

Draft Subpart Q; Closed-Circuit Self-Contained Breathing Apparatus; May 28, 2008

Subpart Q—Closed-Circuit Self-Contained Breathing Apparatus

§ 84.500 Closed-Circuit Self-Contained breathing apparatus; description.

Closed-Circuit Self-Contained breathing apparatus (CC-SCBA) devices designed for use as respiratory protection during entry into hazardous atmospheres that can be Immediately Dangerous to Life and Health (IDLH) are described as an apparatus of the type in which the exhaled breath is rebreathed by the wearer after the carbon dioxide has been effectively removed and oxygen concentration restored to suitable levels.

§ 84.501 Applicability to new and previously approved CC- SCBA.

(a) This subpart applies to the following CC-SCBA:

(1) All CC-SCBA submitted to NIOSH for a certificate of approval after (INSERT DATE RULE BECOMES EFFECTIVE); and

(2) All CC-SCBA sold after (INSERT DATE 3 YEARS AFTER DATE RULE BECOMES EFFECTIVE) that were previously approved by NIOSH under 42 CFR Part 84, Subpart H.

(b) No CC-SCBA in use or available for use shall retain a NIOSH certificate of approval after (INSERT DATE 6 YEARS AFTER DATE RULE BECOMES EFFECTIVE) unless it has been approved under the requirements of this subpart.

§ 84.502 CC-SCBA; required components, attributes, and instructions.

(a) Each apparatus described in § 84.500 shall, where its design requires, contain the following component parts:

(1) Full Facepiece;

(2) Respirable breathing gas container;

(3) Supply of respirable breathing gas;

(4) Capacity gage;

(5) Remaining capacity indicator or warning device;

(6) Hand-operated valves;

(7) Breathing bag;

(8) Safety relief valve or safety relief system; and

(9) Harness.

(b) The components of each CC-SCBA shall meet the minimum construction requirements set forth in subpart G of this part.

(c) The design, construction, or materials of the CC-SCBA shall not constitute a hazard to the user as a result of the wearing, inspection, or use of the CC-SCBA.

(d) The CC-SCBA shall be constructed to be resistant to the permeation of the breathing circuit by gasoline, toluene, and kerosene.

(e) The applicant shall provide, with each new CC-SCBA, clearly written User Instructions (UI) that addresses the following topics and elements:

(1) An explanation of how the CC-SCBA works;

(2) A schematic diagram of the CC-SCBA;

(3) Instructions for proper size selection and fitting of the facepiece;

(4) Procedures for donning and use;

(5) Refilling or replacing procedures for consumable products;

(6) Procedures for inspecting the operating condition of the CC-SCBA;

- (7) Procedures and conditions for storage, including but not limited to any recommended minimum and maximum temperatures for storage;
 - (8) Limitations on use, including but not limited to any recommended minimum and maximum temperatures for use; and
 - (9) Procedures for disposal of components containing hazardous materials.
- (f) Each CC-SCBA shall be permanently, clearly, and legibly labeled to show the capacity rating followed in parentheses by the lowest duration obtained in the Capacity test to indicate the expected duration for a user of average weight at a moderately high work rate. The capacity and expected duration shall be explained in the UI including information explaining the variability of the expected duration. This requirement is in addition to the labeling and marking requirements of § 84.33.

§ 84.503 Breathing tubes; minimum requirements.

Flexible breathing tubes used in conjunction with breathing apparatus shall be designed and constructed to prevent:

- (a) Restriction of free head movement;
- (b) Disturbance of the fit of full facepieces;
- (c) Interference with the wearer's activities; and
- (d) Shutoff of airflow due to kinking, or from chin or arm pressure.

§ 84.504 Harnesses; installation and construction; minimum requirements.

(a) Each apparatus shall be equipped with a suitable harness designed and constructed to hold the components of the apparatus in position against the wearer's body.

§ 84.505 Optional apparatus containers; minimum requirements.

- (a) An applicant's designated container designed to store or protect the CC-SCBA and the required components is optional. If an applicant opts to use a container, the applicant's UI shall identify the container and shall direct the user how to store the CC-SCBA and the required components inside the container.
- (b) Containers designated by the applicant for carrying or storing CC-SCBA shall be inspected, examined, and tested as components of the respirator for which approval is sought.

§ 84.506 Full facepiece minimum requirements.

