

# 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**

**Christopher, Illinois Fire Department Request for an MSA Model Firehawk® M7**

The National Institute for Occupational Safety and Health (NIOSH) conducts a Fire Fighter Fatality Investigation and Prevention Program (FFFIPP) executed by its Division of Safety Research (DSR). In support of this Program, NIOSH's National Personal Protective Technology Laboratory (NPPTL) inspects and evaluates the personal protective equipment (PPE) used by firefighters during fatal events.

***This report provides a summary of NPPTL's inspection and evaluation methods and findings for the self-contained breathing apparatus (SCBA) used by the Christopher Fire Department firefighter during a fatal event. The SCBA being used was an MSA Model Firehawk® M7, 4500 psi, 30-minute unit. The Christopher Fire Department was advised that NIOSH NPPTL would provide a written report of the investigation and any applicable test results.***

*NIOSH evaluated an SCBA used by a firefighter involved in a fatal event. The SCBA was not found to contribute to the fatality.*

*A qualified service technician must inspect, repair, test, clean, and replace damaged components of any SCBA involved in an incident before it may be returned to service.*

## **What NIOSH Did to Protect the Worker**

Upon receipt of the SCBA, NPPTL managed the custody of evidence throughout the entire inspection and evaluation process at its Morgantown, West Virginia facility. NPPTL staff inspected all SCBA components and documented their findings with written and photographic evidence. NIOSH assigned Task Number TN-23126 to identify the unit. NPPTL also tested the SCBA to determine conformance to NPPTL's approval requirements as outlined in Title 42, Code of Federal Regulations, Part 84 (42 CFR 84). Further testing was conducted to provide an indication of the conformance of The SCBA to the National Fire Protection Association (NFPA) Airflow Performance requirements of NFPA 1981, Standard on Open-Circuit Self-Contained Breathing Apparatus for the Fire Service, 2013 Edition.

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If the inspection or evaluation data suggested that the SCBA unit may have contributed to the fatal event, NPPTL would have engaged in corrective action to ensure that no other users of the product would experience a fatal event. In this case, no such corrective action was necessary. NPPTL then managed the disposition of the SCBA.

## Chain of Custody

The SCBA unit was delivered to NIOSH investigators, from DSR, who were assigned to investigate the Christopher Fire Department's fatal event. They delivered the unit to Lab H1513 for secure storage at the NIOSH facility in Morgantown, West Virginia on June 10, 2019.

On July 1, 2019, NPPTL employees Jay Tarley and Matt Duling inspected the SCBA unit. The unit was tested by the same employees on July 2, 2019. The SCBA unit remained in secure storage in Lab H1513 throughout the entire inspection and testing process.

## SCBA Inspection

The inspection process was initiated by employees Jay Tarley and Matt Duling once the SCBA unit was delivered by NIOSH DSR investigators appointed to investigate the Christopher Fire Department's fatal event. They delivered the unit to Lab H1513 in the NIOSH facility in Morgantown, West Virginia on June 10, 2019. The SCBA was identified as belonging to the Christopher 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 an MSA Model Firehawk® M7, 4500 psi, 30-minute unit with NIOSH Approval Number TC-13F-302.

### [SCBA unit as received \(pictured below\)](#)

- SCBA unit was hand delivered to Lab H1513 by NIOSH DSR investigators
- Cylinder was received empty and closed, not attached to CGA fitting
- Bypass was closed
- Mask-mounted regulator (MMR) was not connected to facepiece, a separate facepiece was sent to complete testing



**Figure 1: SCBA unit and cylinder as received**

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

### **Mask-Mounted Regulator (MMR) (Figure 3)**

- MMR label on front: MSA; M/N: 10023684; numbers on inside flange: MX090149 and 10025003
- Overall condition was dirty and scuffed
- MMR was secured to low pressure line
- Bypass closed
- Inside flange dirty with markings
- Sealing area was dirty with substance on seal, possible bodily fluids
- Regulator could be attached and removed
- Locking assembly functioned

### **Low Pressure Regulator Hose (Figure 4)**

- Secured at all attachment points
- Line was in good condition
- Line passed through the shoulder strap to the reducer
- Markings on line: Superflex AUER/MSA 04/03

### **Pressure Reducer Assembly (Figures 5, 6)**

- Overall condition was good
- All airline connections were secure
- Number 10026233 KJH EX091430

### **PASS Control Console MSA Control Module (Figures 7-9)**

- Lines to control module looked good
- Gauge lens was readable
- Protective casing was good and in place
- Manufacturer label present but damaged
- MSA Nightfighter™ HUD unit attached in line with console  
M/N: 7-1219-1, ASSY# 10036995

