



# Self-Contained Breathing Apparatus

## Market Survey Report

November 2023



Science and  
Technology



---

The “Self-Contained Breathing Apparatus Market Survey Report” was prepared by the National Urban Security Technology Laboratory – in conjunction with Pacific Northwest National Laboratory (PNNL) – for the U.S. Department of Homeland Security, Science and Technology Directorate Interagency agreement No. 7ORSAT18KPM000187/P00002.

The views and opinions of authors expressed herein do not necessarily reflect those of the U.S. government.

Reference herein to any specific commercial products, processes or services by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the U.S. government.

The information and statements contained herein shall not be used for the purposes of advertising, nor to imply the endorsement or recommendation of the U.S. government.

With respect to documentation contained herein, neither the U.S. government nor any of its employees make any warranty, express or implied, including but not limited to the warranties of merchantability and fitness for a particular purpose. Further, neither the U.S. government nor any of its employees assume any legal liability or responsibility for the accuracy, completeness or usefulness of any information, apparatus, product or process disclosed; nor do they represent that its use would not infringe privately owned rights.

Photos included were provided by the National Urban Security Technology Laboratory, unless otherwise noted.

---

## FOREWORD

The National Urban Security Technology Laboratory (NUSTL) is a federal laboratory within the U.S. Department of Homeland Security (DHS) Science and Technology Directorate (S&T). Located in New York City, NUSTL is the only national laboratory focused exclusively on supporting the capabilities of federal, state, local, tribal, and territorial responders to address the homeland security mission. The laboratory assists responders with the use of technology to prevent, protect against, mitigate, respond to, and recover from homeland security threats and incidents. NUSTL provides expertise on a wide range of subject areas, including chemical, biological, radiological, nuclear, and explosive detection, personal protective equipment, and tools for emergency response and recovery.

NUSTL manages the System Assessment and Validation for Emergency Responders (SAVER) program, which provides information on commercially available equipment to assist response organizations in equipment selection and procurement. SAVER knowledge products provide information on equipment that falls under the categories listed in the DHS Authorized Equipment List (AEL), focusing primarily on two main questions for the responder community: “What equipment is available?” and “How does it perform?” The SAVER program works with responders to conduct objective, practitioner-relevant, operationally-oriented assessments and validations of commercially available emergency response equipment. Having the right tools provides a safer work environment for responders and a safer community for those they serve.

NUSTL is responsible for all SAVER activities, including selecting and prioritizing program topics, developing SAVER knowledge products, and coordinating with other organizations to leverage appropriate subject matter expertise. In conjunction with Pacific Northwest National Laboratory, NUSTL conducted a market survey of commercially available self-contained breathing apparatus (SCBA). This equipment falls under the AEL reference number O1AR-01-SAR titled “[Respirator, Supplied Air](#),” O1AR-01-SCBA titled “[SCBA, CBRN](#)” and O1AR-01-SCBT titled “[SCBA, CBRN, Tactical](#).”

SAVER reports are available at [www.dhs.gov/science-and-technology/saver-documents-library](http://www.dhs.gov/science-and-technology/saver-documents-library).

Visit the NUSTL website at [www.dhs.gov/science-and-technology/national-urban-security-technology-laboratory](http://www.dhs.gov/science-and-technology/national-urban-security-technology-laboratory) or contact the lab at [NUSTL@hq.dhs.gov](mailto:NUSTL@hq.dhs.gov).



## POINT OF CONTACT

National Urban Security Technology Laboratory (NUSTL)  
U.S. Department of Homeland Security  
Science and Technology Directorate  
201 Varick Street, Suite 900  
New York, NY 10014  
Email: [NUSTL@hq.dhs.gov](mailto:NUSTL@hq.dhs.gov)  
Website: [www.dhs.gov/science-and-technology/SAVER](http://www.dhs.gov/science-and-technology/SAVER)

## TECHNICAL SUPPORT

Pacific Northwest National Laboratory (PNNL)  
902 Battelle Boulevard  
Richland, WA 99354  
Email: [saver@pnnl.gov](mailto:saver@pnnl.gov)  
Website: [www.pnnl.gov](http://www.pnnl.gov)

### Authors:

Bhargav Patel, Project Lead, Senior Technologist, NUSTL  
Joseph Russo, Program Analyst, NUSTL  
Karin Decker, Test Scientist, NUSTL  
Gladys Klemic, Test Scientist, NUSTL  
Rachel Bartholomew, Technical Advisor, PNNL  
Jacob Ellis, Engineer, PNNL  
Richard Ozanich, Technical Advisor, PNNL  
Jason Ray, Technical Advisor, PNNL  
Justine Spencer, Program Analyst, PNNL

---

## EXECUTIVE SUMMARY

Emergency responders use self-contained breathing apparatuses (SCBAs) to enter oxygen-deficient and other extremely hazardous environments. From January 2021 to March 2023, the System Assessment and Validation for Emergency Responders (SAVER) program conducted a market survey of commercially available SCBAs. This market survey report is based on information gathered from manufacturer and vendor websites, internet research, industry publications, and a government-issued request for information that was posted on the System of Award Management website. The survey identified four products ranging in price from \$5,000 to \$12,000.

The market survey is focused on SCBAs used by the fire service that meet the appropriate regulatory and industry standards. The primary function of all these products is to deliver breathable air to the wearer from a source that is independent of the environment. However, new and emerging capabilities that aid the fire service in their response and maintain personnel safety are being integrated into and made interoperable with the SCBA. This market survey maps and explores some of these new capabilities and aims to illustrate the variations in more standard features, such as materials, construction, and physical design.

This market survey is intended to provide emergency responders information to guide the operational and procurement decisions they make for emergency response agencies. Emergency responders should consider the overall capabilities, technical specifications and limitations of SCBAs in relation to their agency's operational needs when making equipment selections. The SAVER program did not independently verify the performance of these products or the information included in this report.

Agencies should also consider impacts associated with integrating equipment into their power and information technology infrastructure, data management, concept of operations, and required maintenance.

# TABLE OF CONTENTS

1.0 Introduction.....	1
2.0 SCBA Overview.....	2
2.1 Current Technologies.....	2
2.1.1 Breathing Air Cylinder.....	2
2.1.2 Pressure Regulator.....	3
2.1.3 Emergency Breathing Safety System.....	3
2.1.4 End-of-service-time indicator.....	3
2.1.5 Facepiece.....	3
2.1.6 Heads-up Display.....	3
2.1.7 Personal Alert Safety System.....	4
2.1.7.1 Console with Remote Gauge.....	4
2.1.8 Rapid Intervention Crew/Company Universal Air Connection (RIC UAC).....	4
2.2 Physical Specifications and Features.....	5
2.3 Custom built Variations.....	5
2.4 Interoperability Considerations.....	5
2.5 SCBA Applications.....	6
2.6 Relevant standards and regulations.....	6
2.7 Emerging Technologies.....	7
2.7.1 Self-Rescue escape systems.....	7
2.7.2 Electronic Supplementary Voice Communications.....	7
2.7.3 Wireless Electronic Safety Features.....	8
2.8 Cybersecurity Considerations.....	9
3.0 Product Information.....	10
3.1 3M Scott, AIR-PAK X3 PRO.....	11
3.2 MSA Safety, MSA G1 SCBA.....	16
3.3 Dräger, PSS 7000.....	19
3.4 Interspiro, Interspiro S9.....	24
4.0 Manufacturer and Vendor Contact Information.....	30
5.0 Conclusions.....	31
Appendix A. Standards and Regulations.....	32
A.1 Applicable Federal Regulations.....	33

A.1.1 29 CFR 1910.134 OSHA Laws and Regulations: Respiratory Protection .....	33
A.1.2 29 CFR 1910.156 OSHA Law and Regulations: Fire Brigades .....	33
A.2 NIOSH Approved Respirator Standards .....	33
A.2.1 42 CFR 84 Respiratory Protective Devices .....	33
A.3 National Fire Protection Association Guidelines .....	34
A.3.1 NFPA 1981 Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services (2019) .....	34
A.3.2 NFPA 1982 Standard on Personal Alert Safety Systems (PASS) (2019) .....	34
A.3.3 NFPA 1852 Standard on Selection, Care, and Maintenance of Open-Circuit Self-Contained Breathing Apparatus (SCBA) (2019) .....	34
References.....	35

## LIST OF FIGURES

Figure 2-1 Breathing Air Cylinder .....	2
Figure 2-2 Emergency Breathing Safety System (EBSS) .....	3
Figure 2-3 Facepiece .....	3
Figure 2-4 3M Scott Heads-Up Display in E-Z Flow C-5 Regulator.....	3
Figure 2-5 Console with remote gauge.....	4
Figure 2-6 A schematic to illustrate the many paths that voice communications can travel.....	8
Figure 3-2 Air-Pak X3 Pro by 3M Scott.....	11
Figure 3-4 Vision C5 Facepiece.....	14
Figure 3-5 AV-3000 HT Facepiece .....	14
Figure 3-6 Vision C5 Facepiece with sight in mask thermal imager option .....	14
Figure 3-7 Console with analog pressure gauge display .....	14
Figure 3-8 EZ-Flo C5 Regulator .....	15
Figure 3-9 Carbon Wrapped Air Cylinder .....	15
Figure 3-10 3M Scott EPIC 3 RI Voice Communication System .....	15
Figure 3-11 Screenshot of Monitor Telemetry Software Solution .....	15
Figure 3-12 3M Scott Pak-Tracker Firefighter Locator System.....	15
Figure 3-13 EPIC 3 Radio Direct Interface Voice Communication System .....	15
Figure 3-14 MSA G1 SCBA Overview .....	16
Figure 3-15 MSA G1 Facepiece .....	18