- (a) The full facepiece shall be designed and constructed to fit persons with various facial shapes and sizes, either:
 - (1) By providing more than one facepiece size; or
 - (2) By providing one facepiece size which will fit varying facial shapes and sizes.
- (b) The CC-SCBA shall meet or exceed the Laboratory Respiratory Protection Level (LRPL) Test Requirement defined in this section.
 - (1) The CC-SCBA shall have a LRPL measurement greater than or equal to a value of 10,000 when the entire CC-SCBA is tested as a complete system as follows:
 - (i) The entire CC-SCBA shall be worn by a human test volunteer in the operational mode in accordance with the applicant's UI.
 - (ii) The LRPL test chamber challenge atmosphere shall be a corn oil aerosol at a concentration of 30 to 40 mg/m³ of a mass median aerodynamic diameter of 0.4 to 0.6 micrometer (µm).
 - (iii) A minimum of eight CC-SCBA shall be tested using a panel of small, medium, and large

designations of facial sizes – 2 small, 4 medium, and 2 large by providing multiple facepiece sizes or by providing one facepiece size which shall fit varying facial shapes and sizes.

(2) The measured LRPL value for the CC-SCBA facepiece shall be greater than or equal to 500 when the CC-SCBA facepiece is tested as described:

(i) The applicant shall provide enough facepieces (approximately 11-25), adapters, and P100 filters to meet the Los Alamos panel requirements along with conversion instructions to convert the CC-SCBA facepiece into a full facepiece air-purifying respirator (APR). The facepiece conversion shall not significantly alter the fit characteristics of the respirator.

(ii) The LRPL test chamber challenge atmosphere shall be a corn oil aerosol at a concentration of 30 to 40 mg/m³ of a mass median aerodynamic diameter of 0.4 to 0.6 micrometer (µm).

(c) The full facepiece shall provide for the optional use of vision correction lenses which shall not reduce the respiratory protective qualities of the CC-SCBA.

(d) The wearer shall not experience undue discomfort because of fit or other characteristics of the facepiece.

§ 84.507 Facepiece; lenses; minimum requirements.

(a) The facepiece primary lens system or the facepiece primary lens system used in conjunction with an optional protective outsert lens system shall be designed and constructed to be impact and penetration resistant, and this shall be demonstrated by meeting or exceeding the requirements of ANSI Z87.1-2003, American National Standard for Occupational and Educational Personal Eye and Face Protection Devices.

(b) Facepiece primary lens system and any optional protective outsert lens system shall be designed and constructed to provide an adequate and non-distorted field of view and shall obtain a Visual Field Score (VFS) of 90 or greater at all temperatures for which it is intended to be used. The VFS score is the average of three fittings of the same respirator on the specified headform.

(c) Facepieces shall be designed to prevent fogging of the primary lenses, the optional protective outsert lenses and the vision correction lenses in any combination of required use and shall demonstrate an average Visual Acuity Score (VAS) of greater or equal to 75 points for all measurements of acuity. The CC-SCBA shall be cold soaked and tested in an environmental chamber at minus 21 °C ± 2°C (-5.8 °F ± 3.6 °F) for four (4) hours. The wearer shall not experience undue discomfort because of restrictions to breathing or other physical or chemical changes to the respirator.

(d) The facepiece primary lens system shall meet the following lens material Haze, Luminous Transmittance and Abrasion Resistance performance requirements:

(1) The haze value of the primary lens material shall be 3% or less when tested in accordance with ASTM D 1003-00.

(2) The luminous transmittance value of the primary lens material shall be 88% or greater when tested in accordance with ASTM D 1003-00.

(3) The haze and luminous transmittance of the primary lens material shall be determined in accordance with ASTM D 1003-00 before and after subjecting the lens material to the abrasion test. The abrasion test shall be conducted in accordance with ASTM D 1044-99 using a CS10F calibrase wheel at a minimum of 70 revolutions under a 500-gram weight. After subjecting the lens material to the abrasion test, remove the residue from the test specimens in accordance with ASTM D 1044-99 or by using a cleaning method recommended by the applicant. After the residue is removed from the test specimens, the test specimens shall not exhibit an increase of

haze greater than 4% and a decrease of luminous transmittance greater than 4%.

(4) The test specimens shall be the flat four (4) inch (102mm) square version as prescribed in ASTM D 1044-99 and shall have the same nominal thickness and within the tolerance range as the primary lens of the CBRN APR. The test specimens shall be subjected to the same coating process and any other processes, as the primary lens would be under normal production conditions. A total of six (6) specimens shall be furnished to NIOSH for certification testing, three pre-abrasion specimens and three specimens after being tested for abrasion in accordance with ASTM D-1044-99.

§ 84.508 Breathing gas; minimum requirements.

The breathing gas used in the cylinders shall meet the requirements of United States Pharmacopoeia (USP).

§ 84.509 Interchangeability of oxygen and air prohibited.

Any apparatus, combination of respirator assemblies, or any apparatus or respirator component shall not be designed or constructed to permit the interchangeable use of oxygen and air.

§ 84.510 Compressed breathing gas and liquefied breathing gas containers; minimum requirements.

(a) Compressed breathing gas and liquefied breathing gas containers shall meet the minimum requirements of the Department of Transportation for interstate shipment of such containers when fully charged.

