

PPE CASE



Personal Protective Equipment Conformity Assessment Studies and Evaluations

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

Howard County Department of Fire and Rescue Services Request for a MSA Model G1

At the request of the Howard County Department of Fire and Rescue Services, NIOSH's National Personal Protective Technology Laboratory (NPPTL) inspected and evaluated the Self-Contained Breathing Apparatus (SCBA) involved in a fatal event at a structure fire.

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 while operating at a structure fire. The SCBA used was a MSA Model G1, 4500 psi, 45 minute unit. The Howard County Department of Fire and Rescue Services was advised that NIOSH NPPTL would provide a written report of the investigation and any applicable test results.

NIOSH evaluated a SCBA involved in a fatal event while the fire fighter operated at a structure fire. The SCBA was not found to contribute to the fatality.

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.

What NIOSH Did to Protect the Worker

Upon receipt of the SCBA, NPPTL managed the custody of evidence throughout the entire 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. NIOSH assigned Task Number TN-22491 to identify the unit. 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) Airflow 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 fatal event, NPPTL would have engaged in corrective action to ensure that no other users of the product would experience a fatal event. In this case, no such corrective action was necessary. NPPTL then managed the disposition of the SCBA.

Chain of Custody

The SCBA unit was delivered by NIOSH investigators, from DSR, who were assigned to investigate the Howard County Department of Fire and Rescue Services fatal event. They delivered the unit to Lab H1513 for secure storage at the NIOSH facility in Morgantown, West Virginia on August 20, 2018. The SCBA unit remained in secure storage in Lab H1513 throughout the inspection and testing process.

SCBA Inspection

On August 23, 2018, NPPTL employees Jay Tarley and Angie Andrews inspected the SCBA unit. These employees identified the SCBA as a Howard County Department of Fire and Rescue Services SCBA and visually examined the device, component by component, in the condition received to determine the conformance of the unit to the NIOSH-approved configuration. The unit was a MSA Model G1, 4500 psi, 45 minute unit; with NIOSH Approval Numbers TC-13F-0798CBRN.

As received (pictured below) SCBA unit

- SCBA unit was hand delivered to Lab H1513 by NIOSH DSR investigators
- Cylinder was received with 2250 psi and closed
- Bypass was closed
- Mask-mounted regulator (MMR) was securely connected to the low pressure line
- Facepiece was included



Figure 1: SCBA as received

Components and Observations for SCBA (Figure 1) (“Right” or “left” are from the user’s perspective) (see Figures in Appendix)

Facepiece (Figures 2-5)

- Facepiece seal P/N: 10161810; M/N: 7-2771-1: CE 0168 EXLLC; EN 136 1998 CL3+
- Nosecup MFG date: 8/14
- Overall condition: fair, dirty with scratches
- Lens was crazed and dirty
- Upper lens ring had molten debris on it
- Lens retaining ring was intact
- MMR housing was clean and in good condition
- HUD was present and intact
- Hairnet was in good condition with dirt present
- All straps and buckles functioned properly

Mask Mounted Regulator (MMR) (Figure 6-8)

- MMR label on front: MSA; M/N: 7-2779-1
- Overall condition was dirty with signs of heat damage
- MMR was secured to low pressure line
- Bypass closed
- Inside flange had normal wear and in good condition
- Sealing area was fair and slightly dirty
- Regulator could be attached and removed
- Outer rubber casing had physical heat damage

Low Pressure Regulator Hose (Figures 8-9)

- Secured at all attachment points
- Line was in good condition
- Line passed through the shoulder strap to the reducer

Pressure Reducer Assembly (Figure 10-11)

- Overall condition was good
- All airline connections were secure
- All lines going to the pressure reducer were in good condition
- 4500 Psi; 2115380

PASS Control Module (Figures 12-14)

- Lines to control module looked good
- Gauge lens was readable
- Protective casing was good and in place
- M/N 2816-1

High Pressure Hose and Cylinder Attachment (Figures 15-17)

- High pressure S/N: 7-2844-1 DP
- High pressure line had heat damage, dirty
- Cylinder quick connect attachments were dirty; rubber wheel was burnt

ExtendAire II EBSS (Emergency Breathing Support System (18-21)

- Quick Connect snap tite 9847-22; 3715
- Fair condition; covered with soot

Quick-Fill line (22-24)

- FD 17 series
- HCFD; sticker 10-14
- Sleeve is frayed

PASS Power Module (Figures 25-26)