Figure 3-16 MSA G1 Regulator .....	18
Figure 3-17 MSA G1 HUD is integrated into Regulator .....	19
Figure 3-18 MSA G1 Control Module includes pressure gauge and Telemetry module (option) .....	19
Figure 3-19 MSA HUB .....	19
Figure 3-20 FireGrid Monitor software .....	19
Figure 3-21 LUNAR wireless handheld device .....	19
Figure 3-22 MSA G1 with integrated thermal imaging camera displayed on the Control Module .....	19
Figure 3-23 Dräger PSS 7000 SCBA .....	20
Figure 3-24 Dräger FPS 7000 Facepiece .....	22
Figure 3-25 Dräger PSS Lung Demand Valve .....	22
Figure 3-26 Dräger FPS 7000 Heads-Up Display .....	23
Figure 3-27 Dräger Sentinel 7000 Digital Monitor with integrated PASS .....	23
Figure 3-28 Dräger FPS COM 7000 .....	23
Figure 3-29 Dräger FPS 5000 .....	23
Figure 3-30 Carbon Composite Cylinders .....	23
Figure 3-31 Dräger FPS 7000 Harness and Backplate .....	23
Figure 3-32 Dräger C-C550 .....	24
Figure 3-33 Dräger C-C440 .....	24
Figure 3-34 Buddy Breather UEBS .....	24
Figure 3-35 Cylinder QuickConnect .....	24
Figure 3-36 Interspiro S9 SCBA .....	25
Figure 3-37 S-USA Ambient Air Hatch .....	27
Figure 3-38 S-USA First Breath Version .....	27
Figure 3-39 Regulator .....	28
Figure 3-40 Heads-up Display .....	28
Figure 3-41 Carbon Fiber Superlight Cylinder .....	28
Figure 3-42 Interspiro S9 Harness and Backplate .....	28
Figure 3-43 Interspiro S9 Incurve Harness and Backplate .....	28
Figure 3-44 Pressure Gauge .....	28
Figure 3-45 PAC Personal Alarm Control .....	29
Figure 3-46 Spirolink Telemetry System .....	29
Figure 3-47 SuperPass II .....	29





## LIST OF TABLES

Table 3-1 Product Comparison Matrix.....	11
Table 3-2 Components, Options and Descriptions of the Air-Pak X3 Pro.....	12
Table 3-3 Images of Air-Pak X3 Components and Options .....	14
Table 3-4 Components, Options and Descriptions of the MSA G1 SCBA.....	16
Table 3-5 Images of MSA G1 SCBA Components and Options.....	18
Table 3-6 Components, Options and Descriptions of the Dräger FPS 7000 .....	20
Table 3-7 Images of the Dräger PSS 7000 Components and Options.....	22
Table 3-8 Components, Options and Descriptions of the Interspiro S9.....	25
Table 3-9 Images of the Interspiro S9 Components and Options .....	27
Table 4-1 Manufacturer (and Vendor) Contact Information.....	30

## 1.0 INTRODUCTION

A self-contained breathing apparatus (SCBA) is commonly used by first responders to supply the user with breathing air from a source independent of the ambient atmosphere. From January 2021 to March 2023, the System Assessment and Validation for Emergency Responders (SAVER) program conducted a market survey of commercially available SCBAs. This market survey report is based on information gathered from manufacturer and vendor websites, internet research, industry publications, and a government-issued [request for information \(RFI\)](#) that was posted on the System of Award Management website. The U.S. Department of Homeland Security Science and Technology Directorate's Technology Scouting Group also contributed to the market research used in the development of this report.

For inclusion in this report, an SCBA unit had to meet the following criteria. The product

- is available to emergency responder organizations as a commercial off-the-shelf (COTS) or government off-the-shelf (GOTS) product;
- is deployable in a variety of situations that are immediately dangerous to life and health and is man portable;
- meets the requirements specified in the U.S. Code of Federal Regulations (see [42 CFR 84 Respiratory Protective Devices – Subpart H](#)), and
  - was approved by National Institute for Occupational Safety and Health, on or after January 2015;
- meets the requirements specified in National Fire Protection Association (NFPA) 1981 (2019);
- is of open circuit design; and
- is primarily of use for fire services and fire service-related applications.

Please note that there are many SCBA products that meet the minimum requirements for inclusion in this report. These products are modular, offering various accessory options. Some vendors use a single base model number for multiple configurations, while others employ different model numbers for varying components and configurations. For simplicity, we aimed to include a representative selection of qualified products from each vendor, though not every configuration is featured. Our report represents a diligent effort to showcase the products available in the market.

## 2.0 SCBA OVERVIEW

A self-contained breathing apparatus (SCBA) is an essential piece of personal protective equipment for the first responder community and for industry. SCBAs supply breathing air from a source carried by users, allowing them to enter areas that pose an immediate danger to life and health. Emergency responders use SCBAs to enter oxygen-deficient and other extremely hazardous environments. SCBAs can weigh more than 30 pounds and require special training to use safely.

SCBAs can be further categorized as open-circuit or closed-circuit. Closed-circuit SCBAs, also known as rebreathers, operate by storing pure oxygen in a cylinder, then filtering, supplementing, and recirculating exhaled gas. Open-circuit SCBAs carry filtered, compressed air rather than pure oxygen and vent exhaled gas to the atmosphere. This market survey report will focus on open-circuit SCBAs.

SCBAs can be further differentiated by additional features and certifications, such as a certification for use in chemical, biological, radiological, and nuclear (CBRN) hazardous environments. Although additional variations in design exist, an SCBA has three main components:

- a breathing air cylinder,
- a pressure regulator, and
- a facepiece.

These components are connected and mounted on a carrying frame. SCBAs are required by federal regulation to have multiple, redundant safety features, including pressure demand (positive pressure), a use time minimum of 30 minutes, an end of service time indicator, a heads-up display (HUD), a non-electronic voice communication system, and a universal air connect. Additionally, SCBAs can be equipped with a variety of accessories including integrated radios, wireless telemetry, thermal imaging, and a personal alert safety system (PASS).

### 2.1 Current Technologies

This section describes the key components and sub-systems that comprise an SCBA.

#### 2.1.1 Breathing Air Cylinder

Breathing air cylinders and tanks connect to a regulator and facepiece via a hose to provide safe, breathable air in environments that are immediately dangerous to life and health (IDLH). Breathing air cylinders, sometimes called SCBA cylinders or bottles, can be refilled using a compatible air compressor. Cylinder size determines how long a cylinder can be used before it needs to be recharged. Cylinders are typically manufactured out of aluminum, steel, or carbon fiber.



**Figure 2-1 Breathing Air Cylinder**

*Image Credit: 3MScott*

## 2.1.2 Pressure Regulator

A pressure regulator is a sub-system or component of an SCBA that has two purposes. First, it lowers the air pressure from the breathing air cylinder (2,000 psi or greater) to a pressure that is manageable for human consumption (100 psi or less), which also extends the length of operation. Second, the pressure regulator maintains positive pressure inside the facepiece. Many SCBAs use two-stage regulators that ensure the pressure inside the facepiece remains positive in relation to the pressure surrounding the outside of the facepiece during inhalation and exhalation.



Figure 2-2 Emergency Breathing Safety System (EBSS)

Image Credit: MSA Safety Inc.

## 2.1.3 Emergency Breathing Safety System

An Emergency Breathing Safety System (EBSS) or a Universal Emergency Breathing Safety System (UEBSS) is a device on an SCBA that allows users to share their available air supply in an emergency with other users. The UEBSS was introduced as part of the NFPA 1981, 2018 Edition, and incorporates standardized Rectus-type fittings to enable compatibility between all NFPA SCBA manufacturers.

## 2.1.4 End-of-service-time Indicator

An end-of-service time indicator (EOSTI), also known as a low-air alarm, is an audible alarm that indicates when the air supply in the cylinder is low. Current standards require an SCBA be equipped with two independent EOSTI devices that require no further activation procedures beyond those required to activate the SCBA. Current standards also require that EOSTI alarms indicate when the air supply reaches 35+/- 2 percent of cylinder capacity.

## 2.1.5 Facepiece

The facepiece is the component on an SCBA that covers the user's eyes, nose, and mouth. Traditionally, polycarbonate has been used for firefighting SCBA facepiece lens applications due to its optical clarity, impact resistance, and thermal resistance.



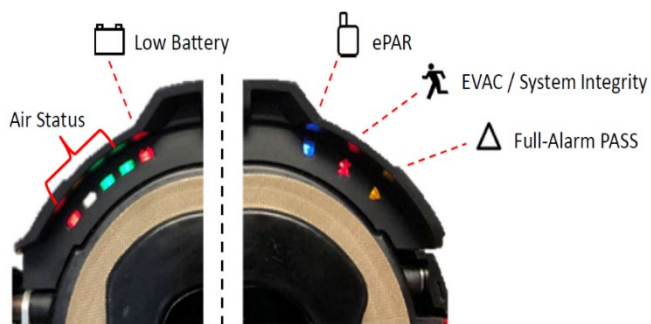
Figure 2-3 Facepiece

Image Credit: 3M Scott

## 2.1.6 Heads-Up Display

The heads-up display is intended to provide visual information about the status of the SCBA to the user and to keep that information within the user's

line of sight. The HUD, at a minimum, is intended to provide a visual indication to the wearer when their remaining air supply is at 100, 75, 50, and 35% of full capacity. It can also be designed to provide other information like an evacuation order signal. This feature is often integrated into the regulator or facemask itself.



