PPE CASE

Personal Protective Equipment Conformity Assessment Studies and Evaluations

Evaluation of a Self-Contained Breathing Apparatus Involved in Near Miss During Live Fire Training with a Recruit at a State Academy

East Hartford Fire Department Request for a Scott® Safety Air-Pak 4.5

At the request of the East Hartford Connecticut Fire Department, NIOSH's National Personal Protective Technology Laboratory (NPPTL) inspected and evaluated the Self-Contained Breathing Apparatus (SCBA) used by a fire fighter during the live fire training evolution.

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 recruit of the Connecticut State Fire Academy. The SCBA used was a Scott® Safety Air-Pak Model 4.5 30 minute, 4500 psi unit. The East Hartford Fire Department was advised that NIOSH NPPTL would provide a written report of the investigation and any applicable test results.

NIOSH received a SCBA used by a recruit during a live fire training evolution at the state fire academy. 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.

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 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, without the air tank, was delivered via UPS ground in a cardboard box to Lab H1513 at the NIOSH facility in Morgantown, West Virginia on December 8, 2017. An air tank, which was not involved in the incident, was delivered via UPS ground in a cardboard box to Lab H1513 in the NIOSH facility in Morgantown, West Virginia on January 16, 2018. The SCBA unit remained in secured storage in Lab H1513 throughout the inspection and testing process.

SCBA Inspection

On December 12, 2017, NPPTL employee Jay Tarley inspected the SCBA unit. The SCBA was identified as belonging to the East Hartford Fire Department and was visually examined, component by component, in the condition received to determine the conformance of the units 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-212CBRN.

As Received

- SCBA was delivered by UPS ground in a cardboard box to Lab H1513
- SCBA was in fair shape with signs of dye sublimation on left shoulder straps
- A cylinder was not included
- The Donning switch was on, with regulator intact
- MMR was loose
- Bypass was closed
- Waist belts were tightened all the way

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, 4)

- Facepiece seal P/N: 31001740; Large; MFG date: 03/2016
- Nosecup P/N: 201128 1; Size: Large; MFG date: 1st Q 2015
- Retaining ring MFG date: 04/2015; P/N: 31002809; right side MFG date 10/2015, left side MFG date 02/2016
- Lens P/N: 805337-13/-33/-36; MFG date: 12/2015
- Overall condition good, some scratches
- Lens was good, with scratches
- Hairnet was fair, but dirty
- Hairnet straps 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 5, 6)

- AirPak Plus with Vibralert and with Heads-Up Display (HUD)
- Regulator assembly P/N, S/N and MFG date: unreadable
- Other markings; A3Q15 stamped; 099X scribed/written
- Overall condition fair
- Outer case fair and front label was fair with scratches
- Donning switch was on and was in good condition
- Bypass found closed, bypass knob was dirty and scratched
- Sealing area dirty with no signs of fraying around the edge, had minimal scratches
- Regulator could be attached and removed
- Locking assembly functioned
- HUD fully intact

Low Pressure Regulator Hose (Figures 7, 8)

- P/N: N/A
- Overall condition was good
- Does not have a Quick Disconnect

Pressure Reducer Assembly (Figures 9 - 10)

- P/N: 802220-04
- S/N 115S0735001406
- MFG date: 08-??
- Overall condition was fair
- All airline 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
- RIC/UAC system connector cover in good condition.

Auxiliary Hose (Figures 14 - 16)

- Auxiliary hose was in pouch, in good condition
- Female end of auxiliary hose stuck in open position
- Auxiliary hose cover attached, operational and in good condition

PASS Console Assembly (Figures 17, 18)

- Scott label with MFG info not present
- Overall condition good
- Lines in good shape—pressure/electrical
- Gauge lens good and readable
- Protective casing good with attachment
- SEI label present, 1998 edition

PASS Control Module with PAK-Alert (Figures 19 - 21)

- Scott P/N: 805898-03
- Scott S/N: N/A
- MFG date: N/A
- Label on back 805794-02; 02191; Apr 06
- 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 22 - 25)