- SEI label:05-2015; 10148687 4500 psi; RFID
- PASS met requirements of NFPA 1982: Standard on Personal Alert Safety Systems (PASS) 2013 edition
- FCC ID P9R 10154953, RPN 10069330
- SCBA containing power module M/N 7-2810-1
- Overall condition was good, but very dirty with debris and melted in spots
- Held securely to backframe
- Power module battery was unattached, looked good with dirt

Backframe Assembly (Figures 27-28)

- S/N: 7-N/A
- SEI label 1981-2013 edition
- NIOSH Approval Number label: TC-13F-0798CBRN
- FD label with E 101C
- Overall condition was fair
- Extensive heat damage to left railing and right top
- Soot and debris were found everywhere
- Shoulder straps were attached to the frame

Straps and Buckles (Figures 29-30)

- Overall condition of straps was good, but dirty
- Hose lines passed through shoulder straps
- All adjustable buckles moved and held in place
- Waist area buckle latched

Compressed Air Cylinder and Cylinder Valve Assembly (Figures 31-32)

- DOT-SP 10915-4500; TC-SU-5134-310; OM 164301
- Luxfer P/N L65M-122; REE 123
- MSA M/N 7-1348-1
- Hydrostatic date: ?/2015; 45 minute, 4500 PSI
- Received with 2250 psi
- Overall condition was poor with heat damage
- Gauge was not readable
- Threads were good; attached to the threads was the male quick connect
- O-ring was present and in good condition
- Rubber bumper at base of cylinder valve was in good condition

SCBA Testing

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

**A replacement cylinder was used for testing due to damaged cylinder gauge on corresponding cylinder and a replacement facepiece was used for Run #2 on the Positive Pressure and Rated Service Time Test.*

Table 1. Summary of results from testing SCBA unit against established NIOSH SCBA certification tests.

NIOSH Tests	Description of Results	PASS/ FAIL
<p>Positive Pressure Test - NIOSH Standard 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 liters 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>Run #1 The unit did not meet the test requirement during the first run (details of test are in the synopsis of findings section).</p> <p>Run #2 The unit met the test requirements the entire second run. The inhalation breathing resistance did not become negative during the test. The PASS, digital remote and HUD were all functional. Run #2 results are recorded here.</p> <p>Inhalation Breathing Resistance: (inches of water column) = 0.34</p>	<p>PASS</p>
<p>Rated Service Time Test - NIOSH Standard 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 liters 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 during both Run #1 and #2. The measured service time (adjusted to correspond with the recorded breathing cycles) was more than the rated service time of 45 minutes. The SCBA did not go negative on inhalation during Run #2; therefore, maintained positive pressure in the facepiece. The PASS functioned. Run #2 results are recorded here.</p> <p>Measured Service Time: 46 Minutes 38 Seconds</p>	<p>PASS</p>

<p>Static Pressure Test - NIOSH Standard Test Procedure Number 122, 42 CFR Part 84 Reference: Subpart H, § 84.91 (d) Requirement: <i>The static pressure (at zero flow) in the facepiece shall not exceed 38 mm (1.5 inches) water column height.</i> 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)= 1.22</p>	<p>PASS</p>						
<p>Gas Flow Test - NIOSH Standard Test Procedure Number 123, 42 CFR Part 84 Reference: Subpart H, § 84.93 (b) and (c) 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 gauge pressure in the facepiece.</i> 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="0"> <tr> <td>Applied Pressure</td> <td>Airflow (liters per minute)</td> </tr> <tr> <td>4500 psig</td> <td>374.1</td> </tr> <tr> <td>500 psig</td> <td>300.2</td> </tr> </table>	Applied Pressure	Airflow (liters per minute)	4500 psig	374.1	500 psig	300.2	<p>PASS PASS</p>
Applied Pressure	Airflow (liters per minute)							
4500 psig	374.1							
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<p>Exhalation Resistance Test - NIOSH Standard Test Procedure Number 122, 42 CFR Part 84 Reference: Subpart H, § 84.91 (c) 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> Procedure: The facepiece is mounted on an anthropometric head form. A probe in the head form is connected to a slant manometer for measuring exhalation breathing resistance. The airflow 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)= 2.19 Static Pressure: (inches of water column)= 1.22 Difference: (inches of water column)= 0.97</p>	<p>PASS</p>						

