

PPE CASE



Personal Protective Equipment Conformity Assessment Studies and Evaluations

Evaluation of a Self-Contained Breathing Apparatus for Potential Contribution to a Fatal Event in the Fire Service

Houston, Texas Fire Department Request for Scott® Safety Air-Pak® 4.5, 4500 psi unit with NIOSH Approval Number TC-13F-212CBRN (August 15, 2016)

As part of the **National Institute for Occupational Safety and Health (NIOSH) Fire Fighter Fatality Investigation and Prevention Program (FFFIPP)**, the National Personal Protective Technology Laboratory (NPPTL) agreed to examine and evaluate a self-contained breathing apparatus (SCBA) unit identified as Scott® Safety model Air-Pak® 4.5, 4500 psi, 30-minute, SCBA.

This SCBA status investigation was assigned NIOSH Task Number 20842. The NIOSH Division of Safety Research (NIOSH/DSR) and the Houston Fire Department were advised that NIOSH/ NPPTL would provide a written report of the inspections and any applicable test results.

The SCBA unit was shipped to the NIOSH facility in Morgantown, West Virginia on May 13, 2016. The unit was taken to the lower floor of the lab, room 1513, for secured storage. The SCBA unit was then removed from storage for inspection on May 13, 2016 and was placed back into secured storage until the testing began on August 5, 2016.

NIOSH evaluated one SCBA unit used by a fire fighter involved in a fatal event. The SCBA was not found to contribute to the fatality. A qualified service technician should always inspect, repair, test, clean, and replace damaged components of any SCBA involved in an incident before it may be returned to service.

Disclaimer

The purpose of Respirator Status Investigations is to determine the conformance of each 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.

Investigator Information

The SCBA performance tests were conducted by Karis Kline (Contractor) and Jeremy Gouzd (Fellow). The SCBA inspections were performed by Karis Kline and Jeremy Gouzd and this report was written by Jeremy Gouzd. The investigators are part of the Evaluation and Testing Branch, National Personal Protective Technology Laboratory, National Institute for Occupational Safety and Health, located in Morgantown, West Virginia.

NIOSH Task Number 20842

SCBA Inspection

The unit was removed from the packaging in room 1513 and inspected on May 13, 2016 by Jeremy Gouzd (Fellow), Karis Kline (Contractor) Morgantown Testing Team (MTT), NPPTL. The SCBA was identified as the Houston Fire Department SCBA and the SCBA was extensively examined, component by component, in the condition received to determine how well the unit conformed to the NIOSH-approved configuration. The unit was identified as the Scott® Safety Company model Air-Pak® 4.5, 30 minute, 4500 psi unit, NIOSH approval number TC-13F-212CBRN. The visual inspection process was documented photographically.

The complete SCBA inspection is summarized in **Appendix I**. The condition of each major component of the SCBA that was photographed with a digital camera is contained in **Appendix III**.

SCBA Testing

The purpose of the testing was to determine how well the SCBA conformed to the approval performance requirements of Title 42, *Code of Federal Regulations*, Part 84 (42 CFR 84). Further testing was conducted to provide an indication of the SCBA's conformance 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*, 1997 Edition.

NIOSH SCBA Certification Tests (in accordance with the performance requirements of 42 CFR 84):

1. Positive Pressure Test [§ 84.70(a)(2)(ii)]
2. Rated Service Time Test (duration) [§ 84.95]
3. Static Pressure Test [§ 84.91(d)]
4. Gas Flow Test [§ 84.93]
5. Exhalation Resistance Test [§ 84.91(c)]
6. Remaining Service Life Indicator Test (low-air alarm) [§ 84.83(f)]

National Fire Protection Association (NFPA) Tests (in accordance with NFPA 1981, 1997 Edition):

7. Airflow Performance Test [Chapter 5, 5-1.1]

Appendix II contains the complete NIOSH test report for the SCBA. **Tables ONE and TWO** summarize the NIOSH and NFPA test results.