- P/N: 804415-11; S/N: N/A
- SEI label readable; NFPA 1981 2002 edition
- NIOSH Approval Number TC-13F-212CBRN
- Other marking: C-22 white/black sticker
- Fire Tech and Safety flow test date sticker: January 2017
- NIOSH white/black CBRN approval sticker
- Overall condition good, no bends/cracks in wire frame, or plate
- Shoulder straps were attached to the frame
- Cylinder strap latch good condition, functional

Straps and Buckles (Figure 26 - 28)

- Overall strap condition good with significant dye sublimation to the left side—shoulder strap and auxiliary hose pouch
- 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
- Waist buckle was tightened as far as it could go
- Lumbar strap in good condition; a spot of dye sublimation at left waist adjustment buckle

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
Positive Pressure Test - NIOSH Test Procedure Number 120 42 CFR Part 84 Reference: Subpart H, § 84.70 (a)(2)(ii) **Requirement:** *The pressure inside the facepiece in relation to the immediate environment is positive during both inhalation and exhalation.* **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.	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) = 0.16**	**PASS**
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:** *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.* **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.	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, 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 functioned. **Measured Service Time:** **33 Minutes 87 Seconds**	**PASS**

Static Pressure Test - NIOSH Test Procedure Number 122 42 CFR Part 84 Reference: Subpart H, § 84.91 (d) **Requirement:** *The static pressure (at zero flow) in the facepiece shall not exceed 38 mm. (1.5 inches) water-column height.* **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.	The SCBA met the test requirement. **Facepiece Static Pressure: (inches of water column) = 0.88**	**PASS**
Gas Flow Test - NIOSH Test Procedure Number 123 42 CFR Part 84 Reference: Subpart H, § 84.93 (b) and (c) **Requirement:** *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.* **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.	The SCBA met the test requirement. **Applied Pressure** — **Air Flow (liters per min.)** **4500 psig** — **481.4** **500 psig** — **495.5**	**PASS** **PASS**

Exhalation Resistance Test - NIOSH Test Procedure Number 122 42 CFR Part 84 **Reference: Subpart H, § 84.91 (c)** **Requirement:** *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.* **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.	The SCBA met the test requirement. **Exhalation Breathing Resistance: (inches of water column) = 1.80** **Static Pressure: (inches of water column) = 0.88** **Difference: (inches of water column) = 0.92**	**PASS**
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:** *Each remaining service life indicator or warning device shall give an alarm when the remaining service life of the apparatus is reduced within a range of 20 to 25 percent of its rated service time or pressure.* *This requirement is modified under § 84.63(c) as follows: For apparatus which do not have a method of manually turning off remote gage in the event of a gage or gage line failure the remaining service life indicator is required to be set at 25% ± 2% of the rated service time or pressure.* **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.	As these SCBA models do not have a remote gauge shutoff, the test requirement is 25% +/- 2 % **Run # / Electric Alarm Point (psi) / Vibralert Alarm Point(psi)** **1 — 1130 — 1100** **2 — 1130 — 1100** **3 — 1130 — 1100** **4 — 1130 — 1100** **5 — 1130 — 1100** **6 — 1130 — 1100** **Average — 1130 — 1100**	**PASS** **PASS**

National Fire Protection Association (NFPA) Test (in accordance with NFPA 1981, 2013 Edition):

NFPA Test	Description of Results	PASS/ FAIL
NFPA Air Flow Performance Test—NFPA 1981 (2013 Edition) Reference: Chapter 5, Performance Requirements, Section 5-1.1 **Requirement:** *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.* **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.	The SCBA passed this test. PASS, HUD, and alarm systems were functional. **Maximum Facepiece Pressure: (inches of water column) = 2.65** **Minimum Facepiece Pressure: (inches of water column) = 0.60**	**PASS** **PASS**

Disposition of SCBA

Following testing on January 19 and January 24, 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 4.5, 30 minute, 4500 psi unit with NIOSH Approval Number TC-13F-212CBRN. A corresponding facepiece was provided with the unit. A cylinder, not involved in this incident, 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 functioned as designed.

