

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 and Conducting Overhaul

Watertown Fire Department Request for a Scott® Safety Air-Pak Model X3

At the request of the Watertown Fire Department, 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 and conducting overhaul. The SCBA used was a Scott® Safety Air-Pak Model X3, 30-minute, 4500 psi unit. The Watertown Fire Department was advised that NIOSH NPPTL would provide a written report of the investigation and any applicable test results.

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 of the SCBA components and documented their findings with written and photographic evidence. NPPTL also tested the SCBA to determine conformance to NIOSH'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 fatality, 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 until it was returned to the fire department.

NIOSH evaluated an SCBA involved in a fatal event while the fire fighter operated at a structure fire and conducted overhaul. The SCBA was not found to contribute to the incident.

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.

Chain of Custody

The SCBA and compressed air cylinder, were delivered via UPS ground in a cardboard box to Lab H1513 at the NIOSH facility in Morgantown, West Virginia on September 27, 2018. The SCBA unit remained in secured storage in Lab H1513 throughout the inspection and testing process.

SCBA Inspection

On October 11, 2018, NPPTL employees Matt Duling and Jay Tarley inspected the SCBA unit. The SCBA was identified as belonging to the Watertown Fire Department and 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 X3, 30-minute, 4500 psi unit, with NIOSH Approval Number TC-13F-0713CBRN.

As Received

- SCBA was delivered by UPS ground in a cardboard box to Lab H1513
- SCBA was in good shape
- A cylinder was included and was empty
- A mask was included
- The donning switch was on, with regulator intact
- Bypass was half open



Figure 1: SCBA as received



Figure 2: SCBA as received

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

Facepiece AV 3000 (Figures 3-5)

- Facepiece seal P/N: 31001740; Large; MFG date: 01/2016
- Nosecup P/N: 201128; Size: Large; MFG date: 4th Q 2015
- Retaining ring top MFG date: 10/2015; P/N: 31002809; bottom MFG date 2/2016, P/N 31002810, Lot # 021016, FT1006
- Lens P/N: 805337-13/-33/-36; MFG date: 03/2014
- Overall condition was good, with minimal scratches
- Lens was good, with minimal scratches
- Hairnet condition was good, but dirty
- Hairnet straps were good, straps moved freely and held in place by buckle, held securely to facepiece
- Attachment points for straps were good
- The facepiece seal was in good condition
- Regulator interface area was in good condition

Mask Mounted Regulator (MMR) (Figures 6, 7)

- Vibralert with Heads-Up Display (HUD)
- Regulator assembly P/N, S/N and MFG date: present P/N 200077-58, S/N 115S1619010318, 2013 LH X3 CGA, MFG date 05/11/16
- Other markings; 1-13, 1-16, 7-14 and 10-15 scribed on inside flange FT 837, A2Q 16
- Overall condition was good
- Outer case was good and front label was good
- Donning switch was on
- Bypass found halfway open, bypass knob was good
- Sealing area was good with no signs of fraying around the edge, had minimal scratches
- Locking assembly functioned
- HUD fully intact

Low Pressure Regulator Hose (Figures 8, 9)

- P/N: 31001446
- Overall condition was good
- No quick disconnect

Pressure Reducer Assembly (Figures 10 -12)

- P/N: 201030-02
- S/N 115S1619011475
- MFG date: 5/11/16
- Overall condition was good, slightly dusty
- All airline connections were secure with no sign of heat damage

High Pressure Hose and Cylinder Attachment (Figures 13 - 15)

- Overall condition was good. No signs of heat damage on inside of high-pressure line attachment rubber cover.
- Cylinder attachment threads were good and O-ring in place
- RIC/UAC system connector markings: not visible
- RIC/UAC system connector cover in good condition
- Additional marking on side of high pressure attachment: FT 988

PASS Console Assembly (Figures 16, 17)

- X3 console assembly, PASS 4500, 1/3
- Scott label: P/N 201110-11, S/N 115S1618013477, MFG Date 5/4/16
- Overall condition was good, slightly dirty
- Lines in good shape—pressure/electrical
- Gauge lens was good and readable
- Attachment not present
- SEI label present, 2013 edition

PASS Control Module with PAK-Alert (Figures 18 - 20)

- Scott P/N: 201160-02 with paktracker
- MFG date: 5/3/2016
- Overall condition was good, slightly dirty
- Held securely to backframe
- Wire connection connected to PASS device
- Wire held secure to backframe and connected to console assembly

Backframe Assembly (Figures 21, 22)

