DRAFT 08/10/2009

Abbreviated Draft Preamble for 42 CFR Part 84 Subpart J:

Supplied-Air Respirators

Subpart J of 42 CFR Part 84 contains the requirements for the approval of Supplied-Air Respirators (SAR). These regulations have been in place for decades and are in need of revision to address present needs, use environments, and updated designs which are available. This abbreviated preamble is a summary of the major changes proposed to Subpart J with consideration to submitted comments. At a later date, a full preamble with a derivation table showing section-by-section changes will be available for a detailed comparison of the existing and new Subparts.

The updates to this subpart are such that many existing airline respirators will be able to continue to be manufactured and sold without change. While some of the requirements have been tightened, many existing systems already meet or exceed these requirements. For many other existing respirator systems, little change should be required. NIOSH is also deleting obsolete criteria for system designs that have not been offered for decades and is adding new criteria to address new designs. With the new criteria, manufacturers will be able to continue to offer traditional airline respirators as they do now and/or optionally offer additional systems to meet additional needs. These new criteria will allow SAR to be approved for use in environments where, when properly designed, they can fill a need that can not be adequately met with present designs. The new categories will also address voids in existing Subpart J for SAR systems that are offered to meet needs but where only part of the system has been evaluated. With these changes and updates to Subpart J users will be assured that the entire respirator system has been evaluated and is safe and reliable for its intended use. In the end, the user will be afforded many more options to address expanding needs in the workplace.

The primary changes proposed are as follows:

1. Criteria are being added for Chemical, Biological, Radiological, and Nuclear (CBRN) and/or Immediately Dangerous to Life or Health (IDLH) SAR approvals when the SAR is properly equipped with components such as a tight-fitting respiratory inlet covering and an escape air cylinder (bottle).

2. Combination SAR/SCBA respirators are being approved under this subpart rather than Subpart H for SCBA since the primary purpose of the combination SAR/SCBA respirator is to operate as a SAR and the SCBA air cylinder is intended for escape use and, in some cases, very limited entry use.

3. SAR types A, AE, B, and BE which consisted of hand and motor blowers with large-diameter low resistance hoses are being eliminated along with the demand type SAR since these designs are essentially obsolete and no submissions for new or extensions of approval for such types of respirators have been submitted for many years.

4. Type C SAR, which are airline respirators, are being re-designated as Airline Respirators to

conform to present terminology.

5. A new optional classification of respirator is being added designated as an Airsource Respirator. It consists of a complete portable system that includes a compressor or blower such as an air turbine for supplying breathable air. This new classification will fill the void for those systems or components not presently evaluated by either NIOSH or OSHA.

To further explain this, presently, NIOSH requires that Grade D or better air, as defined by the Compressed Gas Association (CGA), be supplied to the respirator system. This supply is typically via a stationary connection point at the work site where respirators are used. OSHA has requirements from the compressor system to the stationary connection point and NIOSH has requirements for the respirator system from the stationary connection point to the user. However, often times, NIOSH-approved respirators are sold as systems which include portable compressors or blowers where no one has evaluated the ability of the compressor or blower to assure that it is providing an adequate supply of Grade D or better air. Many distributors and users mistakenly believe these entire systems to be NIOSH approved. With the Airsource classification and approval, manufacturers will be given the option of having their respirators approved as either Airline respirators (when intended to be used with a stationary compressor system regulated by OSHA), as an Airsource respirator (when intended to be part of an entire portable system), or both. Distributors will be able to sell and users will now be able to use systems where they can be assured that the entire system has been evaluated and approved.

6. Body harness requirements are being updated to accommodate larger and heavier wearers. Belts, rings, and attachments for life lines will need to withstand a pull of 500 lbs. for 30 minutes with hoses needing to withstand a pull of 250 lbs. for 30 minutes.

7. Eyepiece/lens requirements are being updated to address field of view, haze, transmittance, abrasion, low temperature, fogging, and communications as applicable to the type of SAR respirator. They will also be required to meet ANSI Z87.1-2003 for impact and penetration or be prominently and permanently labeled that they do not meet this requirement.

8. Exhalation valve leakage requirements have been tightened to ensure better performance. Improved materials and valve design have made this requirement easily attainable and most systems already meet these requirements.

9. Provisions are being provided to allow for an optional pneumatic tool take off. This is again to assure safe operation in situations where many distributors and users mistakenly believe NIOSH already approves this practice. Manufacturers obtain a zero hose length respirator approval consisting primarily of a respiratory inlet covering and a breathing hose. Users and others will add an air distribution block at the wearer's belt such that the air from the airline can be routed to supply air to the respiratory inlet covering and the pneumatic tool. Such a practice can lead to problems such as insufficient air or backflow of the pneumatic tool air into the respiratory inlet covering. On the other hand, requiring two airlines or even a dual airline can be very cumbersome, heavy, and create tripping hazards.

10. Laboratory Respiratory Protection Level (LRPL) testing will be replaced with a Total Inward Leakage (TIL) test. The present Isoamyl Acetate (IAA) test is a qualitative test for measuring faceseal leakage. It has been found not to have a high level of repeatability or

reproducibility because it depends on the ability of the wearer to detect the IAA. The ability of even the same test subject to detect IAA will change from day to day depending on his or her sensitivity to the surrounding environment, weather conditions, pollen count, and many other factors. In addition, the IAA test does not measure total inward leakage that may result from poor component connections and other sources. Additionally, sometimes the complete respirator as intended to be offered for sale can not be tested so a modified version must be used for the test. The intent of the TIL test is to quantitatively measure total inward leakage of the respirator as used in the configuration submitted for certification. Practical performance will also be evaluated during this test which will include the evaluation of items such as breathing tube tangling, shifting of the respirator, and continued clear and unobstructed visibility.

11. CO2 accumulation and O2 depletion requirements are being added. NIOSH has performed studies which demonstrated potential problems of CO2 accumulation and O2 depletion for some respiratory inlet covering designs.

12. Manufacturers will be asked to specify the highest minute air flow rate for the respirator as low (25 lpm), medium (40 lpm) , high (57 lpm) , or very high (78 lpm). The respirator will be required to maintain positive pressure (above ambient as measured at the nose/mouth area of the respiratory inlet covering) during testing at the manufacturers highest specified flow rate.

13. Hoods and helmets will be required to meet ANSI 89.1-2003 for impact and penetration or be prominently and permanently labeled that they do not meet this requirement.

14. Restrictions on total and sectional airline length are being removed because they limit design and the present restrictions do not impact health or safety.