Summary and Conclusions

An SCBA unit was submitted to NIOSH/NPPTL by the Houston Texas Fire Department for evaluation. The SCBA unit was delivered to NIOSH on May 13, 2016 and extensively inspected on May 13, 2016. The unit was identified as a Scott® Safety model Air-Pak® 4.5, 4500 psi, 30-minute, SCBA (NIOSH approval number, TC-13F-212CBRN). A facepiece was not provided with the unit. The unit didn't show any signs of heat damage, but exhibited signs of normal wear and tear for the unit. The cylinder gauges showed that the tank was empty. The mask mounted regulator (MMR) and sealing area were mostly clean, locking assembly functioned, and inside flange had minimal scratching. The NFPA approval label was present and readable. The personal alert safety system (PASS) functioned and overall condition of the SCBA was good. For detailed test results, see appendices below.

In light of the information obtained during this investigation, NIOSH has proposed no further action on its part at this time. The SCBA unit was returned to storage pending return to the Houston 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.

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, should undergo a flow test on an annual basis at a minimum.

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

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

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 I

SCBA Inspection Report



National Personal Protective Technology Laboratory, Evaluation and Testing Branch

Respirator Field Problem Incoming Inspection Report Summary

Task Number: TN-20842	Requestor: NIOSH/DSR for the Houston Fire Department
Date Received: May 13, 2016	
Date Inspected: May 13, 2016	Description: Fatality
Manufacturer: Scott® Safety	Inspected by: Jay Tarley, Jeremy Gouzd, Karis Kline
Approval Number: TC-13F-212 CBRN	SCBA Type: Open Circuit, Pressure-Demand

The SCBA was received in a cardboard box (refer to **Figures 1-2** in **Appendix III**)

Contact Agency: NIOSH/DSR for the Houston City Fire Department

As received:

- Cylinder included and empty
- Bypass in the “on” position
- Donning switch on, regulator inactive
- No facepiece included

Components and Observations

NOTE: All references to “right” or “left” are from the user’s perspective.

Facepiece:

No facepiece included

MMR with Heads up Display (HUD): (refer to **Figures 3-4** in **Appendix III**).

Air-Pak® plus CBRN with Vibralert and E-Z Flo regulator.

Regulator assembly P/N: Not Present
S/N: Not Present

Other Markings: 02 VJTF126 (hand inscribed)

MFG Date: Not Present

- Overall condition is good, some scrapes
- Outer case is good with stickers present
- Donning switch and cover are in fair condition
- Secured to low pressure line
- Bypass in the on position
- Bypass knob normal wear and tear
- Inside flange has scratches
- Sealing area mostly clean
- Locking assembly does function

Low Pressure Line: (refer to **Figures 5** in **Appendix III**).

Scott® partial part number: Not readable

- Overall condition is good, no rips or tears
- Secured at all attachments points
- Quick disconnect in good condition and functions
- Line runs through the shoulder strap to the reducer

4.5 Pressure Reducer Assembly: (refer to **Figures 6-8** in **Appendix III**).

P/N: Present but unreadable Marking: 4.5 sticker, SN engraved: 0606033582AA

S/N: Present but unreadable

HUD control module part number: 200187-01

- Overall condition is good, pretty clean
- All airline connections are secure

High Pressure Line & Cylinder Attachment: (refer to **Figures 9-11** in **Appendix III**).

Cylinder Attachment P/N: 802228-05
for

Other markings: 0708, Scott + 888 above PN

Assembly

- Overall condition is good, some scratches
- Cylinder attachments thread clean, threads on and off, “O” ring in place
- Quick fill and cover in good shape #ETN FD17-1002-10-04

Console Assembly PASS: (refer to **Figures 12-13** in **Appendix III**).

SEI label 2007 ed

HUD # US Patent #50 XXB6, Some unreadable

- Overall condition is good, clean

- Lines in good shape – pressure/electrical
- Gauge lens is readable
- Protective casing slightly dirty
- Rubber attachment strap present, attached to the PASS console and shoulder strap
- SEI Label attached: NFPA 1982, 1998 edition

PASS Control Module: (refer to **Figures 14-15** in **Appendix III**).

P/N: 200451-01,-11

200451-02, -12 with Pak tracker – ID#: 00152-74 label

- Overall condition is good
- Held securely to backframe
- Wire connection connected to PASS device
- Wire held secure to backframe and runs to console assembly

Backframe Assembly: (refer to **Figures 16-18** in **Appendix III**).