## 2.1.7 Personal Alert Safety System

A Personal Alert Safety System (PASS) provides a signal for aid if a firefighter becomes incapacitated. It continually monitors the movement of the wearer and automatically activates an alarm signal if movement is not detected for 30 seconds, emitting loud sounds and flashing bright lights to alert nearby individuals and draw attention to the person in distress. The alarm is preceded by a pre-alarm signal that sounds 10 seconds before the alarm so that the user can de-activate the alarm if it is not needed. The PASS alarm can also be manually activated by the wearer. NFPA 1982 (2018) requires that the associated battery allow it to alarm for a duration of at least one hour.

SCBAs may have an integrated PASS, meaning the components of the PASS are built into the SCBA. This integration and the interface with the PASS device occur within the Console with Remote Gauge. Alternatively, the PASS may be designed to be easily decoupled from the SCBA. In addition to generating audible alarms, some products can transmit a PASS alarm signal wirelessly to incident command, which is called an “RF PASS.” NFPA 1982 (2018) provides performance tests and requirements for RF PASS certification. The RF PASS is an example of a wireless electronic safety feature, described in section 2.7.3.

### 2.1.7.1 Console with Remote Gauge

A console with a remote gauge (also known as a control console) is a critical component that allows users to monitor their air supply status during operations in hazardous environments. The console is a compact unit attached to the SCBA harness and is connected to the air cylinder through a high-pressure hose. It has a small, easy-to-read display that provides real-time information about the remaining air pressure in the SCBA cylinder using an analog dial or digital display.

The console may also display other alerts and contain a button for manually activating the PASS alarm. Typically, the console is shoulder-mounted such that the SCBA wearer may hold it in their hand to view the remaining air pressure or alerts.

The console is an important component in systems with wireless electronics telemetry and safety features. It serves as the SCBA-wearer’s interface for bi-directional communications with an incident commander. Manufacturers may use different commercial names for the console and there are variations in the information it displays.



**Figure 2-5 Console with remote gauge**

*Image Credit: MSA Safety Inc.*

## 2.1.8 Rapid Intervention Crew/Company Universal Air Connection

The Rapid Intervention Crew Universal Air Connection (RIC UAC) is a component of the SCBA that allows the wearer to receive an emergency replenishment of breathing air. It is intended to be used to supply an emergency replenishment of breathing air to an SCBA wearer who is disabled or entrapped during an emergency response. More specifically, it is a male fitting on the SCBA that mates with the female fitting on a filling hose.

## 2.2 Physical Specifications and Features

The main components of SCBAs have different specifications and features. Most manufacturers produce facepieces in multiple sizes: small, medium, and large. The type of heat and fire-resistant material used in the facepiece dictates how well it will withstand thermal degradation. Facepieces will also vary in the amount of peripheral vision they can provide to a wearer, and many contain special coatings to reduce fogging.

Back frames and harnesses can be made of aluminum, plastic composites, carbon fiber, or any combination of these materials; the materials affect the strength and weight of the harness. The harnesses may employ special features or design considerations to help increase the ergonomics of the SCBA, such as swivel pads, lumbar support, or additional straps to spread the weight across the body.

Air cylinders are available in multiple pressures, ranging from 2216 psig to 5500 psig, and in various sizes that provide between 15 minutes and 75 minutes of air. They can be made of carbon, aluminum, or composite material and with wraps that increase strength and durability.

## 2.3 Custom Built Variations

The majority of SCBA manufacturers allow for custom built configurations of SCBAs, offering different models of specific components, each with its own unique set of features, functions, specifications, and capabilities. These custom selections may include the following components:

- Breathing air cylinder pressure ratings
- Integrated thermal cameras
- Integrated voice communication systems
- Integrated remote monitoring and telemetry systems
- Customized harnesses and backplates
- Facepieces styles and sizes
- Pressure gauges

## 2.4 Interoperability Considerations

Understanding which sub-systems, components, accessories, and options are interoperable with each other and the overall system is important to establishing an SCBA configuration that meets the unique needs of each fire department.

An SCBA's wireless communication can be compatible with land mobile radios (LMRs), computer-aided dispatch systems, and third-party applications used by the department to assist with critical communications and information sharing needs during an incident. Thermal imagers can be integrated at the facepiece or remote gauge. Gas sensors integrated into the SCBA measure oxygen levels and toxic gas concentrations. Some SCBA manufacturers list various facepieces as being compatible with their SCBAs.

## 2.5 SCBA Applications

This Market Survey is constrained to SCBAs that are applicable to the fire service. However, the SCBA is a critical piece of equipment that protects first responders while responding to a wide variety of incidents:

- Hazmat responses
  - An SCBA can be used during responses to explosives, compressed gases, flammable solids, flammable liquids, oxidizers, poisons, corrosives, or radioactive material.
- Events that are immediately dangerous to life and health
  - The SCBA is designed to protect responders in IDLH environments, such as during interior structural firefighting or the uncontrolled release of hazardous materials or substances. [1]
- Responses to chemical, biological, radiological, and nuclear (CBRN) events
  - Responders can use the SCBA with CBRN protection for CBRN response, as described by the United States Centers for Disease Control and Prevention’s National Institute for Occupational Safety and Health (NIOSH). [2]
- Responses in confined spaces
  - Confined spaces include sub-basements and cellars, manholes, pits, tunnels, wells, windowless buildings, storage containers, and other spaces that may be oxygen deficient or contain dangerous levels of airborne contaminants.
- Law enforcement applications
  - Law enforcement may use SCBAs during search and rescue missions, emergency escape, firefighting, diving, CBRN response; while deploying non-lethal deterrents such as pepper spray or tear gas; and while executing search warrants at opioid distribution or processing sites. However, this Market Survey Report is focused on firefighter applications. [3]

## 2.6 Relevant Standards and Regulations

Several standards are applicable to SCBAs, and additional standards apply to some of the embedded technologies. Table A.1 in Appendix A lists the most relevant standards with a brief description of their purpose and content.

The current primary SCBA industry standard is [NFPA 1981 \(2019\)](#) [4]. NFPA is revising their firefighter personal protective equipment (PPE) standards, combining NFPA 1971 [5], 1981 [4], 1982 [6], and others into a combined standard, [NFPA 1970, “Standard on Protective Ensembles for Structural and Proximity Firefighting, Work Apparel and Open-Circuit Self-Contained Breathing Apparatus \(SCBA\) for Emergency Services, and Personal Alert Safety Systems \(PASS\).”](#) The consolidated standard is scheduled for release in 2024; product certification would happen after that. Information about forthcoming NFPA 1970 is available at the NFPA website [5].

## 2.7 Emerging Technologies

In recent years SCBA manufacturers have begun to integrate new technologies into the SCBA itself. Some of these technologies, such as thermal infrared cameras and integrated wireless communications, provide entirely new capabilities and features. Some of these technologies are more subtle, such as lumbar support and additional straps for the harness, which have further increased safety and ergonomics.

### 2.7.1 Self-Rescue Escape Systems

Self-rescue escape systems have been offered as accessories to some SCBAs. A self-rescue escape system may be integrated into the harness of the SCBA or provided as a separately worn device. It contains the equipment necessary to allow the wearer to rappel to safety should they become trapped in the upper levels of a structure.

### 2.7.2 Electronic Supplementary Voice Communications

Every NFPA 1981 approved SCBA is required to have, at a minimum, a non-electric voice communication system that is capable of projecting sound in a manner such that others do not require a receiver to hear it. The products discussed in this report also include electronic supplementary voice communication systems or “electronic voice comms.” Electronic voice comms are integrated into SCBAs and can transmit and receive audio from other remote transceivers, whether directly from one SCBA voice communication system to another or by being relayed through third-party LMRs. They operate in different ways and take on different form factors. Figure 2-6 illustrates some of the different transmission paths that electronic voice comms can take.



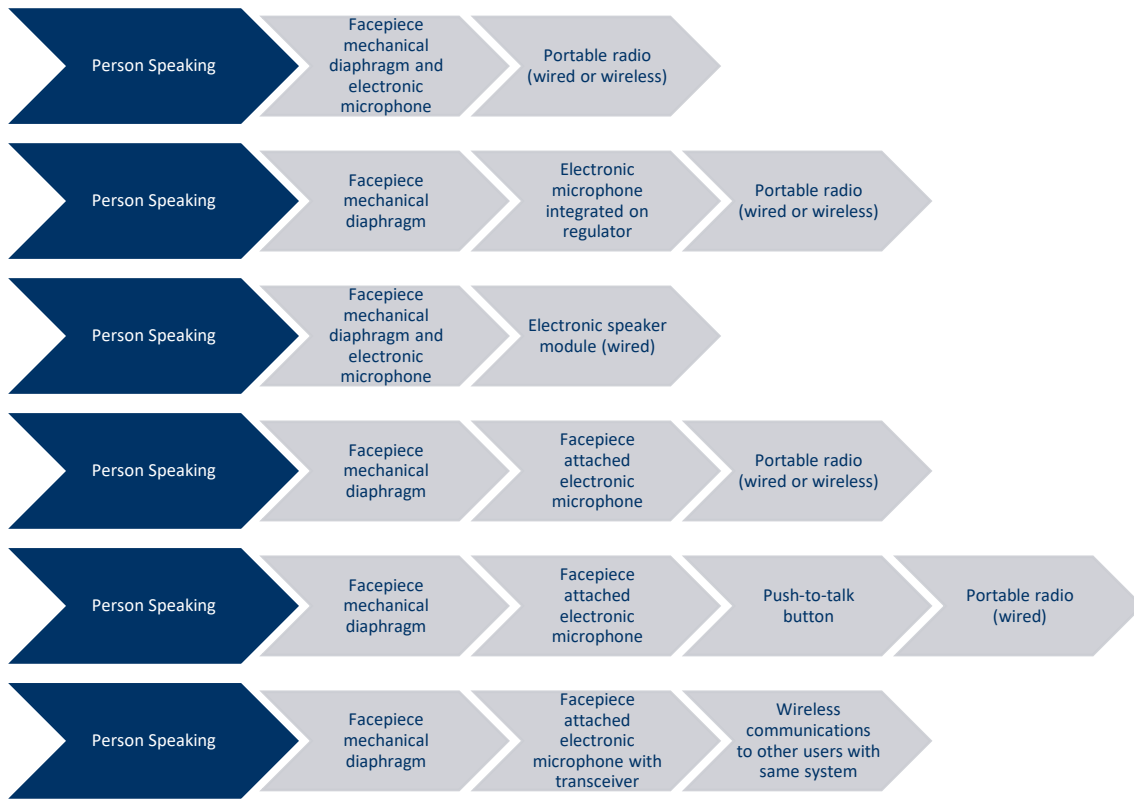


Figure 2-6 A schematic to illustrate the many paths that voice communications can travel.