<p>Remaining Service Life Indicator Test - NIOSH Standard Test Procedure Number 124, 42 CFR Part 84 Reference: Subpart H, § 84.83 (f) 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> 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>The test requirement was identified on the label as 33% - 37% of its remaining rated service time.</p> <table border="1" data-bbox="1312 284 1911 609"> <thead> <tr> <th></th> <th>Electrical</th> <th>Bell</th> </tr> <tr> <th>Run #</th> <th>Alarm Point (psi)</th> <th>Alarm Point (psi)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>1650</td> <td>1640</td> </tr> <tr> <td>2</td> <td>1660</td> <td>1640</td> </tr> <tr> <td>3</td> <td>1620</td> <td>1610</td> </tr> <tr> <td>4</td> <td>1650</td> <td>1640</td> </tr> <tr> <td>5</td> <td>1660</td> <td>1660</td> </tr> <tr> <td>6</td> <td>1560</td> <td>1660</td> </tr> <tr> <td>Average</td> <td>1633</td> <td>1642</td> </tr> </tbody> </table>		Electrical	Bell	Run #	Alarm Point (psi)	Alarm Point (psi)	1	1650	1640	2	1660	1640	3	1620	1610	4	1650	1640	5	1660	1660	6	1560	1660	Average	1633	1642	<p>PASS PASS</p>
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National Fire Protection Association (NFPA) Test (in accordance with NFPA 1981, 2013 Edition):

<p>NFPA Test</p>	<p>Description of Results</p>	<p>PASS/ FAIL</p>
<p>NFPA Airflow Performance Test - NFPA 1981 (1997 Edition) Reference: Chapter 5, Performance Requirements, Sec. 5-1.1 Requirement: <i>SCBA shall be tested for airflow performance as specified in Section 6-1, Airflow 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> 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 this test. PASS unit, HUD, and Alarm system were all functional.</p> <p><i>*During initializing the PosiChek a message popped up stating exhalation valve could be sticky</i></p> <p>Maximum Facepiece Pressure: (inches of water column)= 2.6 Minimum Facepiece Pressure: (inches of water column)= 0.18</p>	<p>PASS PASS</p>

Disposition of SCBA

Following testing on September 11, 2018, the SCBA unit 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 MSA Model G1, 45 minute, 4500 psi unit with NIOSH Approval Numbers TC-13F-0798CBRN. The corresponding facepiece and cylinder were provided with the unit. A cylinder, not involved in the incident, was provided by the fire department for testing. Overall, the SCBA was in fair condition with some heat damage and soot found on the straps, as well as melted debris. The NFPA approval label was present and readable. The PASS, HUD, and alarm systems functioned as designed.

The SCBA did not meet the test requirement of the NIOSH Positive Pressure Test during the first run. The inhalation breathing resistance was negative (-.25) for the first 10 minutes of the test then became positive and stayed positive the remainder of the test. This could possibly be explained by a piece of debris jarring loose from pressure of the air.

The unit was tested again and met the test requirements of the NIOSH Positive Pressure Test, as the SCBA maintained a positive pressure for the 45 minute minimum duration of the test. The unit passed all of the other NIOSH tests, as well as meeting the requirements of the NFPA “Airflow Performance” test.

In light of the information obtained during this investigation, NIOSH NPPTL has proposed no further action on its part at this time. The SCBA was returned to the shipping container to be shipped back to the Howard County Department of Fire and Rescue Services.

CASE Conclusion

No evidence was identified to suggest that the SCBA unit inspected and evaluated contributed to the fatality. NIOSH determined that there was no need for corrective action with regards to the approval holder or users of SCBAs manufactured under the approval numbers granted to these products.

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

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

Actions the 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 22491 in your request.

For more information related to personal protective equipment, visit the NIOSH website www.cdc.gov/niosh/npptl.

To receive documents or other information about occupational safety and health topics, contact NIOSH:

Telephone: 1–800–CDC–INFO (1–800–232–4636)

TTY: 1–888–232–6348

CDC INFO: www.cdc.gov/info

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Appendix Photographs to Support Inspection Findings for SCBA

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Figure 2: Front of facepiece