S/N: None other markings: SH9 on twice

SEI Label attached, NFPA 1981, 2007 Edition

- Overall fair condition, no bends/cracks in wire frame
- Shoulder straps were attached to the frame
- Cylinder strap and latch are in fair condition, dirty
- Cylinder strap adjuster functional
- Cylinder strap and latch is dirty but functional
- E73-2 marked on back frame
- CBRN label present
- NIOSH label present, TC-13F-212CBRN

Straps & Buckles: (refer to **Figure 19** in **Appendix III**).

- Overall strap condition is good
- Both shoulder straps attached at the top of the back frame
- Hose lines and wires pass through shoulder straps
- All adjustable buckles move and hold in place
- Waist area buckle latches and releases
- Right side waist strap worn
- Lumbar strap in good condition with some dirt and minimal fraying at attachment points on either side of the pad

Cylinder & Valve Assembly: (refer to **Figures 20-23** in **Appendix III**).

Some DOT and other information

DOT-SP 10915-4500

TC-SU-5134-310

IL 754674

Luxfer P/N: L65G-002

Cylinder Valve SN: 11551502010157

Other Markings: Red "44" paint

Scott P/N: 10009673

Scott logo visible

Luxfer REE 110

Manufacture Date: 12/14 45 Minute, 4500 PSIG

- Overall condition is fair to good as there are some surface scratches and dirt present
- Gauge is readable
- Threads are okay, some corrosion
- As received cylinder valve fully closed with no air remaining
- Rubber bumper at base on cylinder valve is in good condition

Appendix II

SCBA Test Results



National Personal Protective Technology Laboratory, Evaluation and Testing Branch

SCBA Test Report

Task Number: TN-20842
Manufacturer: Scott® Safety
NIOSH Approval Number: TC-13F-212CBRN
Tests Performed by: Jeremy Gouzd, Karis Kline
Report written by: Jeremy Gouzd
Date of Report: August 12, 2016

I. Background

On May 13, 2016, a SCBA unit from the Houston Fire Department was delivered to the NIOSH facility in Morgantown, West Virginia. The unit was initially removed from the shipping container May 13, 2016 in lab H-1513 for inspection by Jeremy Gouzd (Fellow) and Karis Kline (Contractor) Morgantown Testing Team (MTT), NPPTL. The SCBA was identified as the Houston Fire Department SCBA and was extensively examined, component by component, in the condition received to determine how well the SCBA conformed to the NIOSH-approved configuration. The unit was identified as the Scott® Safety Company model Air-Pak® 4.5, 45 minute, 4500 psi unit, NIOSH approval number TC-13F-212CBRN. The visual inspection process was documented photographically.

II. Test Outlines

1. POSITIVE PRESSURE TEST – NIOSH Test Procedure No. 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.

Results-

The unit was tested on August 5, 2016 and met the test requirement. The facepiece was replaced prior to testing as there was not one provided. The HUD, remote gauge, and donning switch functioned normally.

Inhalation Breathing Resistance: (inches of water column)	
Pass / Fail	0.1
PASS	

2. RATED SERVICE TIME TEST – NIOSH Test Procedure No. 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 continues to run until the inhalation portion of the breathing curve falls below the minimum requirement.

Results - Tested on August 5, 2016, the SCBA met the test requirement.

Test Notes: The measured service time (adjusted to correspond with the recorded breathing cycles) was more than the rated service time of 45 minutes. The PASS unit did function during the test. The SCBA did not go negative on inhalation, but maintained positive pressure in the facepiece at the same level.

Measured Service Time	Minutes	Seconds
	51	25
Pass/Fail	PASS	

3. STATIC PRESSURE TEST – NIOSH Test Procedure No. 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.

Results – Tested on August 9, 2016, the SCBA met the test requirement.

Facepiece Static Pressure:(inches of water column)	0.51
Pass / Fail	Pass

4. GAS FLOW TEST – NIOSH Test Procedure No. 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 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

Results – Tested on August 8, 2016 the SCBA met the test requirement. The bypass appeared to function normally.

Pass/Fail		
Applied pressure	Air Flow (liters per minute)	
4500 psig	501.21	Pass
500 psig	472.89	Pass

5. EXHALATION RESISTANCE TEST – NIOSH Test Procedure No. 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 airflow through the apparatus is adjusted to a rate of 85 liters per minute and the exhalation resistance is recorded.

Results – Tested on August 9, 2016, the SCBA met the test requirement.

