anticipated to occur one or more times during the entire operational life of each aircraft.

3.2.6 *STPD, n*—STPD stands for "Standard Temperature and Pressure, Dry." This is defined to be a temperature of 0 °C and a pressure equal to 101.33 kPa (760 mmHg) with no water vapor.

4. Ventilation

NOTE 1—Table 1 provides correlation between various Aircraft Type Codes and the individual requirements contained within this section; refer to 3.2.1. For each subsection, an indicator can be found under each ATC character field; three indicators are used:

An empty cell ( ) in all applicable ATC character field columns indicates that an aircraft must meet the requirements of that subsection.

A white circle (○) in multiple columns indicates that the requirements of that subsection are not applicable to an aircraft *only* if all such ATC character fields are applicable.

A mark-out (×) in any of the applicable ATC character field columns indicates that the requirements of that subsection are not applicable to an aircraft if that ATC character field is applicable.

Example—An aircraft with an ATC of 1SRLLDLN is being considered. Since all applicable columns are empty for 4.1.1, that subsection is applicable to the aircraft. However, since the "L" altitude column for 4.1.2 contains an ×, then that subsection is not applicable.

4.1 *Ventilation:*

TABLE 1 ATC Compliance Matrix, Section 4

Section	Airworthiness Level				Number of Engines		Type of Engine(s)		Stall Speed			Cruise Speed		Meteorological Conditions			Altitude		Maneuvers	
	1	2	3	4	S	M	R	T	L	M	H	L	H	D	N	I	L	H	N	A
4																				
4.1																				
4.1.1																				
4.1.2																				
4.1.3																				
4.1.4																	×			
4.1.5																	×			
4.1.6																	×			
4.1.6.1																	×			
4.1.7																	×			
4.1.8																	×			

[3] Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096, http://www.sae.org.

4.1.1 Each passenger and crew compartment must be suitably ventilated. Carbon monoxide concentration must not exceed one part in 20 000 parts of air.

4.1.2 The ventilating air in the flightcrew and passenger compartments must be free of harmful or hazardous concentrations of gases and vapors in normal operations and in the event of reasonably probable failures or malfunctioning of the ventilating, heating, pressurization, or other systems and equipment.

4.1.3 If accumulation of hazardous quantities of smoke in the cockpit area is reasonably probable, smoke evacuation must be readily accomplished starting with full pressurization and without depressurizing beyond safe limits.

4.1.4 For aircraft that operate at altitudes above 12 497 m [41 000 ft], under normal operating conditions and in the event of any probable failure conditions (refer to Practice F3230) of any system which would adversely affect the ventilating air, the ventilation system must provide reasonable passenger comfort.

4.1.5 For aircraft that operate at altitudes above 12 497 m [41 000 ft], under normal operating conditions and in the event of any probable failure conditions (refer to Practice F3230) of any system which would adversely affect the ventilating air, the ventilation system must provide a sufficient amount of uncontaminated air to enable the flight crew members to perform their duties without undue discomfort or fatigue.

4.1.6 For aircraft that operate at altitudes above 12 497 m [41 000 ft], under normal operating conditions, the ventilation system must be designed to provide each occupant with at least 0.25 kg [0.55 lbm] of fresh air per minute.

4.1.6.1 In showing compliance with 4.1.6, in the event of the loss of one source of fresh air, the supply of fresh airflow may not be less than 0.18 kg per minute [0.40 lbm] for any period exceeding 5 min.

4.1.7 For aircraft that operate at altitudes above 12 497 m [41 000 ft], other probable and improbable Environmental Control System failure conditions (refer to Practice F3230) that adversely affect the passenger and flight crew compartment environmental conditions may not affect flight crew performance so as to interfere with the reliable performance of published and trained duties to an extent that would interfere with continued safe flight and landing.

4.1.8 For aircraft that operate at altitudes above 12 497 m [41 000 ft], other probable and improbable Environmental Control System failure conditions (refer to Practice F3230) that adversely affect the passenger and flight crew compartment environmental conditions may not affect occupants so as to cause permanent physiological harm.

5. Pressurization

NOTE 2—Table 2 provides correlation between various Aircraft Type Codes and the individual requirements contained within this section; refer to 3.2.1. For each subsection, an indicator can be found under each ATC character field; three indicators are used:

An empty cell ( ) in all applicable ATC character field columns indicates that an aircraft must meet the requirements of that subsection.

A white circle (○) in multiple columns indicates that the requirements of that subsection are not applicable to an aircraft *only* if all such ATC character fields are applicable.

A mark-out (×) in any of the applicable ATC character field columns indicates that the requirements of that subsection are not applicable to an aircraft if that ATC character field is applicable.

