National Personal Protective Technology Laboratory

Technology Evaluation Branch

Certified Product Investigation Program Report of Self-Contained Breathing Apparatus Second Stage Regulators
Submitted by the
DeKalb County, Georgia Fire Department

NIOSH Task Number 18388

July 3, 2012

Disclaimer

The purpose of the Certified Product Investigation Program (CPIP) Respirator/Component Status Evaluation 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/component is tested in its "**as received**" condition to determine its conformance to those performance requirements. Each component 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/component 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 component is in a condition that is safe to be pressurized, handled, and tested. Respirators/components 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/Regulator performance tests were conducted by Mike Commodore, Engineering Technician and Jay Parker, Physical Scientist. This report was written by Tom Pouchot, General Engineer. These investigators are part of the Technology Evaluation Branch, National Personal Protective Technology Laboratory, National Institute for Occupational Safety and Health, located in Bruceton, Pennsylvania.

Certified Product Investigation Program Report of Self-Contained Breathing Apparatus Second Stage Regulators Submitted By the DeKalb County, Georgia Fire Department

NIOSH Task Number 18388

Background

As part of the ***National Institute for Occupational Safety and Health (NIOSH) Certified Product Investigation Program (CPIP)***, the Technology Evaluation Branch was notified of a possible issue with the supplied air respirator identified as the Dräger Safety model PSS 7000, 4500 psig, self-contained breathing apparatus (SCBA). This SCBA CPIP investigation was assigned NIOSH Task Number 18388.

At the request of the International Association of Fire Fighters (IAFF), the DeKalb County Georgia Fire Department was contacted and the SCBA issues were discussed. Samples of the SCBA units in question were requested by NIOSH but the fire department was only able to send facepieces and second stage regulators.

The DeKalb County Fire Department was advised that NIOSH would provide a written report of the inspections and any applicable test results.

The DeKalb Fire Department shipped 2 second stage regulators and two facepieces to NIOSH.

SCBA Inspection

Initially, the package containing the regulators and facepieces were opened in the NPPTL Laboratory office contained in building 20 on June 12, 2012 and a complete visual inspection was conducted by Tom Pouchot, General Engineer, NPPTL. The DeKalb County regulators and facepieces were designated as DeKalb Units #1 and #2. These regulators and facepieces were examined in the condition as received to identify the units and determine the condition of the components. The visual inspection process was documented photographically.

The complete inspections are summarized in **Appendix *I***. *The condition of each component supplied were photographed with a digital camera is contained in* ***Appendix*** **III**.

It was judged that the regulators could be safely pressurized and tested utilizing a replacement SCBA supplied by Dräger Safety.

Testing

The purpose of the testing was to determine the regulators and replacement SCBA conformance 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 regulator and replacement SCBA conformance 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*, 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)]

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

6. Air Flow Performance Test [Chapter 5, 5-1.1]

The DeKalb County units were tested on June 14, 2012 in the NIOSH Respirator Certification Laboratory utilizing a replacement SCBA supplied by Dräger Safety.

Appendix II contains the complete NIOSH and NFPA test reports for the units. **Tables One and Two** summarize the NIOSH and NFPA test results for the DeKalb units.

Summary and Conclusions

At the request of the International Association of Fire Fighters (IAFF), the DeKalb County, Georgia Fire Department was contacted by NIOSH concerning some reported issues with the Dräger Safety SCBA, model PSS7000, 4500 PSIG units. At the request of NIOSH, the DeKalb Georgia Fire Department submitted 2 second stage regulators and 2 facepieces for evaluation. All of these components had been taken out of service due to a SCBA operational issue. These SCBA components were inspected on June 12, 2012. The components appeared to be generally good condition with some signs of wear and tear and some foreign material present on the facepieces. The regulator and facepiece mating and sealing areas on the units were clean and in good condition. Some of the regulators had scratches or scrap marks on the interface connectors. The regulator to facepiece sealing o-rings all appeared to be dry without any lubricant present.

These regulators and facepieces were utilized for all testing along with a replacement SCBA supplied by Dräger Safety. No other maintenance or repair work was performed on the units prior to the testing.

The testing was performed on June 14, 2012 in the NIOSH Respirator Certification Laboratory. Representatives from NIOSH, Drager Safety and SEI/NFPA all witnessed testing.