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 of the other NIOSH tests.

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 East Hartford Fire Department.

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 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 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 21618 in your request.

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Appendix: Photographs to Support Inspection Findings for SCBA .

List of Figures

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

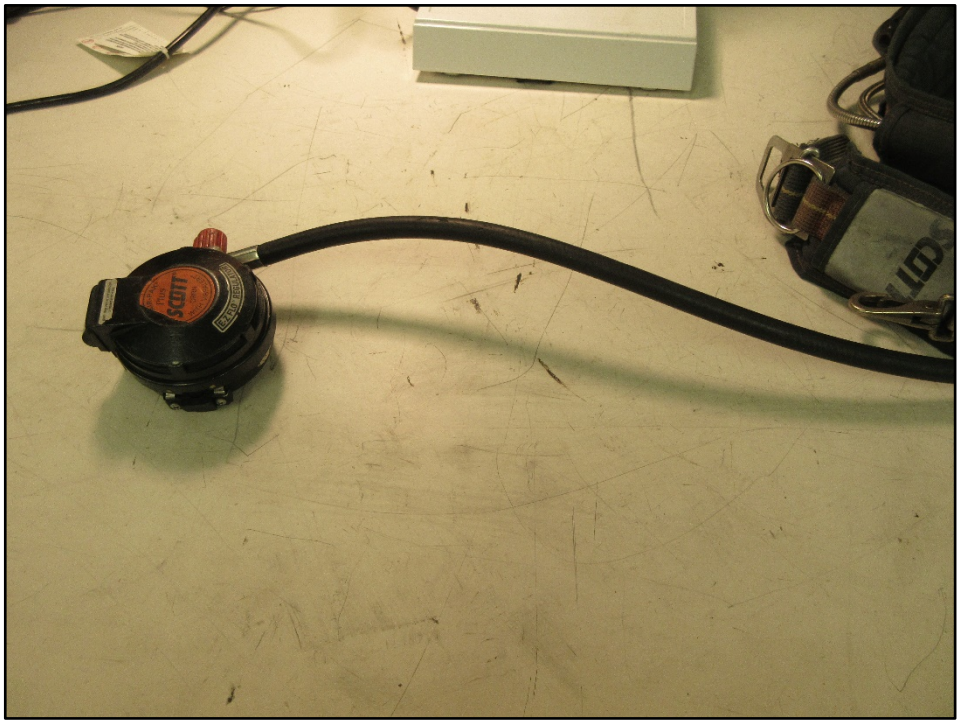

Figure 7: Low pressure hose

Figure 8: Low pressure hose through shoulder strap

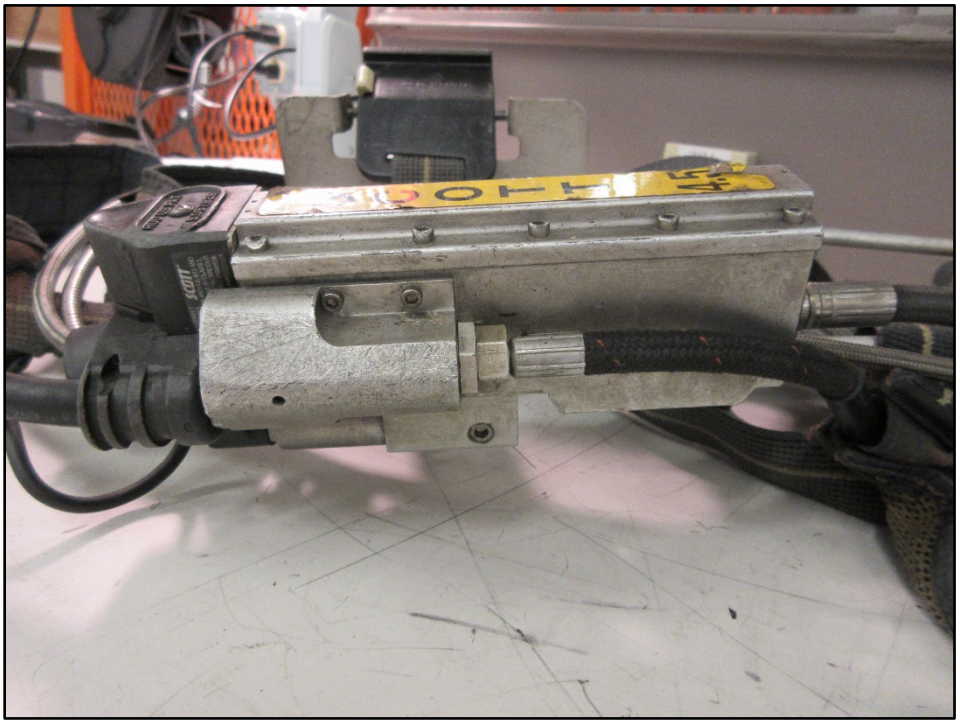

Figure 9: Pressure reducer, outside view