Example—An aircraft with an ATC of 1SRLLDLN is being considered. Since all applicable columns are empty for 5.1.3, that subsection is applicable to the aircraft. However, since the "L" altitude column for 5.1.1 contains an ×, then that subsection is not applicable.

5.1 *Pressurized Cabins:*

5.1.1 The aircraft must be able to maintain a cabin pressure altitude of not more than 4572 m [15 000 ft] in the event of any probable failure condition (refer to Practice F3230) in the pressurization system.

5.1.1.1 In showing compliance with 5.1.1 during decompression, the cabin altitude may not exceed 4572 m [15 000 ft] for more than 10 s and 7620 m [25 000 ft] for any duration.

5.1.2 Pressurized cabins must have at least two pressure relief valves to automatically limit the positive pressure differential to a predetermined value at the maximum rate of flow delivered by the pressure source.

TABLE 2 ATC Compliance Matrix, Section 5

Section	Airworthiness Level				Number of Engines		Type of Engine(s)		Stall Speed			Cruise Speed		Meteorological Conditions			Altitude		Maneuvers	
	1	2	3	4	S	M	R	T	L	M	H	L	H	D	N	I	L	H	N	A
5																				
5.1																				
5.1.1																	×			
5.1.1.1																	×			
5.1.2																				
5.1.2.1																				
5.1.3																				
5.1.4																				
5.1.5																				
5.1.6																				
5.1.7																				
5.1.8																				
5.1.8.1																				
5.1.8.2																				
5.1.8.3																				
5.1.8.4																				
5.1.9																				
5.1.10																				
5.1.11																	×			
5.1.11.1																	×			
5.1.11.2																	×			
5.1.12																	×			
5.1.12.1																	×			
5.1.12.2																	×			
5.1.13																	×			
5.1.14																	×			
5.1.15																	×			
5.1.15.1																	×			
5.1.15.2																	×			
5.1.16																	×			
5.1.17																	×			
5.1.18																	×			
5.2																				
5.2.1																				
5.2.2																				
5.2.3																				
5.2.4																				

5.1.2.1 The combined capacity of the relief valves required by 5.1.2 must be large enough so that the failure of any one valve would not cause an appreciable rise in the pressure differential. The pressure differential is positive when the internal pressure is greater than the external.

5.1.3 Pressurized cabins must have at least two reverse pressure differential relief valves (or their equivalent) to automatically prevent a negative pressure differential that would damage the structure. However, one valve is enough if it is of a design that reasonably precludes its malfunctioning.

5.1.4 Pressurized cabins must have a means by which the pressure differential can be rapidly equalized.

5.1.5 Pressurized cabins must have an automatic or manual regulator for controlling the intake or exhaust airflow, or both, for maintaining the required internal pressures and airflow rates.

5.1.6 Pressurized cabins must have instruments to indicate to the pilot the pressure differential, the cabin pressure altitude, and the rate of change of cabin pressure altitude (refer to Specification F3233/F3233M).

5.1.7 Pressurized cabins must have a warning indication at the pilot station to indicate when the safe or preset pressure differential is exceeded and when a cabin pressure altitude of 3048 m [10 000 ft] is exceeded.

5.1.8 The 3048 m [10 000 ft] cabin altitude warning required by 5.1.7 may be increased up to 4572 m [15 000 ft] for operations from high-altitude airfields (that is, airfields higher in altitude than the normal maximum pressurization system control altitude) provided the requirements of 5.1.8.1 – 5.1.8.4 are met.

5.1.8.1 For compliance with 5.1.8, the landing or the take off modes (normal or high altitude) must be clearly indicated to the flight crew.

5.1.8.2 For compliance with 5.1.8, selection of normal or high-altitude airfield mode must require no more than one flight crew action and must not remain in high-altitude airfield mode when high-altitude airfield operations are completed.

5.1.8.3 For compliance with 5.1.8, the pressurization system must be designed to ensure cabin altitude does not exceed 3048 m [10 000 ft] when in flight above flight level (FL) 250.

5.1.8.4 For compliance with 5.1.8, the pressurization system and cabin altitude warning system must be designed to ensure cabin altitude warning at 3048 m [10 000 ft] when in flight above flight level (FL) 250.

5.1.9 Pressurized cabins must have a warning placard for the pilot if the structure is not designed for pressure differentials up to the maximum relief valve setting in combination with landing loads.

5.1.10 Pressurized cabins must have a means to stop rotation of the compressor or to divert airflow from the cabin if continued rotation of an engine-driven cabin compressor or continued flow of any compressor bleed air will create a hazard if a malfunction occurs.

