AEROSPACE STANDARD

AS8031™	REV. A

Issued 1980-06
Revised 1999-03
Reaffirmed 2021-08

Superseding AS8031

Personal Protective Devices for Toxic and Irritating Atmospheres Air Transport Flight Deck (Sedentary) Crewmembers

RATIONALE

AS8031A has been raffirmed to comply with the SAE five-year review policy.

1. SCOPE:

This SAE Aerospace Standard (AS) covers any protective system that serves the stated purpose.

1.1 Purpose:

This document establishes minimum performance requirements for emergency equipment, which provides flight deck (sedentary) crewmembers with eye and respiratory protection from toxic atmospheres during in-flight emergencies.

Definition of sedentary: "Sedentary" is herein defined as those flight deck crewmembers that remain seated at their flight deck stations throughout the emergency.

For those "nonsedentary" cabin crewmembers whose duty it is to leave their flight station during an emergency (for example, to actively locate and fight an on-board fire). AS8047 applies.

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.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/AS8031A

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

AS8026	Crewmember Demand Oxygen Mask for Transport Category Aircraft
AIR825B	Oxygen Equipment for Aircraft
AS1194	Regulator Oxygen, Diluter Demand Automatic Pressure Breathing
AS1046	Minimum Standard for Portable Gaseous Oxygen Equipment
AS8047	Performance Standard for Cabin Crew Portable Protective Breathing Equipment for Use During Aircraft Emergencies

2.1.2 Other Publications:

TSO C58	Aircraft Microphones
TSO C78	Crewmember Demand Oxygen Mask
TSO C89	Oxygen Regulators, Demand
TSO C99	Protective Breathing Equipment
TSO C116	Crewmember Protective Breathing Equipment
FAR PART 25	
FAR PART 191	
FAA-AM-78-41	FAA Report: Optical Properties of Smoke Protective Devices

2.2 Abbreviations and Definitions:

L/min	Liters per minute
µL	microliter
NTPD	Normal temperature and pressure, dry (21 °C, 760 mmHg)
psia	Pressure in pounds per square inch, absolute
psig	Pressure in pounds per square inch, gauge
Usage rate	Amount of oxygen furnished by the system for breathing and outboard leakage from the mask and/or goggles per unit(s) of time
mmHg	Pressure in millimeters of mercury
ID	Inside diameter Mean contaminant concentrate
R	Ratio of contaminant concentration in protective breathing device to concentration in enclosure.
mbar	Millibar (1 mbar = 0.0145 psi) (1 mbar = 0.75 mmHg) (1 mbar = 100 Pa)
Pa	Pressure in pascals

3. PERFORMANCE:

The emergency equipment provided should assure the wearer protection against an oxygen deficient, toxic or highly irritating environment (e.g., smoke). The equipment donned under stresses of emergency shall orient to the face or head and interface to mating equipment, where required, in an obvious and uncomplicated manner. Respiratory and eye protection shall be provided in a manner that does not compromise the user's ability to perform his/her required tasks.

4. BREATHING GAS SYSTEM:

The protective system described herein requires a supply of breathing gas. This supply may be self-contained or it may be part of the aircraft oxygen system, either fixed or portable. Any system that employs existing components or interfaces with existing components must demonstrate satisfactory performance when interfaced with such system or components.

5. DURATION:

Any system qualified to the requirements of this document shall provide the user with satisfactory protection for at least 15 min at a pressure equivalent to an altitude of 2438 m (8000 ft) with a respiratory rate of 30 L/min BTPD.

For systems or components of systems that require positive pressure to furnish satisfactory protection, a positive pressure versus gas consumption curve shall be supplied with the system, along with instructions on the proper matching of the system of component to assure 15 min minimum duration.

