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NIOSH
Fire Fighter Fatality Investigation and Prevention Program

Death in the line of duty...

A summary of a NIOSH fire fighter fatality investigation *January 11, 2008*

Career Fire Fighter Dies When Trapped by Collapsed Canopy during a Two Alarm Attached Garage Fire – Pennsylvania

SUMMARY

On February 4, 2007, a 27-year-old male career fire fighter (the victim) and a 38-year-old male career fire fighter were trapped under a canopy which collapsed off of a burning residential garage. The victim was pinned under the canopy debris, and was found not breathing while still wearing his SCBA and SCBA mask. The second fire fighter received injuries requiring time off from work.

The victim and the injured fire fighter were responding to a report of an "unknown type" fire. Upon arriving on scene, they advanced a charged 1 ¾-inch pre-connected hose line into the structure through an open garage door located at the A-side. The victim was the nozzle man. The fire fighters worked long enough to empty their air cylinders, went outside to replace them, and then returned to the garage. When roof debris started to fall, they decided to retreat from the garage. Once immediately outside the garage, they paused underneath the canopy.

Incident scene. Photo courtesy of fire marshal's office

As the fire fighters pulled the hoseline from the garage, the canopy, which was connected to the garage roof rafters by long metal bars, fell on both fire fighters, trapping them underneath. The designated rapid intervention team (who had just arrived on-scene) worked for approximately 10 minutes to extricate both fire fighters. The victim and injured fire fighter were sent to the local hospital by ground ambulance. The victim was pronounced dead at the hospital, and the injured fire fighter was treated for injuries requiring time off from work.

Career Fire Fighter Dies When Trapped by Collapsed Canopy during a Two Alarm Attached Garage Fire – Pennsylvania

NIOSH investigators concluded that, to minimize the risk of similar occurrences, fire departments should:

- ***review and follow existing standard operating procedures (SOPs) for structural fire fighting to ensure that fire fighters follow a "2 in 2 out" policy***
- ***ensure that adequate numbers of staff are available to immediately respond to emergency incidents***
- ***establish a collapse zone when structures become unstable***
- ***ensure that the Incident Commander continuously evaluates the risks versus gain when determining whether the fire suppression operation will be offensive or defensive***
- ***ensure that the first arriving company officer does not become involved in the fire fighting effort after assuming the role of the Incident Commander***
- ***ensure that a thermal imaging camera is used during size-up***
- ***ensure that a separate Incident Safety Officer, independent from the Incident Commander, is appointed at each structural fire***

INTRODUCTION

On February 4, 2007, a 27-year-old male career fire fighter (the victim) died when he was trapped underneath a canopy which collapsed / separated from the front of a burning residential garage. A 38-year-old male career fire fighter (injured fire fighter) was also trapped under the canopy. The victim was found lying on his right side, not breathing while still wearing his SCBA. It was the victim's first working fire with this career department. The injured fire fighter received injuries that required time off from work.

On February 5, 2007, the U. S. Fire Administration notified the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR) of this incident. On February 12 and 28, 2007 the DSR Chief of the Fatality Investigations Team, a DSR Safety Engineer, and a medical resident (guest researcher) from the NIOSH Fire Fighter Fatality Investigation and Prevention Program traveled to Pennsylvania to investigate this incident. The NIOSH investigation team met with officials of the fire department, the mutual aid fire department that extricated the trapped fire fighters, representatives of the International Association of Fire Fighters (IAFF) union, and local police and state police fire marshals. The investigation team conducted interviews with officers and fire fighters present at the scene, examined photographs of the incident scene, visited the fireground site, and reviewed other pertinent documents including the fire department's standard operating

procedures and the victim's and incident commanders' (IC) training records. The victim's personal protective clothing worn at the time of the incident was examined. The victim's SCBA was transferred to the NIOSH National Personal Protective Technology Laboratory (NPPTL) for evaluation and testing. The NIOSH test results (see appendix) show the SCBA failed the positive pressure test and failed to meet the required 30.0 minute duration. These test failures are not believed to have significantly contributed to the fatality as the victim was trapped and could not move his arms to remove his facepiece when he ran out of air.

FIRE DEPARTMENT

The career fire department involved in this incident serves a population of approximately 20,000 residents in a geographic area of about 3.2 square miles. It has a contract with a neighboring borough to cover an additional 3,850 residents.

In February 2007, the fire department consisted of 18 uniformed fire fighters and fire officers. The department has two fire stations and extensive written standard operating procedures. In 2006, the fire department responded to 37 structural fires.

Typical staffing is four fire fighters plus one officer per shift. Two fire fighters and an officer are located at Fire Station 1, and two fire fighters staff Fire Station 2. A standard work shift is 24 hours on-duty and 48 hours off-duty. Additionally, all off-duty fire fighters are called to report to Fire Station 1 when there is a confirmed structural fire. The fire fighters who arrive at the station are briefed and respond on an assigned apparatus.

Vehicles which the department operates include two engines (Engine 8 at Station 2 and Engine 9 at Station 1), a 75-foot tele-squirt, a 100 foot aerial ladder truck, 1 pickup truck, and the Chief's command vehicle. Both engines have 500 gallon tanks with 2000 gallons-per-minute (gpm) pumps. The ladder truck has a 300 gallon tank and a 1,500 gpm pump. The department has 1 thermal imaging camera (TIC).

Just weeks prior to the incident, the department entered into a cooperative agreement with a neighboring combination fire department to provide mutual aid in the form of a designated rapid intervention team (RIT) at all working fires in this department's jurisdiction. A 4-person RIT goes on stand-by when the principle fire department is dispatched, and responds when the fire is confirmed (second alarm). Their response time is 7 – 10 minutes.

TRAINING and EXPERIENCE

The fire department follows the city's requirements in hiring and training a probationary fire fighter. The minimum level of training required is NFPA Fire Fighter Level I.

Both the victim and the injured fire fighter had extensive training and fire fighting experience during their careers. The victim had worked for the fire department for approximately one-half year, but had been a volunteer fire fighter in a neighboring borough for approximately 12.5 years. His training

included NFPA Fire Fighter Level I, emergency medical technician (EMT), and hazardous materials training.

The injured fire fighter had 18 years of total fire fighting experience (11 years career at this department, in addition to 7 years as a volunteer). His training included Fire Fighter Level I, paramedic training, 7 weeks of annual training at the fire academy, driver operator training, and confined space rescue.

The Chief of the department had over 27 years of total fire fighting experience at this department and served as Chief since 2004. His training included various fireground tactic and incident management classes. The Chief assumed incident command (IC) when he arrived at the fire scene and remained as the IC throughout the incident.

Administratively, the fire department enforces fire alarm and sprinkler system requirements. The city's Building Inspector's Office enforces building codes. The city follows the International Building Code.

EQUIPMENT and PERSONNEL

The career fire department responded with 3 apparatus and 14 fire fighters on scene prior to the fatal event. Only the units directly involved in operations preceding the fatal event are discussed in this report. Additional volunteer departments were dispatched after the collapse. The timeline for this incident included initial dispatch at 0934 hours. The response, listed in order of arrival and key events, includes:

- **0934 hours**

  Initial alarm; via homeowner call to 911

- **0938 hours**

  Engine 8 (victim and injured fire fighter from Station 2) left Station 2

  Engine 8 arrived on scene and reported heavy black smoke

  Engine 9 (Captain, 2 fire fighters from Station 1) left Station 1

- **0939 hours**

  Command Vehicle (Chief) arrived on scene; Chief assumes Incident Command (IC)

- **0941 hours**

  Engine 9 (1 Captain, 2 fire fighters from Station 1) arrived on scene

  - Crew laid 4" line to establish water supply

- Captain radioed for mutual aid
- Captain and IC perform 360 degree walk-around of structure

- **0942 hours (approximate)**

  Engine 8 crew enters garage with charged hoseline

- **0951 hours**

  Dispatch notified power company and state fire marshal

- **1000 hours**

  Telesquirt -2 (TS-2) (4 off duty fire fighters called back to Station 1) arrived on scene

  - Prepared master stream
  - Chief informed the injured fire fighter that master stream will start

- **1007 hours**

  Victim and the injured fire fighter exited garage to change SCBA bottles

  Victim and the injured fire fighter re-entered garage

  Small burning debris hit the injured fire fighter

  Victim and the injured fire fighter started to back out of the garage

- **1010 hours**

  Ladder (4 fire fighters, mutual aid Rapid Intervention Team) arrived on scene

  Canopy collapsed

  Rapid Intervention Team began extrication of the injured fire fighter

- **1018 hours**

  RIT extricated the injured fire fighter

- **1027 hours**

  Air ambulance helicopter on scene

- **1028 hours**

  Victim extricated from collapse

- **1030 hours**

  Two ground ambulances arrive on scene (1 advanced life support (ALS) and 1 basic life support (BLS)

- **1041 hours**

  ALS ambulance to air landing zone with victim

  Victim's heart is in pulseless electrical activity

- **1047 hours**

  BLS ambulance arrived at the hospital's emergency room with the injured fire fighter

- **1048 hours**

  ALS ambulance redirected to the emergency room

PERSONAL PROTECTIVE EQUIPMENT

At the time of the incident, the victim and injured fire fighter were wearing their full array of personal protective clothing and equipment, consisting of turnout gear (coat and pants), helmet, Nomex® hoods, gloves, boots, and a self-contained breathing apparatus (SCBA) with an integrated personal alert safety system (PASS). The victims were also equipped with portable radios.