Figure 10: Pressure reducer, inside view

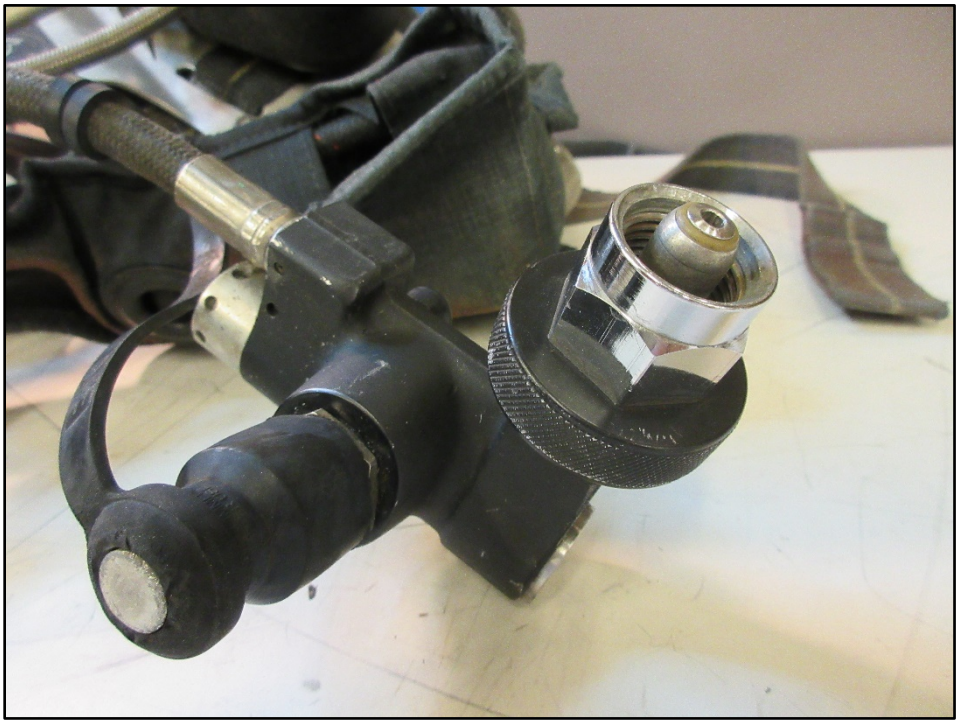

Figure 11: Cylinder attachment and RIC UAC connector

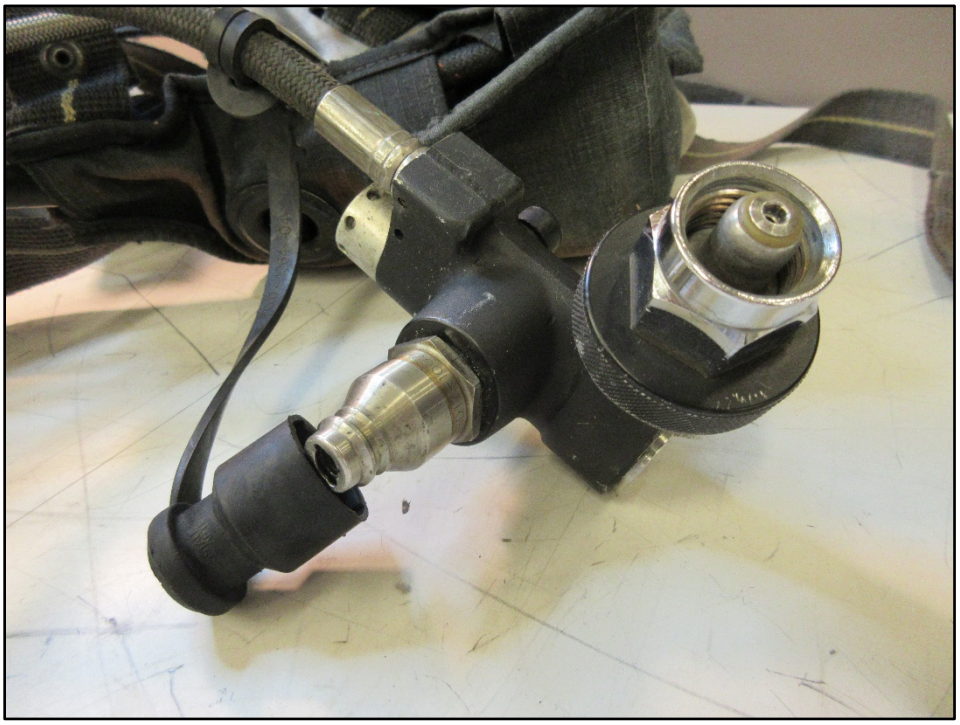

Figure 12: RIC UAC dust cover removed and cylinder attachment O-ring

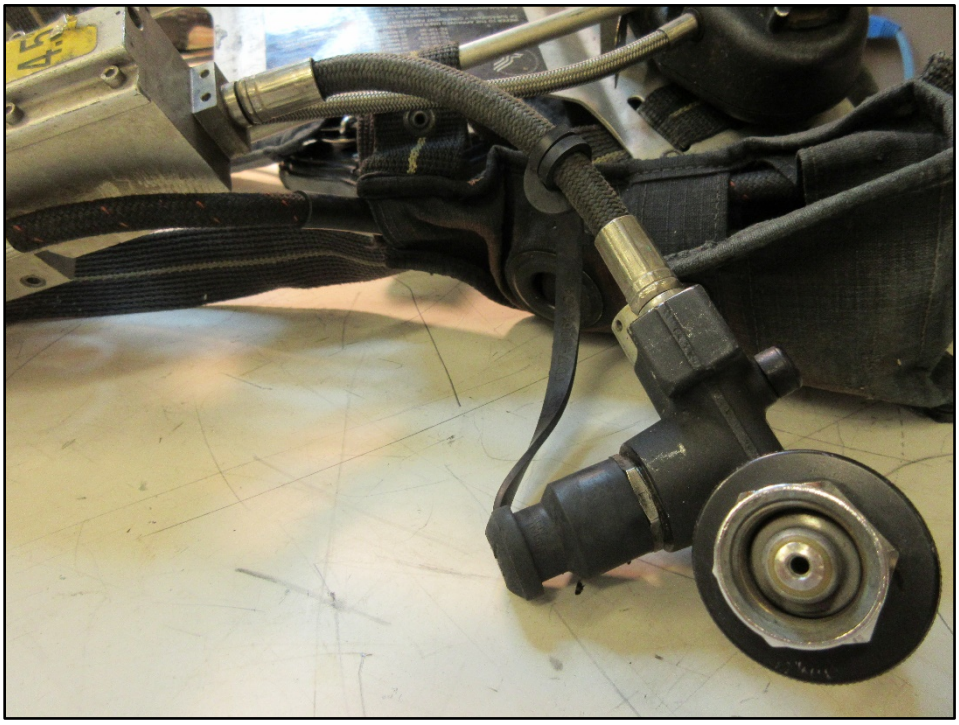

Figure 13: High pressure hose from cylinder attachment to reducer.