6. COMPONENTS:

Typical, but not mandatory in all devices.

a. Face piece, either oronasal or full-face

b. Goggle

c. Hood (with neck closure)

NOTE: a and b may be integrated into a single unit. c may be utilized in lieu of, or in combination with a and b.

d. Suspension device

e. Valve or valves and/or regulator

f. Supply tube assemblies with disconnect

g. Communications accessories

h. Miscellaneous additional components as required

7. MATERIALS:

7.1 The materials to be used in the protective systems shall meet requirements of the appropriate sections of the following:

a. Resistance to Flammability
FAR 25.853
U.L. 94 Tests for Flammability of Plastic Materials for Parts in Devices and Appliances (Self-Extinguishing). Any further testing would be on assembled devices.

b. Resistance to Ozone Degradation
ASTM D 1149-64 “Accelerated Ozone Cracking of Vulcanized Rubber”
MIL-STD 417 “Rubber Composition. Vulcanized General Purpose. Solid”

c. Resistance to Ultraviolet Degradation
ASTM D 750 “Operating Light- and Weather-Exposure Apparatus (Carbon-Arc Type) for Artificial Weather Testing of Rubber Compounds”

7.1 (Continued):

d. Resistance to Wear and Tear (Abrasion)
ASTM D 228 "Abrasion Resistance of Rubber and Elastomeric Materials by the Pico Method"

e. Resistance to Skin Reactions
OSHA Tests

f. Oxygen Compatibility
Manufacturer's data on raw materials or on furnished products. Possibly ASTM D 572-67 "Oxygen-Pressure Test for Aging of Rubber".

g. Odors
Sniff tests by different individuals

h. Resistance to Deformation Due to Stowage
ASTM D 1171-67 or D 572-67 "Weather Resistance Exposure of Automotive Rubber Compounds"

i. Resistance to Aging (other than b, d, and f above)
ASTM D 572-67 "Oxygen-Pressure Test for Aging of Rubber"

j. Resistance to Shatter (Lens)
ANSI Z287.1-1968 "Practice for Occupational and Educational Eye and Face Protection"

k. Optical Quality
ANSI.1 (Table 8) "Optical Quality, Normal Corrective Vision". Clear versus yellow tint and vision distortion testing for thermal protection.

8. IDENTIFICATION:

The following information shall be legibly and permanently marked on each device:

a. AS8031

b. Name or description of device (optional)

c. Date of manufacture

d. Manufacturer's part number

e. Manufacturer's name or trademark

f. Size (if applicable)

g. Serial number (optional)

8. (Continued):

h. If positive pressure is required within the device to meet TSO and/or protective requirements noted herein, the pressure should be recorded during the qualification testing of the protective breathing system. The minimum mean positive pressure required must then be specified and marked on each device where applicable. For example:

1. Goggles _____ (part number) with oronasal mask, fullface mask, or hood _____ (part number) with regulators _____, _____, _____ (part numbers) delivering a minimum mean positive pressure of _____ inches H20

2. Goggles _____ (part number) with oronasal mask, fullface mask, or hood _____, positive pressure is not required.

3. Aircraft demand regulator not required _____. Gas source _____. Type _____. Gas flow _____. Positive pressure _____. Duration _____.

8.1 Cleaning:

Except for those systems that are disposable or not reusable, it shall be possible to clean and sterilize the device without adverse effects on its operation and performance. The manufacturer shall provide adequate instructions with each unit.

9. DETAIL REQUIREMENTS:

9.1 Each protective device shall maintain ratio of contaminant within the device - to ambient contaminant concentration of no more than ____X____ for the respiratory protective device and no more than ____Y____ for the eye protective device both with or without eyeglasses specified in 9.3.1. When respiratory protection and eye protection are integrated into a single or common compartmented device, such as fullface mask or hoods, the mean contaminant protection factor is defined as the concentration inside the device divided by the concentration in the environment. This ratio is considered applicable respiratory protection and shall not exceed ____Z____. Contamination protection shall be determined by testing as described in Section 12. Equivalent test procedures and equipment may be used providing a similar level of accuracy and reliability can be demonstrated. The respiratory protection portion of the device shall meet the requirements of AS8026 except for those areas in conflict with this document. In these areas, this document shall take precedence.

9.2 Sizing Criteria:

Each protective device that is furnished an aircrew member for protection from a toxic atmosphere can fulfill its intended function only if the device properly fits the intended wearer.

Because the professional flying population - male and female - present a very wide range of facial types and sizes, the intended users must personally assure that a good fit can be achieved using the standard protective equipment that is provided by the aircraft operator. Aircraft operators should provide an adequate fit and protective level to the widest possible range of their aircrew member. Individually fitted or custom items should be furnished when an aircrew member cannot be fitted by the standard items regularly provided.

Manufacturers are encouraged to provide protective apparatus of universal sizes wherever feasible. When multiple sizes are required to fit the full range of anticipated users, the apparatus is to be clearly marked or identified as to its size or intended user type.

