

PPE CASE



Personal Protective Equipment Conformity Assessment Studies and Evaluations

Evaluation of a Self-Contained Breathing Apparatus Involved in a Near Miss While Operating at a Structure Fire

Bedford County, VA, Fire and Rescue Requested the Evaluation of a Scott® Safety Air-Pak 4.5

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March 8, 2022 (Revised on October 27, 2022)

This report provides a summary of NPPTL's inspection and evaluation methods, as well as findings, for an SCBA that was being used by a fire fighter that had an out-of-air emergency. The SCBA used was a Scott® Safety Air-Pak Model 4.5, 30-minute, 4500-psi unit that was not in an approved configuration. The Bedford County, VA, Fire and Rescue was advised that NIOSH NPPTL would provide a written report of the investigation and any applicable test results.

REVISION TO REPORT (October 27, 2022): During the initial inspection, the modal acoustic emission label (Figure 21) was mistaken to be a requalification label for cylinder hydrostatic testing. Modal acoustic emission is not an authorized requalification method according to the use conditions set forth by the NIOSH approval holder, 3M Scott Fire & Safety. Therefore, this SCBA was not used in accordance with the approval holder's use conditions and the cylinder is past its 15-year maximum life. The SEI label on the backframe assembly indicates the unit conforms to NFPA 1981:2002 edition while the NIOSH approval label corresponds to the unit conforming to NFPA 1981:2007 edition. This along with other assessments of the labeling, the part numbers, and approval information indicate that this SCBA may have been refurbished. These findings indicate that the SCBA unit received was not in the NIOSH approved configuration. This report was corrected accordingly, and information was added to "Actions to be Taken by Fire Departments with SCBAs Involved in an Incident."

NIOSH received an SCBA used by a fire fighter involved in a near miss. The SCBA was not found to contribute to the incident; however, the SCBA was not in a NIOSH approved configuration.

A qualified service technician must inspect, repair, test, clean, and replace damaged components of any SCBA involved in an incident before it may be returned to service. Only SCBAs within their maximum life should be used.

What NIOSH Did to Protect the Worker

Upon receipt of the SCBA, NPPTL managed the custody of evidence throughout the inspection and evaluation process at its Morgantown, West Virginia, facility. NPPTL staff inspected all SCBA components and documented their findings with written and photographic evidence. NPPTL also tested the SCBA to determine conformance to NPPTL's approval requirements as outlined in Title 42, Code of Federal Regulations, Part 84 (42 CFR 84). Further testing was conducted to provide an indication of the conformance of the SCBA to the National Fire Protection Association (NFPA) Air Flow Performance requirements of NFPA 1981, Standard on Open-Circuit Self-Contained Breathing Apparatus for the Fire Service, 2013 Edition. If the inspection or evaluation data suggested that the SCBA unit may have contributed to the near miss, NPPTL would have engaged in corrective action to ensure that no other users of the product would experience a similar incident. In this case, no such corrective action was necessary. NPPTL then managed the disposition of the SCBA.

Chain of Custody

The SCBA was shipped to Lab H1513 at the NIOSH facility in Morgantown, West Virginia, on January 4, 2022. The SCBA unit remained in secured storage in Lab H1513 throughout the inspection and testing process.

SCBA Inspection

On January 5, 2022, NPPTL employees Jay Tarley and Angela Andrews inspected the SCBA unit. The SCBA was identified as belonging to the Moneta Volunteer Fire Company, which is associated with Bedford County Fire and Rescue. The SCBA was visually examined, component by component, in the condition received to determine the conformance of the unit to the NIOSH approved configuration. The unit was identified as the Scott® Safety Air-Pak Model 4.5, 30-minute, 4500-psi unit, NIOSH Approval Number TC-13F-0076CBRN.

As Received

- The SCBA unit was shipped in a latched box inside of a cardboard container to Lab H1513.
- The unit was in good shape with some signs of dye sublimation in the strapping.
- The cylinder was received empty and closed.
- The donning switch was off with the regulator intact.
- The mask-mounted regulator (MMR) was attached.
- The bypass was closed.