### 2.7.3 Wireless Electronic Safety Features

Some RF PASS-enabled SCBAs have wireless electronic safety features that could improve situational awareness. They enable bidirectional communication of information and alerts between the SCBA wearer and incident command. This may include automatic transmission of data (“telemetry”) such as the remaining cylinder pressure, high air flow, no air flow, battery status, electronics overheat alarms, and automatic notification of PASS alarms.

Wireless electronic safety features may allow for bidirectional accountability checks and response communications and may transmit evacuation orders from incident command. The SCBA-wearer sees the non-verbal communications from incident command as icons on their heads-up display (see Figure 2-4) or on their console and can use buttons on the console to confirm receipt.

Telemetry hardware and firmware may be integrated into the SCBA backplate or housed in the SCBA console. The SCBAs may connect to a local or wide area network provided by the user or use different radio frequencies. Different products may also use various networking approaches to enhance connectivity in challenging environments such as high-rise buildings or subterranean structures, acting as mesh networked SCBAs, repeaters, or additional communication nodes. Typically, proprietary incident command software runs on a laptop or tablet, and the number of SCBAs that can be monitored simultaneously varies between systems. In some systems, data could be further shared with a remote operations center.

## 2.8 Cybersecurity Considerations

Modern SCBAs contain built-in technology that uses a variety of radio frequency standards, including Bluetooth, Wi-Fi, Internet of Things (IoT) mesh, and traditional ultra-high frequency. Each technology enables certain functionality but also adds complexity and the potential for cybersecurity risk associated with wireless transmission protocols.

These devices also collect and transmit data including telemetry about the environment, conditions of the SCBA such as air pressure, alerts, and responder radio communications. Manufacturers are also including the functionality to use these wireless technologies to upgrade the firmware of components locally and via the cloud. [7] If the cybersecurity of these features were compromised, they could risk the effectiveness of field operations and expose users to serious harm.

Agencies should prioritize advanced cybersecurity measures to stay ahead of external threats:

- Minimize time that equipment is left unattended or out in the open.
- Ensure no unknown devices are physically attached to hardware before and after use.
- Store equipment securely and in a place where only those who require access are allowed unsupervised contact.
- Ensure that software supporting and running on equipment is kept up to date, including the firmware of individual components and software that supports the components individually or when interconnected.
- Update software during times of minimal impact to operations and be sure to allocate enough time for updates to complete successfully.
- Use strong and unique passphrases when possible. Do not reuse or implement shared passphrases/passwords as this greatly increases the risk of a cascading compromise.
- Develop a contingency plan should the product malfunction and fail, either partially or catastrophically and understand the impacts failures will have on field operations.

## 3.0 PRODUCT INFORMATION

This section includes product descriptions of four unique SCBA products and the accessories, options, and capabilities associated with each product. When discussing products and the available open-source product information for them, it is important to note that SCBA units available for sale to various emergency responders are modular and configurable, and the way they are configured can have a significant impact on the final cost per unit paid by the purchaser.

Major purchase components, sold separately, include the SCBA frame/harness with regulator, the facepiece, and the cylinder. These components are required for NIOSH and NFPA compliance.

Where manufacturers seek to differentiate themselves is with their available accessories, which appear to center around improving conditions on the fireground. The claims manufacturers make regarding the performance of their SCBA units often involve the inclusion of these accessories, which makes comparing the actual performance of the SCBA units listed in this report challenging.

Table 3-1 provides the general characteristics and specifications of the products, which are listed alphabetically by manufacturer. The information in section 3.0 has not been independently verified by the SAVER program.

Below are definitions of the product information in Table 3-1, listed in column order.

**Tracking:** The proximity, range, and or direction between an SCBA and another device can be conveyed in real-time to a third party such as an incident commander or member of a rapid intervention team.

**RF PASS:** The SCBA offers an Integrated RF PASS option that allows users to send and receive critical data such as alerts, video, or voice communications wirelessly.

**Electronic Voice Comms – Interoperable with LMR:** The SCBA contains a supplemental electronic voice communication system that connects to an LMR using either a wired or wireless mechanism.

**Electronic Voice Comms – Amplification:** The SCBA contains a supplemental electronic voice communication system that can amplify the voice of the speaker.

**Electronic Voice Comms – SCBA to SCBA:** The SCBA contains a supplemental electronic voice communication system that allows for wireless communications between users wearing the same make and model of SCBA without needing an LMR.

**Composite Cylinder:** Air breathing cylinders that are made of or encased in multiple types of materials can have increased durability or reduced weight.

**Thermal Imager:** A thermal imaging device can be integrated into the SCBA.

**Rescue Belt:** The SCBA offers a harness or rappelling kit to help users rapidly evacuate from the upper floors of a building.

Table 3-1 Product Comparison Matrix

Manufacturer and Product	Tracking	RF PASS	Electronic Voice Comms — Interoperable w/LMR	Electronic Voice Comms — Amplification	Electronic Voice Comms — SCBA to SCBA	Composite Cylinder	Thermal Imager	Rescue Belt
3M Scott, Air-Pak X3 Pro	X	X	X	X		X	X	X
MSA Safety, MSA G1 SCBA	X	X	X	X			X	X
Dräger, PSS 7000			X	X	X	X		X
Interspiro, Interspiro S9	X	X	X	X	X		X	

### 3.1 3M Scott, AIR-PAK X3 PRO

The 3M Scott Air-Pak X3 Pro is an open-circuit SCBA that is NFPA 1981 (2019 edition) compliant.



Figure 3-1 Air-Pak X3 Pro by 3M Scott

Image Credit: 3M Scott

Table 3-2 enumerates the different configurable components and options of the Air-Pak X3 Pro.

**Table 3-2 Components, Options, and Descriptions of the Air-Pak X3 Pro**

Component	Options	Description
Facepiece	3M Scott Vision C5 Facepiece (standard, radio direct interface option, sight in mask thermal imager option)	Vision C5 Facepiece has a broader field of view and a new regulator design (EZ Flo C5). When configured with the optional SEMS II Pro wireless telemetry system, the Vision C5 Facepiece is designed to operate with the EZ-Flo C5 Mask-Mounted Regulator (MMR), which incorporates an expanded heads-up display with new status icons and visual alerts.
	3M Scott AV-3000 HT Facepiece	The AV-3000 HT is available in 4-strap and 5-strap head harness variants.
Regulator	EZ-Flo C5 Regulator	The EZ-Flo C5 Regulator is compatible with the Vision C5 Facepiece. It was designed to offer low breathing resistance to improve operational efficiencies.
	EZ-Flo+ Regulator	The EZ-Flo+ Regulator is compatible with the AV-3000 HT Facepiece.
Heads-Up Display	Integrated into the Regulator	The EZ Flo C5 includes an expanded heads-up display with new status icons, and visual alerts are incorporated when configured with the optional SEMS II Pro wireless telemetry system.
Electronic Voice Comms	Vision C5 Facepiece - Radio Direct Interface	The Vision C5 with Radio Direct Interface includes a Bluetooth 4.1 Class 2 connection, bone conduction headphones, microphone with gain control, breath detection technology, and adjustable volume button.
	AV-3000 HT Facepiece with EPIC 3 Radio Direct Interface Voice Communication System	The EPIC 3 Radio Direct Interface voice communication system digitally processes and amplifies the wearers voice through built in speakers. It is also equipped with a Bluetooth radio allowing it to wirelessly connect with compatible handheld field radios and remote speaker microphones. It is compatible with AV-series facepieces.
	AV-3000 HT Facepiece with EPIC 3 RI Voice Communication System	The EPIC RI Voice Communication System contains voice amplification speakers. When paired with a Bluetooth lapel speaker microphone, it enables wireless communication with select two-way field radios.
Air Breathing Cylinder	Aluminum	The aluminum alloy cylinders are rated for 30-, 45-, 60-, or 75-minute durations based on the NIOSH breathing rate of 40 liters per minute.
	Carbon Wrapped	Made from an aluminum alloy inner shell with a total overwrap of carbon fiber, fiberglass, and an epoxy resin, the carbon wrapped cylinders are available with 30-, 45-, 60-, or 75-minute durations based on the NIOSH breathing rate of 40 liters per minute.