9.3 Donning:

The design objective is that the device shall be capable of being donned within 15 s.

9.3.1 The device shall also be capable of being donned over and thereafter allow the user to wear corrective eyeglasses of maximum dimensions: 4.08 cm x 15.24 cm (2 in x 6 in). The device shall not compromise the nominal position of the eyeglasses so as to cause unacceptable distortion nor cause undue discomfort. Subjects who wear eyeglasses should meet the requirements of 9.1 with the eyeglasses on (i.e., one needs to be concerned with leakage around the eyeglass side arms).

9.3.2 The manufacturer shall establish a donning procedure.

9.3.3 Minor post-donning adjustment shall be allowed for fit and comfort.

9.3.4 Protective device suspension system design, including straps, buckles, knobs, and other adjusting mechanisms, should consider angular relationships, strap pull-tab size, and force requirements in relation to force capability of the user population. The device must not prevent or inhibit normal range of movement.

10. COMMUNICATIONS:

10.1 For Flightdeck Crewmembers:

The protective device shall include an integral microphone when necessary to allow the user to communicate (speak) through the aircraft's communication system. Said microphone shall meet requirements of TSO C58.

11. VISION:

11.1 Protective breathing equipment must include provisions designed to protect the eyes from smoke and harmful gasses. When worn by each test subject used in showing compliance with 12.1 the equipment must:

11.1.1 Not cause a displacement of the spectacle frame sufficient to reduce distance visual acuity in the forward direction of subjects wearing bifocal lenses using normal head movements. Goggle evaluation must be done when worn with the mask that completes the smoke protection combination.

11.1.2 Permit peripheral vision in the horizontal meridian 120° (60° on each side of the center point) and in the vertical meridian of at least 60° (40° above and 20° below center point) when evaluated by standard arc perimeter techniques. Results are to be based on mean scores for all subjects. Goggle evaluation must be done when worn with the mask that completes the smoke protection combination.

Transparent areas of protective breathing equipment shall be designed to prevent condensation on the inside surfaces or shall include a means for removing any moisture that may condense on surfaces essential to vision.

11.1.3 Light transmission, refractive deviation, optical haze and distortion shall be tested in accordance with, and meet Table 8. USA Standard Z87.1 requirements of FAA report FAA-AM-78-41.

12. QUALITY ASSURANCE:

12.1 Qualification Testing:

The manufacturer shall perform, or cause to be performed, the tests covered by this standard for initial qualification of the protective breathing device system. Any tests required by this standard that have been performed on similar units may be omitted, provided the manufacturer shows in the test report the analyses establishing similarity of design, and the results of said tests. Each component of the protective breathing system shall be representative of production units and each unit tested shall be individually identified.

12.1.1 Test Subjects: At least 12 male and 12 female human subjects, chosen at random from a sample group representative of the normal population as defined by physical size falling between the 5th and 95th percentiles, must be used to obtain test data. Subjects should be as representative as possible of the population norms relative to those dimensions affecting fit and performance of the protective-breathing device. A testing period of at least 15 min per test subject must be used. When protective-breathing equipment fails to meet the contaminant concentration requirements of 9.1, corrective action must be taken before retesting is done. Test subjects for retesting following a test failure must include the subjects who previously failed or new subjects who must again be chosen at random, with no selection or substitution made to systematically improve test results.

12.1.2 Test Items: This document is intended to describe methodologies for testing protective goggles, oxygen masks, and full-face masks for contaminant leakage. At least two sample ports must be used to sample gas concentrations within these devices. The sample ports must be installed in a manner that does not compromise the intended function of the test item. The ports need to be configured to allow the most representative sampling of protective device dead space volume. If necessary, a compensating port open to the atmosphere outside of the test chamber, which is free of challenge gas, should be utilized.

12.1.2.1 Listed below are items representative of equipment used in the past to perform this type of testing with n-pentane or sulfur hexaflouride (SF_6) as the challenge gas. Other challenge gases consistent with safety and performance standards necessary can be used and the equipment list is by no means all-inclusive.

12.1.2.2 Aircraft Oxygen Regulators:

12.1.2.3 Panel-Mounted: Panel-mounted flight crew oxygen regulators must meet the standards of MIL-R-25410C, TSO-C89, or equivalent, have pressure and flow indicators, and either have an emergency (safety pressure) setting or deliver a continuous positive pressure. For test purposes, the positive pressure delivered by the regulator may be adjusted and varied to determine the optimal positive pressure for a given protective-breathing device. However, pressure delivered by the regulator must be consistent during testing of all the subjects specified in 12.1.1.