(b) Such containers shall be permanently and legibly marked to identify their contents, e.g., compressed breathing oxygen, liquefied breathing air, or liquefied breathing oxygen.

(c) Containers normally removed from apparatus for refilling shall be equipped with a dial indicating gage which shows the pressure in the container.

(d) Compressed breathing gas container valves or a separate charging system or adapter provided with each apparatus shall be equipped with outlet threads specified for the service by the Compressed Gas Association, Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections, V-1 -2005.

§ 84.511 Capacity gage; minimum requirements.

All CC-SCBA shall have accurate capacity indicators and shall give an alarm when the remaining capacity is at 20-25% of the rated capacity.

§ 84.512 Hand-operated valves; minimum requirements.

(a) Hand-operated valves shall be designed and constructed to prevent removal of the stem from the valve body during normal usage to insure against a sudden release of the full pressure of the container when the valve is opened.

(b) Valves shall be designed or positioned to prevent accidental opening and closing, and damage from external forces.

(c) Valves operated during use of the apparatus shall be installed in locations where they can be readily adjusted by the wearer.

(d) Main-line valves, designed and constructed to conserve gas in the event of a regulator or demand valve failure, shall be provided in addition to gas container valves, except when such failure shall not affect performance.

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(e) Hand-operated bypass systems designed and constructed to permit the wearer to breathe and to conserve his gas supply in the event of a regulator or demand valve failure, shall be provided where necessary.

(f) Valves installed on apparatus shall be clearly distinguishable from one another by sight and touch.

(g) The bypass system valve control shall be colored red.

§ 84.513 Breathing bags; minimum requirements.

Breathing bags shall be installed in a location which protects them from damage or collapse by external forces.

§ 84.514 Component parts exposed to oxygen pressures; minimum requirements.

Each applicant shall certify that the materials employed in the construction of component parts exposed to oxygen pressures above atmospheric pressure are safe and compatible for their intended use.

§ 84.515 Compressed gas filters; minimum requirements.

All CC-SCBA using compressed gas shall have a filter down stream of the gas source to effectively remove particulates from the gas stream.

§ 84.516 Permeability resistance; minimum requirements.

(a) Three (3) CC-SCBA units shall be tested in three separate contaminated atmospheres at room temperature (24-30 °C/ 75- 86 °F) for a period of eight hours each; one unit in a gasoline saturated atmosphere, one unit in a kerosene saturated atmosphere, and one unit in a toluene saturated atmosphere.

(b) The CC-SCBA shall be operated during these tests by a breathing machine set at 24 revolutions per minute (rpm), 40 liter minute-volume, and a work rate of 622 kg - m/minute.

(c) The breathing air in the CC-SCBA shall not contain more than 100 parts per million (ppm) of gasoline vapor, 14 ppm of kerosene vapor, and 50 ppm of toluene vapor at the conclusion of each of the respective tests.

§ 84.517 General testing conditions and performance requirements.

(a) The stressors listed in Table 1 shall be continuously monitored in the Capacity, Performance and Wearability tests. The stressors shall be measured at the interface between the CC-SCBA and the wearer's mouth with instruments capable of breath-by-breath measurement. An excursion is considered to be going outside an acceptable range for more than one minute. Operating averages are minute averages averaged over the entire duration of the test.

Table 1: Monitored Stressors and their Acceptable Ranges
[42 CFR Part 84, subpart Q]

Stressor	Acceptable Range Operating Average	Acceptable Range Excursion
Average inhaled CO ₂	< 1.5%	≤ 4.0%
Average inhaled O ₂	> 19.5%	≥ 15.0%
Peak Breathing Pressures	P _{ex} - P _{in} ≤ 200 mm H ₂ O	-300 ≤ ΔP ≤ 200 mm H ₂ O
End-of-breath wet-bulb temperature ⁽¹⁾	< 43°C (109.4 °F)	≤ 50°C (122.0 °F)

¹ Wet-bulb temperature is a measurement of the temperature of a wet surface. It represents the temperature of the inhaled breathing gas in the CC-SCBA user's trachea.

- (b) Capacity and Performance tests shall conclude when the stored gas supply has been fully expended.
- (c) NIOSH will determine a CC-SCBA to have failed a Capacity, Performance, or Wearability test if any of the following occurs during the test:
 - (1) A minute-average measurement of any stressor listed in Table 1 occurs outside the acceptable excursion range specified in Table 1; or an average stressor measurement calculated at the completion of a Performance or Capacity test exceeds the operating average values specified in Table 1; or
 - (2) A human subject cannot complete the test for any reason related to the CC-SCBA, as determined by NIOSH.
- (d) The Capacity, Performance and Wearability tests shall be conducted at an ambient temperature of 22°C ± 3°C (71.6°F ± 5.4°F).
- (e) NIOSH will perform a quantitative leak test on the apparatus submitted for approval. At the greatest negative pressure exhibited by the apparatus in the Performance test, the leak rate into the breathing circuit shall not exceed 32 ml/min.