Component	Options	Description
Backframe and Harness Assembly	3M Scott Air-Pak X3 Pro SCBA	The backframe and harness assembly is designed for carrying cylinder and valve assemblies. It features a solid, one-piece, black powder-coated aluminum alloy frame contoured to the user's back, with integrated features for hose and wire management, adjustable fixtures, and a secure locking system for various cylinder sizes. The harness assembly includes waist and shoulder pads with closed-cell foam design, quick-release buckles, a one-size black para-aramid strap with reflective stripes, seat-belt type waist belt attachment, and box-stitched construction and is removable and machine washable, with additional features like a Drag Rescue Loop for emergency use, and reflective material for enhanced visibility.
Console (Integrated into two different variants of the PASS)	PASS with Accountability	The console associated with the PASS with Accountability is located on the user's right shoulder harness and features an integrated, edge-lit mechanical pressure gauge; various LED alerts; icons for range status, evacuation, withdraw, Electronic Personnel Accountability Report, and radio-frequency identification (RFID) card readiness; color-coded push buttons for specific functions; and an LED "External HUD" for cylinder pressure indication. Distinctively, it emphasizes user safety and accountability with specialized icons and controls for evacuation and personnel reporting.
	PASS with Firefighter Locator	The console associated with the PASS with Firefighter Locator, also situated on the user's right shoulder harness, incorporates similar features, such as the mechanical pressure gauge, LED alerts, photo-sensing diode for brightness adjustment, integrated RFID tag, and color-coded push buttons. However, unlike the Console associated with the PASS with Accountability, it does not include specific icons or functions for evacuation or personnel reporting, focusing more on providing essential information and functionality for firefighters.
Remote Monitoring and Telemetry	SEMS II Wireless SCBA Telemetry System	The SEMS II and the SEMS II Pro Hazmat include sensors and networking devices integrated onto the control console of the SCBA that collect and then relay important information to an incident commander. They also enable the SCBA wearer to receive critical information from the Incident Commander.
	SEMS II Pro Hazmat	SEMS II Pro Hazmat version provides incident command the ability to remotely monitor the status of the firefighter without requiring animated motion during a delicate Hazmat operation.
	Monitor Pro Telemetry Software (optional)	The Monitor Telemetry Software Solution operates on touch-enabled PCs and provides real-time SCBA information to incident command. It displays air, PASS, and evacuation data. It also includes alert notifications for high-flow or no-flow conditions at full-alarm PASS. It allows incident command to electronically request a personnel accountability report with a click or tap, which can reduce radio traffic.
	3M Scotchlite Reflective Materials	The 3M Scotchlite Reflective Materials enhance visibility of the SCBA when operating in low-light conditions. The integrated RFID tags

Component	Options	Description
Other Accessories and Options		facilitate asset tracking by providing the user and the incident command center with the SCBA information.
	3M Scott Pak-Tracker Firefighter Locator System	The 3M Scott Pak-Tracker is a hand-held receiver that can detect and monitor up to 36 SCBAs with a PASS in full alarm, allowing search and rescue personnel to locate firefighters in distress. It does so by using three visual and audible indicators to direct the search crew to downed firefighters. Pak-Tracker Locator's hand-held receiver has IS Division II (UL1604); Atex Zone 2 (EN60079-0 & EN 60079-15) certifications. This indicates that it is NOT intrinsically safe for environments that are likely to contain ignitable or combustible concentrations of gases and vapors.
	3M Scott Sight In-Mask Thermal Imager	The 3M Scott Sight In-Mask Thermal Imager is a hands-free thermal imaging camera that is compatible with and connects to the side of the AV-3000HT facepiece. A display mounted inside the facepiece allows the firefighter to see the thermal image.

Table 3-3 provides images of some of the sub-systems or components discussed in Table 3-2.

**Table 3-3 Images of Air-Pak X3 Components and Options**

*Image Credit: 3M Scott*

 <p data-bbox="329 1266 691 1297"><b>Figure 3-2 Vision C5 Facepiece</b></p>	 <p data-bbox="992 1266 1386 1297"><b>Figure 3-3 AV-3000 HT Facepiece</b></p>
 <p data-bbox="224 1640 800 1703"><b>Figure 3-4 Vision C5 Facepiece with sight in mask thermal imager option</b></p>	 <p data-bbox="870 1640 1507 1671"><b>Figure 3-5 Console with analog pressure gauge display</b></p>



Figure 3-6 EZ-Flo C5 Regulator



Figure 3-7 Carbon Wrapped Air Cylinder



Figure 3-8 3M Scott EPIC 3 RI Voice Communication System



Figure 3-9 Screenshot of Monitor Telemetry Software Solution



Figure 3-10 3M Scott Pak-Tracker Firefighter Locator System



Figure 3-11 EPIC 3 Radio Direct Interface Voice Communication System



### 3.2 MSA Safety, MSA G1 SCBA

The G1 SCBA currently being offered by MSA received NFPA 1981-2019 edition certification in October 2019.



**Figure 3-12 MSA G1 SCBA Overview**

*Image Credit: MSA Safety Inc.*

Table 3-4 enumerates the different configurable components or options of the MSA G1 SCBA.

**Table 3-4 Components, Options, and Descriptions of the MSA G1 SCBA**

Component	Options	Description
Facepiece	G1 Facepiece	The facepiece and nose cup are available in three sizes (small, medium, large). The facepiece includes a large lens and a mechanical speech diaphragm. When the facepiece is not connected to a regulator, an opening in the facepiece connection lets airflow bypass the inhalation and exhalation valves, which decreases breathing resistance. The facepiece includes a range of head harness designs and material options. An optional spectacle kit is available.
Regulator	G1 Regulator	<p>The regulator connects to the facepiece with a push-to-connect connection. The regulator connection includes two independent release buttons. The regulator is available with two cover options (purge and solid). The purge cover lets users activate the regulator or deliver a quick burst of air manually.</p> <p>The regulator includes a bypass valve with a large, accessible bypass knob and an electronic module that provides functionality for HUD and electronic voice communications.</p> <p>The regulator hose is available in two options: continuous and quick-connect. The continuous hose provides an uninterrupted connection from the pressure reducer to the regulator. The quick-connect hose includes a connection positioned on the chest to provide a hose separation point to simplify regulator removal for testing and repair.</p>

Component	Options	Description
Heads-Up Display	Incorporated into Regulator	The HUD is integrated into the regulator and projects light into the facepiece. The HUD lets users see the cylinder pressure and alarm status while wearing the SCBA. The HUD receives power and information about the SCBA and PASS device from the power module. The HUD has seven LEDs that are divided between the left and right sides to improve visibility and clarity. A light sensor in the regulator adjusts the LED intensity according to ambient light conditions (optional setting).
Electronic Voice Comms	Incorporated into Regulator and Speaker Module	<p>The regulator contains dual microphones, which are used to reduce background noise, and the necessary electronics to transmit voice communication via a Bluetooth signal to a third-party portable radio for further communication to an incident commander or other firefighters.</p> <p>The electronic voice comms also includes a speaker module that will both amplify voice communication to anyone who is close and serve as the speaker for communication received through a third-party portable radio. Both the regular microphones and the speaker module are powered by the SCBA's central power supply. The volume of incoming and outgoing voice signals is controlled via the radio.</p>
Air Breathing Cylinder		The cylinder and cylinder valve assembly are available in three rated service pressures (2216 psig, 4500 psig, and 5500 psig). The 2216 psig cylinder and cylinder valve assembly are available in one rated service time (30 minutes) and one material option (carbon). The 4500 and 5500 psig cylinder and cylinder valve assemblies are available in three rated service times (30, 45, and 60 minutes) and one material option (carbon).
Harness and Backplate		The carrier and harness assembly are designed to position the SCBA on the user. The carrier and harness assembly includes an ergonomic backplate, a cylinder band, and adjustable shoulder and waist straps.
Pressure Gauge	G1 Control Module	The G1 control module is the user's interface with the SCBA and PASS device. A pneumatic and electronic hose assembly connects the control module to the high-pressure air source and the power module. The control module has an analog gauge and a graphical display to provide information such as numeric cylinder pressure, battery status, alarms, and service time remaining (optional).
Remote Monitoring and Telemetry	Telemetry Module	The telemetry module is designed to let the SCBA communicate with a remote base station while in use. SCBAs with a telemetry module transmit statistics such as cylinder pressure, thermal alarm (if enabled), service time remaining, and PASS alarm to the base station. The base station can send an evacuation command to the SCBA. The telemetry module uses a special version of the power module.

Component	Options	Description
	MSA HUB	The MSA HUB creates its own local area network for local use – no internet connection is needed – or can connect to the cloud via an existing internet connection. A telemetry-enabled G1 SCBA in conjunction with the MSA HUB allows important data to be shared with on-scene command and with off-site, internet-connected personnel.
	FireGrid Monitor (software)	FireGrid Monitor is an iOS or Android tablet application for local event monitoring and control. Information transmitted and displayed includes air pressure, time remaining, radio contact, PASS alarm, low pressure alarm, thermal alarms, low battery conditions, evacuation alert, and acknowledgement.
Other Accessories and Options	LUNAR	LUNAR is a wireless handheld device that includes Firefighting Assisting Search Technology (FAST). It provides distance and directional information on SCBA devices in alarm and notifies other LUNAR devices, independently of radio, incident command or cell reception.
	MSA G1 Integrated Thermal Imaging Camera (TIC)	The Integrated TIC is embedded into the pressure gauge. It can provide additional situational awareness in environments with limited visibility.

Table 3-5 provides images of some of the components discussed in Table 3-4.