### **High Pressure Hose and Cylinder Attachment (Figures 11-12)**

- High pressure S/N: 10037490
- High pressure line was in good condition, but soot covered
- Cylinder quick connect attachments were in good condition, EATON FD17-1002-10-04. Covering PN: 10038031
- Pressure relief valve in good condition, markings 0904
- Warning label present, number 10036292

### **Backframe Assembly (Figure 13, 14)**

- S/N: 10024153
- SEI label not present
- NIOSH Approval Number label: TC-13F-302
- Additional Labels: Sentinel Emergency Solutions: Test to factory specs 8/8/16; CFD
- Overall condition was good
- No cracks or melting found
- Some soot present
- Shoulder straps were attached to the frame

### **Straps and Buckles (Figure 15)**

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

## 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 the SCBA against established NIOSH SCBA certification tests.**

NIOSH Tests	Description of Results	PASS/ FAIL
<p><b>Positive Pressure Test - NIOSH Standard Test Procedure Number 120, 42 CFR Part 84 Reference: Subpart H, § 84.70 (a)(2)(ii)</b>  <b>Requirement:</b>  <i>The pressure inside the facepiece in relation to the immediate environment is positive during both inhalation and exhalation.</i>  <b>Procedure:</b>            A breathing machine with a 622 kg.-m./min cam operating at 24 RPM with a 40 liters per minute flow rate (115 liters per minute peak flow) is connected to an anthropometric head for cycling. A pressure tap in the head is connected to a transducer which in turn is connected to a strip chart recorder for determining the pressure in the facepiece.</p>	<p>The unit did not meet the test requirement. The unit went negative three times during the test. Twice at the 15 min mark and also at the 19 min mark.</p> <p>*A different facepiece was supplied by the Christopher FD.</p> <p>* A different cylinder was supplied by the Christopher FD.</p> <p><b>Inhalation Breathing Resistance: (inches of water column) = -0.1</b></p>	<p><b>FAIL</b></p>
<p><b>Rated Service Time Test - NIOSH Standard Test Procedure Number 121, 42 CFR Part 84 Reference: Subpart F, § 84.53 (a) and Subpart H, § 84.95 (a) and (b)</b>  <b>Requirement:</b>  <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>  <b>Procedure:</b>            A breathing machine with a 622 kg.-m./min cam operating at 24 RPM with a 40 liters per minute flow rate is connected to an anthropometric head for cycling. A pressure tap in the head is connected to a transducer which in turn is connected to a strip chart recorder for determining the pressure in the facepiece. The breathing machine is run until the inhalation portion of the breathing curve falls below the minimum requirement.</p>	<p>The SCBA did not meet 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; however, the unit went negative on inhalation and did not maintain positive pressure in the facepiece. The PASS unit did sound but was hard to reset with movement.</p> <p><b>Measured Service Time: 31 Minutes 56 Seconds</b></p>	<p><b>FAIL</b></p>

<p><b>Static Pressure Test - NIOSH Standard Test Procedure Number 122, 42 CFR Part 84 Reference: Subpart H, § 84.91 (d)</b></p> <p><b>Requirement:</b>  <i>The static pressure (at zero flow) in the facepiece shall not exceed 38 mm (1.5 inches) water column height.</i></p> <p><b>Procedure:</b>  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>* A different facepiece was supplied by the Christopher FD.</p> <p><b>Facepiece Static Pressure:(inches of water column) = 1.4</b></p>	<p><b>PASS</b></p>						
<p><b>Gas Flow Test - NIOSH Standard Test Procedure Number 123, 42 CFR Part 84 Reference: Subpart H, § 84.93 (b) and (c)</b></p> <p><b>Requirement:</b>  <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><b>Procedure:</b>  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> <p>* A different facepiece was supplied by the Christopher FD.</p> <table border="0"> <tr> <td><b>Applied Pressure</b></td> <td><b>Airflow (liters per minute)</b></td> </tr> <tr> <td><b>4500 psig</b></td> <td><b>237.86</b></td> </tr> <tr> <td><b>500 psig</b></td> <td><b>240.69</b></td> </tr> </table>	<b>Applied Pressure</b>	<b>Airflow (liters per minute)</b>	<b>4500 psig</b>	<b>237.86</b>	<b>500 psig</b>	<b>240.69</b>	<p><b>PASS</b> <b>PASS</b></p>
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<p><b>Exhalation Resistance Test - NIOSH Standard Test Procedure Number 122, 42 CFR Part 84 Reference: Subpart H, § 84.91 (c)</b></p> <p><b>Requirement:</b>  <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><b>Procedure:</b>  The facepiece is mounted on an anthropometric head form. A probe in the head form is connected to a slant manometer for measuring exhalation breathing resistance. The airflow through the apparatus is adjusted to a rate of 85 liters per minute and the exhalation resistance is recorded.</p>	<p>The SCBA met the test requirement.</p> <p>* A different facepiece was supplied by the Christopher FD.</p> <p><b>Exhalation Breathing Resistance: (inches of water column) = 1.75</b>  <b>Static Pressure: (inches of water column) = 1.4</b>  <b>Difference: (inches of water column) = 0.35</b></p>	<p><b>PASS</b></p>						