Exhalation Breathing Resistance: (inches of water column)	1.95
Static Pressure: (inches of water column)	0.51
Difference: (inches of water column)	1.44
Pass / Fail	Pass

6. REMAINING SERVICE LIFE INDICATOR TEST – NIOSH Test Procedure No. 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.

Results – Tested on August 8, 2016. The test requirement is 25% ± 2%.

Testing Notes:

Run #	Alarm Point (psig) VibrAlert	Alarm Point (psig) HUD
1.	1040	1130
2.	1040	1140
3.	1040	1130
4.	1040	1130
5.	1050	1130
6.	1045	1140
Avg.	1043	1133
Pass / Fail	Pass	PASS

7. NFPA AIR FLOW PERFORMANCE TEST

NFPA 1981 (1997 Edition) Reference: Chapter 5, Performance Requirements, Sec. 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 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.

Results – Tested on August 11, 2016. The SCBA passed this test.

Test Notes – PASS unit was functional. HUD was functional. Alarm systems were functional. Used a stock Scott facepiece as no facepiece was provided

Maximum Facepiece Pressure: (inches of water column)	2.725
Minimum Facepiece Pressure: (inches of water column)	0.35
Pass / Fail	PASS

III. Disposition:

Following testing, the SCBA unit was returned to the package in which the unit was shipped to NIOSH and placed in secured storage. The unit was then removed from secured storage and a download of the data logger was conducted by the MTT in lab H-1513 on September 14, 2016. The unit was placed back into secured storage until it was shipped back to the fire department.

The results of all tests are summarized in Tables One and Two which follow.

TABLE ONE – Summary of NIOSH Test Results –

Task Number: 20842
Manufacturer: Scott® Safety
NIOSH Approval Number: TC-13F-212CBRN
Tests Performed By: Jeremy Gouzd, Karis Kline
Dates of Tests: August 5, 2016 – August 11, 2016

TEST / 42 CFR PART 84 REFERENCE	STANDARD	RESULT	PASS	FAIL
1. POSITIVE PRESSURE TEST Reference: Subpart H, § 84.70 (a)(2)(ii) ≥ 0.00 INWC		0.1 INWC	X	
2. RATED SERVICE TIME TEST Reference: Subpart F, § 84.53 (a), Subpart H, § 84.95 (a) and (b) ≥ 30 min.		51 min 25 s	X	
3. STATIC PRESSURE TEST Reference: Subpart H, § 84.91 (d) ≤ 1.50 INWC		0.51 INWC	X	
4. GAS FLOW TEST (at Full Cylinder Pressure) Reference: Subpart H, § 84.93 (b) and (c) ≥ 200 lpm		501.21 LPM	X	
4. GAS FLOW TEST (at 500 psig) Reference: Subpart H, § 84.93 (b) and (c) ≥ 200 lpm		472.89 LPM	X	
5. EXHALATION RESISTANCE TEST Reference: Subpart H, § 84.91 (c) Difference ≤ 2.00 INWC		1.44 INWC	X	
6. REMAINING SERVICE LIFE INDICATOR TEST (vibrating alarm) Reference: Subpart H, § 84.83 (f) and Subpart G, § 84.63 (c) Between 1035 and 1215 psig		1043 PSIG	X	

6. REMAINING SERVICE LIFE INDICATOR TEST (light alarm HUD) Reference: Subpart H, § 84.83 (f) and Subpart G, § 84.63 (c) Between 1035 and 1215 psig	1133 PSIG	X	
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NOTE: The Positive Pressure Test and Rated Service Life Test are run simultaneously.

TABLE TWO – Summary of NFPA Test Results

TEST / REFERENCE	STANDARD	RESULT	PASS	FAIL
7. NFPA AIR FLOW PERFORMANCE Reference: NFPA 1981 (1997 Edition), Section 5-1.1	≤ 3.50 INWC Exhalation Resistance	2.725 INWC	X	
7. NFPA AIR FLOW PERFORMANCE Reference: NFPA 1981 (1997 Edition), Section 5-1.1	≥ 0.00 INWC Inhalation Resistance	0.35 INWC	X	