Figure 14: Auxiliary hose pouch

Figure 15: Auxiliary hose connectors with dust hood removed

Figure 16: Female adapter stuck in open position

Figure 17: PASS control console

Figure 18: SEI label on back of PASS control console, 1998 edition

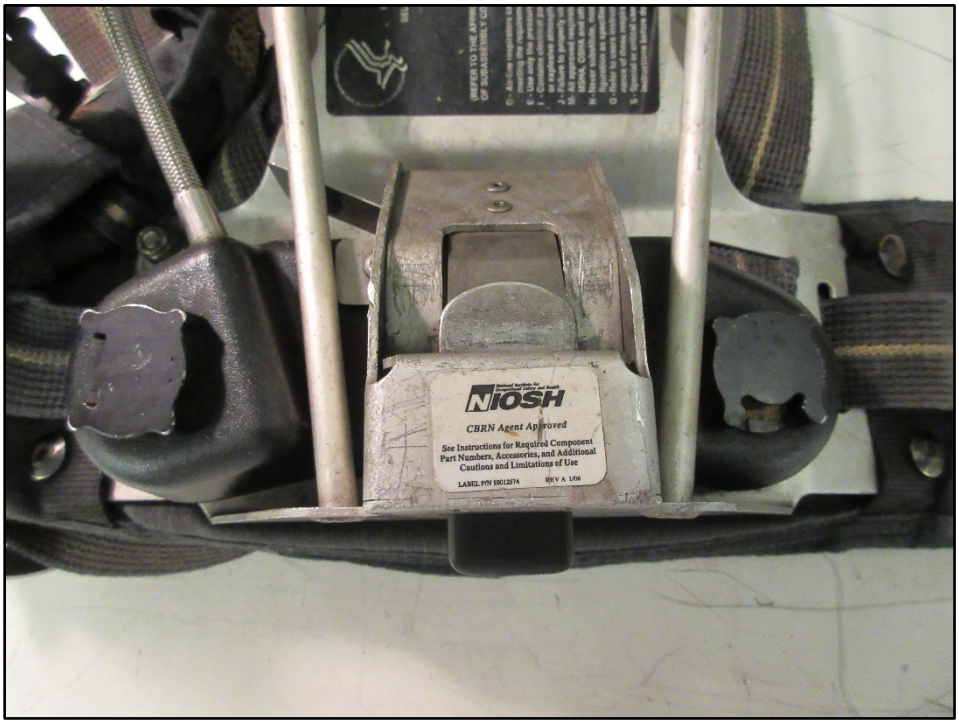

Figure 19: PASS control module under cylinder attachment and CBRN sticker on backframe