12.1.2.4 Mask-Mounted: Mask-mounted flight crew oxygen regulators must meet the requirements of MIL-R-25410C, TSO-C89, or equivalent and have an emergency (safety pressure) setting or deliver a continuous positive pressure. For test purposes, the positive pressure delivered by the regulator may be adjusted and varied to determine the optimum positive pressure for a given protective-breathing device. However, pressure delivered by the regulator must be consistent during testing of all the subjects specified in 12.1.1.

12.1.2.5 Compressed Gas Source: Oxygen or air may be used for testing. The compressed gas source shall call out oxygen per AS8010, MIL-0-27210, or breathing air equivalent in cleanliness and dryness to AS8010 or MIL-PRF-27210. The compressed gas source must have storage sufficient to supply a flow rate of at least 60 L/min for 15 min. The source must not contain levels of minor constituents that introduce significant errors with the detector employed.

12.1.2.6 Flow Controller (Metering Valve Type): The metering valve must be capable of controlling and delivering an airflow range from 9 to 60 L/min NTPD, at an inlet pressure not to exceed. 689 kPa (100 psig).

12.1.2.7 Gas Flow Meters: The gas flow meter must be capable of accurately measuring airflow through the range from 0 to 60 L/min NTPD. Lower range flow meters may be used with parallel flow circuits.

12.1.2.8 Communication System: A minimal size speaker designed for use in an explosive atmosphere is recommended for installation in the enclosure. An appropriate audio amplifier with controls and a microphone must be available to communicate with personnel outside the enclosure.

12.1.3 Test Protocol: In general terms, the testing of protective equipment covered by this document requires the ability to create a challenge environment, monitor the effectiveness of the test item by accurately measuring gas concentrations, and record the results while the test subject performs specific functional tasks. The detector/analytical system utilized should have a limit of detection equal to 1%, or lower, of the intended challenge gas concentration. Inherent in this process is the requirement that an environment safe for human test subject participation is maintained.

12.1.3.1 The Challenge Environment: It is necessary to maintain control over gas concentrations to properly conduct these tests. Historically, this has been achieved by conducting the test in an enclosure that can be sealed to keep diffusion of gases between its interior and the ambient atmosphere at a minimum. The enclosure must be configured so that the concentration of a test gas contaminant can be controlled and test gas contaminant concentration remains relatively constant within the test enclosure during each testing period. Ideally, the maximum expected challenge gas concentration should not result in a partial pressure of the challenge agent which is greater than 20% of the equilibrium vapor pressure for the condensed phase of the challenge agent, under the ambient temperature and pressure at which the test is conducted. This would reduce the possibility of condensation or adsorption of the challenge gas on surfaces within the chamber.

The test gas contaminant introduction system must be capable of providing the specified challenge gas concentration in the enclosure from ambient atmospheric conditions within 3 min. Furthermore, the contaminant gas introduction system must have the ability to maintain a specified enclosure contaminant gas concentration during the 15-min test period. The test gas contaminant must be a gas that is physiologically innocuous under the contemplated exposure conditions. The test gas contaminant must not react with test subjects, materials of the test equipment within the enclosure, or the protective breathing equipment to the extent that test results will be compromised. Each enclosure test sample must be taken from as near as practicable to the test item without the sample being affected by the subject's expired respiratory gases. The enclosure must be at room temperature, pressure and humidity. For safety reasons, it is recommended that testing should be terminated if the enclosure oxygen concentration reaches 40% or falls below 17.5%.

12.1.3.2 Detection of the Challenge Agent: A number of methodologies exist for the measurement of gases. These include manometric and galvanic methods; analysis based on paramagnetism, gas chromatography, mass spectrometry, and the use of gas specific electrodes. Currently, mass spectrometers would be the instrument of choice for most laboratories performing testing consistent with this document. However, any of the other systems mentioned above could serve the intended purpose. The primary concern should not be the type of detection instrument, but the ability of the instrument and operators to achieve accurate and consistent data.