Appendix III

SCBA Inspection Report

Figure 1: Cardboard box containing SCBA as received
Figure 2: Overview of unit out of bag
Figure 3: Mask Mounted Regulator
Figure 4: Inside flange, mask mounted regulator
Figure 5: Low pressure hose
Figure 6: Pressure reducer assembly
Figure 7: Interior view of pressure reducer assembly
Figure 8: Top view of pressure reducer assembly
Figure 9: Cylinder attachment overview and relief valve
Figure 10: Cylinder attachment identifying markings
Figure 11: Quick fill port on cylinder attachment and overview of threads
Figure 12: PASS console
Figure 13: Back of PASS console, SEI label
Figure 14: PASS control module
Figure 15: Label on side of PASS control module
Figure 16: Overview of pack assembly
Figure 17: Labels inside of pack
Figure 18: Labels on back frame
Figure 19: Overview of straps and buckles
Figure 20: Overview of cylinder
Figure 21: Overview of cylinder label
Figure 22: Cylinder gauge is readable
Figure 23: Overview of top of cylinder



Figure 1: Cardboard box containing SCBA as received



Figure 2: Overview of unit out of bag



Figure 3: Mask mounted regulator



Figure 4: Inside flange, Mask mounted regulator



Figure 5: Low pressure hose



Figure 6: Pressure reducer assembly



Figure 7: Interior view of pressure reducer assembly

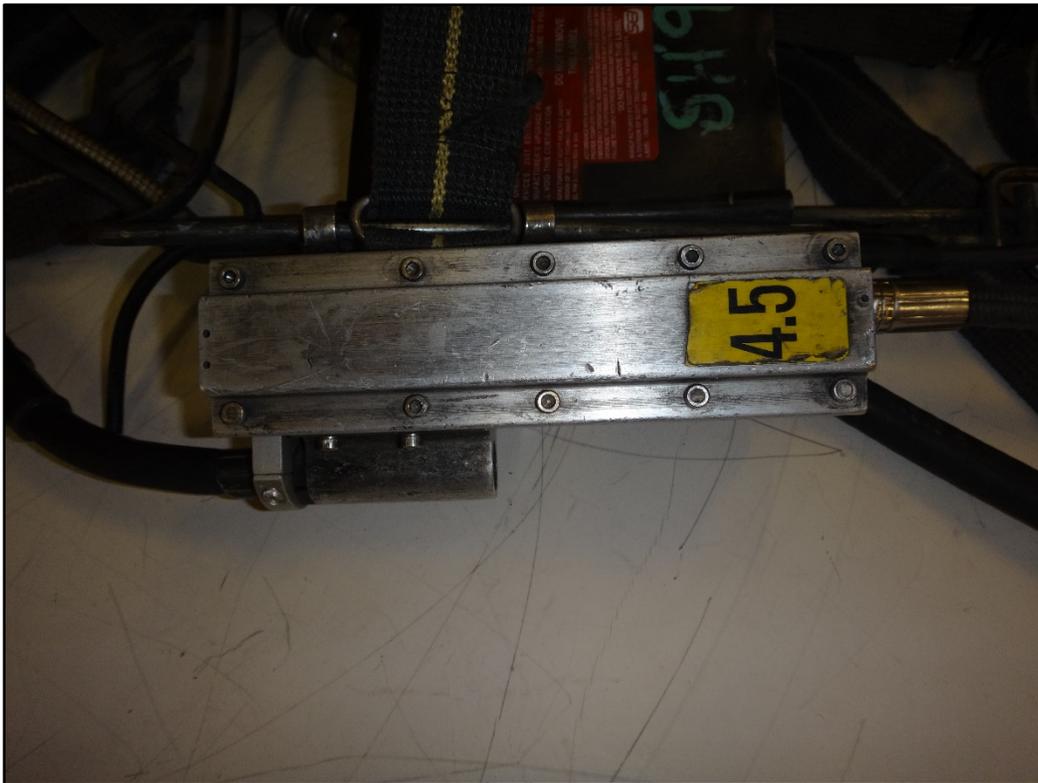


Figure 8: Top view of Pressure reducer assembly



Figure 9: Cylinder attachment overview and relief valve



Figure 10: Cylinder attachment identifying markings



Figure 11: Quick fill port on cylinder attachment and overview of threads



Figure 12: PASS console



Figure 13: Back of PASS console, SEI label



Figure 14: PASS control module



Figure 17: Labels inside of pack



Figure 18: Labels on back frame



Figure 19: Overview of straps and buckles



Figure 20: Overview of cylinder



Figure 21: Overview of cylinder label



Figure 22: Cylinder gauge is readable



Figure 23: Overview of top of cylinder