- SEI label P/N 201100-001, S/N 115S1619013089, MFG date 5/11/16
- NIOSH label TC-13F-0713CBRN
- Other marking: Two additional labels: ID00285613, WTN C201
- Overall condition was good, no bends or cracks in wire frame, or plate
- Shoulder straps were attached to the frame
- Cylinder strap latch was in good condition, functional

Straps and Buckles (Figures 23, 24)

- Overall strap condition was good
- Both shoulder straps were 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 was in good condition; no fraying showing

Compressed Air Cylinder and Cylinder Valve Assembly

(Figures 25 - 27)

Minute Duration: 30-minute

DOT –Number: DOT-ST 10915-4500

TC-3CCM-310

OK 550092

REE: 76

Scott P/N: 10009671

Scott logo visible Luxfer L45M-018

MFG date: 3/2016 4500 PSIG

- Overall condition was good as there were no surface scratches or dirt present (minimal)
- Gauge was readable
- Threads were clean
- As received, cylinder valve was fully closed with no air remaining
- Rubber bumper at base on cylinder valve was in good condition
- Rehydro label was present: 3/16
- S/N for assembly/cylinder 115S1617079169
- On Stem: 115A1617078920

SCBA Testing

The SCBA unit was tested using the six NIOSH test methods 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 Standard Test Procedure Number 120</p> <p>42 CFR Part 84 Reference: Subpart H, § 84.70 (a)(2)(ii)</p> <p>Requirement: <i>The pressure inside the facepiece in relation to the immediate environment is positive during both inhalation and exhalation.</i></p> <p>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 computer-based 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 and HUD did not function.</p> <p>Inhalation Breathing Resistance: (inches of water column) = 0.4</p>	<p>PASS</p>
<p>Rated Service Time Test - NIOSH Standard Test Procedure Number 121</p> <p>42 CFR Part 84 Reference: Subpart F, § 84.53 (a) and Subpart H, § 84.95 (a) and (b)</p> <p>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></p> <p>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 computer-based 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 did not go negative on inhalation; therefore, maintained positive pressure in the facepiece. 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 did not function.</p> <p>Measured Service Time: 32 Minutes 68 Seconds</p>	<p>PASS</p>

<p>Static Pressure Test - NIOSH Standard Test Procedure Number 122</p> <p>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) = 1.10</p>	<p>PASS</p>						
<p>Gas Flow Test – NIOSH Standard Test Procedure Number 123</p> <p>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 gauge 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="0" data-bbox="1304 721 1793 850"> <tr> <td>Applied Pressure</td> <td>Air Flow (liters per min.)</td> </tr> <tr> <td>4500 psig</td> <td>470 lpm</td> </tr> <tr> <td>500 psig</td> <td>606 lpm</td> </tr> </table>	Applied Pressure	Air Flow (liters per min.)	4500 psig	470 lpm	500 psig	606 lpm	<p>PASS PASS</p>
Applied Pressure	Air Flow (liters per min.)							
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<p>Exhalation Resistance Test - NIOSH Standard Test Procedure Number 122</p> <p>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 head form. A probe in the head form 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) = 1.94</p> <p>Static Pressure: (inches of water column) = 1.01</p> <p>Difference: (inches of water column) = 0.93</p>	<p>PASS</p>																											
<p>Remaining Service Life Indicator Test - NIOSH Standard Test Procedure Number 124</p> <p>42 CFR Part 84 Reference: Subpart H, § 84.83 (f) and Subpart G, § 84.63 (c)</p> <p>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>The test requirement was identified on the label as 33% - 37% of its remaining rated service time.</p> <table border="1" data-bbox="1287 678 1803 995"> <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>NA</td> <td>1540</td> </tr> <tr> <td>2</td> <td>NA</td> <td>1550</td> </tr> <tr> <td>3</td> <td>NA</td> <td>1550</td> </tr> <tr> <td>4</td> <td>NA</td> <td>1540</td> </tr> <tr> <td>5</td> <td>NA</td> <td>1540</td> </tr> <tr> <td>6</td> <td><u>NA</u></td> <td><u>1540</u></td> </tr> <tr> <td>Average</td> <td>0</td> <td>1543</td> </tr> </tbody> </table>		Electric	Vibralert	Run #	Alarm Point (psi)	Alarm Point(psi)	1	NA	1540	2	NA	1550	3	NA	1550	4	NA	1540	5	NA	1540	6	<u>NA</u>	<u>1540</u>	Average	0	1543	<p>FAIL 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 8, Performance Requirements, Section 8-1.1</p> <p>Requirement: <i>SCBA shall be tested for air flow performance as specified in Section 8.1, Air flow Performance Test, and the SCBA facepiece pressure shall not be less than 0.0 in. (0.0 mm) water column and not 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 equipment specified in the NFPA standards will be 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. PASS and HUD systems were not functional which caused the unit to fail the test.</p> <p>Maximum Facepiece Pressure: (inches of water column) = 2.2 Minimum Facepiece Pressure: (inches of water column) = 0.7</p>	<p>FAIL</p>