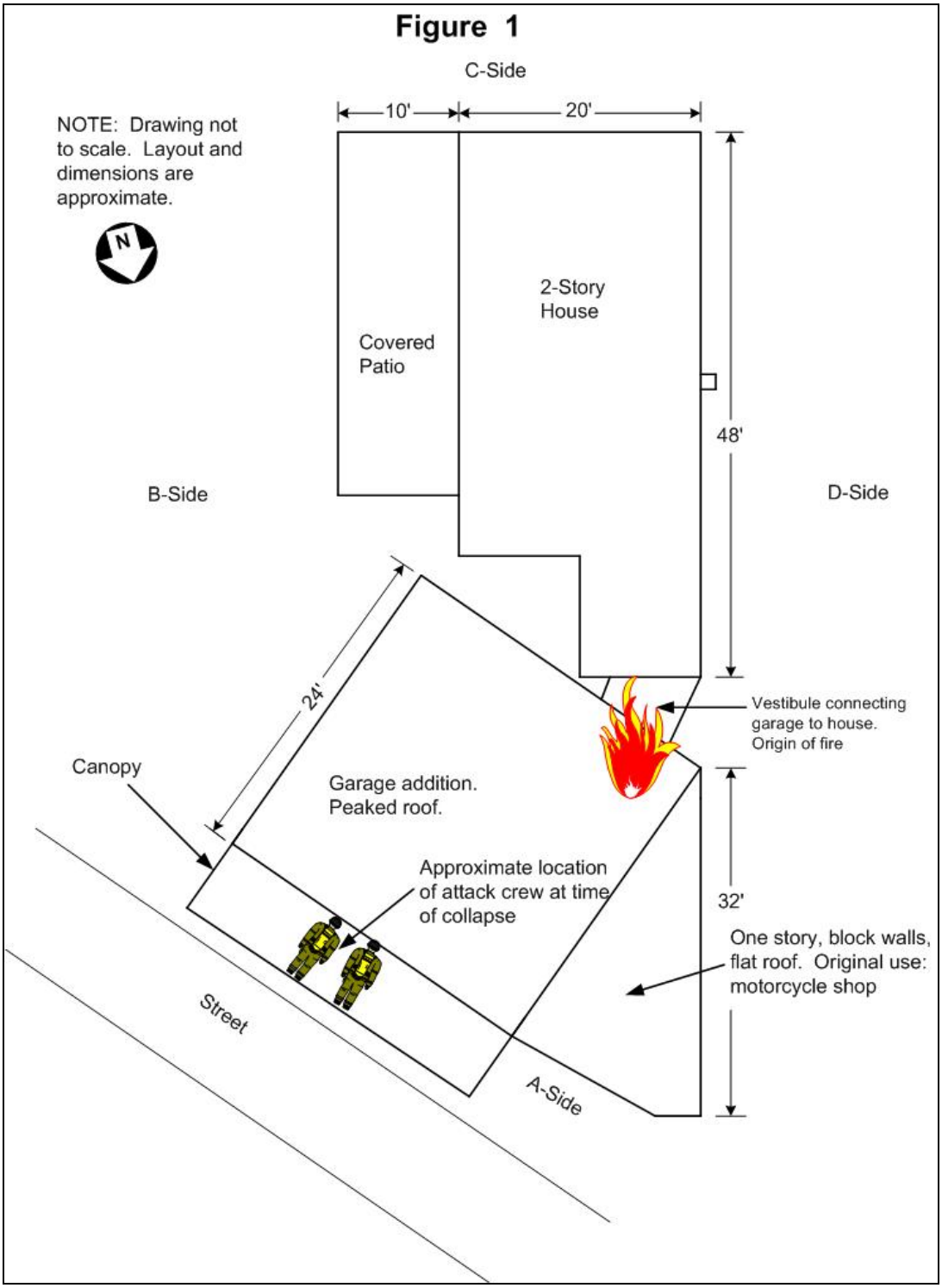
STRUCTURE

The structure involved in this incident included a residential two story house with an attached garage built in 1910, and renovated in 1950 (Photos 1-3). The house dimensions were approximately 48 feet long by 20 feet wide and the garage was approximately 24 feet long and 24 feet wide. The garage was of traditional wooden construction. The garage had a peaked gable roof with attic storage, and the floor was concrete. Several layers of siding were present on the garage including wooden clapboard, covered with weather brick, covered by aluminum siding. The garage was connected to the property's 2-story house by a small vestibule room. The home was of balloon construction, was 1,316 square feet, and was listed as having 5 rooms (2 bedrooms, 1 bathroom). The garage was also attached to an irregular-shaped concrete block structure that had been a commercial motorcycle shop at one time (Figure 1).

A large canopy covered the main garage door (Photo 3). This canopy did not have support columns underneath. Three metal bars connected the canopy to the garage's roof rafters by turn buckles (Photos 4-7). The canopy had a slight pitch for water runoff and it was two layers thick (studs, plywood, and shingles covered by another layer of studs, plywood, and shingles.)

Career Fire Fighter Dies When Trapped by Collapsed Canopy during a Two Alarm Attached Garage Fire – Pennsylvania

Figure 1



Career Fire Fighter Dies When Trapped by Collapsed Canopy during a Two Alarm Attached Garage Fire – Pennsylvania

According to state fire marshal investigators, the cause and origin of the fire was faulty electrical wiring in the vestibule. The fire started low on an interior wall and traveled up the wall to both the house and garage. The fire spread rapidly through the garage attic area. The owner of the building tried to put the fire out with a ½-inch garden hose before calling the fire department. Both the house and the garage were extremely cluttered with an accumulation of various household articles which restricted access and made entry difficult.

WEATHER

The weather at the time of the incident included a temperature high of 14°F, and a low of 3°F. Winds were variable between 10-20 mph, with gusts up to 30 mph from the West and Northwest. No precipitation was reported on the day of the incident. It was determined that the cold weather conditions may have played a significant factor in this incident. Fire fighters were limited in their mobility and slipped on the frozen overspray, and equipment failed (low-pressure air bags failed to deploy to raise debris, regulator couplings froze and could not connect after becoming frozen). The streets around the structure were plowed prior to the incident.

INVESTIGATION

On February 4, 2007, at approximately 0934 hours, the homeowner called 911 (emergency dispatch) and reported a fire in his house. The homeowner had attempted to extinguish the fire with a garden hose for some time before reporting the fire. The municipal (career) fire department was immediately dispatched for "an unknown type fire."

At the time of the dispatch five fire fighters were on duty. A captain and two fire fighters were working at Station 1, and two fire fighters were on duty at Station 2. Engine 8 (E8) was the first engine dispatched. It left Station 2 at 0938 hours with the victim (E8 fire fighter) and injured fire fighter (E8 engineer/operator or EO) on-board. The incident site was approximately 6 city blocks from Station 2.

The Chief of the department was off-duty but driving through town near Station 1 when he heard the dispatch. He immediately proceeded to the scene. Engine 9 (E9) left Station 1 with a captain and two fire fighters on-board at 0938 hours. Just days prior to the incident, the same crews had responded to the same address for a downed power line and wondered whether this call was related.