Figure 1: Boxed SCBA as received



Figure 2: Unboxed SCBA as received

Components and Observations for SCBA (“right” or “left” are from the user’s perspective; “good” means functional and may show signs of dirt/soot; “fair” means functional, but with signs of some damage; “bad” means not functional, needs to be inspected by technician to possibly replace part(s)) (see Figures in Appendix)

Facepiece AV 3000 (Figures 3, 4)

- Facepiece seal P/N: 10011306; Small.
- Nosecup P/N: 10011011; Size Small; MFG date: 2nd Q 2011.
- Retaining ring top P/N 1001124 MFG date: 03/2012; bottom P/N: 10011025; MFG date 03/2012.
- Facepiece assembly P/N: 11/-31; MFG date: 12/2011.
- Facepiece retaining ring, seal, lens, and hairnet were all in good condition.
- Overall condition good.
- Fluid in nose cup and outside of nose cup at bottom of lens.
- Hairnet straps good, straps moved freely held in place, held securely to facepiece.
- Attachment points for straps were good.
- Regulator interface area was in good condition.

Mask-Mounted Regulator (MMR) (Figures 5, 6)

- E-Z Flow with Vibralert and with Heads-Up Display (HUD).
- Regulator assembly S/N: unreadable.
- Other markings; A3Q03.
- Overall condition good.
- Donning switch was off.
- Bypass was found closed.
- Sealing area in good condition with marking “103”.
- Regulator could be attached and removed.
- Locking assembly functioned.
- HUD fully intact.

Low-Pressure Regulator Hose (Figures 7, 8)

- P/N: 31001446.
- Overall condition was good.
- Quick Disconnect attached and functioned.

Pressure Reducer Assembly (Figures 9, 10)

- P/N: 802220-03; S/N: RED 0403001812 AB.
- MFG date: NA.
- Overall condition was good.
- Visualert added to pressure reducer assembly to upgrade edition requirements.
- All air line connections were secure with no sign of heat damage.

High-Pressure Hose and Cylinder Attachment (Figures 11-13)

- Overall condition was good.
- Cylinder attachments threads good and “O” ring in place.
- RIC/UAC system connector markings: Eaton FD17-1002-10-04, 30503; P/N: 802228-05,0304.
- RIC/UAC system connector cover in good condition.
- RIC/UIC connector was found removed.

PASS Console Assembly (Figures 14, 15)

- Label number: unreadable.
- Overall condition good.
- Lines were in good shape—pressure/electrical.
- Gauge lens good and readable.
- No protective casing, had rubber attachment.
- SEI label present, 1998 ed.

PASS Control Module with PAK-Alert (Figures 16)

- Scott label: P/N: 805796-02.
- Scott Control Module Assy SE+ 805794-01, P72172 March 04.
- Overall condition was good.
- Held securely to backframe.
- Wire connection connected to PASS device.
- Wire held secure to backframe and connected to console assembly.

Backframe Assembly (Figures 17, 18)

- P/N: 804415-11.
- SEI label readable; NFPA 2002 edition.
- NIOSH Approval Number TC-13F-0076CBRN.
- Other markings: 8-22 in marker, R8102 sticker, FD inventory label, and service label from Atlantic Emergency Solutions (January 2021).
- NIOSH white/black CBRN approval sticker.
- Overall condition good.
- Shoulder straps were attached to the frame but with dye sublimation (only to strapping and not webbing).
- Cylinder strap latch good condition, functional.

Straps and Buckles (Figure 19)

- Overall strap condition good with dye sublimation.
- Both shoulder straps attached at the top of the backframe.
- Hose lines and wires passed through shoulder straps.
- All adjustable buckles moved and held in place.
- Waist area buckle latched and released.
- Lumbar strap in good condition.

Compressed Air Cylinder and Cylinder Valve Assembly (Figures 20-22)

- Minute Duration: 30 minute.
- DOT Number: DOT-E-10915-4500.
- TC-SU-5134-310.
- OK80697-LUXFER.
- Scott Part number: 10009671.
- Scott logo visible; Luxfer: L45M-18; REE: 78.
- Manufacture date: 01/2004 (over 15 years old); 4500 PSIG
 - Cylinder was past its maximum life and should not have been in service.
 - Gauge was readable.
- Threads clean.
- As received, cylinder valve fully closed with no air remaining.
- Rubber bumper at base on cylinder valve was in good condition with a small crack.
- Cylinder requalification label was not present. There was a label that was mistaken as a cylinder requalification label. The modal acoustic emission testing process used is not authorized by the NIOSH approval holder as a qualification method; therefore, leaving the cylinder in a non-approved configuration.
- Additional label for a supplier of refurbished SCBAs
- On Stem: P/N: 804721-0.

The SCBA unit was tested using the six NIOSH standard testing procedures and one NFPA test method as described in **Table 1**.

Table 1. Summary of results from testing SCBA.