§ 84.518 Capacity test requirements.

- (a) NIOSH will conduct the Capacity test a total of four times on the CC-SCBA submitted for approval, as follows:
 - (1) The CC-SCBA shall be tested twice on a NIOSH automated breathing and metabolic simulator (ABMS) or equivalent;
 - (2) The CC-SCBA shall be tested on an ABMS at the cold-temperature limit recommended by the applicant under § 84.502(e)(8) of this subpart after it has been stored for a minimum of 24 hours at this limit;
 - (3) The CC-SCBA shall be tested by a human subject on a treadmill; and,
 - (4) For CC-SCBA to be used in coal mines, the CC-SCBA shall also be tested by a human subject under the specifications of § 84.99 and § 84.100 of this part that are applicable to a Man test 4.
- (b) The Capacity test shall begin upon the first inhalation from or exhalation into the unit.
- (c) The metabolic parameters of the Capacity test are as given in Table 2. All volumes in this standard are given at standard temperature (0 °C) and pressure (760 mm Hg), dry, (STPD) unless otherwise noted.

Table 2: Capacity Test Requirements
[42 CFR Part 84, subpart Q]

$\dot{V}O_2$ (L/min)	$\dot{V}CO_2$ (L/min)	$\dot{V}e$ (L/min)	RF (Breaths/min)
1.35	1.15	30	18

$\dot{V}O_2$ = Volume of oxygen consumed/min; $\dot{V}CO_2$ = Volume of carbon dioxide produced/min

$\dot{V}e$ = Volume of gas exhaled/min; RF = Respiratory frequency

(d) The capacity rating will be determined by multiplying the lowest duration obtained in any of the Capacity tests by the oxygen consumption rate, 1.35 L/min, rounded down to the nearest 5-L increment. In addition to the capacity rating, in parentheses on the label shall be given the lowest duration obtained in the Capacity test as an expected duration for a user of average weight at a moderately high work rate.

§ 84.519 Performance test requirements.

(a) NIOSH will conduct the Performance test a total of four times on the CC-SCBA submitted for approval, as follows:

- (1) The CC-SCBA shall be tested twice on an ABMS;
- (2) The CC-SCBA shall be tested on an ABMS at the cold-temperature limit recommended by the applicant under § 84.502(e)(8) of this subpart after it has been stored for a minimum of 24 hours at this limit; and
- (3) The CC-SCBA shall be tested by a human subject on a treadmill.

(b) The Performance test will apply a repeating cycle of work rates, according to the sequence and requirements specified in Table 3, until the oxygen supply of the unit is exhausted.

(c) The Performance test will begin with two exhalations into the apparatus, at the specified ventilation rate, to determine the design's susceptibility to hypoxia.

Table 3: Performance Test Requirements
[42 CFR Part 84, subpart Q]

Work-Rate Test Sequence	Duration per cycle	$\dot{V}O_2$ (L/min)	$\dot{V}CO_2$ (L/min)	$\dot{V}e$ (L/min)	RF (breaths/min)
Peak	5 min.	3.00	3.20	65	25
High	15 min.	2.00	1.80	44	20
Low	10 min.	0.50	0.40	20	12

$\dot{V}O_2$ = Volume of oxygen consumed/min; $\dot{V}CO_2$ = Volume of carbon dioxide produced/min

$\dot{V}e$ = Volume of gas exhaled/min; RF = Respiratory frequency

§ 84.520 Wearability test requirements.

(a) NIOSH will conduct the Wearability test three times at ambient and once in a cold chamber

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at the lowest temperature recommended for use by the applicant. Three human subjects (two (2) males and one (1) female), will perform the tests at ambient temperature. The three subjects will range in height and weight as follows: one subject of height ≥ 174 centimeters (cm) (68.5 inches (in)) and weight ≥ 90 kilograms (kg) (198.4 pounds (lb)); one subject of either 163 cm (64.2 in) \leq height < 174 cm (68.5), regardless of weight, or of 72 kg (158.7 lb) \leq weight < 90 kg (198.4 lb) regardless of height; and one subject of height < 163 cm (64.2 in) and weight < 72 kg (158.7 lb). All CC-SCBA tested shall meet all conditions specified in this section to receive approval. A human subject of any weight and height can be used in the cold wearability test.

(b) NIOSH will continuously monitor the CC-SCBA used by each test subject during the activities specified in Table 4 to evaluate the ability of the CC-SCBA to provide an adequate and uninterrupted breathing supply, including but not limited to the requirements of § 84.517(a) of this subpart, without harming or hindering a user. NIOSH will not certify a CC-SCBA if the use of any unit during these activities indicates to NIOSH any potential for the CC-SCBA to harm or hinder a user or to fail to provide an adequate and uninterrupted breathing supply to a user during reasonably anticipated conditions of use.