Engine 8 arrived on the scene and the fire fighters saw heavy black smoke. The EO called dispatch to report what they saw, and the victim pulled a 150-foot length of 1 ¾-inch preconnected hose line from the truck. The E8 EO confirmed the hose the E8 FF (victim) was using, and then engaged the pump and charged the line. As this was occurring, the Chief arrived on scene and assumed Incident Command (IC) while the two fire fighters were preparing to make entry. *Note: Due to limited staffing, the fire department does not have a fire fighter stationed at the pump panel during fire suppression operations. The EO engages the pump than assists with handling the hoseline.*

Career Fire Fighter Dies When Trapped by Collapsed Canopy during a Two Alarm Attached Garage Fire – Pennsylvania

The homeowner met the E8 fire fighters at the garage door and told them the fire was in the back right corner of the garage. The E8 FF advanced through the open garage door (side A) holding the nozzle, and the E8 EO backed him up. The E8 EO also carried an ax.

While enroute, the E9 captain heard Engine 8 arrive on-scene and report heavy smoke showing so he radioed dispatch to request the mutual aid RIT team be dispatched. When Engine 9 arrived on-scene at 0941, the captain radioed dispatch and requested a 2nd alarm for additional mutual aid.

Engine 9 was positioned about 70 yards behind Engine 8. The crew on Engine 9 laid a 4-inch hose from the hydrant to Engine 8. The steamer valve blew off when the Engine 9 crew first tried to connect to the hydrant, so the hydrant was shut off, the steamer valve was reconnected, and the water flow was resumed. A volunteer fire fighter from a neighboring department arrived on-scene and assisted with connecting the line to the hydrant. Engine 8 did not run out of water during this process.

The Chief (IC) and the captain did a 360 degree walk-around, and found a door on side D that accessed the vestibule. Entry was attempted but could not be made due to the accumulation of cluttered objects inside.

After establishing the water supply to Engine 8, the Engine 9 fire fighters went to the structure to assist with the fire ground operations. The volunteer fire fighter was asked to monitor the pumps on Engine 8. One Engine 9 fire fighter got a 24' ladder intending to vent the garage roof. The second Engine 9 fire fighter was directed by the Chief to go to side D to vent the windows in the house. The second Engine 9 fire fighter met the captain on the D side. Dispatch notified the power company and the state fire marshal of the fire at 0951 hours.

TS-2 arrived on scene with 4 fire fighters at 1000 hours and prepared to start a master stream directed at the roof. TS-2 members laid a 4-inch line from another hydrant to supply the master stream. The captain directed the crew to make entry into side D. Three fire fighters took a 1 ¾-inch preconnected handline to side D along with irons (an ax and a Halligan bar). Entry was difficult due to clutter blocking the door. The Engine 9 fire fighter on side D retrieved a 24' ladder from TS-2 and put it up to the second floor window. The captain left side D and walked completely around the house to check the conditions on the other sides. The Chief assisted the fire fighters on side D in knocking out windows in the house for horizontal ventilation.

The first Engine 9 fire fighter had just completed throwing a ladder up to the garage canopy (side A) intending to vent the garage roof when the captain returned and stated he needed manpower on side B. A second 1 ¾-inch preconnected handline was pulled from Engine 8 and pulled to side B, and the Engine 9 fire fighter took this nozzle and entered the house with the captain following him. Fire was observed near the front of the house. The Engine 9 fire fighter began flowing water to knock the fire down. The captain's SCBA ran low on air and his alarm began to sound, so both fire fighters backed out of the house. The captain went to Engine 8 to change his air cylinder while the other fire fighter remained at the side B door and continued to flow water through the door.

COLLAPSE

The Chief (IC) called to the E8 EO as he and the victim were fighting the fire inside the garage. The E8 EO backed up a few steps to hear the Chief say that the TS-2 master stream was going to go into operation to stop the fire spread on the back side of the house. The E8 FF (victim) remained in the garage, bouncing water off of the ceiling onto the fire. At this point, both E8 fire fighters backed out of the garage to change SCBA cylinders since they were running low on air.

Meanwhile, one of the fire fighters who arrived on TS-2 went to side B to assist the Engine 9 fire fighter with the hand line while the Captain was changing his air cylinder. These two fire fighters made entry through the side B door and into the house. They advanced about 10 feet and encountered heavy fire to the right. Water was directed in this area and appeared to be effective in knocking down the fire there. The Captain returned to side B and called the two fire fighters outside to tell them that the master stream on TS-2 was going into operation. As the two fire fighters were talking with the captain, they heard an air horn and then heard the Chief call a mayday over the radio.

After changing cylinders, the E8 crew (victim and E8 EO) had re-entered the garage to resume putting water on the fire. Some debris from the ceiling fell on the E8 EO's head, knocking him to his knees. He told the E8 FF (the victim) that they needed to back out due to the deteriorating conditions.

They backed out of the garage door, but remained near the doorway and still under the canopy with the hose line still in operation. The E8 FF was on his knees, directing the nozzle towards the fire. The E8 EO told the E8 FF they needed to back up more to get out from under the canopy. As they were stepping back, the canopy collapsed on them without warning. They were approximately 3 minutes into their second SCBA cylinders.

The canopy hit the E8 EO in the back and knocked his helmet off. One arm was pinned by the construction materials of the canopy (2x4 and 2x6 lumber). The other arm was free, so he activated his PASS and started pounding on debris. He saw daylight, and was able to move enough so that he could free his arm and wiggle out of his SCBA straps and scoot toward the light. When he reached the light, he was able to wave his hand through a small opening in the debris. He removed his face piece when the air in his SCBA cylinder ran out. The E8 EO heard the victim's PASS and was able to speak to him.

The Chief (IC) had just returned to side D and began knocking out windows for ventilation, when a civilian told him that the canopy had just collapsed on two fire fighters. The Chief returned to side A to see the collapse as the mutual aid Rapid Intervention Team (RIT) arrived on scene. At 1010 hours, the Chief called a mayday, and all the career fire fighters were directed to the front of the building. A volunteer fire department kept water flowing at the back of the house and garage.

EXTRICATION

The mutual aid rapid intervention team (RIT) arrived just as the canopy collapsed. Two civilians ran up to the RIT team and told them that two fire fighters were trapped under the canopy. The RIT team took its tool bag (cordless saw and drill, rope, hand tools and irons), and the RIT team leader took a 6-foot steel roof hook.

The RIT team leader approached the front of the garage and directed his team to use cribbing to support the canopy. He then crawled into the void space between the collapsed canopy and the garage wall and was able to speak to the injured fire fighter.

Air bags were brought out to lift the collapsed canopy, but the intense cold and overspray froze the airbags and line couplings, rendering them useless. A mechanical spreader was used to lift the canopy, but it just broke through the wood without lifting the canopy and its use was discontinued. A ventilation fan was started to blow smoke away from the canopy.

The RIT team then used power saws to cut the injured fire fighter out of the debris. The E8 EO told the RIT team where he thought the victim was. *(Note: it was stated by the RIT team leader that it was difficult to cut the victim out of the debris because his exact location was not known. Some rescuers reported hearing a muffled PASS device while others stated they did not hear a PASS device.*) When found, the victim's upper torso was uncovered first. His face piece and helmet were still on and in place. His arms were pinned, and he did not appear to be breathing. Additionally, the victim was laying on his right side because the SCBA tank was still on his back. Rescuers removed the victim's face piece to administer oxygen while his legs were still pinned. The canopy was fully cut away, and the victim was removed from the debris.

A helicopter landed on scene, but it was not used because the victim did not have vital signs.
Both the victim and the injured fire fighter were transported to the city hospital by ground ambulance.
The E8 EO was treated for smoke inhalation and an ankle sprain.

CAUSE OF DEATH

According to the coroners' findings, the cause of death for the victim was asphyxiation due to entrapment under a collapsed roof.

RECOMMENDATIONS

Recommendation #1: Fire departments should review and follow existing standard operating procedures (SOPs) for structural fire fighting to ensure that fire fighters follow a 2- in 2-out policy.

Discussion: The Occupational Safety and Health Administration (OSHA) Respirator Standard and Hazardous Waste Operations and Emergency Response Standard requires four persons (two in and two out); each with protective clothing and respiratory protection as the minimum number essential for the safety of those performing work inside a structure.[1,2] The National Fire Protection Association (NFPA), and the fire department's standard operating procedure, also recommend two in and two out and that the team members should be in communication with each other through visual, audible, or electronic means to coordinate all activities, and determine if emergency rescue is needed.[3,4] During this incident's initial response, the limited manpower both on duty and available, was not adequate to ensure compliance with two in two out requirements at all times.