15. Quick connect fittings (hand operated detachable couplings) will be required to be of a design to prevent accidental disconnection. Designs such as those requiring two distinct movements for disconnection will be encouraged. The purpose is to minimize the possibility of accidental disconnection when hoses are being dragged, moved, or pulled around corners. The design of quick disconnects will also have to be such that it is readily obvious when the fitting has not been properly connected.

16. There are added requirements that the air supply hose be resistant to kerosene and a mixture of methyl ethyl ketone (MEK) and toluene in addition to gasoline. Since airline respirators are often used in manufacturing, machine repairing, refinishing, aviation refueling, and painting and coatings operations, there is a potential for them to be repeatedly exposed to solvents. Kerosene is representative of jet fuel and other low volatility solvents and lubricants that may involve high exposure time if not cleaned completely prior to storage. The MEK/toluene mixture is representative of paint thinners, reducers and cleaning solvents that contain higher volatility ketones and aromatic hydrocarbons.

There are other changes to the standard including but not limited to updating terms, improving readability, improving format, and updating references. Readers are strongly encouraged to read the entire proposal and not rely on this document alone.

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Proposed Concept:

Supplied –Air Respirators

(SAR) Standard

Subpart J

August 10, 2009

1 Scope
2 Definitions
3 Descriptions
4 Base Requirements – All SAR shall meet the following base requirements:

4.1 Non-respiratory Requirements

4.1.1 Required components
4.1.2 General construction
4.1.3 Harness; minimum requirements
4.1.4 Respiratory inlet covering; minimum requirements
4.1.5 Visors/lenses of respiratory inlet coverings; minimum requirements
4.1.6 Noise levels
4.1.7 Failure Mode and Effects Analysis (FMEA)

4.2 Respiratory Requirements

4.2.1 Continuous flow class; minimum requirements
4.2.2 Pressure demand class; minimum requirements
4.2.3 Breathing air quality for Airline SAR; minimum requirements
4.2.4 Breathing air quality for Airsource SAR; minimum requirements (optional)
4.2.5 Inhalation and exhalation valves; check valves; minimum requirements
4.2.6 Exhalation valve leakage
4.2.7 Breathing resistance requirements
4.2.8 Breathing rate verification of low, moderate, high and/or very high air flow rates using a simple sinusoidal wave form
4.2.9 Breathing gas: carbon dioxide (CO_2) machine tests
4.2.10 Breathing gas concentrations determination: oxygen (O_2) and CO_2 human subject generated
4.2.11 Total Inward Leakage (TIL)

4.3 Airsource portable blower/air compressor requirements (optional)

4.4 Air supply hose requirements

4.4.1 Airline air supply hose; minimum requirements
4.4.2 Airsource air supply hose; minimum requirements
4.4.3 Airline and Airsource air supply hose; minimum requirements

5 Enhanced SAR/SCBA requirements (optional) – Performance requirements in addition to base requirements that may be desired by the applicant for approval

5.1 Airline and/or Airsource SAR with integrated escape cylinder
5.2 Lens material haze, luminous transmittance and abrasion resistance

6 Enhanced CBRN requirements (optional) - Performance requirements in addition to base and Enhanced SAR/SCBA requirements that may be desired by applicant for approval

6.1 Airline and/or Optional Airsource SCBA SAR CBRN requirements
6.2 Escape cylinder requirements for combination SAR/SCBA for use in CBRN environments
6.3 Respirator containers; minimum requirements
6.4 Chemical agent permeation and penetration resistance against sulfur mustard (HD) and sarin (GB) requirement
6.4.4 (Table 5)Simultaneous liquid and vapor challenge of SAR/SCBA with HD
6.4.5 (Table 6)Vapor challenge of SAR/SCBA with GB
6.5 Hydration Device (drink tube)

7 Additional enhanced requirements (optional)

7.1 Pneumatic tool take-off

1 **Scope** Supplied-Air Respirators (SAR) shall be approved under this standard.

1.1 To establish procedures and minimum requirements for issuing approvals and extensions of approval specifically for SAR. SAR shall meet the applicable requirements of subparts A thru G of 42 CFR Part 84 plus this subpart.

1.2 Requirements are separated into two areas, base and enhanced. Base requirements are standards that all SAR shall meet for approval; Enhanced requirements are for unique hazards and performance characteristics beyond Base SAR use.

1.3 Base requirements are described in two sections: respiratory and non-respiratory.

2 **Definitions**

2.1 *Supplied-Air Respirator (SAR)* - completely assembled atmosphere supplying respirators designed for use as respiratory protection during entry into and escape from atmospheres not immediately dangerous to life or health (non-IDLH).

2.2 *Self-contained breathing apparatus (SCBA)* - completely assembled, portable, self-contained devices designed for use as respiratory protection during entry into and escape from or escape only from hazardous atmospheres.

2.3 *Supplied-Air Respirator/Self-contained breathing apparatus (SAR/SCBA)* - completely assembled atmosphere supplying respirators with an integrated SCBA cylinder designed for use as respiratory protection during entry into and escape from hazardous atmospheres including atmospheres immediately dangerous to life or health (IDLH).

2.4 *Airline Respirator* - respiratory protection system that starts where the system connects to the Grade D or better breathing gas and includes the respiratory inlet covering.

2.5 *Airsource Respirator* - respiratory protection system that encompasses a portable blower/air compressor supplying breathing air to the respiratory inlet covering.

2.6 *Portable blower/air compressor* - primary air supply for Airsource respirators which can be readily moved or carried (100 lb maximum) or rolled via a permanently-mounted manually propelled cart (300 lb maximum). These limitations do not include respiratory inlet coverings, hoses, or other components but do include batteries, cords, transformers, etc. as needed to power the portable blower/compressor. Portable blower/air compressors may not be attached or mounted in any way to a structure or self propelled vehicle.

2.7 *Tight-fitting SAR* - a SAR which contains a respiratory inlet covering that is designed to seal to the face or neck.

2.8 *Loose-fitting SAR* - a SAR which contains a respiratory inlet covering that may contact but does not seal completely to the face or neck. It may consist of a hood, helmet or loose fitting facepiece.

2.8.1 *Hood* - a loose-fitting respiratory inlet covering that covers the head and neck and may cover portions of the shoulders and torso.

2.8.2 *Helmet* - a loose-fitting non-flexible respiratory inlet covering that is designed to offer impact and penetration protection of the head. It covers the head and may cover portions of the neck and shoulders.

2.8.3 *Loose-fitting facepiece* - a respiratory inlet covering which makes contact with but does not seal to the face. It does not cover the neck, the back of the head or shoulders. It may or may not include head protection.