Drager Safety performed a regulator pressure test on all the units supplied prior to any NIOSH testing. None of the units pass this Drager test. The regulators and facepieces supplied by the DeKalb Fire Department along with the replacement SCBA unit met the requirements of the

NIOSH Positive Pressure Test, with a minimum pressure of 0.00 inches of water for DeKalb Unit #1 and 0.05 inches of water for DeKalb Unit #2. The units met the requirements of all of the other NIOSH tests performed. In addition the units did pass the NFPA flow test. The NFPA facepiece pressure test was also performed prior to the flow test. Neither facepiece passed this evaluation step.

Following the inspection and testing, the second stage regulators and facepieces were placed in storage pending return to the DeKalb County Fire Department.

Users of SCBA units must pay close attention to the instructions for proper care and maintenance issued by the SCBA manufacturer. Maintenance procedures and training are unique to each respirator manufacturer and model; therefore, any equipment changes to the original respirator configuration may entail new training and maintenance requirements. Additionally, manufacturers are required to update the training and maintenance manual if an equipment modification impacts the use or maintenance of the respiratory assembly. NFPA 1852 Standard of Selection, Care & Maintenance of Open-Circuit Self-Contained Breathing Apparatus (SCBA) provides guidance that can be followed to ensure the continued efficient operation of SCBA.

If these units are to be placed back in service, the components must be tested and inspected by a qualified service technician, including such testing and other maintenance activities as prescribed by the schedule from the SCBA manufacturer and repaired.

Appendix I

Component Inspection Report

National Personal Protective Technology Laboratory / Technology Evaluation Branch

Respirator Component Evaluation
Incoming Inspection Report Summary – DeKalb Unit #1

Task Number:	18388	**Requestor:**	DeKalb Fire Department
SCBA Type:	Open Circuit, Pressure Demand		
Date Inspected:	June 12, 2012	**Description:**	Reported Performance Issue
Manufacturer:	Dräger Safety	**Inspected by:**	Tom Pouchot

The DeKalb County, Georgia Fire Department submitted 2 second stage regulators and 2 facepieces for evaluation. These components were identified as DeKalb Unit #1 and DeKalb Unit #2. See Figure 1 in Appendix III for the unit packaging arrangement.

Components and Observations – DeKalb Unit #1

1. Facepiece Unit #1 (Refer to Figures 2 and 3 in Appendix III):

- The overall condition of the facepiece was fair to good with some dirt present.
- The regulator is easily removed and locks into place securely. The interface area was clean.
- Facepiece lens had some light scratches and vision through the lens was considered good.
- The headharness was securely fastened to the facepiece and the adjustment buckles functioned easily.
- The nose cup was securely attached to the facepiece.

2. Pressure Demand (Second Stage) Mask Mounted Regulator with Low Pressure Hose (Refer to Figures 3 - 5 in Appendix III):

- The regulator and low pressure hose were in good condition.
- The inside of the regulator was clean.
- The outside housing was in good condition.
- The attachment sealing o-ring was in place and in good condition but appeared to be dry.
- The regulator cover boot was in place and in fair to good condition with general signs of normal wear.
- The low pressure hose was in good condition and securely attached to the regulator.

- The low pressure hose quick disconnect was in good condition.

Respirator Component Evaluation
Incoming Inspection Report Summary – DeKalb Unit #2

Task Number:	18388	**Requestor:**	DeKalb Fire Department
SCBA Type:	Open Circuit, Pressure Demand		
Date Inspected:	June 12, 2012	**Description:**	Reported Performance Issue
Manufacturer:	Dräger Safety	**Inspected by:**	Tom Pouchot

Components and Observations – DeKalb Unit #2

1. Facepiece Unit #1 (Refer to Figures 6 and 7 in Appendix III):

- The overall condition of the facepiece was fair to good with some dirt present.
- The regulator is easily removed and locks into place securely. The interface area was clean.
- Facepiece lens had some light scratches and vision through the lens was considered good.
- The headharness was securely fastened to the facepiece and the adjustment buckles functioned easily.
- The nose cup was securely attached to the facepiece.

2. Pressure Demand (Second Stage) Mask Mounted Regulator with Low Pressure Hose (Refer to Figures 8 and 9 in Appendix III):

- The regulator and low pressure hose were in good condition.
- The inside of the regulator was clean.
- The outside housing was in good condition.
- The attachment sealing o-ring was in place and in good condition but appeared to be dry.
- The regulator cover boot was in place and in fair to good condition with general signs of normal wear.
- The low pressure hose was in good condition and securely attached to the regulator.
- The low pressure hose quick disconnect was in good condition.