Disposition of SCBA

Following testing on October 12, 2018, 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 X3, 30-minute, 4500 psi unit with NIOSH Approval Number TC-13F-0713CBRN. A facepiece was provided with the unit. A cylinder was provided by the fire department for testing. Overall, the SCBA was in good condition. The NFPA approval label was present and readable. The PASS, HUD, and alarm systems did not function.

The unit did not pass the electronic part of the Remaining Service Life Indicator Test - NIOSH Standard Test Procedure Number 124, 42 CFR Part 84 Reference: Subpart H, § 84.83 (f) and Subpart G, § 84.63 (c) due to the HUD and electronic warning devices not working. The SCBA did meet the requirements of the NIOSH Positive Pressure Test (NIOSH Standard Test Procedure 120, 42 CFR Part 84 Reference: Subpart H, 84.70 (a)(2)(ii)) and the other NIOSH tests. It did not meet the requirements of the NFPA "Airflow Performance" test due to the HUD and PASS not operating.

In light of the information obtained during this investigation, NIOSH NPPTL suggests that the unit be sent back to the manufacturer to fix the HUD and electrical safety components. The SCBA was returned to the shipping container to be shipped back to the Watertown Fire Department.

If this unit is to be placed back in service, the SCBA must be 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. Typically, a flow test is required on at least an annual basis.

CASE Conclusion

This SCBA unit failed to pass all tests conducted by NIOSH. Per guidance in the Synopsis of Findings, it is recommended that the end user send the unit back to the manufacturer.

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

- Sign up for [NPPTL's Listserv](#) 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 22547 in your request.

For more information related to personal protective equipment, visit the NIOSH NPPTL website

<https://www.cdc.gov/niosh/npptl/>

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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: Facepiece hairnet