12.1.3.3 Effectiveness of the Test Item: Effectiveness of the test item is defined by the ability to exclude the contaminant gas from within the dead space volume of the test item at a specified contamination level in the enclosure atmosphere. Specifically, the mean contaminant protection factor is defined as the contaminant concentration inside the mask divided by the contaminant concentration outside of the mask. This ratio is not permitted to exceed 5% (9.1). Currently, there are numerous devices available commercially that can be configured to test both contaminant and atmospheric gas concentrations. These include a variety of electronic analyzers utilized in environmental monitoring and other work, gas chromatographs, and mass spectrometers. Historically, gas chromatography has been used to perform this type of testing. Therefore a brief overview of minimal or basic requirements are presented in Appendix A. A description of the test requirements is presented below.

As a minimum, the system used to evaluate the test item must be capable of sampling at a rate of one sample per minute from each of the sample lines connected to the test item. Optimally, sampling would be continuous for gas concentrations both within the dead space volume of the test item and the test chamber enclosure in a manner that permitted real time recording and mean contaminant protection factor analysis for all practical purposes. Samples must be collected through flexible nonpermeable and nondiffusing tubing. Tubing material should not alter the gas composition of the sample. Sampling tubes must allow for head movements by the subject, but no longer than necessary so as to minimize the sample volume and transit times to the gas concentration measurement device.

12.1.3.4 Data Recording: Numerous methodologies are currently available for accurately recording the data for analysis. Options range from a basic strip chart recorder to computer based analytical instruments for data acquisition, recording and analysis. The primary criterion for the recording device is a full-scale response time of 1 s or less. Whatever analytical system utilized, it must provide data necessary to determine the ratio of mask test gas contaminant concentration to enclosure test gas contaminant concentration as the measure of mask leak fraction (or percentage if multiplied by 100).

If a discrete sampling method is used, not less than 15 evenly spaced samples from the protective breathing' equipment must be analyzed for each test subject. For protective breathing equipment having separate respiratory and visual compartments, 15 samples from each must be analyzed for each test subject. If a continuous sampling method is used and the data processing uses only discrete samples from the results, not less than 15 equally spaced samples per compartment must be analyzed. In all cases, a minimum of one sample per sample line per minute must be taken throughout the testing period. Samples from each compartment must be analyzed separately and data from separate compartments must not be combined. The mean value of the total test measurements for each compartment for each test subject must be determined and used to show compliance. All compartments of the protective breathing equipment must meet the standard of 9.1 for at least 80% of the duration of each of the subject test periods.

12.1.3.5 Subject Safety: It is recommended that oxygen level inside the test enclosure are maintained between 17.5 and 40%. Current oxygen analyzer technology capable of monitoring O_2 levels in this range makes oxygen analyzer the system of choice for this testing procedure.

12.1.4 Test Procedures:

12.1.4.1 Pretest Procedures: All flowmeters, pressure gauges, vacuum pumps, and analytical instruments should be appropriately calibrated prior to other startup procedures necessary to test the protective breathing device. In the case of a mechanical sampling system which is utilized to alternatively draw samples from different sampling lines attached to the test item, care should be taken to ensure that variations in vacuum among the different positions of the selector valve do not compromise the accuracy of the analytical results. Prior to actual testing the system should be operated in a manner that ensures that the recording device maintains a stable baseline value. Once calibrations and baseline data have been established, the test gas contaminant in the enclosure should be raised to a concentration 5% beyond what will be used in actual device testing. The atmospheric gas control system used for the enclosure must be capable of maintaining the desired test gas contaminant concentration within ±2.5% once steady-state is reached. The gas analysis system used must read all samples collected during this pretest period within ±1%.

Once the ability to control and sample at the upper limit of the gas contaminant concentration has been established, the response characteristics of the analyzer system should be verified. The enclosure should be cleared of the contaminant gas by stopping test gas contaminant infusion and providing venting. Enclosure clearing should be verified by the return of the analyzers to levels consistent with the ambient atmosphere (i.e., baseline values). To check the response characteristics of the analyzer system, introduce the test gas contaminant at not less than four equally spaced levels between zero and the upper limit level previously established (~20%, ~40%, ~60%, and ~80%). Draw at least four discrete samples at each concentration level and record. Calculate a response curve using least squares regression. Although the system response is not required to be linear, the calibration curve must be calculated through zero for the test gas contaminant. If a nonlinear regression equation is derived, the number of data points must exceed the number of terms in the expression. Deviation of any data point from the fitted calibration curve is not to exceed 5% of the fitted curve value for that point.