Recommendation #2: Fire departments should ensure that adequate numbers of staff are available to immediately respond to emergency incidents

Discussion: NFPA 1710 *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments (2004 Edition)* contains recommended guidelines for minimum staffing of career fire departments.[5]

NFPA 1710 § 5.2.2 (Staffing) states the following: "On-duty fire suppression personnel shall be comprised of the numbers necessary for fire-fighting performance relative to the expected fire-fighting conditions. These numbers shall be determined through task analyses that take the following factors into consideration:

1. Life hazard to the populace protected
2. Provisions of safe and effective fire-fighting performance conditions for the fire fighters
3. Potential property loss
4. Nature, configuration, hazards, and internal protection of the properties involved
5. Types of fireground tactics and evolutions employed as standard procedure, type of apparatus used, and results expected to be obtained at the fire scene."

The NFPA standard states that both engine and truck companies shall be staffed with a minimum of four on-duty personnel. The standard also states that in jurisdictions with tactical hazards, high hazard occupancies, high incident frequencies, geographical restrictions, or other pertinent factors identified by the authority having jurisdiction, these companies shall be staffed with a minimum of five or six on-duty members. Jurisdictions where fire companies deploy quint apparatus designed to

operate as either an engine company or a ladder company should also follow these same staffing guidelines.

NFPA 1710 also states that the fire department's fire suppression resources shall be deployed to provide for the arrival of an engine company within a 4-minute response time and/or the initial full alarm assignment within an 8-minute response time to 90 percent of the incidents as established in Chapter 4. The fire department shall have the capability to deploy an initial full alarm assignment within an 8-minute response time to 90 percent of the incidents as established in Chapter 4. The initial full alarm assignment shall provide for the following:

(1) Establishment of incident command outside of the hazard area for the overall coordination and direction of the initial full alarm assignment. A minimum of one individual shall be dedicated to this task.
(2) Establishment of an uninterrupted water supply of a minimum 1520 L/min (400 gpm) for 30 minutes. Supply line(s) shall be maintained by an operator who shall ensure uninterrupted water flow application.
(3) Establishment of an effective water flow application rate of 1140 L/min (300 gpm) from two handlines, each of which shall have a minimum of 380 L/min (100 gpm). Each attack and backup line shall be operated by a minimum of two individuals to effectively and safely maintain the line.
(4) Provision of one support person for each attack and backup line deployed to provide hydrant hookup and to assist in line lays, utility control, and forcible entry.
(5) A minimum of one victim search and rescue team shall be part of the initial full alarm assignment. Each search and rescue team shall consist of a minimum of two individuals.
(6) A minimum of one ventilation team shall be part of the initial full alarm assignment. Each ventilation team shall consist of a minimum of two individuals.
(7) If an aerial device is used in operations, one person shall function as an aerial operator who shall maintain primary control of the aerial device at all times.
(8) Establishment of an Incident Rapid Intervention Crew (IRIC) that shall consist of a minimum of two properly equipped and trained individuals.

Due to staffing and manpower limitations within the department, the small size of the initial responding crews at this incident could not appropriately and safely respond to the necessary fireground operations–e.g. incident command, scene size-up, search-and-rescue, a staged Incident Rapid Intervention Crew (IRIC), hydrant connections, ventilation, and medical aid and transport. Additional manpower was requested and off-duty fire fighters were called to return to work.

The city funds the fire department involved in the incident. According to the Fire Chief, staffing has been a concern since 1997 when a consultant was hired to determine the number of fire fighters needed for the city. The consultant recommended a minimum of 21, with at least 27 fire fighters as optimal.

Recommendation #3: Fire departments should establish a collapse zone when structures become unstable.

Discussion: Buildings can collapse due to the structural damage directly caused by a fire, or the activities of fire fighting operations. A fire department's familiarity with types of construction in their community is an important tool in safely fighting fires. Fire fighters should be able to immediately evacuate a building where collapse is possible. A collapse zone equal to one and a half times the height of the building should be established. This perimeter assists in keeping personnel out of imminent danger. [6-8] Once a collapse zone is established, fire departments should enforce a "no re-entry" policy unless the Incident Commander is aware and approves. In this incident, the first crew arrived on-scene at 0938 hours and the collapse occurred at approximately 1010 hours. Fire fighters had been on the scene for 32 minutes and the fire had been affecting the structural integrity of the building for at least that long.

Fire fighters need to recognize the dangers of operating underneath or near overhanging awnings, porches, and other areas susceptible to collapse. Immediate safety precautions must be taken if factors indicate the potential for a building collapse. An external load, such as a parapet wall, steeple, overhanging porch, awning, sign, or large electrical service connections reacting on a wall weakened by fire conditions may cause a wall to collapse. Other factors include fuel loads, damage, renovation work, deterioration caused by the fire as well as pre-existing deterioration, support systems and truss construction.[6,7] A collapse is a possibility after fire involvement of more than 10 minutes.[8] The canopy which collapsed in this incident was supported by metal rods connected to the garage's roof rafters.

Recommendation #4: Fire departments should ensure that the Incident Commander continuously evaluates the risks versus gain when determining whether the fire suppression operation will be offensive or defensive.

Discussion: The initial size-up conducted by the first arriving officer allows the officer to make an assessment of the conditions and to assist in planning the suppression strategy. The following general factors are important considerations during a size-up: occupancy type involved, potential for civilians trapped in the structure, smoke and fire conditions, type of construction, age of structure, exposures, and time considerations such as the time of the incident, length of time fire was burning before arrival, and time fire was burning after arrival.[9,10] The Incident Commander must perform a risk analysis to determine what hazards are present, what the risks to personnel are, how the risks can be eliminated or reduced, and the benefits to be gained for interior or offensive operations.[11] The initial size-up should include a complete 360º walk-around of the structure if possible.

The size-up must include continued assessment of risk versus gain during incident operations. According to NFPA 1500 §A-6-2.1.1, "The acceptable level of risk is directly related to the potential to save lives or property. Where there is no potential to save lives, the risk to the fire department

members must be evaluated in proportion to the ability to save property of value. When there is no ability to save lives or property, there is no justification to expose fire department members to any avoidable risk, and defensive fire suppression operations are the appropriate strategy."[3] Retired New York City Fire Chief Vincent Dunn states "When no other person's life is in danger, the life of the firefighter has a higher priority than fire containment."[12]

The first-responding officer, as well as the incident commander, needs to make a judgment as to what is at risk – people or property. This will help determine the risk profile for the incident. Many fire fighters stand by the notion that all incidents are "people" events until proven otherwise. Some fire fighters are willing to concede that a fire environment has become too hostile to sustain life and therefore, the only thing left to save is property.[13]

In this incident, the structure involved was not occupied, the only resident of the adjoining house was known to be outside and the garage and house were greatly cluttered making entry difficult. The first crew arrived on-scene at 0938 hours and the collapse occurred at approximately 1010 hours. Fire fighters had been on the scene for 32 minutes and the fire had been affecting the structural integrity of the building for at least that long. Fire officers and fire fighters need to understand that they have very little time to offensively fight a fire once the structural elements have become involved and also how different construction types, age of construction, and factors such as the steel support rods on the canopy can be affected by fire.

Recommendation #5: Fire departments should ensure that the first arriving company officer does not become involved in the fire fighting effort when assuming the role of the Incident Commander.

Discussion: Fire fighter safety starts with a strong command presence. According to NFPA 1561, §4.1.1, "the Incident Commander shall be responsible for the overall coordination and direction of all activities at an incident." In addition to conducting an initial size-up, Incident Command (IC) should maintain a command post outside of the structure to assign companies and delegate functions, and continually evaluate the risk versus gain of continued fire fighting efforts.[14] According to the International Fire Service Training Association (IFSTA) publication, *Fire Department Company Officer*, there are three modes of operation for the first-arriving officer assuming IC: nothing showing, fast attack, and command. [15]

"**Nothing-showing mode.** When the problem generating the response is not obvious to the first-in unit, the company officer should assume command of the incident and announce that nothing is showing. He should direct the other responding units to stage at Level I, accompany the crew on an investigation of the situation, and maintain command using a portable radio."

"**Fast-attack mode.** When the company officer's direct involvement is necessary for the crew to take immediate action to save a life or stabilize the situation, the officer should take command and announce that the company is in the fast-attack mode."

"Command mode. Because of the nature of some incidents, immediate and strong overall command is needed. In these incidents, the first-in officer should assume command by naming the incident and designating the command post, give an initial report on conditions, and request the additional resources needed."

In this incident, smoke coming from the roof and inside the building required the "Command mode" of operation. The first arriving officer initiated the "Command mode" by declaring command of the incident over the radio and reporting smoke coming from the roof and inside the building. However, due to insufficient staffing and manpower limitations, the Incident Commander became involved in fire ground duties such as pulling hose lines and assisting in ventilation.