5.1.11 If certification for operation above 12 497 m [41 000 ft] and not more than 13 716 m [45 000 ft] is requested, then after decompression from any probable pressurization system failure in conjunction with any undetected, latent pressurization system failure condition (refer to Practice F3230) the aircraft must prevent cabin pressure altitude from exceeding the requirements of 5.1.11.1 and 5.1.11.2.

5.1.11.1 In showing compliance with 5.1.11, if depressurization analysis shows that the cabin altitude does not exceed 7620 m [25 000 ft], the pressurization system must prevent the cabin altitude from exceeding the cabin altitude-time history shown in Fig. 1; note that time starts at the moment cabin altitude exceeds 3048 m [10 000 ft] during decompression.

5.1.11.2 In showing compliance with 5.1.11, maximum cabin altitude is limited to 9144 m [30 000 ft]. If cabin altitude exceeds 7620 m [25 000 ft], the maximum time the cabin altitude may exceed 7620 m [25 000 ft] is 2 min; note that time starts at the moment cabin altitude exceeds 7620 m [25 000 ft] and ends when it returns to 7620 m [25 000 ft].

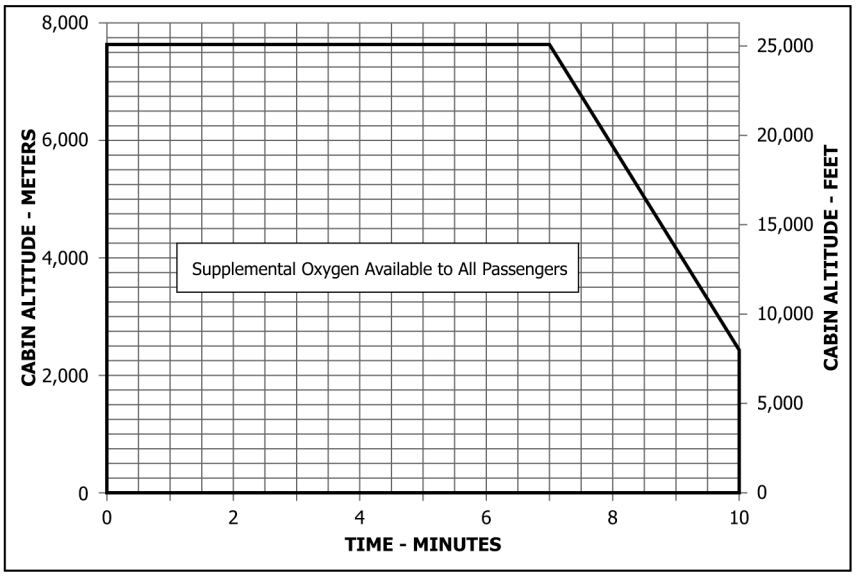

FIG. 1 Cabin Altitude Limit Versus Time

5.1.12 If certification for operation above 12 497 m [41 000 ft] and not more than 13 716 m [45 000 ft] is requested, then after decompression from any single pressurization system failure in conjunction with any probable fuselage damage, the aircraft must prevent cabin pressure altitude from exceeding the requirements of 5.1.12.1 and 5.1.12.2.

5.1.12.1 In showing compliance with 5.1.12, if depressurization analysis shows that the cabin altitude does not exceed 11 278 m [37 000 ft], the pressurization system must prevent the cabin altitude from exceeding the cabin altitude-time history shown in Fig. 2; note that time starts at the moment cabin altitude exceeds 3048 m [10 000 ft] during decompression.

5.1.12.2 In showing compliance with 5.1.12, maximum cabin altitude is limited to 12 192 m [40 000 ft]. If cabin altitude exceeds 11 278 m [37 000 ft], the maximum time the cabin altitude may exceed 7620 m [25 000 ft] is 2 min; note that time starts at the moment cabin altitude exceeds 7620 m [25 000 ft] and ends when it returns to 7620 m [25 000 ft].

5.1.13 In showing compliance with 5.1.11 and 5.1.12, it may be assumed that an emergency descent is made by an approved emergency procedure. A 17-s flight crew recognition and reaction time must be applied between cabin altitude warning and the initiation of an emergency descent. Fuselage structure, engine and system failures are to be considered in evaluating the cabin decompression.

5.1.14 If certification for operation above 13 716 m [45 000 ft] and not more than 15 545 m [51 000 ft] is requested, pressurized cabins must be equipped to provide a cabin pressure altitude of not more than 2438 m [8000 ft] at the maximum operating altitude of the aircraft under normal operating conditions.

5.1.15 If certification for operation above 13 716 m [45 000 ft] and not more than 15 545 m [51 000 ft] is requested, after decompression from any failure condition not shown to be extremely improbable (refer to Practice F3230), the aircraft must meet the requirements of 5.1.15.1 and 5.1.15.2.