**Table 3-5 Images of MSA G1 SCBA Components and Options**

*Image Credit: MSA Safety INC.*

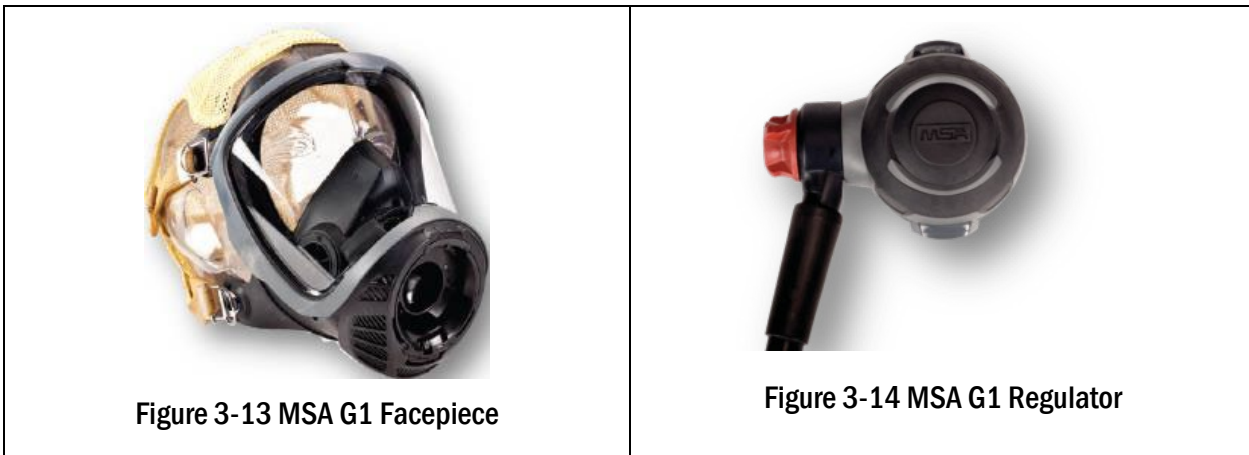




Figure 3-15 MSA G1 HUD is integrated into Regulator



Figure 3-16 MSA G1 Control Module includes pressure gauge and Telemetry module (optional)



Figure 3-17 MSA HUB

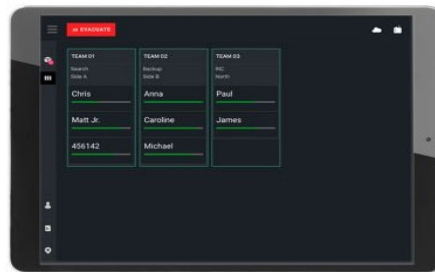


Figure 3-18 FireGrid Monitor software



Figure 3-19 LUNAR wireless handheld device



Figure 3-20 MSA G1 with integrated thermal imaging camera displayed on the Control Module

### 3.3 Dräger, PSS 7000

The Dräger PSS 7000 is a self-contained breathing apparatus certified to the 2018 Edition of NFPA 1981 and 1982. The operating temperature for the SCBA is between  $-22^{\circ}\text{F}$  and  $140^{\circ}\text{F}$  ( $-30^{\circ}\text{C}$  and  $60^{\circ}\text{C}$ ).



**Figure 3-21 Dräger PSS 7000 SCBA**

*Image Credit: Dräger*

Table 3-6 enumerates the different configurable components or options of the Dräger PSS 7000.

**Table 3-6 Components, Options and Descriptions of the Dräger FPS 7000**

Component	Options	Description
Facepiece	Dräger FPS 7000	The Dräger FPS 7000 full-face mask has three sealing edges and two sealing surfaces to contour to the user's face. It comes in nine size combinations to ensure maximum fit and comfort by adapting to different head and face shapes.
Regulator	Dräger PSS Lung Demand Valve	The Dräger positive pressure lung demand valve controls the breathing air supplied into the mask of a breathing apparatus wearer. The lung demand valve connects the medium-pressure supply from the breathing apparatus to the mask, and a sealed and balanced piston unit inside the valve controls the quantity of air flow through the valve in response to the breathing demand of the wearer. The positive-pressure valve maintains a greater pressure than atmospheric inside the mask. Although the pressure drops as the wearer inhales, the pressure inside the mask remains above atmospheric.
Heads-Up Display	Integrated with Sentinel 7000	The HUD is always within users' field of view, allowing them to monitor the cylinder contents and battery status without any manual action.
Electronic Voice Comms	FPS-COM 7000	The Dräger FPS-COM 7000 provides hands-free communication along with optional connection to tactical radios. The FPS-COM 7000 is voice-activated and provides full-duplex communication on one of 10 user-selectable channels. Each channel supports up to 10 users who can be connected without using a tactical radio.
Electronic Voice Comms	FPS-COM 5000	The FPS-COM 5000 communication unit for NFPA-certified SCBAs is designed to connect to the Dräger FPS 7000 full-face masks, this communication unit offers communication through either a voice amplifier or a tactical radio.

Component	Options	Description
Electronic Voice Comms	Dräger C-C550	This microphone/loudspeaker communications control unit connects standard tactical radios to the FPS-COM 5000 or 7000 communication units and can also be used independently. The C-C550 includes two large push-to-talk buttons to allow audio transmission through a connected tactical radio.
Electronic Voice Comms	Dräger C-C440	This communications control unit has a large push-to-talk button to handle the radio transmitter and is rated to IP67.
Air Breathing Cylinder	Carbon Composite	The cylinders are made of aircraft-grade materials and provide a choice of service times (30, 45, and 60 mins) and pressure (2216 psig and 4500 psig). Dräger also offers several colors and can customize each cylinder with the logo of a fire department or jurisdiction.
Harness and Backplate	PSS 7000 Backplate	<p>The Dräger PSS 7000 SCBA is designed so the heaviest components sit at a lower center of gravity. The vendor suggests this is to increase stability and balance, allowing the wearer to work more effectively with less fatigue. The PSS 7000 includes an adjustable harness suspension system. Durable webbing and advanced compression-molded comfort padding offer up to 6.5-times higher abrasion resistance than traditional padding. The material surface is supposedly easy to clean and disinfect with a high resistance to chemical and mechanical damage.</p> <p>The harness has a high-grip, anti-slip inner surface that stays in place without a chest strap or having to over-tighten the shoulder straps. It is suggested that cooling channels in the shoulder straps and waist belt reduce the likelihood of compression burns. A stainless-steel, harness-friction buckle is used to don and doff the SCBA.</p> <p>The vendor claims the backplate automatically lengthens and pivots to mirror wearer movements. The self-adjusting and pivoting waist belt keeps the SCBA on the hips when a firefighter reaches, preventing the bunker coat from riding up. To reduce back strain, the SCBA's weight is designed to ride on the hips. The three-position, carbon-fiber composite backplate adjusts to fit different torso lengths. A slide-and-lock harness mechanism allows the harness and waist belt to be connected or removed from the backplate quickly without tools. To minimize the risk of snagging or damage, supply hoses are integrated into the backplate.</p>
Pressure Gauge	Sentinel 7000	<p>The Sentinel 7000 electronic monitoring system provides options to satisfy the needs of any fire department. Incorporating a centralized power supply and pressure sensor module within the backplate, the robust system combines component protection with balanced weight distribution to reduce physical stress. The Sentinel 7000 is encased in materials that are both impact-resistant and water-resistant, providing dependable performance in fire-fighting environments.</p> <p>An electronic gauge provides real-time monitoring of the following information:</p> <ul style="list-style-type: none"> <li>• A PASS device</li> <li>• Push-button operation</li> </ul>

Component	Options	Description
		<ul style="list-style-type: none"> <li>• Configurable settings to suit individual preferences</li> <li>• Data logging for post-incident analysis</li> <li>• Accurate, continuously updated digital display of pressure and time to EOSTI activation (time based on dynamic breathing rate)</li> <li>• Battery status display</li> <li>• 360° visual and audible alarms triggered when the PASS is activated</li> <li>• Automatic self-tests and system tests</li> </ul>
Other Accessories and Options	Buddy Breather	The Buddy Breather UEBSS enables two firefighters to share a single source of air.
Other Accessories and Options	QuickConnect	The QuickConnect allows users to connect cylinders to the backplate without threading, potentially allowing a firefighter to re-enter a fire much faster than with a conventional threaded connection.

Table 3-7 provides images of some of the sub-systems or components discussed in Table 3-6.