A. Dräger pre-NIOSH testing pressure test: (Refer to Figure 10 in Appendix III)

B. DeKalb Unit #2 Facepiece post testing inspection: (Refer to Figures 11 – 16 in Appendix III):

- Dirt present on exhalation valve assembly.
- Dirt or Soot present on exhalation valve, retainer and valve spring.
- Exhalation valve seat is dirty.

Appendix II

SCBA Component Test Results

National Personal Protective Technology Laboratory / Technology Evaluation Branch

SCBA Component Test Report

Task Number:	18388
Manufacturer:	Dräger Safety
Tests Performed by:	Mike Commodore, Jay Parker
Date of Report:	June 14, 2012

I. Background

NIOSH received reports of issues with the Dräger Safety Self Contained Breathing Apparatus (SCBA) model PSS7000, 4500 psig. At the request of the International Association of Fire Fighters (IAFF), DeKalb County, Georgia Fire Department was contacted. Two second stage regulators (also called lung demand valves (LDV)) with facepieces were sent to NIOSH for evaluation and testing from the DeKalb County, Georgia, Fire Department. These units were labeled DeKalb Unit #1 and DeKalb Unit #2. The regulators with facepieces were then removed from the packaging and inspected on June 12, 2012. The regulators with facepieces were judged to be safe to pressurize and tested using a replacement SCBA supplied by Dräger Safety Company. A series of performance tests were conducted on all the regulator units on June 14, 2012. The Positive Pressure Test and Rated Service Time Test were conducted simultaneously.

II. Test Outlines DeKalb Units

A. 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.^{2}/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 DeKalb County, GA Fire Department second stage regulators and facepieces were tested on June 14, 2012 with a replacement SCBA supplied by Dräger Safety.

The inhalation breathing resistances did not become negative during the test. The SCBA components met the test requirement.

	Unit # 1	Unit #2
Inhalation Breathing Resistance: (inches of water column)	**0.00**	**0.05**
Pass / Fail	**Pass**	**Pass**

B. 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 is run until the inhalation portion of the breathing curve falls below the minimum requirement.

Results

The DeKalb County, GA Fire Department second stage regulators and facepieces were tested on June 14, 2012 with a replacement SCBA supplied by Dräger Safety.

The measured service times (adjusted to correspond with the recorded breathing cycles) were more than the rated service time of 30 minutes for the SCBA unit supplied by Dräger. The SCBA components passed the test requirement.

	Unit # 1	Unit #2
Measured Service Time:	**31 Minutes 24 Seconds**	**33 Minutes 26 Seconds**
Pass / Fail	**Pass**	**Pass**

C. 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

The DeKalb County, GA Fire Department second stage regulators and facepieces were tested on June 14, 2012 with a replacement SCBA supplied by Dräger Safety. Both facepieces had audible leaks from the exhalation valve area.

The units met the test requirement.

	Unit # 1	Unit #2
Facepiece Static Pressure:(inches of water column)	**1.00**	**0.86**
Pass / Fail	**Pass**	**Pass**

D. 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 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.

Results

The DeKalb County, GA Fire Department second stage regulators and facepieces were tested on June 14, 2012 with a replacement SCBA supplied by Dräger Safety. The SCBA components met the test requirements.

	Unit # 1	Unit #2	Pass / Fail
Applied pressure	**Air Flow (liters per minute)**	**Air Flow (liters per minute)**	
4500 psig	**427.6**	**>441.7**	**Pass/Pass**
500 psig	**430.5**	**>444.6**	**Pass/Pass**

E. 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 air flow through the apparatus is adjusted to a rate of 85 liters per minute and the exhalation resistance is recorded.

Results

The DeKalb County, GA Fire Department second stage regulators and facepieces were tested on June 14, 2012 with a replacement SCBA supplied by Dräger Safety. The SCBA Components met the requirement.

	Unit # 1	Unit #2
Exhalation Breathing Resistance: (inches of water column)	**2.16**	**2.30**
Static Pressure: (inches of water column)	**1.00**	**0.86**
Difference: (inches of water column)	**1.16**	**1.44**
Pass / Fail	**Pass**	**Pass**

F. 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 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:

A breathing machine as specified in Section 6-1.12 operating at 30 ± 1 breaths/min with a 103 ± 3 L/min 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 flatbed chart recorder for determining the pressure in the facepiece.

Results

The DeKalb County, GA Fire Department second stage regulators and facepieces were tested on June 14, 2012 with a replacement SCBA supplied by Dräger Safety.
The SCBA components **did** meet the NFPA flow test requirements.