Table 4: Wearability Test Requirements
[42 CFR Part 84, subpart Q]

Activity	Minimum Duration
Sitting	1 min.
Stooped walking	1 min.
Crawling	1 min.
Lying on left side	1 min.
Lying on right side	1 min.
Lying on back	1 min.
Bending over to touch toes	1 min.
Turning head from side to side	1 min. (at least 10 times)
Nodding head up and down	1 min. (at least 10 times)
Climbing steps or a laddermill	1 min. (1 step/sec)
Carrying 22.68 kg (50-lb) bag on treadmill at 5 km/hr (3.11 mph)	1 min.
Lifting 9.07 kg (20-lb) weight from floor to an upright position	1 min. (at least 10 times)
Running on treadmill at 10 km/hr (6.21 mph)	1 min.

§ 84.521 Chemical, biological, radiological, and nuclear (CBRN) CC-SCBA; Optional requirements; for Use Against (CBRN) Agents.

(a) A CC-SCBA designed for use as respiratory protection during entry into chemical, biological, radiological, and nuclear (CBRN) hazardous atmospheres that are IDLH shall meet or exceed the optional performance requirements specified in Section § 84.521 through § 84.526 of Subpart Q to gain a CBRN CC-SCBA certification.

(b) A CC-SCBA may be optionally NIOSH approved for CBRN Protection after it has been determined by NIOSH that the device has met the minimum performance requirements in Section § 84.500 through Section § 84.520 in Subpart Q.

§ 84.522 Additional Requirements for CBRN CC-SCBA.

(a) The purpose of this Operational Performance test is to evaluate the performance of the CC-SCBA and not the capacity.

(b) The CC-SCBA shall not exceed the ranges of human stressors listed in Table 5. An excursion is considered to be going outside an acceptable range for more than one minute. Operating averages are minute averages averaged over the entire duration of the test.

(1) The CC-SCBA shall be tested on the NIOSH ABMS or equivalent in accordance with the Test Regimen of Table 6 that consists of the Test Parameters and Workloads described in Table 6a and the Test Time Duration per Assigned Workload described in Table 6b.

(2) The remaining components shall be mounted on a manikin torso to simulate the wearing position during the test.

(3) Remaining capacity indicators, alarms or any monitoring system present shall be tested for functionality, as specified by the applicant, during all Operational Performance tests.

(4) The Operational Performance test shall be conducted at an Ambient temperature of $22^{\circ}\text{C} \pm 3^{\circ}\text{C}$ ($71.6^{\circ}\text{F} \pm 5.4^{\circ}\text{F}$).

(c) The Operational Performance test shall conclude when the stored gas supply has been fully expended.

(d) NIOSH will determine a CC-SCBA to have failed the Operational Performance test if a minute-average measurement of any stressor listed in Table 5 occurs outside the acceptable excursion range specified in Table 5; or a test-average stressor measurement calculated at the completion of the Operational Performance test exceeds the operating average values specified in Table 5.

Table 5: Human Stressors and Acceptable Range Requirements
[42 CFR Part 84, subpart Q]

Human Stressors	Acceptable Operating Average Requirement	Acceptable Excursion Requirement
Average inhaled CO ₂	<1.5% by volume	≤ 4.0% by volume
Average inhaled O ₂	>19.5% by volume	≥ 15.0% by volume
End-of-Inhalation wet-bulb temperature ⁽¹⁾	< 43°C (109.4 °F)	≤ 45 °C (113.0 °F)
Peak Exhalation Pressure (PEP)	≤ 200 mm, H ₂ O	≤ 200 mm, H ₂ O
Peak Inhalation Pressure (PIP)	≥ 0 mm, H ₂ O	≥ 0 mm, H ₂ O

¹ Wet-bulb temperature is a measurement of the temperature of a wet surface. It represents the temperature of the inhaled breathing gas in the CC-SCBA user's trachea

Table 6: Test Regimen

Table 6a: Test Parameters and Workloads
[42 CFR Part 84, Subpart Q]

Parameter	Work load A	Work load B
Ventilation rate, liters/min, absolute volume displacement	100	40
Respiratory frequency, breaths/min	30	18
Oxygen consumption rate, liters/min, * STPD	3.2	1.35
Carbon dioxide production rate, liters/min, * STPD	3.4	1.15

* Standard temperature [0°C (32.0°F)] and Pressure (760 mm Hg), Dry

Table 6b: Test Time Duration per Assigned Workload Sequence
[42 CFR Part 84, Subpart Q]

Starting time (minutes)	Work load	Duration (minutes)
0	A	12
12	B	43
55	A	5
60	B	25
85	A	5
90	B	25
115	A	5
120	B	25
145	A	5
150	B	30
180	B	60

§ 84.523 Temperature-Extreme Operational Performance Requirements.