2.9 *CBRN protection* - A SAR that provides protection from chemical, biological, radiological, and nuclear hazards that have been represented by Live Agent Testing (LAT).

2.10 *Respiratory inlet covering* - A half or full facepiece, hood, helmet or loose fitting facepiece or some combination of these that serves as a respiratory protective covering to the nose and mouth area.

2.11 *Work flow*- A SAR air flow rating. The four ratings are low, moderate, high, or very high as designated by the manufacturer.

2.12 *Positive pressure in the breathing zone of the respiratory inlet covering* – Pressure inside the facepiece in relation to the immediate environment is positive during both inhalation and exhalation. The measurement method and tolerance will be defined in a NIOSH standard test procedure (STP).

3 **Descriptions**

3.1 Supplied-air respirators (SAR) : SAR including all completely assembled respirators and accessories designed for use as respiratory protection during entry into non-IDLH atmospheres are described as follows:

3.1.1 *Supplied-air respirator-Airline*: A respirator equipped with a pressurized air supply hose which is used for entry into atmospheres not immediately dangerous to life or health. It utilizes a source of respirable breathing air not carried by the user and consists of an air supply hose, detachable coupling(s), an arrangement for attaching the hose to the wearer, and a respiratory inlet covering usually consisting of a tight-fitting or loose fitting facepiece, a hood, or a helmet. Specific designs may require a control valve, orifice or pressure demand valve.

3.1.2 *Supplied-air respirator*- Abrasive Blasting (AB): An Airline respirator equipped with additional accessories designed to protect the wearer's head and neck against impact and abrasion from rebounding abrasive particulate or toxic material, and with shielding material such as plastic, glass, woven wire, sheet metal, or other suitable resistant material to protect the lenses of respiratory inlet coverings.

3.1.3 *Supplied-air respirator-Airsource*: SAR, for entry into atmospheres not immediately dangerous to life or health, which requires a portable blower/air compressor, air hose, detachable coupling(s), an arrangement for attaching the hose to the wearer and respiratory inlet covering usually consisting of a tight-fitting or loose fitting facepiece, a hood, or a helmet. Specific designs may require a control valve, orifice or pressure demand valve.

3.1.4 *Supplied-air respirator-Airsource Abrasive Blasting(AAB)*: An Airsource SAR equipped with additional accessories designed to protect the wearer's head and neck against impact and abrasion from rebounding particulate and toxic material and designed with shielding material such as plastic, glass, woven wire, sheet metal, or other suitable material to protect the lens of respiratory inlet coverings.

3.2 Atmosphere supplying respirator for concentrations immediately dangerous to life or health (IDLH): SAR/escape SCBA designed for use as respiratory protective devices during entry into and escape from IDLH atmospheres are described in Section 5.0 of this subpart.

3.3 Atmosphere supplying respirator for chemical, biological, radiological, and nuclear (CBRN) hazards: SAR/escape SCBA designed for use as respiratory protection during entry into and escape from IDLH atmospheres which may contain CBRN hazards are described in Section 6.0 of this subpart.

4 **Base Requirements** – All SAR shall meet base requirements. The base requirements are described in two sections, non-respiratory and respiratory.

4.1 *Non-respiratory requirements*

4.1.1 Required components - SAR shall, where its design requires, contain the following component parts:

4.1.1.1 Airline SAR:

4.1.1.1.1 Respiratory inlet covering;
4.1.1.1.2 Air supply valve, or orifice;
4.1.1.1.3 Air supply hose;
4.1.1.1.4 Detachable couplings;
4.1.1.1.5 Flexible breathing tube; and
4.1.1.1.6 Respirator harness.

4.1.1.2 Airsource SAR:

4.1.1.2.1 Respiratory inlet covering;
4.1.1.2.2 Air supply valve, or orifice;
4.1.1.2.3 Air supply hose;
4.1.1.2.4 Detachable couplings;
4.1.1.2.5 Flexible breathing tube;
4.1.1.2.6 Respirator harness; and
4.1.1.2.7 Portable blower or air compressor as a source of respirable breathing air.

4.1.2 General construction

4.1.2.1 The component parts of all SAR shall meet the minimum construction requirements set forth in subpart G of 42 CFR Part 84.

4.1.2.2 Quick connect fittings (hand operated detachable couplings) shall be required to be of a design to prevent accidental disconnection to minimize the possibility of accidental disconnection when hoses are being dragged, moved, pulled around corners, etc. The design of quick disconnects shall also be such that it is readily obvious when the fitting has not been properly connected.

4.1.3 Harness; minimum requirements

4.1.3.1 Body harnesses

4.1.3.1.1 Each SAR shall, where necessary, be equipped with a suitable harness designed and constructed to hold the components of the respirator in position against the wearer's body.

4.1.3.1.2 Harnesses shall be designed and constructed to permit easy removal and replacement of respirator parts.

4.1.3.1.3 Harness shall protect the pressure reducer from accidental change in adjustment if so equipped.

4.1.3.1.4 Harness shall be designed for multiple shapes and sizes of users.

4.1.3.2 Head harnesses

4.1.3.2.1 Head harnesses for respiratory inlet coverings shall be designed and constructed to keep it in place during use and an even distribution of pressure over the entire contact area.

4.1.3.3 Harness tests

4.1.3.3.1 Shoulder straps employed on SAR shall be tested for strength of material, joints, and seams and must separately withstand a pull of 136 kg. (300 pounds) for 30 minutes without failure.

4.1.3.3.2 Belts, rings, and attachments for life lines must withstand a pull of 227 kg. (500 pounds) for 30 minutes without failure. If the harness is designed to act as a safety/rescue harness it shall meet the American National Standards Institute (ANSI) Z359.1-2007 Fall Arrest Standard or the National Fire Protection Association (NFPA) standard NFPA 1983: Standard on Life Safety Rope and Equipment for Emergency Services.

4.1.3.3.3 The hose shall be firmly attached to the harness so as to withstand a pull of 113 kg. (250 pounds) for 30 minutes without separating, and the hose attachments shall be arranged so that the pull or drag of the hose behind an advancing wearer does not disarrange the harness or exert pull upon the respiratory inlet covering.

4.1.3.3.4 The design of the harness and attachment of the line shall permit dragging the maximum length of hose and diameter (heaviest hose configuration) considered for approval over a concrete floor without disarranging the harness or exerting a pull on the respiratory inlet covering.

4.1.3.3.5 The arrangement and suitability of all harness accessories and fittings shall be considered for discomfort, disturbance, or interference with the movements of the wearer, and shall be easily adjustable to various wearer sizes.