	Unit # 1	Unit #2
Maximum Facepiece Pressure: (inches of water column)	**2.60**	**3.00**
Minimum Facepiece Pressure: (inches of water column)	**0.6**	**0.7**
Pass / Fail	**Pass**	**Pass**

Test Notes: The NFPA facepiece pressure test was performed prior to the NFPA flow test on both DeKalb facepeices. Neither facepiece passed this NFPA test. The facepiece exhalation valve from DeKalb Unit #2 was removed and cleaned with soap and water and the NFPA facepiece test performed again. The facepiece then passed this test. At the beginning of the flow test for DeKalb Unit #1, the facepiece exhalation valve snapped open on the first exhalation cycle but this action did not cause a failure. The exhalation valves of both facepieces were examined and found to have significant dirt present.

III. Disposition:

Following testing, the SCBA components were placed in storage pending return to the DeKalb County Fire Department.

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

<u>TABLE ONE</u> – Summary of NIOSH Test Results – DeKalb Units # 1 and #2

Task Number: 18388

Manufacturer: Drager Safety

Tests Performed By: Mike Commodore and Jay Parker

Dates of Tests: June 14, 2012

TEST / 42 CFR PART 84 REFERENCE	STANDARD	SAMPLE	RESULT	PASS	FAIL
A. POSITIVE PRESSURE TEST **Reference:** Subpart H, § 84.70 (a)(2)(ii)	≥ 0.00 INWC	#1	0.00 INWC	**X**	
A. POSITIVE PRESSURE TEST **Reference:** Subpart H, § 84.70 (a)(2)(ii)	≥ 0.00 INWC	#2	0.05 INWC	**X**	
B. RATED SERVICE TIME TEST **Reference:** Subpart F, § 84.53 (a), Subpart H, § 84.95 (a) and (b)	≥ 30 min.	#1	31 min, 24 s	**X**	
B. RATED SERVICE TIME TEST **Reference:** Subpart F, § 84.53 (a), Subpart H, § 84.95 (a) and (b)	≥ 30 min.	#2	33 min, 26 s	**X**	
C. STATIC PRESSURE TEST **Reference:** Subpart H, § 84.91 (d)	≤ 1.50 INWC	#1	1.00 INWC	**X**	
C. STATIC PRESSURE TEST **Reference:** Subpart H, § 84.91 (d)	≤ 1.50 INWC	#2	0.86 INWC	**X**	
D. GAS FLOW TEST (at Full Cylinder Pressure) **Reference:** Subpart H, § 84.93 (b) and (c)	≥ 200 lpm	#1	427.6 lpm	**X**	
D. GAS FLOW TEST (at 500 psig) **Reference:** Subpart H, § 84.93 (b) and (c)	≥ 200 lpm	#1	430.5 lpm	**X**	
D. GAS FLOW TEST (at Full Cylinder Pressure) **Reference:** Subpart H, § 84.93 (b) and (c)	≥ 200 lpm	#2	>441.7 lpm	**X**	
D. GAS FLOW TEST (at 500 psig) **Reference:** Subpart H, § 84.93 (b) and (c)	≥ 200 lpm	#2	>444.6 lpm	**X**	
E. EXHALATION RESISTANCE TEST **Reference:** Subpart H, § 84.91 (c)	Difference ≤ 2.00 INWC	#1	1.16 INWC	**X**	
E. EXHALATION RESISTANCE TEST **Reference:** Subpart H, § 84.91 (c)	Difference ≤ 2.00 INWC	#2	1.44 INWC	**X**	

NOTE: The Positive Pressure Test and Rated Service Life Test are run simultaneously.

TABLE TWO – Summary of NFPA Test Results – DeKalb Units # 1 and #2

TEST / REFERENCE	STANDARD	SAMPLE	RESULT	PASS	FAIL
F. NFPA AIR FLOW PERFORMANCE **Reference:** NFPA 1981 (1997 Edition), Section 5-1.1	≤ 3.50 INWC Exhalation Resistance	#1	2.60 INWC	**X**	
F. NFPA AIR FLOW PERFORMANCE **Reference:** NFPA 1981 (1997 Edition), Section 5-1.1	≥ 0.00 INWC Inhalation Resistance	#1	0.60 INWC	**X**	
F. NFPA AIR FLOW PERFORMANCE **Reference:** NFPA 1981 (1997 Edition), Section 5-1.1	≤ 3.50 INWC Exhalation Resistance	#2	3.00 INWC	**X**	
F. NFPA AIR FLOW PERFORMANCE **Reference:** NFPA 1981 (1997 Edition), Section 5-1.1	≥ 0.00 INWC Inhalation Resistance	#2	0.70 INWC	**X**	

In addition, the facepieces were also tested against the NFPA Facepiece Pressure Test. Both DeKalb facepiece failed the facepiece pressure test. DeKalb #2 Facepiece exhalation valve was cleaned and retested. The DeKalb #2 facepiece then passed the test.