NIOSH Tests	Description of Results	PASS /FAIL
<p>Positive Pressure Test - NIOSH Test Procedure Number 120 42 CFR Part 84 Reference: Subpart H, § 84.70 (a)(2)(ii) Requirement: <i>The pressure inside the facepiece in relation to the immediate environment is positive during both inhalation and exhalation.</i> Procedure: A breathing machine with a 622 kg.-m./min. cam operating at 24 RPM with a 40-liter per minute flow rate (115 liters per minute peak flow) is connected to an anthropometric head for cycling. A pressure tap in the head is connected to a transducer which in turn is connected to a strip chart recorder for determining the pressure in the facepiece.</p>	<p>The unit met the test requirement. The inhalation breathing resistance did not become negative during the test. *The PASS unit functioned; the digital remote functioned and there was a HUD. Inhalation Breathing Resistance: (inches of water column) = 0.19</p>	PASS
<p>Rated Service Time Test - NIOSH Test Procedure Number 121 42 CFR Part 84 Reference: Subpart F, § 84.53 (a) and Subpart H, § 84.95 (a) and (b) Requirement: <i>Service time will be measured while the apparatus is operated by a breathing machine as described in § 84.88. The open-circuit apparatus will be classified according to the length of time it supplies air or oxygen to the breathing machine. Classifications are listed in § 84.53.</i> Procedure: A breathing machine with a 622 kg.-m./min. cam operating at 24 RPM with a 40-liter per minute flow rate is connected to an anthropometric head for cycling. A pressure tap in the head is connected to a transducer which in turn is connected to a strip chart recorder for determining the pressure in the facepiece. The breathing machine is run until the inhalation portion of the breathing curve falls below the minimum requirement.</p>	<p>The SCBA met the test requirement. The measured service time (adjusted to correspond with the recorded breathing cycles) was more than the rated service time of 30 minutes. The PASS unit functioned during the test. The SCBA did not go negative on inhalation; therefore, positive pressure was maintained in the facepiece. Measured Service Time: 34 Minutes 51 Seconds</p>	PASS

<p>Exhalation Resistance Test - NIOSH Test Procedure Number 122 42 CFR Part 84 Reference: Subpart H, § 84.91 (c)</p> <p>Requirement: <i>The exhalation resistance of pressure-demand apparatus shall not exceed the static pressure in the facepiece by more than 51 mm. (2 inches) water-column height.</i></p> <p>Procedure: The facepiece is mounted on an anthropometric headform. A probe in the headform is connected to a slant manometer for measuring exhalation breathing resistance. The air flow through the apparatus is adjusted to a rate of 85 liters per minute and the exhalation resistance is recorded.</p>	<p>The SCBA met the test requirement.</p> <p>Exhalation Breathing Resistance: (inches of water column) = 2.09</p> <p>Static Pressure: (inches of water column) = 0.82</p> <p>Difference: (inches of water column) = 1.27</p>	<p>PASS</p>
<p>Static Pressure Test - NIOSH Test Procedure Number 122 42 CFR Part 84 Reference: Subpart H, § 84.91 (d)</p> <p>Requirement: <i>The static pressure (at zero flow) in the facepiece shall not exceed 38 mm. (1.5 inches) water-column height.</i></p> <p>Procedure: The facepiece is fitted to an anthropometric head for testing. A pressure tap in the head is connected to a calibrated manometer. Full cylinder pressure is applied to the unit at zero flow and a reading from the manometer is recorded.</p>	<p>The SCBA met the test requirement.</p> <p>Facepiece Static Pressure: (inches of water column) = 0.82</p>	<p>PASS</p>