(a) The CC-SCBA shall be tested for temperature-extreme operational performance and meet the requirements in § 84.522(a), (b)(1), b(2) and b(3) except for the wet-bulb temperature breathing gas requirement in Table 5 during the hot and hot temperature shock conditions when tested in accordance with the following:

(1) The apparatus shall be tested to a Temperature-Extreme sequence that shall start with the first environmental condition listed at the top of Table 7, and end with the last test listed at the bottom of Table 7.

(2) The cold temperature used in the test sequence shall be the same minimum temperature specified by the applicant in accordance with Section § 84.502(e)(8).

(3) The apparatus shall be placed in an ambient environment of $22^{\circ}\text{C} \pm 3^{\circ}\text{C}$ ($71.6^{\circ}\text{F} \pm 5.4^{\circ}\text{F}$) with a relative humidity of 50 percent \pm 25 percent for a minimum 12-hour dwell after being tested in each environmental condition.

(i) Those components or materials expended during normal apparatus operation shall be replaced after the dwell period between environmental test conditions.

(ii) The apparatus shall be visually inspected during the dwell periods and shall show no signs of any gross damage that could cause an unsafe test condition.

Table 7: Temperature-Extreme Sequence Test Conditions, Temperature, Duration and Procedures
[42 CFR Part 84, Subpart Q]

Environment	Temperature	Test duration	Test procedure
Cold (*RBA)	* RBA Temp $\pm 2^{\circ}\text{C}$ (RBA Temp $^{\circ}\text{F} \pm 3.6^{\circ}\text{F}$)	Cold soak for a minimum of 12 hours	Perform test at * RBA Temp $\pm 2^{\circ}\text{C}$ (* RBA Temp $^{\circ}\text{F} \pm 3.6^{\circ}\text{F}$)
Hot	$71^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($159.8^{\circ}\text{F} \pm 3.6^{\circ}\text{F}$)	Hot soak for a minimum of 12 hours	Perform test at $71^{\circ}\text{C} \pm 5^{\circ}\text{C}$ ($159.8^{\circ}\text{F} \pm 9^{\circ}\text{F}$)
Cold temperature shock	$71^{\circ}\text{C} \pm 2^{\circ}\text{C}$ ($159.8^{\circ}\text{F} \pm 3.6^{\circ}\text{F}$) transferred to * RBA Temp $\pm 2^{\circ}\text{C}$ (* RBA Temp $^{\circ}\text{F} \pm 3.6^{\circ}\text{F}$); Test temperature shall be * RBA Temp $\pm 2^{\circ}\text{C}$ (* RBA Temp $^{\circ}\text{F} \pm 3.6^{\circ}\text{F}$)	Hot soak for a minimum of 12 hours; initiate test within 3 minutes in cold chamber	Initiate test within 3 minutes after transferring apparatus to cold chamber
Hot temperature shock	* RBA Temp $\pm 2^{\circ}\text{C}$ (* RBA Temp $^{\circ}\text{F} \pm 3.6^{\circ}\text{F}$) transferred to $71^{\circ}\text{C} \pm 1^{\circ}\text{C}$ ($159.8^{\circ}\text{F} \pm 3.6^{\circ}\text{F}$); Test temperature shall be $71^{\circ}\text{C} \pm 5^{\circ}\text{C}$ ($159.8^{\circ}\text{F} \pm 9^{\circ}\text{F}$)	Cold soak for a minimum of 12 hours; initiate test within 3 minutes in hot chamber	Initiate test within 3 minutes after transferring apparatus to hot chamber

* RBA - Cold temperature limit Recommended By Applicant (RBA) under § 84.502(e)(8).

§ 84.524 Environmental Test Requirements for CBRN Use.

(a) The CC-SCBA shall meet the Operational Performance requirements of § 84.522(a), (b)(1), b(2) and b(3) and all control or operating features of the apparatus shall properly function, as specified in the applicant's UI, after being subjected to the following vibration shock test conditions:

(1) The CC-SCBA shall be subjected to unrestrained vibration shock within a holding box that shall be constructed with a minimum of one large compartment and one smaller compartment that meets the compartment dimensional requirements of Section 8.3.4.2 of NFPA 1981- 2007 Edition. The sides and base of the holding box shall be constructed of 6 mm (1/4 inch) stainless steel and the top of the compartments shall remain open.

(2) The CC-SCBA facepiece and those components that attach directly to the facepiece shall be tested in the small compartment. The CC-SCBA hoses and any regulators shall remain attached to the CC-SCBA and the adjustment straps shall be full extended: the CC-SCBA shall be tested in the large compartment of the holding box.