4.1.4 Respiratory inlet coverings; minimum requirements

4.1.4.1 Half-mask facepieces and full facepieces shall be designed and constructed to fit persons with various facial shapes and sizes either:

4.1.4.1.1 By providing more than one facepiece size.

4.1.4.1.2 By providing one facepiece size which shall fit varying facial shapes and sizes.

4.1.4.2 Breathing tubes

4.1.4.2.1 All SAR shall employ a flexible non-kinking breathing tube which extends from the respiratory inlet covering to a connection point on the belt or harness.

4.1.4.2.2 The breathing tube shall permit free head movement, insure against closing off due to kinking during movement, and shall not create a pull that shall loosen or reduce protection of the respiratory inlet covering.

4.1.4.3 Common safety and/or corrective eyewear shall not interfere with the fit of half-mask facepieces.

4.1.4.4 Full facepieces shall provide for optional use of corrective eyewear, which shall not interfere with the sealing surface, pass between the sealing surfaces or reduce the respiratory protective qualities of the respirator.

4.1.4.5 Hoods, helmets, and loose-fitting facepieces shall be designed and constructed to fit persons with various head sizes, allow for the optional use of corrective eyewear, and ensure against restriction of movement or vision by the wearer.

4.1.4.6 Helmets shall meet the requirements of ANSI Z89.1-2003 Type I or Type II protective cap standards. Head gear not designed to provide head protection shall be prominently and permanently labeled to indicate that they are not impact and penetration resistant.

4.1.4.7 SAR intended for use in abrasive particulate blasting operations shall be designed and constructed to provide protection against impact and abrasion from rebounding abrasive materials to the wearer's head and neck.

4.1.4.8 Neck seal designs shall provide a seal around the neck without causing discomfort to the user and permit easy donning and doffing.

4.1.5 Visors/lenses of respiratory inlet coverings; minimum requirements

4.1.5.1 Respiratory inlet coverings shall be designed and constructed to provide adequate field of view.

4.1.5.1.1 Respiratory inlet coverings with visors shall obtain an average Visual Field Score (VFS) of 90 or greater following the VFS method described by the American Medical Association (AMA).

4.1.5.2 All lenses of respiratory inlet coverings shall be designed and constructed to be impact and penetration resistant via the requirements of ANSI Z87.1-2003, American National Standard for Occupational and Educational Personal Eye and Face Protection Devices or the lenses shall be prominently and permanently labeled to indicate that they are not impact resistant.

4.1.5.3 The lenses of abrasive particulate type Airline and Airsource SAR shall be shielded by plastic, glass, woven wire, sheet metal, or other suitable material which does not interfere with the vision or breathing zone of the wearer.

4.1.6 Noise levels

4.1.6.1 Noise levels generated by the respirator during normal operation shall be measured at maximum airflow obtainable within pressure and hose length requirements and shall

be less than 80 dBA at both ear canals. Noise levels generated by the portable blower or air compressor of Airsource systems shall be ≤ 85 dBA at 92 centimeters (3 feet) diameter circle centered at the pump with the system.

4.1.7 Failure Mode Effects Analysis (FMEA)

4.1.7.1 Manufacturers shall demonstrate that reliability is assessed and controlled within their quality assurance plan by conducting a system FMEA on their device, component or electronic/software indicators.

4.1.7.2 The manufacturer shall provide a written declaration that the FMEA was completed.

4.1.7.3 The manufacturer shall maintain a copy of the FMEA in their records.

4.2 *Respiratory requirements*

4.2.1 Continuous flow class; minimum requirements

4.2.1.1 Respirators tested under this section shall be approved only when they supply respirable air at the pressures and quantities required.

4.2.1.2 The manufacturer shall specify the range of air pressure at the point of attachment of the air-supply hose to the air-supply system, and the range of hose length for the respirator. For example, the manufacturer may specify that the respirator be used with compressed air at pressures ranging from 280-550 kPa (40 to 80 pounds per square inch) with from 6 to 76 m. (15 to 250 feet) of air-supply hose.

4.2.1.3 The specified air pressure at the point of attachment of the hose to the air-supply system shall not exceed 863 kPa (125 pounds per square inch gage).

4.2.1.4 Where the pressure at any point in the supply system exceeds 863 kPa (125 pounds per square inch gage), the system shall be equipped with a pressure-release mechanism that shall prevent the pressure at the hose connection from exceeding 863 kPa (125 pounds per square inch gage) under any conditions.

4.2.2 Pressure demand class; minimum requirements

4.2.2.1 Respirators tested under this section shall be approved only when used to supply respirable air at the pressures and quantities required.

4.2.2.2 The manufacturer shall specify the range of air pressure at the point of attachment of the air-supply hose to the air-supply system, and the range of hose length for the respirator. For example, the manufacturer may specify that the respirator be used with compressed air at pressures ranging from 280-550 kPa (40 to 80 pounds per square inch) with from 6 to 76 m. (15 to 250 feet) of air-supply hose.

4.2.2.3 The specified air pressure at the point of attachment of the hose to the air-supply system shall not exceed 863 kPa (125 pounds per square inch gage).

4.2.2.4 Where the pressure in the air-supply system exceeds 863 kPa (125 pounds per square inch gage), the system shall be equipped with a pressure-release mechanism that shall prevent the pressure at the point of attachment of the hose to the air-supply system from exceeding 863 kPa (125 pounds per square inch gage).

4.2.3 Breathing air quality for Airline SAR; minimum requirements

4.2.3.1 Compressed breathing air shall meet the applicable minimum grade requirements for Grade D breathing air set forth in the Compressed Gas Association Commodity Specification for Air, G-7.1, 5th Edition, 2004 (Grade D or higher quality).

4.2.3.2 The pressure shall remain positive in the breathing zone of the respiratory inlet covering(s) at the manufacturer's specified work rate(s) as defined in Section 4.2.8.

4.2.4 Breathing air quality for Airsource SAR; minimum requirements

4.2.4.1 Blowers/air compressors for Airsource SAR capable of generating CO in any operating condition shall be equipped with a CO alarm to warn the user if the CO concentration in the air supply is $\geq$ 10 ppm of CO.

4.2.4.2 The temperature of the air produced by the blower/air compressor for all Airsource respirators shall not exceed 6 degrees Celsius above ambient as measured at the air entrance point of the respiratory inlet covering.

4.2.4.3 The pressure shall remain positive in the breathing zone of the respiratory inlet covering(s) at the manufacturer's specified work rate(s) as defined in Section 4.2.8.

4.2.4.4 Airsource SAR shall be equipped with a filter between the portable blower/air compressor and the respiratory inlet covering(s) to effectively remove at least 95% of the particles from the breathing air.