<p><b>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)</b></p> <p><b>Requirement:</b>  <i>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 33 to 37 percent of its rated service time or pressure.</i>  <i>This requirement is modified under § 84.63(c) as follows: For apparatus which do not have a method of manually turning off remote gauge in the event of a gauge or gauge line failure the remaining service life indicator is required to be set at 33% + 4% of the rated service time or pressure.</i></p> <p><b>Procedure:</b>  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>As these SCBA models do not have a remote gauge shutoff, the test requirement is 25% +/- 4%.</p> <table border="1"> <thead> <tr> <th></th> <th>Electric</th> <th>Bell</th> </tr> </thead> <tbody> <tr> <td><b>Run #</b></td> <td><b>Alarm Point (psi)</b></td> <td><b>Alarm Point (psi)</b></td> </tr> <tr> <td><b>1</b></td> <td><b>1175</b></td> <td><b>1010</b></td> </tr> <tr> <td><b>2</b></td> <td><b>1210</b></td> <td><b>1175</b></td> </tr> <tr> <td><b>3</b></td> <td><b>1175</b></td> <td><b>NA</b></td> </tr> <tr> <td><b>4</b></td> <td><b>1180</b></td> <td><b>NA</b></td> </tr> <tr> <td><b>5</b></td> <td><b>1180</b></td> <td><b>NA</b></td> </tr> <tr> <td><b>6</b></td> <td><b>1180</b></td> <td><b>NA</b></td> </tr> <tr> <td><b>Average</b></td> <td><b>1183</b></td> <td><b>NA</b></td> </tr> </tbody> </table>		Electric	Bell	<b>Run #</b>	<b>Alarm Point (psi)</b>	<b>Alarm Point (psi)</b>	<b>1</b>	<b>1175</b>	<b>1010</b>	<b>2</b>	<b>1210</b>	<b>1175</b>	<b>3</b>	<b>1175</b>	<b>NA</b>	<b>4</b>	<b>1180</b>	<b>NA</b>	<b>5</b>	<b>1180</b>	<b>NA</b>	<b>6</b>	<b>1180</b>	<b>NA</b>	<b>Average</b>	<b>1183</b>	<b>NA</b>	<p><b>Electric Alarm-PASS</b></p> <p><b>Bell Alarm-FAIL</b></p>
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**National Fire Protection Association (NFPA) Test** (in accordance with NFPA 1981, 2013 Edition):

<b>NFPA Test</b>	<b>Description of Results</b>	<b>PASS/ FAIL</b>
<p><b>NFPA Airflow Performance Test - NFPA 1981 (2013 Edition) Reference: Chapter 5, Performance Requirements, Sec. 5-1.1</b></p> <p><b>Requirement:</b>  <i>SCBA shall be tested for airflow performance as specified in Section 6-1, Airflow Performance Test, and the SCBA facepiece pressure shall not be less than 0.0 in (0.0 mm) water column and 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><b>Procedure:</b>                      The required equipment specified in the NFPA standards were used to conduct the tests on this unit. A pressure tap in the head is connected to a transducer which in turn is connected to a flatbed chart recorder for determining the pressure in the facepiece.</p>	<p>The unit failed this test due to the resistance of the first breath activation being too great for the machine to start.</p> <p><b>Maximum Facepiece Pressure: (inches of water column) = N/A</b>  <b>Minimum Facepiece Pressure: (inches of water column) = N/A</b></p>	<p><b>FAIL</b></p> <p><b>FAIL</b></p>

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## Disposition of SCBA

Following testing at the NIOSH facility, the SCBA was returned to secure storage in Lab H1513 at the NIOSH facility in Morgantown, West Virginia. The unit was then transported to MSA headquarters in Cranberry Township, Pennsylvania on Tuesday August 6, 2019 so that the manufacturer could inspect the mask mounted regulator.