(3) The holding box with the compartments housing the CC-SCBA shall be subjected to a vibration movement on the test table bed of a 25.4 mm (1 inch) orbital path operating in synchronous mode at 250 rpm, ± 5 rpm for a period of 3 hours.

(4) The oxygen cylinder shall have 0 gauge pressure during the vibration test.

(b) The CC-SCBA shall meet the Operational Performance requirements of § 84.522(a), (b)(1), b(2) and b(3) and all control or operating features of the CC-SCBA shall properly function, as specified in the applicant's UI, after being subjected to the following accelerated corrosion test conditions:

(1) The accelerated corrosion test conditions shall be in accordance with MIL-STD-810F, Environmental Test Methods, Method 509.4, Salt Fog.

(2) The CC-SCBA and components shall be mounted on a test manikin to simulate a typical wearing position as specified by the applicant's UI.

(3) The CC-SCBA and consumable components shall be exposed to a 5 percent \pm 1 percent salt fog for 24 hours. After the 24-hour salt fog exposure, the SCBA shall be removed from the salt fog chamber and be placed in a drying chamber set at 35°C \pm 2°C (95°F \pm 3.6°F) for 24 hours.

(4) The CC-SCBA and consumable components shall then be exposed to a second 24-hour cycle of salt fog and drying period as described in § 84.524(b)(3).

(c) The CC-SCBA shall meet the Operational Performance requirements of 84.522(a), (b)(1), b(2) and b(3) and all control or operating features of the CC-SCBA shall properly function, as specified in the applicant's UI, while being exposed to particulate test conditions in accordance with MIL-STD-810F, Method 510.4, Procedure I – Blowing Dust as described:

(1) The CC-SCBA and components shall be mounted on a test manikin integrated with the NIOSH ABMS.

(2) The ABMS shall be operated at work load B as defined in Table 6a. The test duration shall be one hour, and the ABMS shall be in operation throughout the entire test.

(3) The conditions of the Blowing Dust Test shall be the following:

(a) Air velocity: 533.4 m/min \pm 76.2 m/min (1750 ft/min \pm 250 ft/min)

(b) Temperature: 22°C \pm 3°C (71.6°F \pm 5.4°F)

§ 84.525 Communications Performance Requirement for CBRN Use.

(a) The CC-SCBA shall have a means of communication capable of achieving an average calculated value of not less than 80 percent when tested in accordance with Section 8.10 of the National Fire Protection Association (NFPA) 1981, Standard on Open-Circuit Self-Contained Breathing Apparatus for Fire Emergency Services- 2007 Edition.

(b) Under the authority stated in § 84.63(c), NIOSH will make the determination in the future whether to require the performance requirement stated in § 84.525(a) and § 84.528(a) through § 84.531(a) be tested in accordance with the NFPA 1981- 2007 Edition or a later Edition of NFPA 1981 for new applications when NIOSH deems the later Edition of NFPA 1981 serves as a more thorough test or is more beneficial to establish the quality, effectiveness and safety of the CC-SCBA. The test method described in the later Edition shall be equal to or more stringent as the test described in the current NFPA 1981-2007 Edition. If deemed necessary, NIOSH will revise the Edition in this document by Policy Letter and will inform all interested parties by writing a Letter to All Interested Parties.

§ 84.526 Chemical Agent Permeation and Penetration Resistance Against Distilled Mustard (HD) and Sarin (GB) Agent Test Requirement for CBRN Use.

The CC-SCBA, including all components and accessories, shall resist the permeation and penetration of distilled sulfur mustard (HD) and Sarin (GB) chemical agents by meeting the requirements and test conditions specified in Table 8 for HD and Table 9 for GB.

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Table 8: Test Parameters Simultaneous Liquid and Vapor Challenge of SCBA with Distilled Sulfur Mustard (HD)
[42 CFR Part 84, Subpart Q]

Agent	Challenge concentration	Duration of challenge (min)	Breathing machine airflow rate (L/min)	Maximum peak excursion (mg/m ³)	Maximum breakthrough (concentration integrated over minimum Test Duration) (mg-min/m ³)	Number of systems tested	Minimum Test Duration (hours)
HD-Vapor	300 mg/m ³ ⁽⁵⁾	30 ⁽¹⁾	40 L/min ⁽⁶⁾	0.60 ⁽³⁾	6.0 ⁽⁴⁾	3	6 ⁽²⁾
HD-Liquid	0.86 ml	360					

1. Vapor challenge generation shall start immediately after the liquid drops have been applied and the test chamber has been sealed.
2. The test period begins upon the start of initial vapor generation.
3. Three consecutive sequential test data points at or exceeding 0.6 mg/m³ shall collectively constitute a failure where each test value is based on a detector sample time of approximately 2 minutes.
4. The cumulative C_t, including all peak data points, shall not be exceeded for the duration of the six (6) hour test.
5. Decay rate of vapor challenge shall follow the same profile as the decay rate of the NIOSH CBRN Standard for an Open-Circuit SCBA.
6. Absolute volume with the air parameters being the following: Temperature = 32°C ± 1°C (89.6°F ± 1.8°F), Atmospheric Pressure At Sea Level = 760 mm Hg and saturation = 100%.