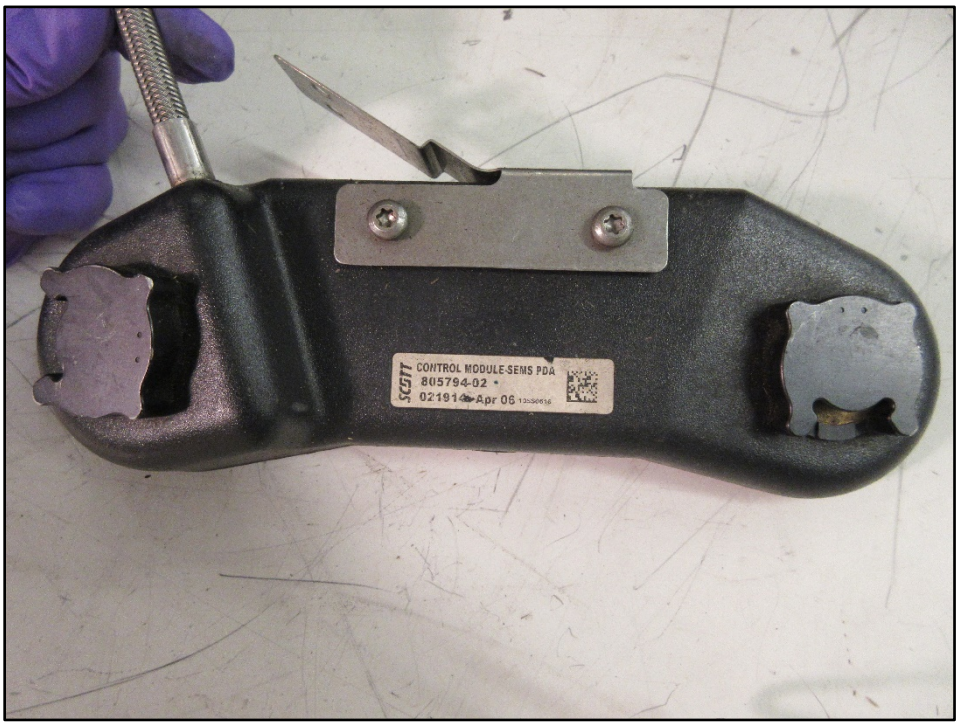

Figure 20: Front of PASS Control module

Figure 21: Back of PASS control module

Figure 22: Overall of backframe

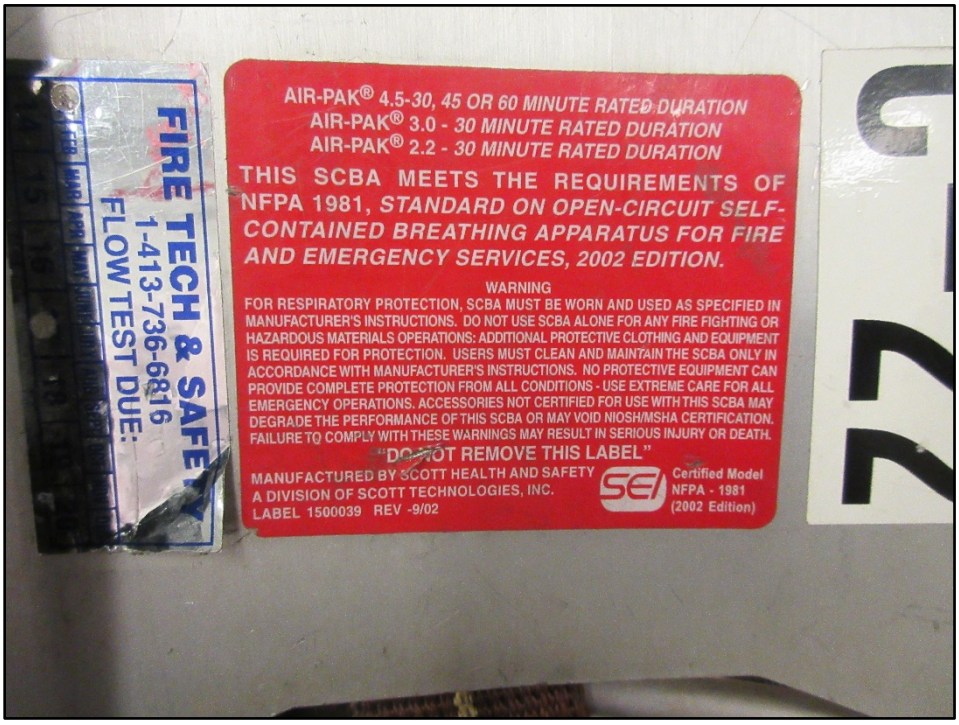

Figure 23: SEI label on inside of backframe, 2002 edition

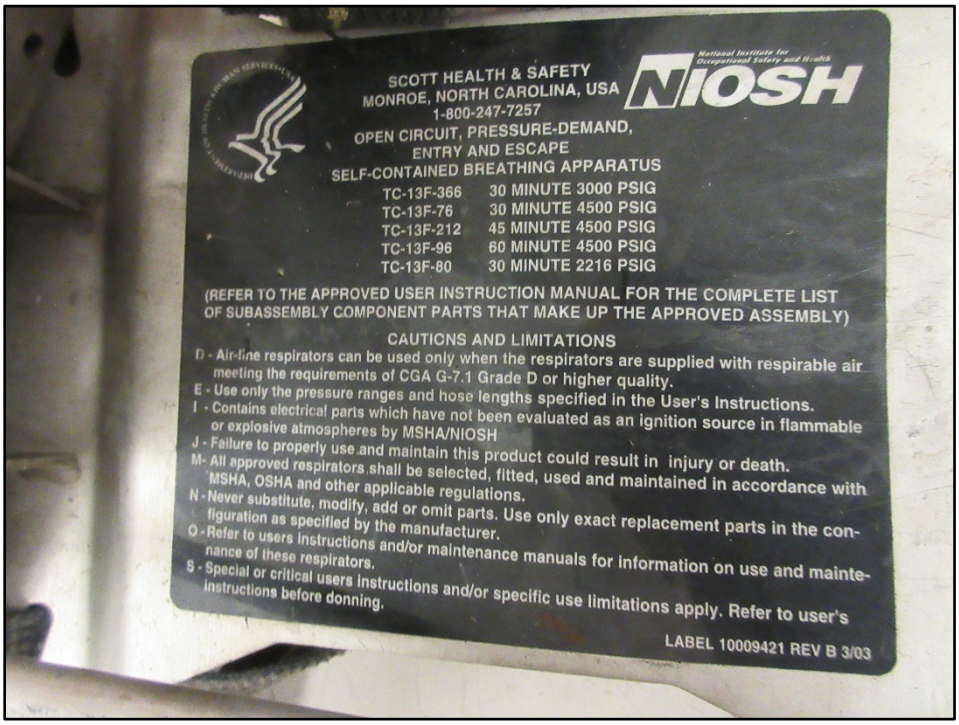

Figure 24: NIOSH label on backframe