To effectively coordinate and direct fire fighting operations on the scene, it is essential that the IC does not become involved in fire fighting efforts. A delay in establishing an effective command post may result in confusion of assignments, lack of personnel and apparatus coordination which may contribute to rapid fire progression. The involvement of the initial IC in fire fighting also hampers the communication of essential information as command is transferred to later arriving officers.

Recommendation #6: Fire departments should consider using a thermal imaging camera as a part of the initial size-up operation to aid in locating fires in concealed areas.

Discussion: Thermal imaging cameras are being used more frequently by the fire service. One function of the camera is to locate the fire or heat source. Infrared thermal cameras assist fire fighters in quickly getting crucial information about the location of the source (seat) of the fire from the exterior of the structure, so they can plan an effective and rapid response with the entire emergency team before initiating the interior attack. Knowing the location of the most dangerous and hottest part of the fire may help fire fighters determine a safe approach and avoid structural damage in a building that might have otherwise been undetectable. Ceilings and floors that have become dangerously weakened by fire damage and are threatening to collapse may be spotted with a thermal imaging camera. The use of a thermal imaging camera may provide additional information the Incident Commander can use during the initial size-up. [16] In this incident, the use of a thermal imaging camera may have aided the fire fighters in identifying that the fire was burning in the garage's roof rafters sooner, allowing them to exit the garage sooner.

Recommendation #7: Fire departments should ensure that a separate Incident Safety Officer, independent from the Incident Commander, is appointed at each structural fire.

Discussion: According to NFPA 1561 *Standard on Emergency Services Incident Management System, 2005 Edition*, paragraph 7.1.1, "The Incident Commander shall have overall authority for management of the incident (7.1.1) and the Incident Commander shall ensure that adequate safety measures are in place (7.1.2)." This shall include overall responsibility for the safety and health of all personnel and for other persons operating within the incident management system. While the Incident Commander (IC) is in overall command at the scene, certain functions must be delegated to ensure

adequate scene management is accomplished.[14] According to NFPA 1500 *Standard on Fire Department Occupational Safety and Health Program, 2007 Edition*, "as incidents escalate in size and complexity, the incident commander shall divide the incident into tactical-level management units and assign an incident safety officer (ISO) to assess the incident scene for hazards or potential hazards (8.1.6)."[3] These standards indicate that the IC is in overall command at the scene, but acknowledge that oversight of all operations is difficult. On-scene fire fighter health and safety is best preserved by delegating the function of safety and health oversight to the ISO. Additionally, the IC relies upon fire fighters and the ISO to relay feedback on fireground conditions in order to make timely, informed decisions regarding risk versus gain and offensive versus defensive operations. The safety of all personnel on the fireground is directly impacted by clear, concise, and timely communications among mutual aid fire departments, sector command, the ISO, and IC.

Chapter 6 of NFPA 1521, *Standard for Fire Department Safety Officer*, defines the role of the ISO at an incident scene and identifies duties such as recon of the fire ground and reporting pertinent information back to the Incident Commander; ensuring the department's accountability system is in place and operational; monitoring radio transmissions and identifying barriers to effective communications; and ensuring established safety zones, collapse zones, hot zone, and other designated hazard areas are communicated to all members on scene.[17]

Larger fire departments may assign one or more full-time staff officers as safety officers who respond to working fires. In smaller departments, every officer should be prepared to function as the ISO when assigned by the IC. The presence of a safety officer does not diminish the responsibility of individual fire fighters and fire officers for safety. The ISO adds a higher level of attention and expertise to help the individuals. The ISO must have particular expertise in analyzing safety hazards and must know the particular uses and limitations of protective equipment.[17]

The department involved in this incident did not have a permanent safety officer position and limited manpower and staffing at the incident did not allow for the designation of a separate Incident Safety Officer. A designated safety officer could have assisted with continual size-up and timely communications regarding safety on the fireground, including the need to establish a collapse zone.

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INVESTIGATOR INFORMATION

This investigation was conducted by Robert Koedam, Chief, Fatality Investigations Team, and Tim Merinar, Safety Engineer, with the Fire Fighter Fatality Investigation and Prevention Program, Surveillance and Field Investigations Branch, Division of Safety Research, NIOSH. Vance Kochenderfer, NIOSH Quality Assurance Specialist, National Personal Protective Technology Laboratory, conducted an evaluation of the victim's self-contained breathing apparatus. Luci Kovacevic, MD, Guest Researcher at the NIOSH, Division of Safety Research also assisted in the investigation. This report was authored by Luci Kovacevic. An expert technical review was conducted by Battalion Chief of Safety Stephen Miles, Virginia Beach (VA) Fire Department.

Photo 1: Aerial view of house and garage. Photo courtesy http://maps.google.com/

Career Fire Fighter Dies When Trapped by Collapsed Canopy during a Two Alarm Attached Garage Fire – Pennsylvania

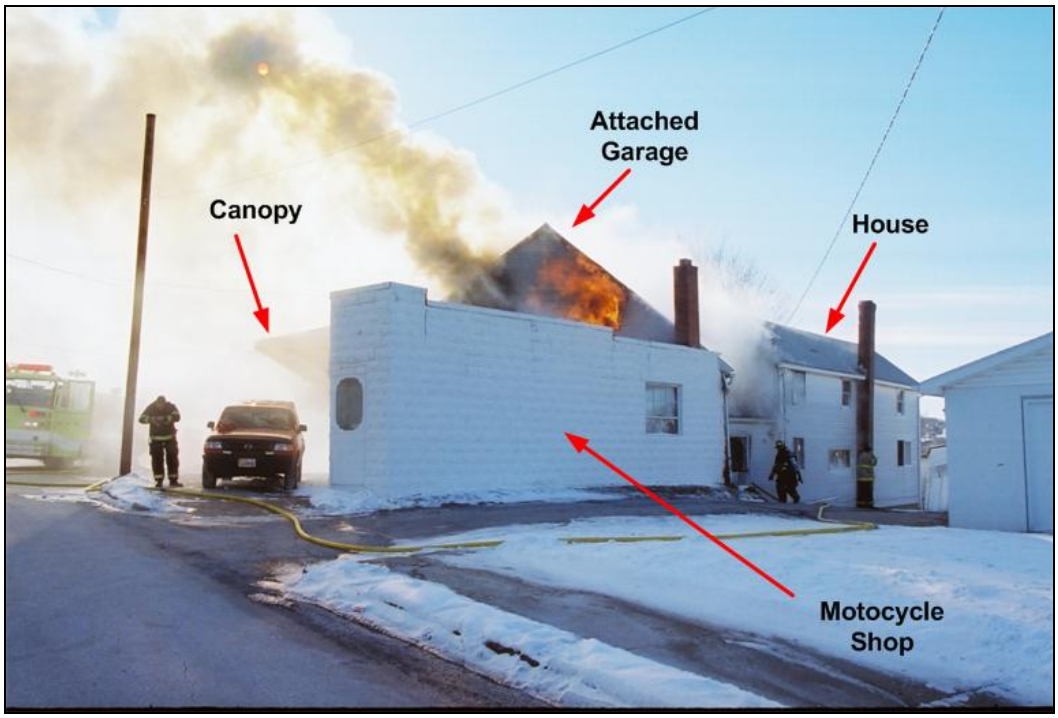


Photo 2: Canopy pre-collapse, side D. Canopy is just visible above and to the right of the truck. Photo courtesy of fire marshal's office