Table 9—Test Parameters of Vapor Challenge of SCBA with Sarin (GB)
[42 CFR Part 84, Subpart Q]

Agent	Vapor challenge concentration (mg/m ³)	Vapor challenge time (minutes)	Breathing machine airflow rate (L/min)	Maximum peak excursion mg/m ³	Maximum breakthrough (concentration integrated over minimum Test Duration) (mg-min/m ³)	Number of systems tested	Minimum Test Duration (hours)
GB	2,000 mg/m ³ ⁽⁵⁾	30 ⁽¹⁾	40 L/min ⁽⁶⁾	0.087 ⁽³⁾	2.1 ⁽⁴⁾	3	6 ⁽²⁾

1. The vapor challenge generation shall be initiated immediately after test chamber has been sealed.
2. The test period begins upon initial generation of vapor concentration.
3. Three consecutive sequential test data points at or exceeding 0.087 mg/m³ shall collectively constitute a failure where each test value is based on a detector sample time of approximately 2 minutes.
4. The cumulative C_t including all peak data points shall not be exceeded for the duration of the of the six (6) hour test.
5. Decay rate of vapor challenge shall follow the same profile as the decay rate of the NIOSH CBRN Standard for an Open-Circuit SCBA.
6. Absolute volume with the air parameters being the following: Temperature = 32°C ± 1°C (89.6°F ± 1.8°F), Atmospheric Pressure At Sea Level = 760 mm Hg and saturation = 100%.

§ 84.527 Firefighter Protection Requirements for CBRN Use (Optional and in addition to Section § 84.521 through § 84.526 of Subpart Q).

A NIOSH prohibition exists, as stated in Federal Register (Vol. 50, No. 222, pages 47456 – 47457 dated Monday, November 18, 1985), for entry into high radiant heat and open flame environments while wearing a pure oxygen, positive-pressure CC-SCBA. However, optional testing may be obtained. In the event that this prohibition is lifted sometime in the future, approval could then be granted without additional testing. Sections § 84.527 through § 84.531 specifies minimum requirements to ensure that the CC-SCBA possesses some features of high radiant heat and open flame resistance characteristics. These requirements are not meant to sanction its use in high radiant heat and open flame environments unless NIOSH repeals the prohibition.

§ 84.528 Heat and Flame Resistance Performance Requirement.

- (a) The CC-SCBA and its accessories shall meet the following requirements when tested in accordance with Section 8.11 of NFPA 1981- 2007 Edition with modifications made to the test apparatus and procedure to accommodate a CC-SCBA:
- (1) The peak exhalation pressure shall be ≤ 200 mm H₂O and the peak inhalation pressure ≥ 0 mm, H₂O when measured as described in § 84.517(a).
 - (2) The components of either the SCBA or its accessories shall have an after-flame no greater than 2.2 seconds.
 - (3) The components of either the CC-SCBA or its accessories shall not separate or fail in such a manner that would cause the CC-SCBA to be worn and used in a position not specified by the applicant's UI.

- (4) The facepiece lens shall not obscure vision below the 20/100 vision criteria.
- (5) The CC-SCBA remaining capacity indicators shall meet the performance requirements in § 84.511.
- (b) As described in § 84.525(b), NIOSH will make the determination whether to revise the Edition of NFPA 1981 to test the performance requirement stated § 84.528(a).

§ 84.529 Fabric Flame Resistance Requirement.

- (a) All apparatus fabric used to secure the CC-SCBA to the wearer shall meet the performance requirement of Section 7.4 of NFPA 1981- 2007 Edition.
- (b) As described in § 84.525(b), NIOSH will make the determination whether to revise the Edition of NFPA 1981 to test the performance requirement stated § 84.529(a).

§ 84.530 Fabric Heat Resistance Requirement.

- (a) All fabric components of the CC-SCBA shall meet the performance requirement of Section 7.5 of NFPA 1981- 2007 Edition.
- (b) As described in § 84.525(b), NIOSH will make the determination whether to revise the Edition of NFPA 1981 to test the performance requirement stated § 84.530(a).

§ 84.531 Thread Heat Resistance Requirement.

- (a) All thread used in the CC-SCBA shall meet the performance requirement of Section 7.6 of NFPA 1981- 2007 Edition.
- (b) As described in § 84.525(b), NIOSH will make the determination whether to revise the Edition of NFPA 1981 to test the performance requirement stated § 84.531(a).