Figure 6: Mask mounted regulator



Figure 7: Inside seal of mask mounted regulator and HUD



Figure 8: Low pressure hose

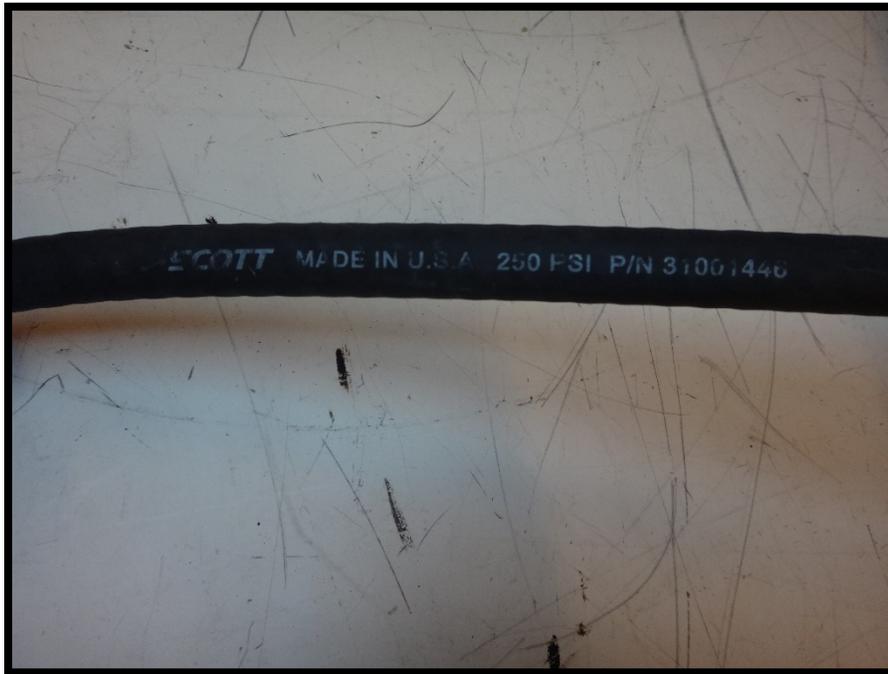


Figure 9: Low pressure hose manufacturer and part number



Figure 10: Pressure reducer, top view



Figure 11: Pressure reducer, label



Figure 12: Pressure reducer, low pressure connection



Figure 13: Cylinder attachment and RIC UAC connector

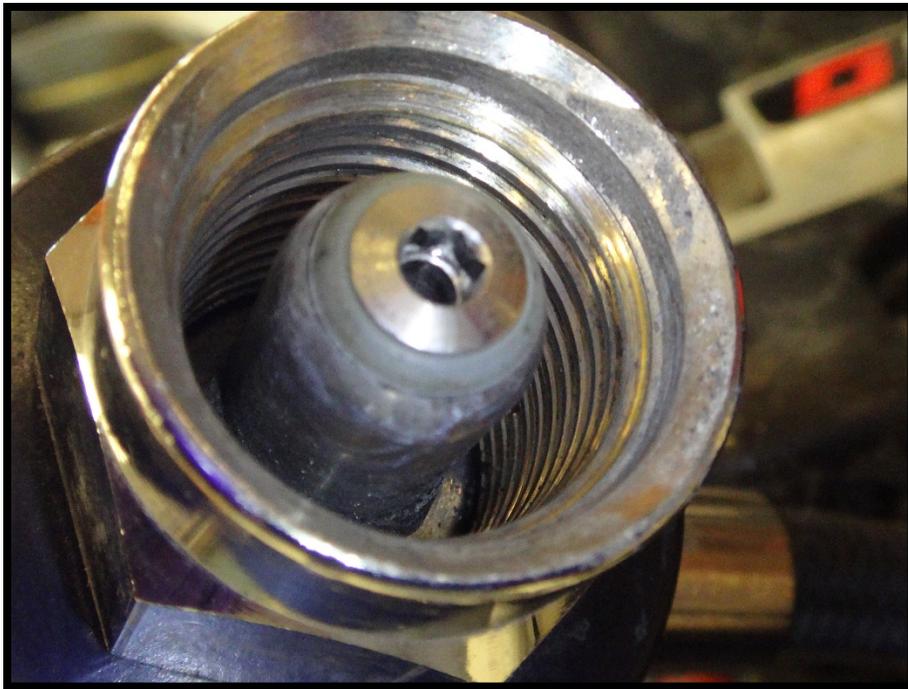


Figure 14: Cylinder attachment threads and O-ring

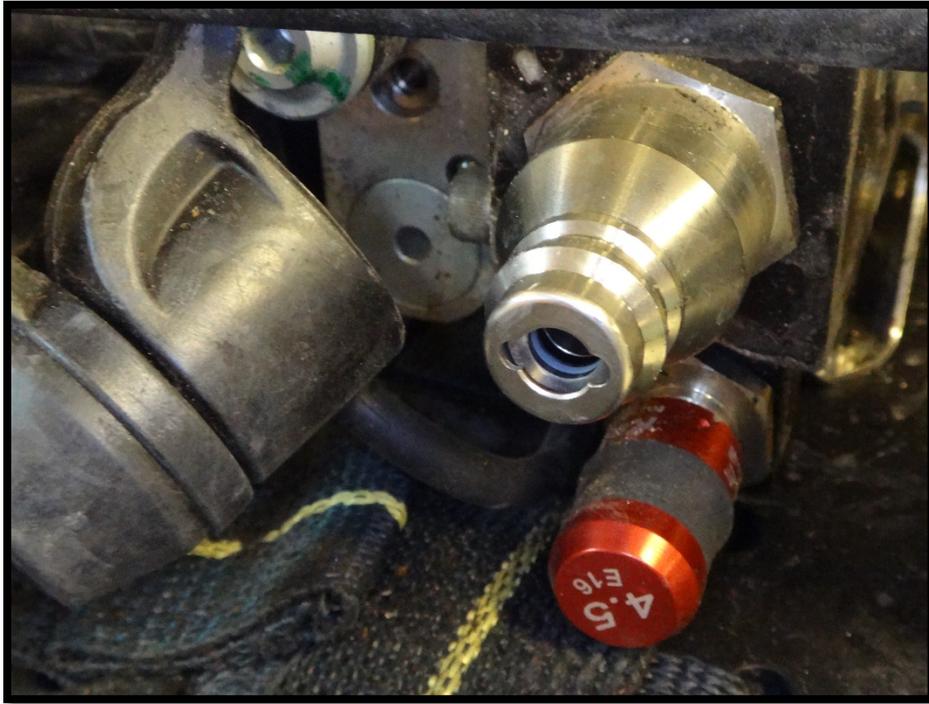


Figure 15: RIC UAC dust cover removed



Figure 16: PASS control console



Figure 17: SEI label on back of PASS control console, 2013 edition