**Table 3-7 Images of the Dräger PSS 7000 Components and Options**

*Image Credit: Dräger*

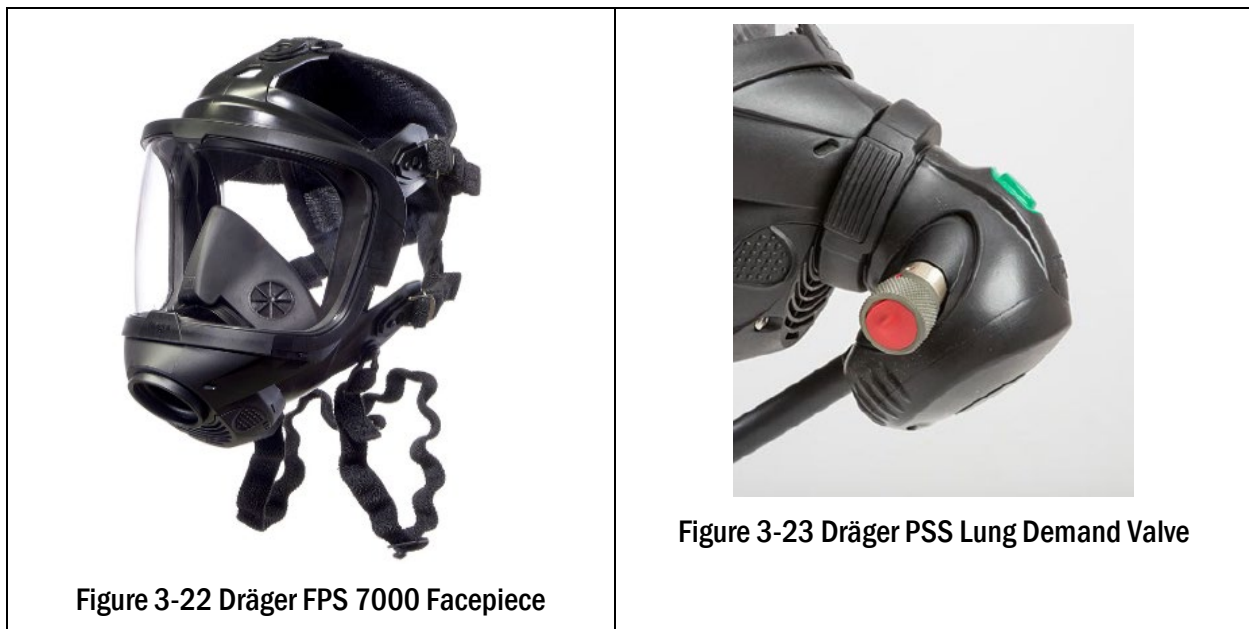




Figure 3-24 Dräger FPS 7000 Heads-Up Display



Figure 3-25 Dräger Sentinel 7000 Digital Monitor with integrated PASS



Figure 3-26 Dräger FPS COM 7000



Figure 3-27 Dräger FPS 5000



Figure 3-28 Carbon Composite Cylinders



Figure 3-29 Dräger FPS 7000 Harness and Backplate





Figure 3-30 Dräger C-C550



Figure 3-31 Dräger C-C440



Figure 3-32 Buddy Breather UEBSS



Figure 3-33 Cylinder QuickConnect

### 3.4 Interspiro, Interspiro S9

The Interspiro S9 SCBA is an open-circuit SCBA compliant with NFPA 1981/1982 (2018 edition). It comes with a 15-year limited warranty.



**Figure 3-34 Interspiro S9 SCBA**

*Image Credit: Interspiro*

Table 3-8 enumerates the different configurable components or options of the Interspiro S9 SCBA.

**Table 3-8 Components, Options, and Descriptions of the Interspiro S9**

Component	Options	Description
Facepiece	S-USA Ambient Air Hatch Facepiece S-USA First Breath Facepiece	<p>The Ambient Air Hatch Facepiece is equipped with an ambient air hatch that enables users to breath ambient air while the mask is fully donned to save the compressed air in the cylinder. Users push on the hatch cover to activate the air in the cylinder. An indicator arm shows users when the ambient air hatch is open.</p> <p>The First Breath Facepiece will automatically activate when the user inhales to take the first breath. When the mask is removed, users can use handle on the breathing valve to shut it off.</p> <p>Both facepieces have no protruding parts, providing unrestricted visibility and reducing the risk of snagging and mechanical damage, and both have breathing valves that connect to the mask using a secure, positive lock connection. Both masks are compatible with the communications system, the HUD, and the optional spectacles kit. There is an ergonomic head harness with buckles.</p> <p>There are two variants of both masks, the rubber head harness or textile (“Spironet”) head harness. Both variants are available in four sizes, (small, medium, large, x-large). Both are NIOSH and NFPA approved and have a polycarbonate visor.</p>
Regulator	Spiromatic-S Series Regulator	<p>The regulator has an integral bypass with a large handle that can be used to temporarily increase the air flow to the mask. The integrated second stage in the face mask provides a wide field of vision, better sealing due to optimal weight distribution and clear speech quality and remains securely connected and always protected.</p>

Component	Options	Description
Heads-Up Display	Optional Wireless Heads-Up Display	The wireless HUD gives a hands-free indication of cylinder pressure and is visible to other team members. The status of the motion alarm is shown in the heads-up display to eliminate the risk of missing pre-alarm indication when working in noisy environments. It is installed without additional parts or tools inside the mask and dims and brightens based on ambient light conditions. It is powered by two AAA alkaline batteries.
Electronic Voice Comms	Spirocom Wired Spirocom Wireless	According to the manufacturer's website, neither version of the Spirocom is available for sale in the United States. It is included in this report only for completeness.
Air Breathing Cylinder	Carbon Fiber Superlight Cylinder DOT-LP Cylinder	The Superlight Cylinder is a lightweight wrapped composite-type cylinder designed for high pressure (4,500 psi) versions of the S9, available in 30, 45, or 60-minute durations. The DOT-LP cylinder has a working pressure of 2,216 psi and a 30-minute duration.
Harness and Backplate	S9 Ergonomic Harness Concept S9 Incurve	The harness has a double pivot feature that allows the shoulder straps and waist belt to move independently, helping to ensure optimal weight distribution. A protective rubber pad runs over the shoulder straps and protects against burning material. The fit can be adjusted from inside of harness for different body sizes. The ergonomic shoulder straps distribute weight away from the neck muscles. Two waist straps, two shoulder straps, and a chest strap are required to fully don the unit, which can be done in less than one minute. The harness for the S9 Incurve, a variant of the S9, is designed with a minimum of textile parts, making it less susceptible to contamination and easier to clean.
Pressure Gauge		Two large buttons operate the integrated PASS, and the motion sensor is in the display unit to make it easy to reset. The SCBA computer is protected in the backframe and controls all electronics and saves all usage data for future analysis. LED ramps give clear 360° indication of PASS status and cylinder air pressure. Most Interspiro SCBAs can be upgraded with the Personal Alarm Control (PAC) unit which has features including buddy reading, PASS alarm and distress signals. The Bluetooth connection allows the user to change settings and to download log files. An optional turn-back warning can be activated which gives a warning indication when the pre-set cylinder pressure is reached. The backlight function helps with reading the mechanical pressure gauge. The PAC is powered by a battery pack that includes three AAA-batteries.

Component	Options	Description
Remote Monitoring and Telemetry	Integrated PASS and Motion Sensor Optional Telemetry Connection Optional Tracking Unit	The S9 has an integrated PASS and motion sensor with all user data stored on the unit for future analysis. Interspiro also offers Spirolink, an optional telemetry connection, and Spiropulse, an optional tracking unit. Spirolink keeps track of all firefighters on site and provides information about cylinder pressure and absorbed pressure to the Incident Commander. The unit is portable, with a harness, radio and integrated telemetry unit in the backplate. Spiropulse is an integrated system that allows a rapid intervention team to track down the wearer using ultrasonic technology.
Other Accessories and Options	UEBS System SuperPASS II	The UEBS system is an available option. SuperPASS II is an automatic non-motion alarm with a manually operated panic button and with an optional temperature sensor and warning for absorbed temperature. The unit has an auto-on feature and activates when the accountability key is removed. The key can be provided with personal information and has an adjustable strap that can be used to set it to activate automatically. During use, the panic button on the front side can be pressed to activate the full alarm mode. When motion is not detected for 20 seconds, an increasingly loud pre-alarm is started. The pre-alarm is reset if motion is detected. If motion is not detected for 10–15 seconds after the pre-alarm is activated, the unit enters the full alarm mode with very strong sound and pulsing light warnings. Once in full alarm mode, the unit can be reset by simultaneously pressing the two side buttons. To switch off the unit, the accountability key must be attached before pressing the side buttons.

Table 3-9 provides images of some of the sub-systems or components discussed in Table 3-8.

**Table 3-9 Images of the Interspiro S9 Components and Options**

*Image Credit: Interspiro*

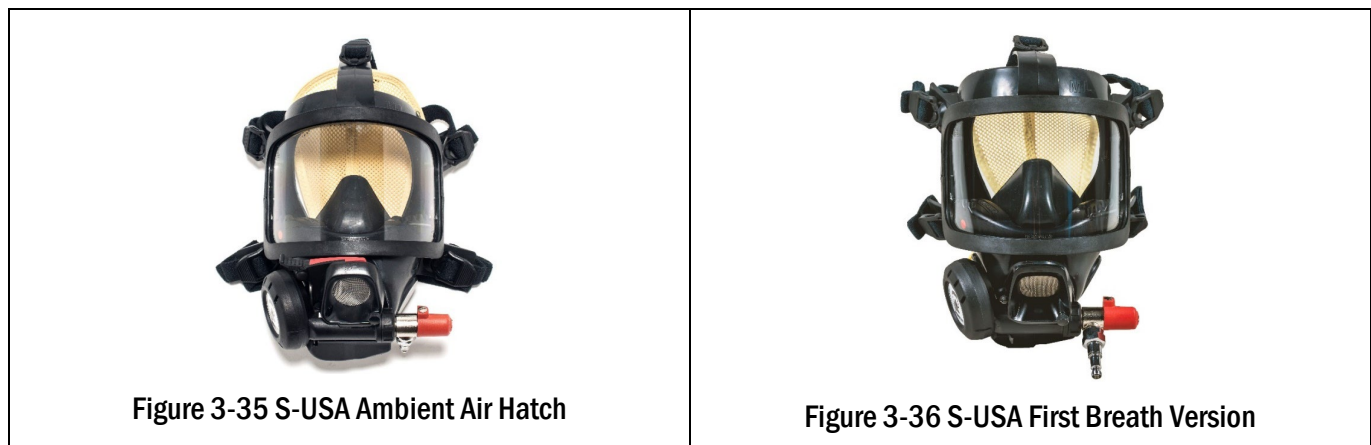




Figure 3-37 Regulator



Figure 3-38 Heads-Up Display



Figure 3-39 Carbon Fiber Superlight Cylinder



Figure 3-40 Interspiro S9 Harness and Backplate



Figure 3-41 Interspiro S9 Incurve Harness and Backplate



Figure 3-42 Pressure Gauge



Figure 3-43 PAC Personal Alarm Control



Figure 3-44 Spirolink Telemetry System



Figure 3-45 SuperPass II

## 4.0 MANUFACTURER AND VENDOR CONTACT INFORMATION

Additional information on the products included in this market survey report can be obtained from the manufacturers listed in Table 4-1.