Figure 25: Backframe part number

Figure 26: Overall of straps and buckles, dye sublimation on left shoulder strap

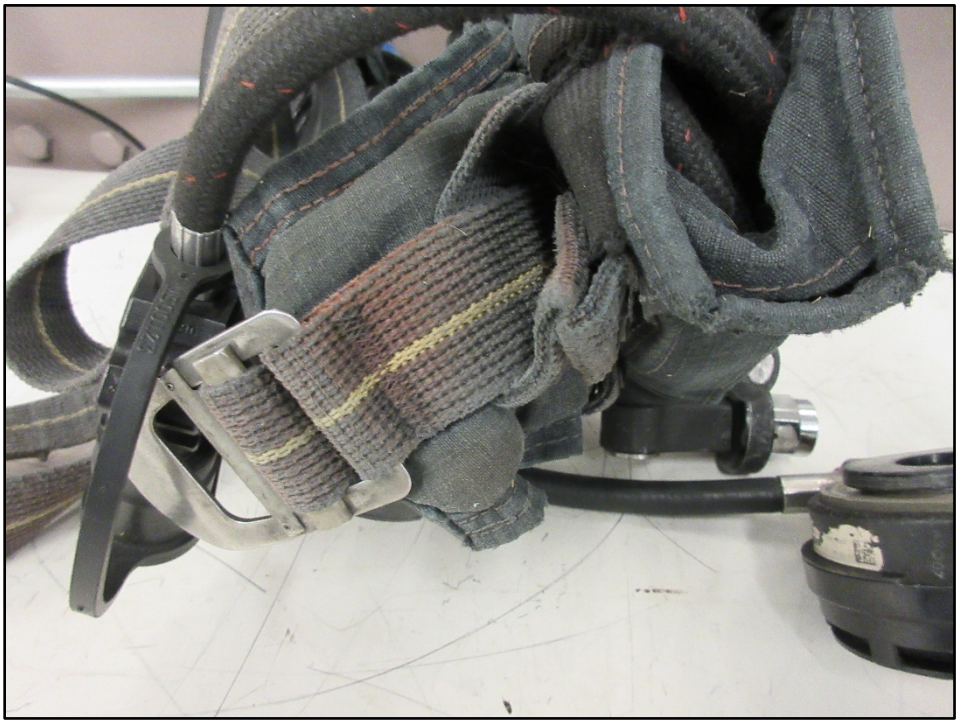

Figure 27: Dye sublimation of left side waist belt

Figure 28: Waist belt completely tightened

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.

Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health