4.2.4.5 The filter between the blower/air compressor and the respiratory inlet covering shall be easily replaceable by the user. The manufacturer's filter change-out scheduled should be followed as specified in the user instructions.

4.2.4.6 Compressors used to supply breathing air to Airsource respirators shall be constructed to supply Grade D or better air.

4.2.5 Inhalation and exhalation valves; check valves; minimum requirements

4.2.5.1 Inhalation valves shall be provided as necessary and be protected against damage, distortion and external influences.

4.2.5.2 Exhalation valves shall be protected against damage, distortion, and external influence.

4.2.5.3 Exhalation valves are to be designed and constructed to prevent inward leakage of contaminated air.

4.2.6 Exhalation valve leakage

4.2.6.1 When dry, exhalation valves and valve seats shall be subjected to a suction of 25 mm water column height while in any orientation the leakage between the valve and valve seat shall not exceed 15 milliliters per minute.

4.2.7 Breathing resistance requirements

4.2.7.1 Inhalation and exhalation resistance to airflow shall be measured inside the respiratory inlet coverings at the nose/mouth area. Pressure, including static pressure shall also be measured inside the respiratory inlet covering at the nose/mouth area. All configurations for which approval is sought shall meet the following requirements as applicable:

Table 1: Airflow resistance

Respirator type	Respirator class	Maximum Inhalation pressure	Maximum Exhalation resistance	Test air flow rate
Airsource	Continuous flow	Positive pressure in the breathing zone	25 mm H2O	@ Manuf. spec. work rate
	Pressure Demand	Positive pressure in the breathing zone	51 mm H20 above static pressure*	@ Manuf. spec. work rate
Airline	Continuous flow	Positive pressure in the breathing zone	25 mm H2O	@ Manuf. spec. work rate
	Pressure Demand	Positive pressure in the breathing zone	51 mm H20 above static pressure*	@ Manuf. spec. work rate

* Static pressure in breathing area relative to external pressure shall not exceed 38 mm (1.5") above ambient.

4.2.8 Breathing rate verification of low, moderate, high and/or very high air flow rates using a simple sinusoidal wave form

4.2.8.1 The manufacturer shall specify the highest air flow rate from Table 2 for the intended use of the SAR system. The SAR must maintain pressure above ambient in the face area and/or breathing zone of the respiratory inlet covering while properly mounted on a headform and operating at the manufacturer's minimum supply pressure and maximum hose resistance configuration at each of the rates desired for approval.

Table 2: NIOSH Approved Air Flow Rates

Air Flow Rate	Minute Volume	Tidal Volume and Respirations
Low	25 Lpm	1.30 liters @19.2 respirations per minute
Moderate	40 Lpm	1.67 liters @ 24 respirations per minute
High	57 Lpm	1.95 liters @ 29.1 respirations per minute
Very High	78 Lpm	2.00 liters @ 39 respirations per minute

4.2.8.1.1 Air pressure shall be measured in the area of the nose and mouth, inside the respiratory inlet covering of the completely assembled SAR on a headform.

4.2.8.1.2 A breathing machine shall be used to meet the work rates as described in Table 2.

4.2.8.2 Pressure shall remain above ambient at all times during testing. Static pressure relative to external pressure may not exceed 38 mm (1.5") of water column height for any SAR during testing.

4.2.9 Breathing gas: carbon dioxide (CO_2) machine test

4.2.9.1 Respirators will be tested under normal operating conditions with the manufacturer's minimum specified operating pressure and maximum length of hose for which approval is sought.

4.2.9.2 The concentration of CO_2 in the inspired gas shall be measured at the mouth of a headform while the respiratory inlet covering is properly mounted on a headform connected to a breathing machine.

4.2.9.3 This test shall be conducted with the SAR operating at the minimum supply pressure specified by the manufacturer.

4.2.9.4 A NIOSH sedentary cam shall be used on a breathing machine with a breathing rate of 14.5 respirations per minute generating a minute volume of 10.5 liters. Note: If a nose cup is specified as being an optional component by the manufacturer, this test shall be conducted with and without the nose cup. No additional materials may be used to enhance the seal between the nose cup and headform.

4.2.9.5 A concentration of 5% CO_2 in air shall be exhaled into the respiratory inlet covering through the mouth port of the headform.

4.2.9.6 The respirator shall be tested at a temperature of 25 ± 5°C.

4.2.9.7 During testing, the concentration of CO_2 in the inspired gas at the mouth shall be continuously recorded and the average concentration measured during the inhalation portion of the breathing cycle for each of three donnings shall be determined.

4.2.9.8 A minimum of three respiratory inlet coverings, or one of each size, whichever number is greater, shall be tested. For example - three of a single size device, one small/medium and two medium/large for a two size device or one each of a three-size device.

4.2.9.9 The maximum allowable average CO_2 concentration is determined by subtracting the blank run average CO_2 level measured during the inhalation phase from the average CO_2 level measured during the inhalation phase with the respirator properly mounted on the headform. At least one sample of the three tested shall not exceed 1.0 %.

4.2.10 Breathing gas concentration determinations: oxygen (O_2)and CO_2 human subject generated

4.2.10.1 The concentration of CO_2 and O_2 in inspired air in a SAR shall be measured at the nose/mouth area of a test subject.

4.2.10.2 This test shall be conducted with the SAR operating at the minimum specified breathing air pressure.

4.2.10.3 Twelve human subjects (equally distributed for each respiratory inlet covering size (when multiple sizes exist) shall perform the following activities for 10 minutes each:

4.2.10.3.1 Standing.
4.2.10.3.2 Walking on a treadmill at 0° grade at 3.5 miles per hour.

4.2.10.4 CO_2 and O_2 data shall be considered for the last five minutes of each exercise.

4.2.10.5 For each of these last five minutes, a minimum of the last five breaths shall be considered.

4.2.10.6 The inhaled fractional CO_2 concentration during the inhalation portion of the breathing cycle shall not exceed 0.02 (or 2.0%).

4.2.10.7 The inhaled fractional O_2 concentration shall be no less than 0.195 (or 19.5%).

4.2.10.8 The respirator shall be tested at a temperature of 25 ± 5°C.

4.2.10.9 The respirator shall meet these criteria for 11 of 12 subjects.

4.2.11 Total Inward Leakage (TIL)

4.2.11.1 The measured TIL for SAR shall be determined with the respirator operating in the candidate approval design mode as described in the applicable user instructions at the manufacturer's specified work rate as described in Section 4.2.8. The minimum TIL values are as follows:

Note: The following TIL minimum values will be verified with benchmark testing.