<p>Gas Flow Test - NIOSH Test Procedure Number 123 42 CFR Part 84 Reference: Subpart H, § 84.93 (b) and (c)</p> <p>Requirement: <i>The flow from the apparatus shall be greater than 200 liters per minute when the pressure in the facepiece of demand apparatus is lowered by 51 mm. (2 inches) water column height when full container pressure is applied. Where pressure-demand apparatus are tested, the flow will be measured at zero gage pressure in the facepiece.</i></p> <p>Procedure: A pressure tap in the anthropometric head is connected to a manometer for determining when the pressure inside the facepiece is at zero. A mass flow meter is connected in line between the anthropometric head and an adjustable vacuum source to measure flow. The SCBA cylinder is replaced by a test stand which is adjusted initially to full cylinder pressure. The vacuum source is adjusted during the test to maintain the desired pressure inside the facepiece. Once the proper facepiece pressure has stabilized, a flow reading is recorded. The procedure is then repeated with the test stand adjusted to 500 psig.</p>	<p>The SCBA met the test requirement.</p> <table border="1" data-bbox="1283 293 1806 456"> <thead> <tr> <th>Applied Pressure</th> <th>Air Flow (liters per min.)</th> </tr> </thead> <tbody> <tr> <td>4500 psig</td> <td>456.8</td> </tr> <tr> <td>500 psig</td> <td>634.3</td> </tr> </tbody> </table>	Applied Pressure	Air Flow (liters per min.)	4500 psig	456.8	500 psig	634.3	<p>PASS</p> <p>PASS</p>
Applied Pressure	Air Flow (liters per min.)							
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<p>Remaining Service Life Indicator Test - NIOSH Test Procedure Number 124 42 CFR Part 84 Reference: Subpart H, § 84.83 (f) and Subpart G, § 84.63 (c) Requirement: <i>Each remaining service-life indicator or warning device must give an alarm when the remaining service life is reduced to a minimum of 25 percent of its rated service time, or any higher minimum percent value or values as specified in the approval. Open-circuit demand and pressure-demand respirators must alarm continuously until depletion of the breathing air supply. The percent value set for indicator activation must be identified by labels and/or markings on each respirator unit.</i></p> <p>Procedure: A calibrated gauge is connected in line between the air supply and the first-stage regulator. The unit is then allowed to gradually bleed down. When the low-air alarm is activated, the pressure on the gauge is recorded. This procedure is repeated six times. The average of the six readings is calculated and recorded.</p>	<p>As these SCBA models do not have a remote gauge shutoff, the test requirement is 25% +/- 2 %.</p> <p>The electrical warnings did not function during the test. The unit “chirped” during testing indicating that the batteries were depleted.</p> <table border="1" data-bbox="1283 500 1808 899"> <thead> <tr> <th></th> <th>Electric</th> <th>Vibralert</th> </tr> <tr> <th>Run #</th> <th>Alarm Point (psi)</th> <th>Alarm Point(psi)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>x</td> <td>1060</td> </tr> <tr> <td>2</td> <td>x</td> <td>1065</td> </tr> <tr> <td>3</td> <td>x</td> <td>1065</td> </tr> <tr> <td>4</td> <td>x</td> <td>1060</td> </tr> <tr> <td>5</td> <td>x</td> <td>1065</td> </tr> <tr> <td>6</td> <td>x</td> <td><u>1060</u></td> </tr> <tr> <td>Average</td> <td>x</td> <td>1063</td> </tr> </tbody> </table>		Electric	Vibralert	Run #	Alarm Point (psi)	Alarm Point(psi)	1	x	1060	2	x	1065	3	x	1065	4	x	1060	5	x	1065	6	x	<u>1060</u>	Average	x	1063	<p>FAIL</p> <p>PASS</p>
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National Fire Protection Association (NFPA) Test (in accordance with NFPA 1981, 2013 Edition):

NFPA Test	Description of Results	PASS/ FAIL
<p>NFPA Air Flow Performance Test - NFPA 1981 (2013 Edition) Reference: Chapter 5, Performance Requirements, Section 5-1.1</p> <p>Requirement: <i>SCBA shall be tested for air flow performance as specified in Section 6-1, Air Flow Performance Test, and the SCBA facepiece pressure shall not be less than 0.0 in. (0.0 mm) water column and nor greater than 3½ in. (89 mm) water column above ambient pressure from the time the test begins until the time the test is concluded.</i></p> <p>Procedure: The required equipment specified in the NFPA standards were used to conduct the tests on this unit. A pressure tap in the head is connected to a transducer which in turn is connected to a flatbed chart recorder for determining the pressure in the facepiece.</p>	<p>The SCBA passed the pressure portion of this test. The HUD system did not function, which caused the unit to fail the test.</p> <p>Maximum Facepiece Pressure: (inches of water column) = 2.5 Minimum Facepiece Pressure: (inches of water column) = 0.40</p>	<p>Both FAIL due to HUD</p>

Disposition of SCBA

Following testing on January 12, 2022, the SCBA was returned to secure storage in Lab H1513 at the NIOSH facility in Morgantown, West Virginia.