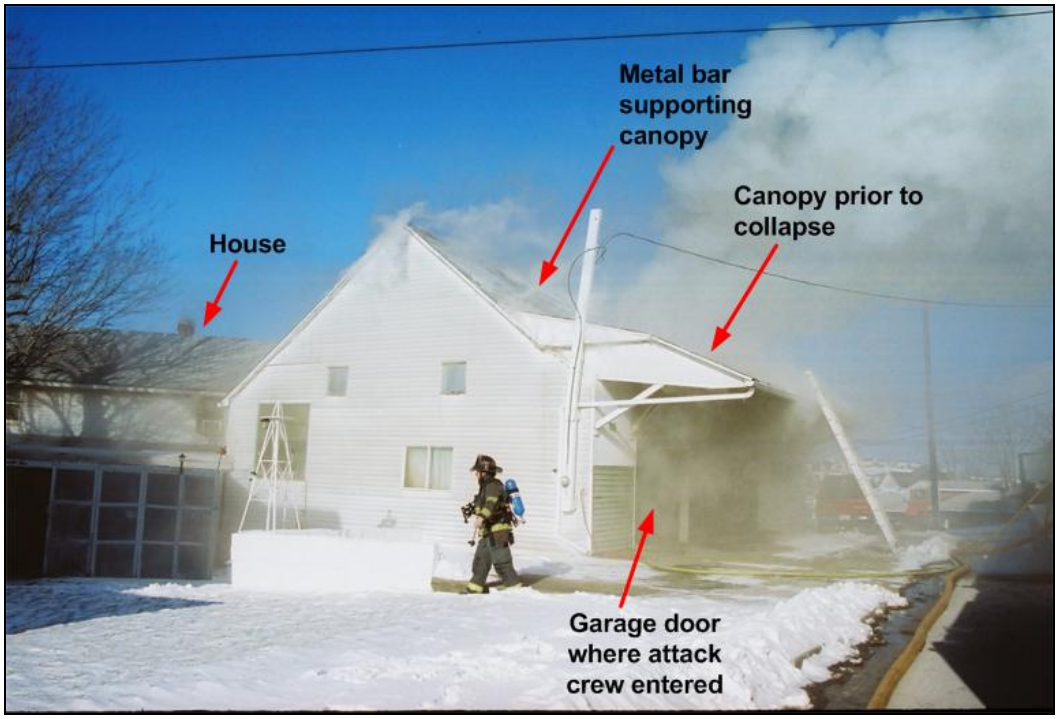


Photo 3: Canopy pre-collapse, side B as viewed from A-B corner. Photo courtesy of fire marshal's office

Photo 4: Canopy post-collapse, side D. Photo courtesy of fire marshal's office

Photo 5: Canopy post-collapse, side D. Note failed metal support rods and turn-buckles. Photo courtesy of fire marshal's office

Career Fire Fighter Dies When Trapped by Collapsed Canopy during a Two Alarm Attached Garage Fire – Pennsylvania

Photo 6: Failed metal support rods and turn-buckle. Photo courtesy of fire marshal's office.

Photo 7: Failed metal support rods bolted to roof rafter. Photo courtesy of fire marshal's office.

APPENDIX

National Personal Protective Technology Laboratory

Technology Evaluation Branch

Status Investigation Report of One Self-Contained Breathing Apparatus Submitted by the Washington Police Department Washington, Pennsylvania

NIOSH Task No. 15057

January 18, 2008

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 inspection and performance tests were conducted by Eric Welsh, Engineering Technician and Vance Kochenderfer, Quality Assurance Specialist, both of the Technology Evaluation Branch, National Personal Protective Technology Laboratory, National Institute for Occupational Safety and Health, located in Bruceton, Pennsylvania. This report was written by Vance Kochenderfer.

Status Investigation Report of One Self-Contained Breathing Apparatus Submitted by the Washington Police Department Washington, Pennsylvania

NIOSH Task No. 15057

Background

As part of the ***National Institute for Occupational Safety and Health (NIOSH) Fire Fighter Fatality Investigation and Prevention Program***, the Respirator Branch agreed to examine and evaluate one Dräger Safety UK Ltd. 4500 psi, 30-minute, self-contained breathing apparatus (SCBA).

This SCBA status investigation was assigned NIOSH task number 15057. The Washington Police Department was advised that NIOSH would provide a written report of the inspections and any applicable test results.

The SCBA, sealed in a corrugated cardboard box, was delivered to the NIOSH facility in Bruceton, Pennsylvania on March 21, 2007 by Detective Chris Luppino of the City of Washington Police Department. The package was opened that day and stored data downloaded from the Sentinel remote pressure gauge and Personal Alert Safety System device. A copy of the data was provided to Detective Luppino at that time. The package was then taken to the Firefighter SCBA Evaluation Lab (building 108) and stored under lock until the time of the evaluation.

SCBA Inspection

The package was opened and the SCBA inspection was performed on October 2, 2007. The SCBA was examined, component by component, in the condition as received to determine its conformance to the NIOSH-approved configuration. The visual inspection process was videotaped. The SCBA was identified as the Dräger UK Limited AirBoss PSS100 model.

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

The SCBA generally appeared to be undamaged and overall in very good condition. The barrel of the lung demand valve was slightly separated from the housing body. Also, a few gouges were noted in the cylinder surface. Although this damage may require repair before the cylinder is returned to use, it was judged that the cylinder could safely be used for laboratory testing with appropriate precautions being observed.

Personal Alert Safety System (PASS) Device

A combination Personal Alert Safety System (PASS) and remote air pressure gauge, known as a Sentinel device, was incorporated in the SCBA. On March 21, 2007, the Sentinel device was examined to determine if it contained any stored data. Data were obtained and three charts from the day of last use are attached as **Appendix II**. The data also indicate that the PASS device alarmed due to lack of motion at 11:37:15 on the date of last use and that the alarm had never been manually activated on that date. Although during the visual inspection the PASS device was activated and appeared to function normally, it was not tested against the specific performance requirements of NFPA 1982, *Standard on Personal Alert Safety Systems (PASS)*, 1998 Edition. Because NIOSH does not certify PASS devices, no further testing or evaluations were conducted on the PASS unit.

SCBA Testing

The purpose of the testing was to determine the SCBA's conformance to the approval performance requirements of Title 42, *Code of Federal Regulations*, Part 84 (42 CFR 84).

The following performance tests were conducted on the SCBA:

NIOSH SCBA Certification Tests (in accordance with the 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, 2002 Edition):

7. Air Flow Performance Test [Chapter 7, 7.1.1]

Testing was performed on October 3, 4, 9, and 17, 2007. All testing was videotaped with the exception of the Exhalation Resistance Tests and Static Pressure Tests.

The SCBA passed all performance tests with the exception of the Positive Pressure Test and Rated Service Time Test. The SCBA allowed the facepiece pressure to drop slightly below ambient during the Positive Pressure Test, then it dropped lower when the cylinder was exhausted one minute and three seconds prior to the rated time. The heads-up display incorporated in the facepiece did not function at all during testing.

Appendix III contains the complete NIOSH and NFPA test reports for the SCBA. **Tables One and Two** summarize the test results.

Summary and Conclusions

The SCBA submitted to NIOSH by the Washington Police Department for evaluation was delivered to NIOSH on March 21, 2007 and inspected on October 2, 2007. The unit was identified as a Dräger UK Limited AirBoss PSS100 30-minute, 4500 psi SCBA (NIOSH approval number TC-13F-378). The unit was determined to be in a condition safe for testing.

The unit was subjected to a series of seven performance tests on October 3, 4, 9, and 17, 2007. The SCBA was able to meet the requirements of all tests except the Positive Pressure Test and Rated Service Time Test. The heads-up display was not functional. No maintenance or repair work was performed on the unit at any time.

In light of the information obtained during this investigation, NIOSH has proposed no further action at this time. Following inspection and testing, the SCBA was returned to the package in which it was received. It was returned to the Washington Police Department on December 13, 2007.

If the SCBA is to be placed back in service, it must be thoroughly inspected, repaired, and tested by a qualified service technician. The damage to the cylinder should be evaluated and, if necessary, repaired by a certified retester before it can be put back into use.

Appendix I

SCBA Inspection Report

National Personal Protective Technology Laboratory / Respirator Branch

Respirator Field Problem
Incoming Inspection Report Summary

Task Number:	15057	**Requestor:**	Washington Police Department
Date Received:	21 March 2007		
Date Inspected:	2 October 2007	**Description:**	Fatality
Manufacturer:	Dräger UK Ltd.	**Inspected by:**	Vance Kochenderfer
Approval Number:	TC-13F-378	**SCBA Type:**	Open Circuit, Pressure-Demand

As received, the SCBA was packaged in a corrugated cardboard box (refer to **Figures 1 and 2** in **Appendix IV**).

Components and Observations

NOTE: All references to "right" or "left" are from the user's perspective.

1. Facepiece (Refer to Figures 3 through 6 in Appendix IV):

The facepiece appears to be a Dräger Panorama Nova EPDM facepiece assembly which consists of a rubber facepiece seal, lens, lens clamp, and rubber head harness. Overall the facepiece is in very good condition. The lens surface has a few scratches and is slightly dirty but remains intact. Visibility through the lens is very good to excellent. The number "**38**" is affixed to the bottom center of the lens. The lens clamp holds the lens to the faceseal. The clamp is intact and the two screws holding the clamp halves together appear to be fully tightened.