Figure 18: PASS control module with sticker

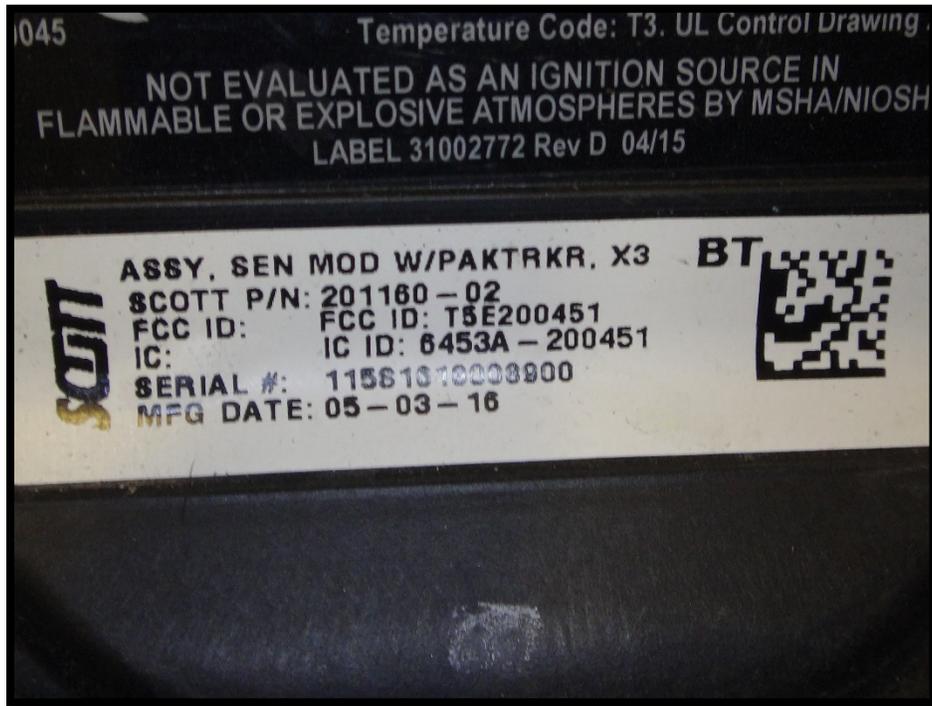


Figure 19: Manufacturer sticker on PASS control module



Figure 20: Wire connections to PASS control module



Figure 21: Backframe



Figure 22: Cylinder attachment

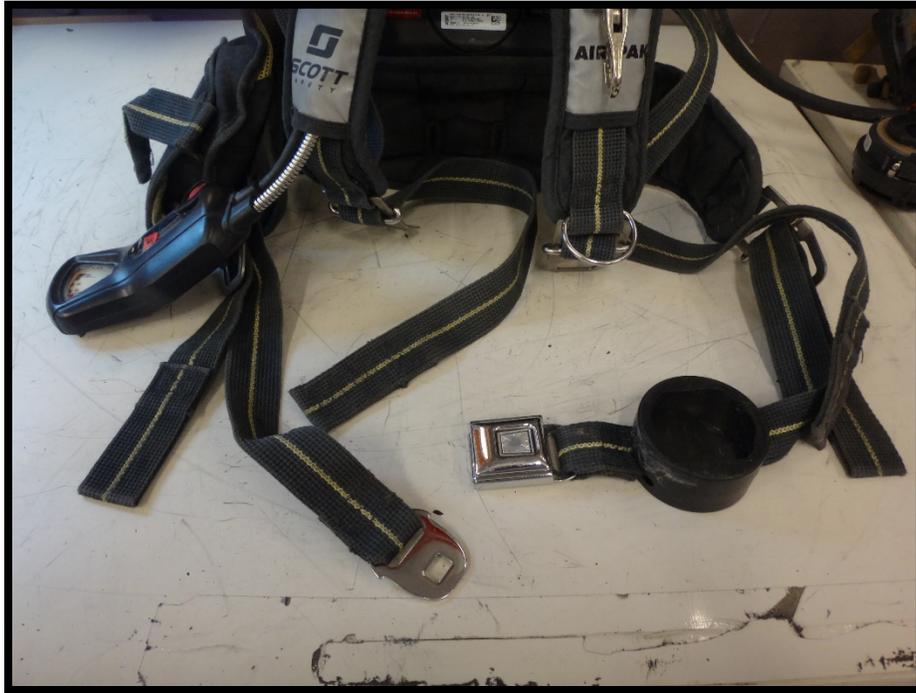


Figure 23: Straps and buckles on pack frame



Figure 24: Shoulder strap attachments



Figure 25: Compressed air cylinder



Figure 26: Gauge, threads, cylinder valve, and rubber bumper



Figure 27: Manufacturer's labels on stem and bottle

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.



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