Synopsis of Findings

The SCBA unit inspected and evaluated by NPPTL was a Scott® Safety Air-Pak Model 4.5, 30-minute, 4500-psi unit with NIOSH Approval Number TC-13F-0076CBRN. The unit had a cylinder that was past its 15-year maximum life and therefore was no longer in a NIOSH approved configuration. The requalification methodology of modal acoustic emission is not authorized by the NIOSH approval holder as an acceptable requalification method. A corresponding facepiece and cylinder were provided with the unit. The NFPA original approval label was present and readable. The SCBA met the requirement of the NIOSH Positive Pressure Test, as the SCBA maintained a positive pressure for the 30-minute minimum duration of the test. The unit passed all other NIOSH tests. The unit was tested on the NFPA “Airflow Performance” test and failed both portions of the test due to the HUD not functioning. The PASS and primary alarm functioned, but the HUD and alarm systems did not function. The batteries were depleted in the unit.

In light of the information obtained during this investigation, NIOSH NPPTL proposes that the unit be taken out of service until a new cylinder or one that is within its maximum life of 15 years, and has a certified cylinder requalification label in accordance with the approval holder’s use instructions, be used with the SCBA to return it to an approved configuration. The SCBA was returned to the shipping container to be shipped back to Bedford County Fire and Rescue.

CASE Conclusion

No evidence was identified to suggest that the SCBA inspected and evaluated contributed to the incident. NIOSH determined that there was no need for corrective action with regards to the approval holder or users of the SCBAs manufactured under the approval number granted to this product.

Actions to be Taken by Fire Departments with SCBAs Involved in an Incident

- Any SCBA that has a cylinder past its 15-year maximum life shall be removed from service.
- Ensure that processes are used to requalify cylinders are in accordance with the NIOSH approval holder’s use conditions.
- If upgrading or purchasing a refurbished SCBA, ensure the parts/components are consistent with the NIOSH approval holder’s approved configuration to ensure the unit remains NIOSH approved. Contact the NIOSH approval holder for questions regarding the SCBA.
- Any SCBA unit involved in an incident may not be placed back in service until the SCBA has been repaired, tested, cleaned, and any damaged components replaced and inspected by a qualified service technician, including such testing and other maintenance activities as prescribed by the schedule from the NIOSH approval holder.

- All SCBA units, even those not involved in an incident, must undergo a flow test on at least an annual basis.

Actions PPE Users, Selectors, and Purchasers May Take to Further Protect Themselves and Others from Hazards

- Sign up for NPPTL's Listserv at <https://www.cdc.gov/niosh/npptl/sub-NPPTL.html> to receive email notifications relevant to PPE

To request additional information about this report, contact NPPTL at ppeconcerns@cdc.gov, and reference NIOSH Task Number 25514 in your request.

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Appendix: Photographs to Support Inspection Findings for SCBA

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Figure 3: Front of facepiece



Figure 4: Inside of facepiece



Figure 5: Mask-mounted regulator



Figure 6: Inside seal of mask-mounted regulator and HUD



Figure 7: Low-pressure hose



Figure 8: Low-pressure hose quick disconnect



Figure 9: Pressure reducer, outside view



Figure 10: Pressure reducer, inside view



Figure 11: Cylinder attachment and RIC UAC connector



Figure 12: RIC UAC dust cover removed



Figure 13: High-pressure hose from cylinder attachment to reducer



Figure 14: PASS control console



Figure 15: SEI label on back of PASS control console, 1998 edition



Figure 16: PASS control module under cylinder attachment and CBRN sticker on backframe



Figure 19: Overall of straps and buckles



Figure 20: Overall of cylinder



Figure 21: Modal Acoustic Emission testing label and refurbished supplier label



Figure 22: Cylinder valve assembly

Disclaimer

These evaluations are done to determine if the SCBA was a contributing factor to the incident. Several performance tests are selected from the complete list of 42 CFR Part 84 requirements and each respirator is tested in its “**as received**” condition to determine its conformance to those performance requirements.

To gain additional information about its overall performance, each respirator may also be subjected to other recognized test parameters, such as those within National Fire Protection Association (NFPA) consensus standards. While the test results give an indication of the respirator’s conformance to the NFPA certification requirements, NIOSH does not actively correlate the test results from its NFPA test equipment with those of certification organizations which list NFPA-compliant products. Thus, the NFPA test results are provided for information purposes only.

Tests are conducted only after it has been determined that each respirator is in a condition that is safe to be pressurized, handled, and tested. Respirators whose condition has deteriorated to the point where the health and safety of NIOSH personnel and/or property is at risk will not be tested.

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the National Institute for Occupational Safety and Health. Mention of any company or product does not constitute endorsement by NIOSH.

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Centers for Disease Control
and Prevention
National Institute for Occupational
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