The assembly that houses the demand valve port, speech diaphragm, and exhalation valve sub-assemblies is in very good condition. The exhalation valve appears to be properly seated. A speech diaphragm is installed and appears normal. The demand valve can be easily attached to and removed from the housing. The clamp holding the housing to the faceseal is secure.

The black rubber facepiece seal is in excellent condition. The rubber face seal is pliable and has no cuts, tears or other damage. All five head harness attachment points are secure. There are no cuts, deformities, or any signs of damage to the seal. The text "**4052955**" and "**ARUE-0867**" is molded into the lower left attachment point. Molded into the right cheek area on the faceseal exterior is a Dräger logo and "**PANORAMA NOVA EPDM**"; the interior has a circular date code indicating the seal was molded in the **first half of 2004.**

There is a black rubber nosecup assembly installed in the facepiece. The nosecup is firmly

attached to the facepiece assembly and the rubber is flexible and appears undamaged. The two inhalation valves installed in the nosecup are undamaged. There is a small amount of yellowish debris inside the nosecup. Molded on the nosecup interior is the part number "**R52822**" and a circular date code indicating it was molded in the **first half of 2004**.

The black rubber head harness is in excellent condition. All five straps can be easily adjusted. Molded into the back of the head harness is a circular date code indicating it was molded in the **first half of 2004** along with the part number "**R54724**." A black webbing neck strap is included with the facepiece. Although undamaged, the right side of the neck strap is detached from the facepiece.

A heads-up display is installed in the facepiece. It is undamaged and bears the serial number "**011369**."

2. <u>Lung Demand Valve and Hose</u> (Refer to Figures 7 through 10 in Appendix IV):

The facepiece-mounted lung demand valve (also known as the second stage pressure demand regulator) assembly is in very good condition overall. The barrel which connects to the facepiece is slightly separated from the rest of the housing body on the left side. The serial number "**BRSJ 1852**" is marked at the bottom, along with the letter "**P**.". The bypass valve on the right side is in the fully open position and operates smoothly. The donning switch is not engaged, and it can be set and released properly. The o-ring seal is intact and slightly dirty. The low pressure hose swivels freely where it connects to the demand valve.

The low pressure hose is undamaged with no cuts, tears, or cracking. The quick-disconnect coupling is clean and can be easily joined and released. The hose is routed through the right shoulder strap and down the left side of the backframe and is securely fastened at the pressure reducer. The hose is marked "**Draeger R21034 08/02**" along its length. The hose is free to turn at the pressure reducer connection.

3. <u>Air Pressure Reducer and Supplied Air Line</u> (Refer to Figures 11 through 13 in Appendix IV):

The air pressure reducer (also known as the first stage regulator) appears to be in very good condition. The exterior of the metal housing is somewhat dirty but undamaged. The reducer is securely fastened to the backframe. The housing is marked with the serial number "**BRTM 4657**" along with the designations "**03**" and "**3351941**." The low-air alarm whistle attached to the housing is intact and the whistle outlet is not blocked. The cylinder connector nut and handwheel are undamaged. There is a small amount of white powdery corrosion on the cylinder sealing nipple, and the o-ring is clean and intact.

The supplied air line is securely connected to the pressure reducer. The hose jacket is undamaged and is marked "**Draeger R21034 08/02**." The hose extends along the left side of the waistbelt and ends in a female quick-disconnect fitting. The coupling is clean and

protected by a rubber dust cap.

4. <u>Remote Air Pressure Gauge and PASS Device</u> (Refer to Figures 14 and 15 in Appendix IV):

This SCBA is equipped with a Sentinel electronic remote air pressure gauge and PASS device. The gauge body is covered with a protective rubber boot. The lens is somewhat scratched and dirty, but the gauge still appears to be readable. The PASS device appeared to function normally. It was activated with the alarm button and went into full alarm, then was manually reset into the sensing mode. The device appeared to properly enter pre-alarm and was reset by motion. It was then allowed to proceed through pre-alarm to full alarm, which could not be reset by motion. Although NFPA 1982 contains specific requirements for the sensitivity, sound level, and other characteristics of PASS devices, these were not evaluated because NIOSH does not certify PASS devices. On the back of the unit is a label certifying the device to the **1998 edition** of **NFPA 1982** along with the serial number "**BRSL-1091**" and the manufacture date "**SEP/02**."

The gauge hose is undamaged is routed through the left shoulder strap to the heads-up display transmitter housing mounted on the left side of the backframe. This hose is marked "**Draeger R21034 07/03**" along its length. The heads-up display transmitter housing is in very good to excellent condition. A blue circular label handwritten with "**007328**" is affixed to the front. The hose running from the housing to the pressure reducer is also undamaged and is marked "**Drager R21034 10/03**."

5. <u>Backframe and Harness Assembly</u> (Refer to Figures 16 through 19 in Appendix IV):

The backframe body is made of molded plastic. It is basically undamaged with not much evidence of wear and appears structurally sound. The cylinder retention webbing is in very good condition and properly secures the cylinder to the backframe.

Affixed to the back of the backframe is a NIOSH approval label showing that the SCBA was manufactured under the approval number **TC-13F-378**. Also on the back is a label indicating the unit is certified to the **2002 edition** of **NFPA 1981**; this label is hand-marked with the serial number "**BRSK-3813**." A "**DrägerService**" label indicates that the unit was due for inspection in **November 2003**.

Both shoulder straps are in very good to excellent condition. They are securely fastened at the top of the backframe. The adjustment buckles work well, and both adjustment straps are undamaged and securely attached to the backframe at the bottom.

The waistbelt is securely fastened to the backframe, and its webbing and fabric components are also in very good to excellent condition. The waistbelt buckle and both adjustment mechanisms function properly. There is some whitish molten material adhered to the left side of the waistbelt near the backframe.

6. <u>Compressed Air Cylinder</u> (Refer to Figures 20 through 26 in Appendix IV):

The cylinder is fully wound with composite reinforcement. The cylinder exterior is generally in very good condition and shows few signs of wear, however there are a few gouges approximately 3/8" across. The cylinder is rated for a pressure of **4500 psi** and was manufactured by the Pressure Technology Division of Carleton Technologies Inc. under Department of Transportation (DOT) exemption **E11194**. The DOT label indicates that the cylinder is serial number "**6112-10633**," Dräger part number "**3338042**," and was produced in **November 2002**. A wraparound label under the composite reads "**WASHINGTON 010**" along with a Dräger logo.

The cylinder valve assembly is in very good to excellent condition. Visibility of the pressure gauge is excellent and the gauge reads empty. The valve handwheel operates smoothly. A burst disc assembly is installed in the valve. The cylinder outlet threads are slightly dirty but remain undamaged.