Table 4-1 Manufacturer (and Vendor) Contact Information

Manufacturer/Vendor	Website	Phone Number	Email Address
3M Scott Fire and Safety	3m.com	1-703-789-3962	wfhesse@mmm.com
MSA Safety Inc.	us.msasafety.com	1-877-672-3473	fire.cs@msasafety.com
Draeger, Inc	draeger.com	1-800-437-2437	Sean.carey@draeger.com
Interspiro, Inc.	interspiro.com	1-262-947-9901	info.us@interspiro.com

## 5.0 CONCLUSIONS

The capabilities associated with SCBAs have grown in the last few years, making them more than just products that supply air to the wearer. The optional capabilities and features available for selection when purchasing an SCBA are rapidly changing and bringing a new level of situational awareness, communications, and safety to the wearer. Each of these features has limitations and comes with trade-offs that need to be accounted for when making purchasing decisions.

Having a strong understanding of a fire service's concept of operations, standard operating procedures, and inventory of tools and technologies can help to inform and navigate the trade-offs associated with the optional offerings of an SCBA. The baseline requirements established by NIOSH and NFPA ensure that minimum performance capabilities are not compromised in the process.

Emergency responders should carefully research the overall capabilities and limitations of SCBAs in relation to their agency's operational needs when making equipment selections.



## Appendix A. STANDARDS AND REGULATIONS

Standards and regulations on SCBA for the first responder community and for industry specify the minimum design, performance, testing, and certification requirements. Table A-1 lists the most relevant standards with a brief description of their purpose and content. Additional information is provided below the table.

Table A-1

Standard or Regulation	Description
<a href="#">29 CFR 1910.134 OSHA Laws and Regulations: Respiratory Protection</a>	This regulation describes what type of worker should employ respiratory protection equipment, such as SCBAs, and under what circumstances.
<a href="#">29 CFR 1910.156 OSHA Law and Regulations: Fire Brigades</a>	This regulation describes requirements for the organization, training, and personal protective equipment of fire brigades whenever they are established by an employer.
<a href="#">42 CFR 84 Respiratory Protective Devices</a>	This regulation describes the procedures and prescribes requirements that must be met when filing applications to the National Institute for Occupational Safety and Health for new respirators or for changes or modifications to approved respirators.
<a href="#">NFPA 1852 Standard on Selection, Care, and Maintenance of Open-Circuit Self-Contained Breathing Apparatus (SCBA) (2019)</a>	This standard establishes requirements for the selection, care, and maintenance of self-contained breathing apparatus (SCBA) as required by the respiratory protection program in NFPA 1500: Fire Department Occupational Safety and Health Program to reduce health and safety risks associated with improper maintenance, contamination, or damage.
<a href="#">NFPA 1981 Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) For Emergency Services (2019)</a>	This standard establishes levels of respiratory protection and functional requirements for SCBA used by emergency services personnel.
<a href="#">NFPA 1982 Standard on Personal Alert Safety Systems (PASS) (2018)</a>	This standard establishes requirements intended to ensure reliable performance of personal alert safety systems (PASS) that enable emergency responders to signal for help if they get lost, disoriented, trapped, injured, or run out of breathing air during emergency operations.
<a href="#">NFPA 1852 Standard on Selection, Care, and Maintenance of Open-Circuit Self-Contained Breathing Apparatus (SCBA) (2019)</a>	This standard establishes requirements for the selection, care, and maintenance of self-contained breathing apparatus (SCBA) as required by the respiratory protection program in NFPA 1500: Fire Department Occupational Safety and Health Program to reduce health and safety risks associated with improper maintenance, contamination, or damage.

## **A.1 Applicable Federal Regulations**

### **A.1.1 29 CFR 1910.134 OSHA Laws and Regulations: Respiratory Protection**

**1910.134(a)(1)** - In the control of those occupational diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors, the primary objective shall be to prevent atmospheric contamination. This shall be accomplished as far as feasible by accepted engineering control measures (for example, enclosure or confinement of the operation, general and local ventilation, and substitution of less toxic materials). When effective engineering controls are not feasible, or while they are being instituted, appropriate respirators shall be used pursuant to this section.

**1910.134(a)(2)** - A respirator shall be provided to each employee when such equipment is necessary to protect the health of such employee. The employer shall provide the respirators which are applicable and suitable for the purpose intended. The employer shall be responsible for the establishment and maintenance of a respiratory protection program, which shall include the requirements outlined in paragraph (c) of this section. The program shall cover each employee required by this section to use a respirator.

### **A.1.2 29 CFR 1910.156 OSHA Law and Regulations: Fire Brigades**

**1910.156(a)(1)** - Scope. This section contains requirements for the organization, training, and personal protective equipment of fire brigades whenever they are established by an employer.

**1910.156(a)(2)** - Application. The requirements of this section apply to fire brigades, industrial fire departments, and private or contractual type fire departments. Personal protective equipment requirements apply only to members of fire brigades performing interior structural firefighting. The requirements of this section do not apply to airport crash rescue or forest fire fighting operations.

**1910.156(b)(1)** - Organizational statement. The employer shall prepare and maintain a statement or written policy which establishes the existence of a fire brigade; the basic organizational structure; the type, amount, and frequency of training to be provided to fire brigade members; the expected number of members in the fire brigade; and the functions that the fire brigade is to perform at the workplace. The organizational statement shall be available for inspection by the Assistant Secretary and by employees or their designated representatives.

## **A.2 NIOSH Approved Respirator Standards**

### **A.2.1 42 CFR 84 Respiratory Protective Devices**

The purpose of the regulations contained in part 84 is:

- (a) To establish procedures and prescribe requirements which must be met in filing applications for approval by the National Institute for Occupational Safety and Health of respirators or changes or modifications of approved respirators;
- (b) To establish a schedule of fees to be charged each applicant for the inspections, examinations, and testing conducted by the Institute under the provisions of this part;
- (c) To provide for the issuance of certificates of approval or modifications of certificates of approval for respirators which have met the applicable construction, performance, and respiratory protection requirements set forth in this part; and

(d) To specify minimum requirements and to prescribe methods to be employed by the Institute and by the applicant in conducting inspections, examinations, and tests to determine the effectiveness of respirators used during entry into or escape from hazardous atmospheres.

### **A.3 National Fire Protection Association Guidelines<sup>1</sup>**

#### **A.3.1 NFPA 1981 Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services (2019)**

This standard establishes levels of respiratory protection and functional requirements for SCBA used by emergency services personnel.

#### **A.3.2 NFPA 1982 Standard on Personal Alert Safety Systems (PASS) (2019)**

This standard establishes requirements intended to ensure reliable performance of personal alert safety systems (PASS) that enable emergency responders to signal or help if they get lost, disoriented, trapped, injured, or run out of breathing air during emergency operations.

#### **A.3.3 NFPA 1852 Standard on Selection, Care, and Maintenance of Open-Circuit Self-Contained Breathing Apparatus (SCBA) (2019)**

This standard establishes requirements for the selection, care, and maintenance of self-contained breathing apparatus (SCBA) as required by the respiratory protection program in NFPA 1500: Fire Department Occupational Safety and Health Program to reduce health and safety risks associated with improper maintenance, contamination, or damage.

---

<sup>1</sup> The Safety Equipment Institute (SEI) tests products to National Fire Protection Association (NFPA) standards and publishes lists of certified products on their website, [www.seinet.org/search.htm](http://www.seinet.org/search.htm).

## REFERENCES

- [1] Occupational Safety and Health Administration, "Response to IDLH or Potential IDLH atmospheres," Department of Labor, 04 10 2023. [Online]. Available: <https://www.osha.gov/laws-regs/standardinterpretations/1995-05-01-2#>. [Accessed 04 10 2023].
- [2] Centers for Disease Control and Prevention, "Approved Respirator Standards," 04 10 2023. [Online]. Available: [https://www.cdc.gov/niosh/npptl/respstandards/approvedstandards/scba\\_cbrn.html](https://www.cdc.gov/niosh/npptl/respstandards/approvedstandards/scba_cbrn.html). [Accessed 04 10 2023].
- [3] Interspiro, "Military-Police," [Online]. Available: <https://interspiro.com/en-gb/area-of-use/military-police>. [Accessed 04 10 2023].
- [4] National Fire Protection Association, *NFPA 1981: Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*, National Fire Protection Association, 2019.
- [5] National Fire Protection Association, "NFPA 1971: Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting," 2018. [Online]. Available: [www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=1971](http://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=1971).
- [6] National Fire Protection Association, *NFPA 1982: Standard on Personal Alert Safety Systems (PASS)*, National Fire Protection Association, 2018.
- [7] National Urban Security Technology Laboratory (NUSTL), "Self-Contained Breathing Apparatus – FDNY Support - DRAFT, Phase I Research Findings Report," New York City, NY, 2022.
- [8] National Fire Protection Association , "NFPA 1970 Proposed Standard," [Online]. Available: [www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=1970&tab=nextedition](http://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=1970&tab=nextedition). [Accessed 10 05 2022].
- [9] Safety Equipment Institute , "SEI Certified Products," Safety Equipment Institute, 2023. [Online]. Available: <https://www.seinet.org/search.htm>. [Accessed August 2023].