Table 3: TIL Values

Respiratory inlet covering	Maximum TIL value, %
Constant flow half mask	0.2%
Constant flow full facepiece or neck dam	0.01%
Constant flow hood, helmet, or loose fitting facepiece	0.001%
Pressure demand half mask	0.001%
Pressure demand full facepiece	0.001%
Any IDLH or CBRN SAR	0.001%
Any combination with one of the above	The unit must meet or exceed the minimum TIL of each type when tested in that mode.

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4.2.11.2 Practical performance shall also be evaluated in this test. The practical performance of the respirator shall evaluate human interface issues associated with the use of the respirator. At a minimum, factors which shall be evaluated (if applicable based upon the respirator design) are: the likelihood for breathing tubes to tangle causing the respirator position on the wearer to move to an improper position, continued clear and unobstructed visibility with turning of the head or looking up or down, and ease of use. Test subjects shall be trained on proper use of the respirator in accordance with the applicant's user's instructions.

4.3 Airsource SAR portable blowers/air compressor requirements (optional)

4.3.1 Portable blowers/air compressors shall be designed and constructed to maintain positive pressure in the breathing zone of the respiratory inlet covering(s) at the manufacturer's specified work rate(s) as defined in Section 4.2.8.

4.3.2 Portable blowers/air compressors shall undergo a performance evaluation by operating them at their specified running parameters for 8 hours a day for a total of 15 days in the most demanding configuration for which the device is to be approved.

4.3.2.1 The portable blower/air compressor shall be located in the laboratory for this evaluation.

4.3.2.2 The portable blower/air compressor shall operate in the most demanding configuration with the maximum number respirators mounted on head forms. Each head form will be actuated by a breathing machine at the manufacturers maximum approved work rate throughout the period without failure or evidence of wear such that any part of the respirator no longer meets the performance requirements.

4.3.2.3 The filter(s) shall not be changed during this evaluation.

4.3.3 Noise levels at the portable blowers/air compressors shall be $\leq$ 85 dBA at 92 centimeters (3 feet) diameter circle centered at the pump with the system operating in the most flow restrictive configuration.

4.3.4 Any system component exceeding 60 degrees Celsius shall be protected against incidental user contact.

4.3.5 Multiple user systems, whereby more than one user is supplied by a single portable blower/air compressor, may be approved, if each hose line is connected directly to a manifold (requires pressure gauge and regulator) at the blower/air compressor. The manifold can be remote from the portable blower/air compressor as long as a pressure gauge and regulator are integral to the manifold.

4.3.6 Multiple user systems shall be designed such that air shall not back flow from one line to another.

4.3.7 Multiple user systems shall be designed such that each line shall flow properly regardless of occurrences in other lines (such as total blockages or disconnected free flow).

4.3.8 Carts for Airsource respirators shall be easily maneuverable, durable, substantial and suitable for their intended purpose. Carts mounted on more than two wheels shall be equipped with permanently mounted wheel locks or other means to prevent the cart from rolling unintentionally.

4.4 Air supply hose requirements

4.4.1 *Airline air supply hose; minimum requirements.* Total length of Air hose(s): manufacturer specified, in multiples as desired.

4.4.1.1 Air flow:

4.4.1.1.1 The air-supply hose with air regulating valve or orifice shall maintain positive pressure in the respiratory inlet covering at the manufacturer's specified work rate(s) as defined in Section 4.2.8 through the maximum length of hose and greatest number of connections for which approval is sought. This will be evaluated at the manufacturer's minimum specified air-supply pressure.

4.4.1.1.2 The air-supply hose, detachable coupling, and pressure-demand valve of the pressure-demand class for Airline SAR, shall be capable of delivering respirable air to maintain positive pressure in the respiratory inlet covering at the manufacturer's specified work rate(s) as defined in Section 4.2.8 with any combination of air-supply pressure and length of hose within the applicant's specified range of pressure and hose length. The pressure-demand valve shall be actuated 20 times per minute by a source of intermittent suction.

4.4.1.2 Air-regulating: If an air-regulating valve is provided, it shall be so designed that it shall remain at a specific adjustment, which shall not be affected by the ordinary movement of the wearer.

4.4.1.3 Pressure demand valve: If a pressure-demand valve replaces the air-regulating valve, it shall be connected to the air-supply at the maximum air pressure for which approval is sought by means of the minimum length of air-supply hose for which approval is sought. The outlet of the pressure-demand valve shall be connected to a source of intermittent suction so that the pressure-demand valve is actuated approximately 24 times per minute for a total of 100,000 inhalations. To expedite this test, the rate of actuation may be increased if mutually agreeable to the applicant and NIOSH. During this test the valve shall function without failure and the wear should not affect the valve's performance to the point where it no longer meets specifications. The pressure-demand valve shall not be damaged in any way when subjected at the outlet to a pressure or suction of 25 cm. (10 inches) of water gage for 2 minutes.

4.4.2 *Airsource air supply hose; minimum requirements.* Total length of air hose(s): manufacturer specified, in multiples as desired.

4.4.2.1 Air flow: Using the blower/air compressor as the supply, the air-supply hose shall maintain positive pressure in the respiratory inlet covering at the manufacturer's specified air flow rate(s) as defined in Section 4.2.8 through the maximum length of hose and greatest number of connections for which approval is sought. This will be evaluated at the manufacturer's minimum specified air-supply pressure.

4.4.3 *Airline and Airsource air supply hose; minimum requirements.*

4.4.3.1 Non-collapsibility: The hose shall not collapse or exhibit permanent deformation when a force of 90 kg (200 lbs) is applied for five minutes between two planes 7.6 cm (3 inches) wide on opposite sides of the hose. This test will be conducted with the

air supply hose operated at the manufacturer's specified work rate and pressure and shall maintain positive pressure in the respiratory inlet covering.

4.4.3.2 Non-kinkability: A 7.6 m. (25 foot) section of the hose shall be placed on a horizontal-plane surface and shaped into a one-loop coil with one end of the hose connected to the respiratory inlet covering operating on a breathing machine at the manufacturer's specified work rate and the other end of hose supplied with air at the minimum specified supply pressure. The connection shall be in the plane of the loop. The other end of the hose shall be pulled tangentially to the loop and in the plane of the loop until the hose straightens. To meet the requirements of this test the loop shall maintain a uniform near-circular shape and ultimately unfold as a spiral, without any localized deformation that causes the pressure in the respiratory inlet covering to become negative.

4.4.3.3 Strength of hose and couplings: Air supply hose and couplings shall not exhibit any separation or failure when tested with a pull of 45 kg. (100 pounds) for 5 minutes and when tested by subjecting them to an internal air pressure of 2 times the maximum respirator-supply pressure that is specified by the applicant or at 173kPa (25 pounds per square inch) gage, whichever is higher.