Appendix III

Images

IMAGES

Self-Contained Breathing Apparatus Components from the DeKalb Fire Department
DeKalb County, Georgia

NIOSH Task No. 18388

List of Figures:

Figure 1: DeKalb Units #1 and #2 Packaging
Figure 2: DeKalb Unit #1 Facepiece and Second Stage Regulator
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Figure 1 – DeKalb Units #1 and #2 Packaging

Figure 2: DeKalb Unit #1 Facepiece and Second Stage Regulator

Figure 3 – DeKalb Unit #1 Facepiece Regulator Interface Area

Figure 4 – DeKalb Unit #1 Second Stage Regulator Facepiece Interface Area

Figure 5 – DeKalb Unit #1 Second Stage Regulator

Figure 6 – DeKalb Unit #2 Facepiece and Second Stage Regulator

Figure 7 – DeKalb Unit #2 Facepiece Regulator Interface Area

Figure 8 – DeKalb Unit #2 Second Stage Regulator Facepiece Interface Area

Figure 9 – DeKalb Unit #2 Second Stage Regulator

Figure 10 - Dräger Regulator Pressure Test Prior to NIOSH Testing

Figure 11 – DeKalb Unit #2 Facepiece Exhalation Valve Assembly

Figure 12 – DeKalb Unit #2 Facepiece Exhalation Valve Retainer and Spring

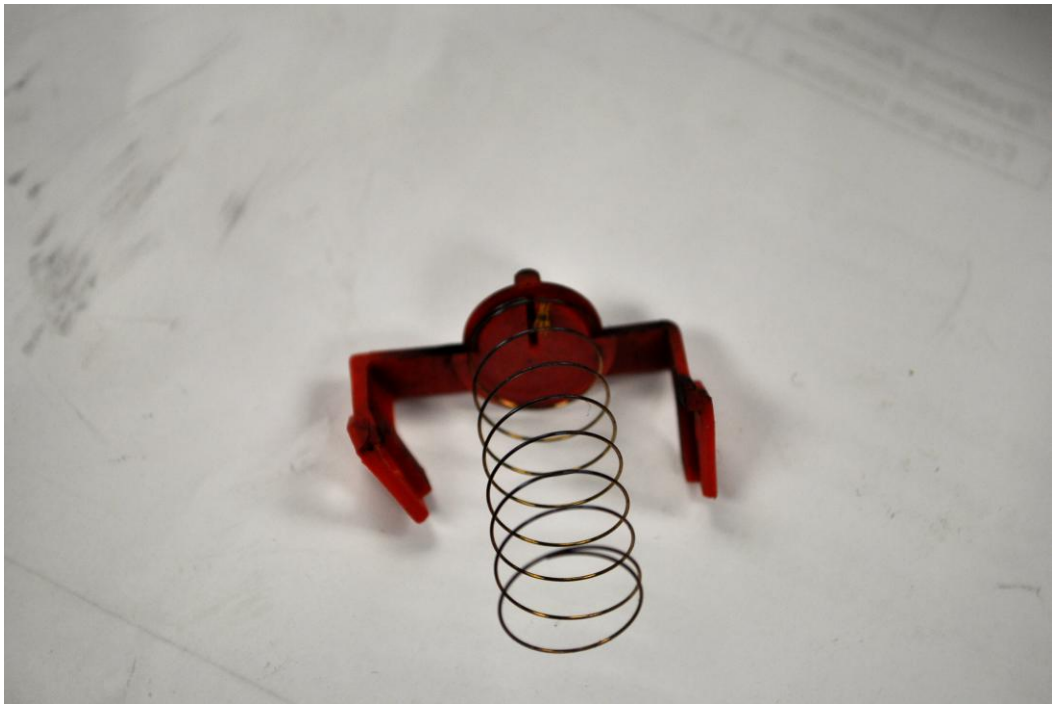

Figure 13 – DeKalb Unit #2 Exhalation Valve, Sealing Side

Figure 14 – DeKalb Unit #2 Exhalation Valve

Figure 15 – DeKalb Unit #2 Facepiece Exhalation Valve Cover

Figure 16 – DeKalb Unit #2 Facepiece Exhalation Valve Seat Area