5.1.15.1 In showing compliance with 5.1.15, the aircraft must prevent cabin pressure altitude from exceeding 7620 m [25 000 ft] for more than 2 min.

5.1.15.2 In showing compliance with 5.1.15, the aircraft must prevent cabin pressure altitude from exceeding 12 192 m [40 000 ft] for any duration.

5.1.16 If certification for operation above 13 716 m [45 000 ft] and not more than 15 545 m [51 000 ft] is requested, the fuselage structure, engine, and system failures are to be considered in evaluating the cabin decompression.

5.1.17 If certification for operation above 13 716 m [45 000 ft] and not more than 15 545 m [51 000 ft] is requested, in addition

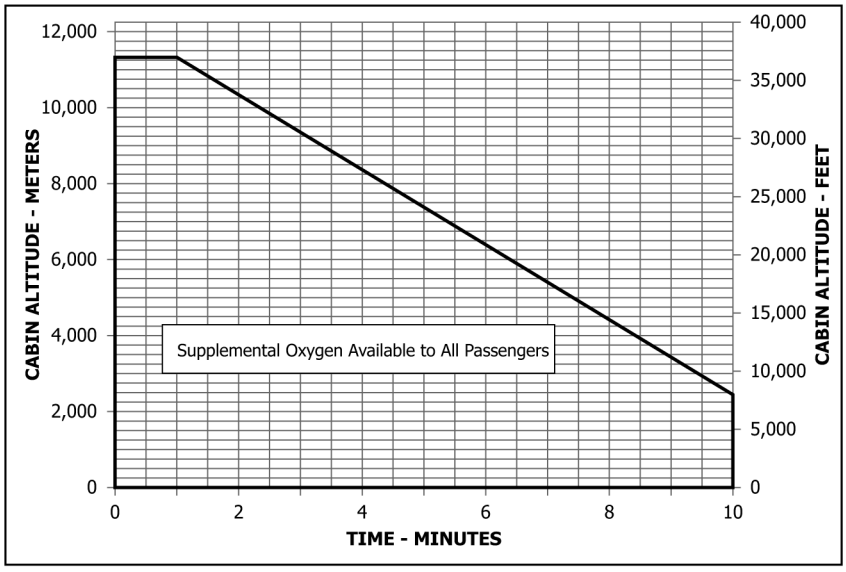

FIG. 2 Cabin Altitude Limit Versus Time

to the cabin altitude indicating means in 5.1.7, an aural or visual signal must be provided to warn the flight crew when the cabin pressure altitude exceeds 3048 m [10 000 ft].

5.1.18 If certification for operation above 13 716 m [45 000 ft] and not more than 15 545 m [51 000 ft] is requested, the sensing system and pressure sensors necessary to meet the requirements of 5.1.6, 5.1.7, 5.1.17, and 6.4.9 must, in the event of low cabin pressure, actuate the required warning and automatic presentation devices without any delay that would significantly increase the hazards resulting from decompression.

5.2 *Pressurization Functional Tests:*

5.2.1 For aircraft with pressurized cabins, tests of the functioning and capacity of the positive and negative pressure differential valves, and of the emergency release valve, must be performed to simulate the effects of closed regulator valves.

5.2.2 For aircraft with pressurized cabins, tests of the pressurization system must be performed to show proper functioning under each possible condition of pressure, temperature, and moisture, up to the maximum altitude for which certification is requested.

5.2.3 For aircraft with pressurized cabins, flight tests must be performed to show the performance of the pressure supply, pressure and flow regulators, indicators, and warning signals, in steady and stepped climbs and descents at rates corresponding to the maximum attainable within the operating limitations of the aircraft, up to the maximum altitude for which certification is requested.

5.2.4 For aircraft with pressurized cabins, tests must be performed of each door and emergency exit to show that they operate properly after being subjected to the flight tests prescribed in 5.2.3.

6. Oxygen Systems

NOTE 3—Table 3 provides correlation between various Aircraft Type Codes and the individual requirements contained within this section; refer to 3.2.1. For each subsection, an indicator can be found under each ATC character field; three indicators are used:

An empty cell ( ) in all applicable ATC character field columns indicates that an aircraft must meet the requirements of that subsection.

A white circle (○) in multiple columns indicates that the requirements of that subsection are not applicable to an aircraft *only* if all such ATC character fields are applicable.

A mark-out (×) in any of the applicable ATC character field columns indicates that the requirements of that subsection are not applicable to an aircraft if that ATC character field is applicable.

Example—An aircraft with an ATC of 1SRLLDLN is being considered. Since all applicable columns are empty for 6.1.1, that subsection is applicable to the aircraft; however, since the "L" altitude column for 6.1.6 contains an ×, then that subsection is not applicable.