4.4.3.4 Tightness: Leakage of air exceeding 50 cc. per minute at each coupling or connection shall not be permitted when the hose and couplings are joined and are immersed in water under a pressure of 173 kPa (25 pounds per square inch) gage applied to the inlet end of the air-supply hose, or at twice the supply pressure that is specified by the applicant, whichever is higher.

4.4.3.5 Air supply Hose permeation with gasoline (CAS# 8006-61-9): An unused 7.6 m. (25 feet) section of air supply hose and one coupling (if applicable) shall be immersed in gasoline for 2 hours with air flowing through the hose at the rate of 8 liters per minute. If more than one type of coupling or connection is used all variations shall be tested. After the second hour the airflow shall be stopped for 1 hour then the airflow shall resume for 2 additional hours, for a total test time of 5 hours. The air inside the hose shall not contain more than 100ppm by volume of gasoline vapor at the end of the test.

4.4.3.6 Air supply Hose permeation with kerosene (CAS# 8008-20-6): An unused 7.6 m. (25 feet) section of air supply hose and one coupling (if applicable) shall be immersed in kerosene for 2 hours with air flowing through the hose at the rate of 8 liters per minute. If more than one type of coupling or connection is used all variations shall be tested. After the second hour the air flow shall be stopped for 1 hour then the air flow shall resume for 2 additional hours, for a total test time of 5 hours. The air inside the hose shall not contain more than 100ppm by volume of kerosene vapor at the end of the test.

4.4.3.7 Air supply Hose permeation with MEK/toluene (CAS# 108-88-3): An unused 7.6 m. (25 feet) section of air supply hose and one coupling (if applicable) shall be immersed into a mixture of MEK/toluene for 1 hour with air flowing through the hose at the rate of 8 liters per minute. If more than one type of coupling or connection is used all variations shall be tested. After the second hour the air flow shall be stopped for 1 hour then the air flow shall resume for 2 additional hours, for a total

test time of 5 hours. The air inside the hose shall not contain more than 100ppm by volume of MEK/toluene vapor at the end of the test.

4.4.3.8 Detachable coupling: A hand-operated detachable coupling by which the wearer can readily attach or detach the air supply hose shall be provided at a convenient location. This coupling shall be durable, remain connected under all conditions of normal respirator use, prevent unintentional disconnection, and meet the prescribed tests for strength and tightness of hose and couplings. The design of quick disconnects shall also be such that it is readily obvious when the fitting has not been properly connected.

5 **Enhanced SAR/SCBA requirements** (Optional) – Performance requirements beyond base requirements that may be desired by the applicant for approval.

5.1 *Airline and/or Airsource SAR with integrated escape cylinder*, to include all completely assembled respirators with an integrated escape breathing gas cylinder and accessories meeting the following requirements:

5.1.1 Tight fitting respiratory inlet covering offering, positive pressure, pressure demand protections that are designed to seal to the face or neck.

5.1.2 Incorporation of a escape air cylinder with enough capacity to permit an egress of 5 minutes, 10 minutes or longer based on the highest work rate as defined in Section 4.2.8, with air hose supply used during entry.

5.1.3 Incorporation of a escape air cylinder with enough capacity to permit an egress of 15 minutes or longer based on the high work rate as defined in Section 4.2.8, allowing not more than 20 percent of the rated cylinder capacity of air supply to be used during entry into a hazardous area.

5.1.4 If the connection to air supply hose occurs in a hazardous atmosphere zero dead volume connectors must be used.

5.1.5 The connection between the air hose and the rest of the respirator, including the escape air cylinder shall incorporate a check valve or other means such that no contaminated air shall reach the wearer in the event of disconnection, severing, or damage to the air hose and no back flow of the cylinder air through the disconnected air supply hose.

5.1.6 The connection between the air hose and the rest of the respirator shall be such that breathing air from the cylinder shall only flow to the tight fitting respiratory inlet covering and shall not flow back through the supply air hose or pneumatic tool connection if so equipped.

5.1.7 The unit must automatically switch to the escape cylinder if the air supply hose is disconnected, severed, catastrophically fails or cannot supply adequate breathing air.

5.1.7.1 Supplied breathing air will be disconnected and the respirator will automatically switch to the available SCBA integrated breathing air cylinder source in the event of loss of air hose supplied air. This shall occur without loss of air pressure to the user and with no detectable inward leakage of contaminants.

5.1.8 An alarm providing an indication that the system is on cylinder air shall be readily visible (via light) or detectable (via sound or vibration) to the user without manipulation of the respirator and without affecting protection and performance.

5.1.9 These respirators must also meet the applicable criteria for subpart H- SCBA.

5.2 *Lens material haze, luminous transmittance and abrasion resistance*: Required for SAR/SCBA intended for use in IDLH.

5.2.1 Lens Material Haze: The haze value of the primary lens material shall be 3% or less when tested in accordance with ASTM D 1003-00.

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

5.2.1.2 Lens material abrasion resistance: 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 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%.

5.2.1.2.1 The test specimens shall be the flat 102 mm (4 inches) 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 SAR. 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 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.

5.2.2 Impact and penetration resistance: All lenses of respiratory inlet coverings shall be designed and constructed to be impact and penetration resistant via the requirements of ANSI Z87.1-2003, American National Standard for Occupational and Educational Personal Eye and Face Protection Devices.

5.2.3 Low temperature fogging: The respirator shall demonstrate an average Visual Acuity Score (VAS) of greater or equal to 75 points for all measurements of acuity. The respirator shall be cold soaked and tested in an environmental chamber at minus 21 ^{0}C or lower if requested by the manufacturer for four (4) hours. The wearer shall not experience undue discomfort because of restrictions to breathing or other physical or material changes to the respirator outfitted with accessories.

5.2.4 Communications: Communications are based upon performance using a modified rhyme test (MRT). The communications requirement is met if the overall performance rating is greater than or equal to seventy (70) percent. The MRT shall be performed with a steady background noise of 60 dBA consisting of a broadband "pink" noise. The distance between the listeners and speakers shall be 3 meters (9.8 feet).

6 **Enhanced CBRN requirements** - Performance requirements in addition to base and Enhanced SAR/SCBA requirements that may be desired by the applicant for approval.

6.1 *Airline and/or Optional Airsource SCBA SAR CBRN*, which includes all completely assembled respirators with an integrated escape cylinder, meeting the following requirements:

6.1.1 Tight fitting respiratory inlet covering offering, positive pressure, pressure demand protections that are designed to seal to the face or neck.