Figure 3: Inside facepiece



Figure 4: Labeling on facepiece seal



Figure 5: Facepiece hairnet and straps



Figure 6: Mask mounted regulator with signs of heat damage



Figure 7: Inside of mask mounted regulator



Figure 8: Mask mounted regulator and low pressure line connected to SCBA

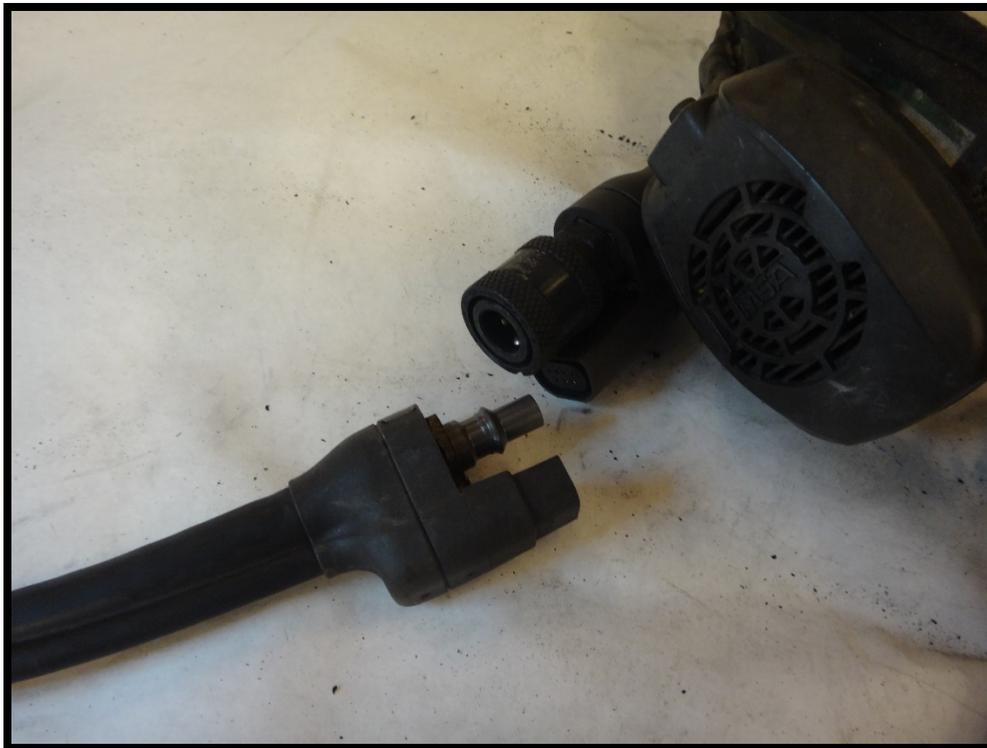


Figure 9: Low pressure line disconnected from intermediate pressure hose



Figure 10: Pressure reducer, RIC UAC with primary low pressure warning device (bell)



Figure 11: Bottom view of pressure reducer assembly



Figure 12: PASS control module and medium pressure line



Figure 13: Front of PASS control module



Figure 14: Back of PASS control module



Figure 15: High pressure hose and cylinder attachment



Figure 16: Top view of high pressure hose



Figure 17: Cylinder attachment and Quick Connect adapter



Figure 18: ExtendAire II EBSS (Emergency Breathing Support System)



