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AEROSPACE INFORMATION REPORT

SAE AIR825/10

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Protective Breathing Equipment for Flight Deck and Cabin Crew Members

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1. SCOPE:

This SAE Aerospace Information Report (AIR) provides general information to aircraft engineers, regarding the types of Protective Breathing Equipment (PBE) configurations which are available, the intended functions of such equipment, and the technical approaches which may be used in accomplishing these functions.

The term "PBE" or "Protective Breathing Equipment" has been used to refer to various types of equipment, which are used in a variety of applications. This way of using the terminology has been a source of confusion in the aviation industry. One objective of this AIR is to assist the reader in distinguishing between the types of PBE applications. A further objective is to assist in understanding the technical approaches which can be used in each of the major applications.

Principles of PBE design are reviewed briefly. However, discussion of specific performance specifications and information regarding the details of manufacture and testing of such equipment is beyond the scope of this document.

2. REFERENCES:

2.1 Applicable Documents:

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. 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.

2.1.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AIR825/11	Closed Cycle Breathing Apparatus
AIR1133	Chemical Oxygen General Information
AS8031	Personal Protective Devices for Toxic and Irritating Atmospheres, Air Transport Flight Deck (Sedentary) Crew Members
AS8047	Performance Standard for Cabin Crew Portable Breathing Equipment for Use During Aircraft Emergencies

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2.1.2 FAA Publications: Available from Superintendent of Documents. U.S. Government Printing Office, Washington, DC 20402.

FAR Part 121	Certification and Operations: Domestic, Flag, and Supplemental Air Carriers and Commercial Operators of Large Aircraft
TSO C99	Protective Breathing Equipment
TSO C116	Crew Member Protective Breathing Equipment

2.1.3 EUROCAE Publications: Available from EUROCAE, 11, rue Hamelin - 75783, Paris CEDEX 16, France.

ED-65	Minimum Operational Performance Specification for Passenger Protective Breathing Equipment (PPBE)

2.2 Definitions:

CLOSED CIRCUIT: A PBE configuration in which exhaled gas is processed to remove metabolic products and replace oxygen which was consumed and recycled to be inhaled repeatedly.

OPEN CIRCUIT: A PBE configuration in which exhaled gas containing metabolic products is discharged from the breathing circuit and fresh oxygen containing gas is supplied to be inhaled.

PROTECTION FACTOR: A measure of the degree to which a PBE isolates a user from contaminants such as toxic or irritating fumes and particles present in the external environment. This concept is expressed in Equation 1 where C is the concentration of a contaminant.

$$\text{Protection Factor} = C_{\text{OUTSIDE PBE}} / C_{\text{INSIDE PBE}} \quad \text{(Eq. 1)}$$

PROTECTIVE BREATHING EQUIPMENT (PBE): For the purposes of this document, equipment which is intended to isolate aircraft occupants from dangerous and irritating gases and smoke produced by a fire, while supporting metabolic demand for oxygen and removing exhaled carbon dioxide. Such equipment is generally intended to furnish a degree of protection against eye irritation, as well as respiratory protection. Some PBE devices are intended to furnish hypoxia protection, in addition to protection from smoke and fire gases.

SEMI-CLOSED CIRCUIT: A PBE configuration in which part of the exhaled gas is discharged from the breathing circuit and part is processed to remove metabolic products.

SMOKE HOOD: A style of PBE in which the wearer's head is completely enclosed in a gas-tight flexible chamber. The PBE is sealed at the wearer's neck. This term has also been used loosely to refer to PBE units in general, regardless of style or design.

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3. PBE APPLICATIONS:

There are three general types of PBE applications. They are:

3.1 Crew Member Sedentary:

This equipment is intended to allow flight deck crew to continue to pilot the aircraft and communicate with air traffic control is case of smoke or irrespirable atmosphere in the flight deck area. This equipment is covered by TSO C99 and by AS8031. present standards for this equipment type do not address the possibility of direct contact with fire during use. This equipment is usually designed to furnish hypoxia protection.

Protection must be provided for a minimum of 15 minutes. Regulations require that equipment of this type must be provided for all on-duty flight crew members on the flight deck.

3.2 Crew Member Fire Fighting:

This equipment is intended to allow flight deck crew or cabin attendants to seek out and fight in-flight fires. This equipment is portable.

This equipment is covered by TSO C116 and by AS8047. Designs are not generally intended to protect the user from thermal effects of fires, although present standards for this equipment type require safe operation in the event of brief direct contact with fire during use. Protection must be provided for a minimum of 15 minutes.

A PBE of this type is usually located on the flight deck, and adjacent to each required fire extinguisher in the cabin, as well as in certain cargo areas.

Because this equipment is intended to be used by crew members, acceptable designs may require significant training of potential users.

Some versions of this equipment may also be intended for use by crew members in facilitating passenger evacuation following a crash or an emergency landing involving smoke or fire.

3.3 Passenger:

This equipment would be used by passengers (or other cabin occupants) as protection from smoke in the cabin during a flight, and/or as an aid in escape following a crash or an emergency landing involving smoke. This equipment is not currently covered by a TSO or a released Aerospace Standard, and there is currently no requirement to install this category of PBE on commercial transports. One document defining minimum operational performance standards for passenger PBE is EUROCAE ED-65.

It should be noted that phase dilution passenger masks do not provide smoke protection.

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4. LEVEL OF PROTECTION:

4.1 Toxic Gas Threat:

PBE equipment has been designed to provide protection from the threat of toxic and irritating gases and smoke particles which might be encountered under a variety of otherwise survivable fire scenarios. A key element in defining PBE performance is establishing the target level of protection against toxic gases and smoke.

4.2 Crew Member Protection Factor:

A protection factor of 20, representing a contaminant concentration which is 5% of the value outside the equipment, has been specified for the region near the nose and mouth of the user for crew member PBE. When available fire test data and toxicology data were compared, a protection factor of 20 was judged to give a significant improvement in a typical individual's ability to survive and function during an aircraft smoke emergency of 15 minute duration. This approach was used in preparing AS8031 and AS8047, on which TSO C99 and TSO C116 respectively are based.

In the case of TSO C99 equipment, a protection factor of 10 is mandated for the area around the user's eyes, if this region is a separate compartment from the region around the nose and mouth. If a TSO C99 design has a single compartment for both the nose and mouth and the eyes, a protection factor of 20 is required for the eyes. All TSO C116 designs must furnish a protection factor of 20 for the eyes.

4.3 Passenger Protection Factor:

An alternative approach has been devised for use in defining the level of protection in passenger PBE applications, as depicted in EUROCAE ED-65. In that approach, a protection factor is established separately for each of several individual gases. These gases are judged to be representative of those anticipated to be encountered in a hypothetical fire atmosphere. This reflects the belief that filter technology may be an alternative means of protection against toxic gases in passenger PBE designs. The approach recognizes that an optimum filter design might remove gases which present a greater acute hazard with higher efficiency than would be needed for gases offering a lesser hazard.

5. PRINCIPLES OF OPERATION:

5.1 Performance Objective:

A PBE must protect the user from toxic and irritating atmospheres, supply metabolic oxygen requirements, remove metabolic carbon dioxide, and control the humidity resulting from metabolically produced water.

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