6.1.2 Incorporation of a 15 minute or longer duration escape air cylinder based on the high work rate as defined in Section 4.2.8.

6.1.3 Connection of the SAR portion of the SAR/SCBA CBRN to the portable Airsource or Airline must occur in the non-contaminated atmosphere prior to entry into the CBRN (contaminated area) atmosphere. Disconnection of the SAR from the portable Airsource or Airline must occur in the CBRN atmosphere as required for escape.

6.1.4 No half-mask SAR shall be approved for CBRN protection.

6.1.5 These respirators must meet the applicable criteria for subpart H: SCBA and those for SAR/SCBA CBRN in this subpart.

6.2 *Escape cylinder requirements for combination SAR/SCBA for use in CBRN environments*:

6.2.1 The self-contained breathing apparatus must provide a minimum of 15 minutes of air or longer service time based on the manufacturer's specified work rate(s) as defined in Section 4.2.8.

6.3 *Respirator containers; minimum requirements*

6.3.1 Required packaging configuration: (minimum packaging configuration): The SAR/SCBA CBRN and the required components shall be subjected to the environmental and transportation portions of the durability conditioning in the manufacturer specified minimum packaging configuration.

6.3.2 The minimum packaging configuration is the protective packaging configuration that the end user* shall normally store or maintain the SAR and the required components before and after it has been issued for immediate use. The user's instructions (UI) shall identify the minimum packaging configuration and shall direct the end user how to store or maintain the SAR/SCBA CBRN and the required components inside the manufacturer specified minimum packaging configuration while in the possession of the end user. The same minimum packaging configuration identified in the UI shall encase the SAR/SCBA CBRN and the components when NIOSH performs the durability conditioning. The type of minimum packaging configuration, if any, is left to the discretion of the manufacturer. Examples of common minimum packaging configurations are respirator carriers, clamshell containers, draw string plastic bags, hermetically-sealed or nothing at all.

6.3.3 If over cases, packaging, or shipping containers are provided by the applicant over and above the minimum packaging configuration, these additional packaging levels may not be a substitute for the minimum packaging configuration and shall not be used by NIOSH in the durability conditioning of the application.

* End user: The definition of the end user is the person who shall derive protection from the respirator by wearing it. It is understood that the end user shall store the respirator in a location where it shall be available for immediate access and use during an emergency.

6.3.4 SAR/SCBA CBRN shall meet the conditioning requirements in Table 4 prior to testing. The SAR/SCBA CBRN must meet all testing requirements after conditioning. All components must perform as intended following conditioning.

Table 4: Conditioning Requirements

Test	Test Method	Test Conditions	Duration
Hot Diurnal	Mil-Std-810F 501.4	35°C to 71°C, 24-Hour cycle	3 Weeks Diurnal Cycle
Cold Constant	Mil-Std-810F 502.4	Basic Cold, -32°C, Constant	3 Days
Humidity	Mil-Std-810E 507.3	Realistic, Natural Cycle Humidity Profiles in the U.S. (range 88°F @ 88%RH to 5°F @ 59%RH, 24-hr period)	5 Days "quick look" Mil-Std-810E Table 507.3-II
Transportation Vibration	Mil-Std-810F 514.5	U. S. Roadway Vibration, Unrestrained	12 hours/axis, 3 Axes Total duration = 36 hours = 12,000 miles

6.4 *Chemical agent permeation and penetration resistance against sulfur mustard (HD) and sarin (GB) requirement*

6.4.1 Chemical agent permeation and penetration resistance against distilled HD and GB agent requirement: the SAR including all components and accessories shall resist the permeation and penetration of HD and GB chemical agents when tested on an upper-torso manikin connected to a breathing machine operating at an air flow rate of 40 liters per minute (L/min), 36 respirations per minute, 1.1 liters tidal volume.

6.4.2 During the evaluation of the SAR/SCBA CBRN for chemical agent permeation and penetration resistance against HD and GB the apparatus will start in normal operating mode with the SAR/SCBA CBRN breathing from the air supply hose for a minimum of six hours. The air hose breathing air supply will be terminated and the SAR must switch automatically to the escape air cylinder.

6.4.3 All connections and material interfaces shall be tested for resistance and penetration to liquid sulfur mustard. The respirator shall not be damaged to the extent that it would no longer meet any of the performance requirements of this section or have a agent penetration in excess of the requirements in Table 5 in the breathing zone.

6.4.4 Table 5: Simultaneous liquid and vapor challenge of SAR/SCBA CBRN with sulfur mustard (HD)

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 Service Life) ($mg\text{-}min/m^3$)	Number of Systems Tested	Minimum Service Life (hours)
HD-Vapor	300 mg/m^3	30 [1]	40	0.60 [3]	6.0 [4]	3	6 [2]
HD-Liquid	0.86 ml	360					

[1] Vapor challenge concentration shall start immediately after the liquid drops have been applied and the test chamber has been sealed.

[2] The test period begins upon start of initial vapor generation.

[3] Three consecutive sequential test data points at or exceeding 0.6 mg/m^3 shall collectively constitute a failure where each test value is based on a detector sample time of approximately 2 minutes.

[4] The cumulative Ct including all peak data points must not be exceeded for the duration of the 6-hour test.

6.4.5 Table 6: Vapor challenge of SAR/SCBA CBRN with sarin (GB)

Challenge Agent	Vapor 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 Service Life) ($mg\text{-}min/m^3$)	Number of Systems Tested	Minimum Service Life (hours)
GB	2,000 mg/m^3	30 [1]	40	0.087 [3]	2.1 [4]	3	6 [2]

[1] The vapor challenge concentration 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/m^3 shall collectively constitute a failure where each test value is based on a detector sample time of approximately 2 minutes.

(4) The cumulative Ct including all peak data points must not be exceeded for the duration of the 6-hour test.

6.5 Hydration (optional): Dry drinking tube valves, valve seats, or seals shall be subjected to a suction of 75 millimeters water column height while in any orientation with the hydration tube removed from its holder. Leakage between the valve and the valve seat shall not exceed 30 milliliters per minute.

7 **Additional enhanced requirements** (optional)

7.1 *Pneumatic tool take-off*

7.1.1 Airline and/or Airsource SAR equipped with a pneumatic tool take-off manifold must be equipped with a check valve and filter at the take off point which prevents any back flow or contamination from the take off point into the respirator.

7.1.2 The respirator shall be designed such that if the take-off line were to be operated without any restriction to flow or fully blocked to flow, the user(s) continues to maintain positive pressure in the respiratory inlet covering(s) at the manufacturer's specified rate(s) and specifications defined herein.