Figure 19: ExtendAire II EBSS hose with male and female Quick Connect

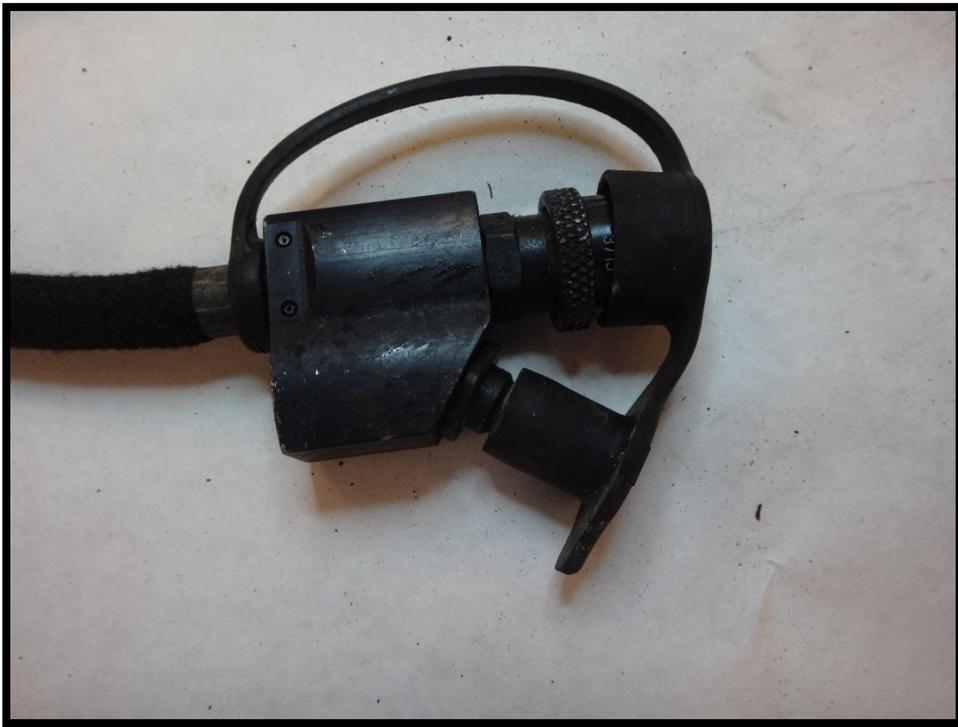


Figure 20: Male and female Quick Connect



Figure 21: Quick Connect cover removed to show markings



Figure 22: Quick-Fill pouch



Figure 23: Quick-Fill hose



Figure 24: Quick-Fill hose with covers off

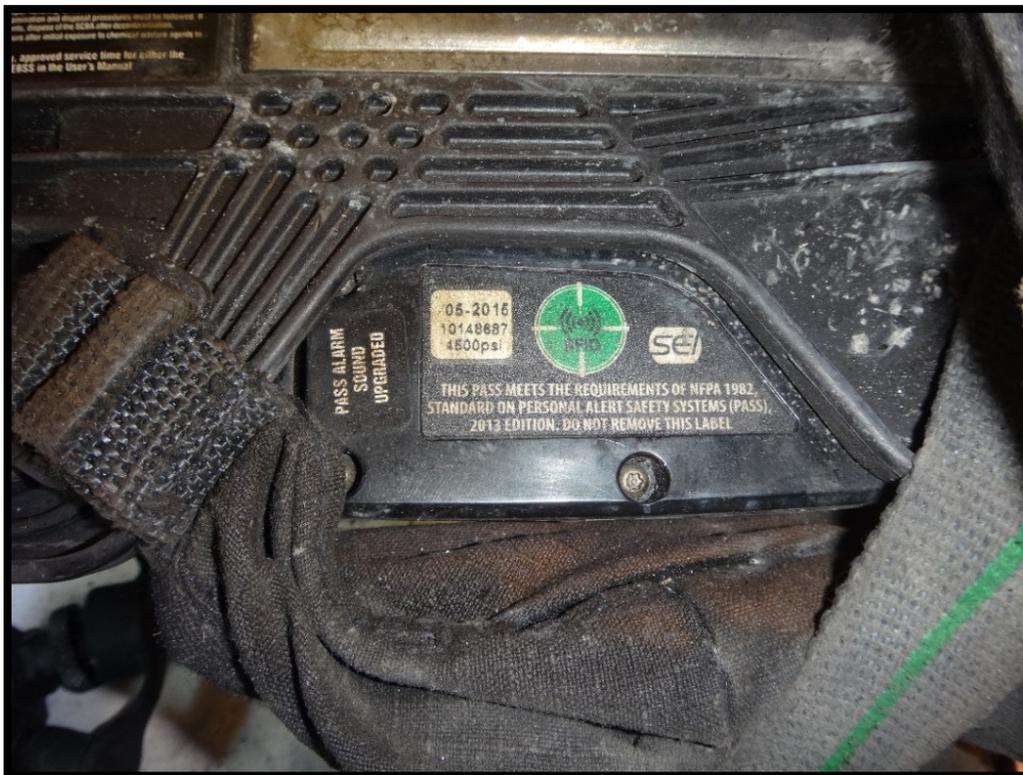


Figure 25: PASS power module SEI label



Figure 26: Power module MSA label



Figure 27: Back of backframe with labels



Figure 28: Cylinder strap and heat damage to side rail



Figure 29: Overview of straps and cylinder connected to SCBA



Figure 30: Overview of waist belt, straps, and buckles



Figure 31: Cylinder gauge



Figure 32: Top view of cylinder with labeling

Disclaimer

The purpose of this effort was to determine the conformance of a respirator to the NIOSH approval requirements found in Title 42, *Code of Federal Regulations*, Part 84. A number of performance tests are selected from the complete list of Part 84 requirements and each respirator is tested in its “**As received**” condition to determine its conformance to those performance requirements. Each respirator is also inspected to determine its conformance to the quality assurance documentation on file at NIOSH.

In order to gain additional information about its overall performance, each respirator may also be subjected to other recognized test parameters, such as National Fire Protection Association (NFPA) consensus standards. While the test results give an indication of the respirator’s conformance to the NFPA approval 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.

Selected 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.