## Synopsis of Findings

The SCBA unit inspected and evaluated by NPPTL was identified as an MSA Model Firehawk® M7, 4500 psi, 30-minute unit with NIOSH Approval Number TC-13F-302. The unit was hand delivered by DSR investigators with a replacement facepiece that was supplied by the Christopher Fire Department. During the inspection process by the NPPTL investigators, it was determined that a replacement cylinder was needed because the investigators were not able to verify that the hydrostatic test was in compliance. As received, the cylinder was empty with the valve closed and not attached to the GCA fitting. The MMR bypass was found in the closed position. Overall condition of this unit was fair with normal wear and tear. This unit did not meet the requirements of the NIOSH Positive Pressure Test (Standard Test Procedure Number 120, 42 CFR Part 84 Reference: Subpart H, 84.70 (a)(2)(ii)), which caused a failure of the Rated Service Time Test (Standard Test Procedure Number 121, 42 CFR Part 84 Reference: Subpart F, § 84.53 (a) and Subpart H, § 84.95 (a) and (b)), even though the unit lasted for 31.56 minutes. The unit passed all the other NIOSH tests except the Remaining Service Life Indicator Test (Standard Test Procedure Number 124, 42 CFR Part 84 Reference: Subpart H, § 84.83 (f) and Subpart G, § 84.63 (c)). The mechanical alarm portion (bell) of this unit only sounded the first two times during this test and failed. The electronic portion of this test passed. The unit did not pass the NFPA Airflow Performance Test - NFPA 1981 (2013 Edition) Reference: Chapter 5, Performance Requirements, Sec. 5-1.1. The testing apparatus was not able to overcome the pressure for the first breath activation to initiate the test.

It was suspected that the bodily fluids observed by the NPPTL investigators during the inspecting and testing process contributed to the pressure failures. The NIOSH investigators transported the unit to MSA headquarters in Cranberry Township, Pennsylvania on Tuesday August 6, 2019 so that the manufacturer could inspect the mask mounted regulator. MSA verified that the MMR had bodily fluids inside the diaphragm and all around the seal. It was also verified that the MMR was out of adjustment. The manufacturer determined that these factors contributed to the unit failing the tests, but they did not have a contributing factor to the fatality.

## CASE Conclusion

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

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

- Any SCBA unit involved in an incident may not be placed back in service until the SCBA has been repaired, tested, cleaned, and any damaged components replaced and inspected by a qualified service technician, including such testing and other maintenance activities as prescribed by the schedule from the SCBA manufacturer
- All SCBA units, even those not involved in an incident, must undergo a flow test on at least an annual basis

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

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

To request additional information about this report, contact NPPTL at [ppeconcerns@cdc.gov](mailto:ppeconcerns@cdc.gov), and reference NIOSH Task Number 23126 in your request.

For more information related to personal protective equipment, visit the NIOSH website [www.cdc.gov/niosh/npptl](http://www.cdc.gov/niosh/npptl).

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

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TTY: 1-888-232-6348

CDC INFO: [www.cdc.gov/info](http://www.cdc.gov/info)

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## Appendix Photographs to Support Inspection Findings for SCBA

### List of Figures

Figure 1: SCBA unit and cylinder as received .....	12
Figure 2: Overall of SCBA unit.....	12
Figure 3: MMR with identifying markings .....	12
Figure 4: MMR and low pressure line .....	13
Figure 5: Pressure reducer, outside view .....	13
Figure 6: Pressure reducer, inside view.....	14
Figure 7: Front of PASS control console .....	14
Figure 8: Back of PASS control held console, 1998 edition .....	15
Figure 9: Top view Nightfighter™ heads-up display.....	15
Figure 10: Side view of Nightfighter™ .....	16
Figure 11: Cylinder attachment and RIC UAC connector .....	16
Figure 12: Cylinder attachment and RIC UAC connector with dust cover off .....	17
Figure 13: Backframe.....	17
Figure 14: Backframe showing cylinder attachment.....	18
Figure 15: Backframe straps and buckles .....	18



Figure 2: Overall of SCBA unit



Figure 3: MMR with identifying markings



**Figure 4: MMR and low pressure line**



**Figure 5: Pressure reducer, outside view**



**Figure 6: Pressure reducer, inside view**



**Figure 7: Front of PASS control console**



Figure 8: Back of PASS control held console, 1998 edition



Figure 9: Top view Nightfighter™ heads-up display



Figure 10: Side view of Nightfighter™



Figure 11: Cylinder attachment and RIC UAC connector



Figure 12: Cylinder attachment and RIC UAC connector with dust cover off



Figure 13: Backframe



**Figure 14: Backframe showing cylinder attachment**



**Figure 15: Backframe straps and buckles**

## Disclaimer

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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.