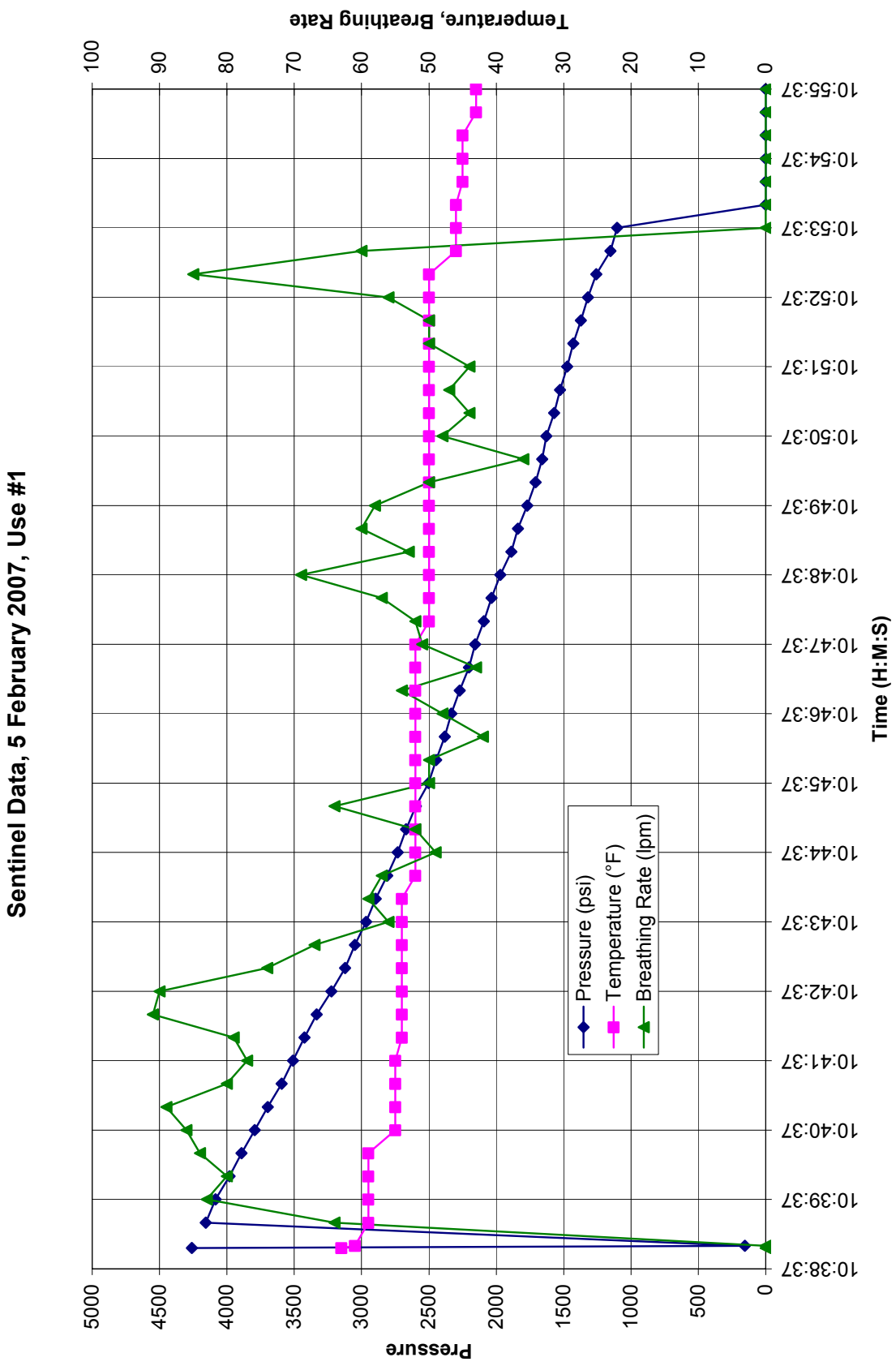
<u>Sentinel Evaluation</u>

Upon receipt of the package on March 21, 2007, the Sentinel device on the SCBA was examined to determine if it held any useful data. Approximately every 20 seconds while the SCBA is in use, this device records the cylinder pressure, user's breathing rate, and temperature of the case. When the data are downloaded to a computer, the memory of the Sentinel device is wiped clean.

It was found that the unit contained usage data marked with the dates 12/31/1998, 7/5/2000, 7/12/2000, 7/16/2000, 8/6/2000, 8/10/2000, 8/25/2000, 9/6/2000, 9/13/2000, 9/19/2000, 9/25/2000, 9/27/2000, 10/5/2000, 11/23/2000, 11/24/2000, 12/20/2000, 12/27/2000, 2/11/2001, 2/13/2001, 2/15/2001, 2/17/2001, 3/26/2001, 5/18/2001, 5/19/2001, 6/7/2001, 6/18/2001, 7/8/2001, 7/15/2001, 8/11/2001, 10/11/2001, 10/18/2001, 12/30/2001, 12/31/2001, 12/30/2003, 5/11/2004, 5/25/2004, 5/27/2004, 7/30/2004, 8/17/2004, 9/7/2004, 11/8/2004, 1/4/2005, 3/9/2005, 3/24/2005, 3/29/2005, 4/20/2005, 4/27/2005, 5/17/2005, 7/27/2005, 10/12/2005, 11/23/2005, 12/30/2005, 12/31/2005, 1/19/2007, 1/30/2007, 2/1/2007, and 2/5/2007. Graphs of the data from 2/5/2007 are attached in **Appendix II**. According to the downloaded data, the PASS device alarmed due to lack of motion at 11:37:15 on 2/5/2007, and the alarm was never manually activated on that date. The full data file will be provided on disc along with this report. It could also be determined that the device's thermal alarm was not activated, the half-empty warning alarm was enabled at 2230 psi, and the device was configured for a 30-minute duration 4500 psi cylinder.

Appendix II

Sentinel Data


Sentinel Data, 5 February 2007, Use #1
Pressure
Temperature, Breathing Rate
Time (H:M:S)
Pressure (psi)
Temperature (°F)
Breathing Rate (lpm)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
0
10
20
30
40
50
60
70
80
90
100
10:38:37
10:39:37
10:40:37
10:41:37
10:42:37
10:43:37
10:44:37
10:45:37
10:46:37
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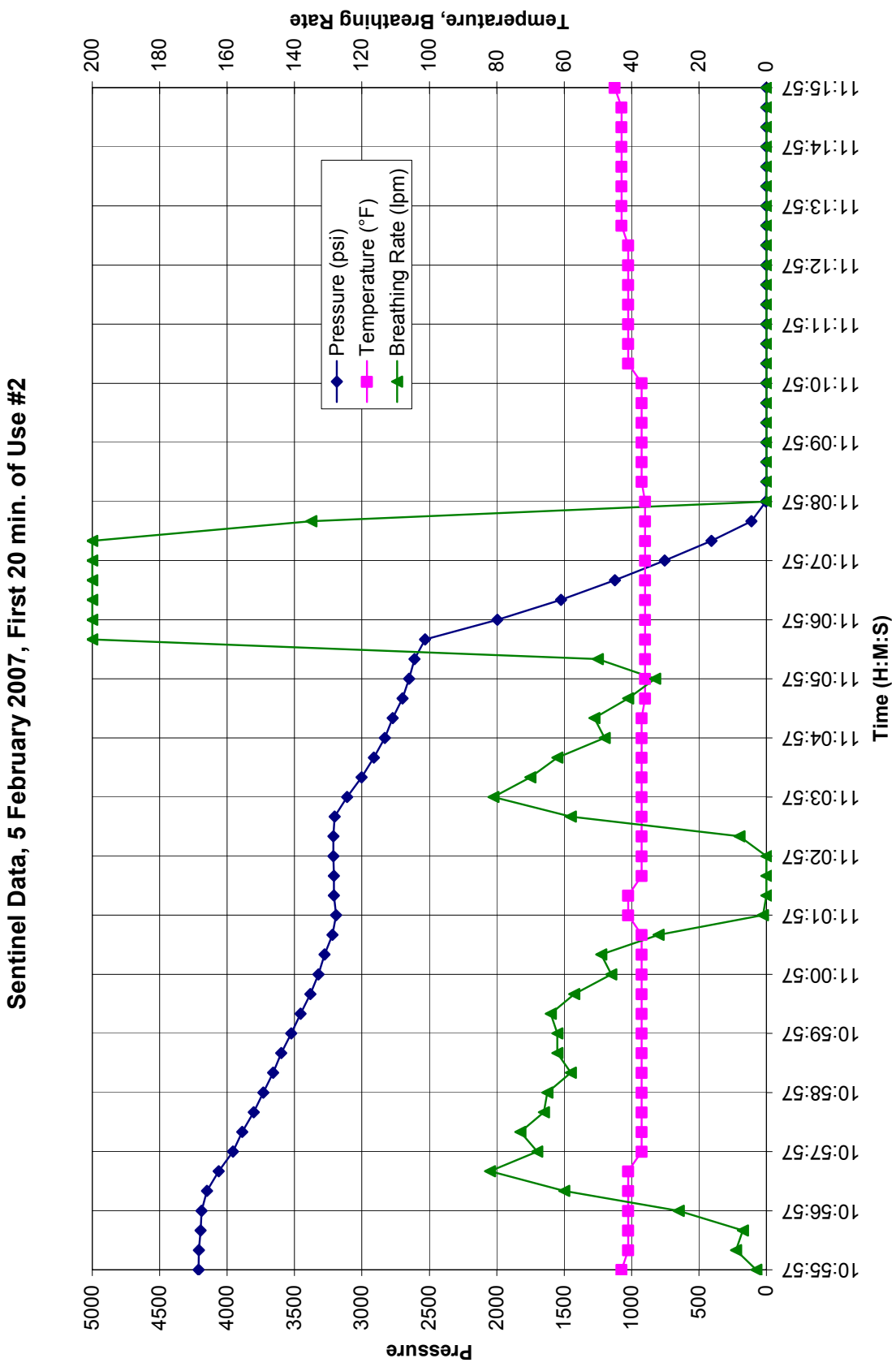
Sentinel Data, 5 February 2007, First 20 min. of Use #2
Pressure
Temperature, Breathing Rate
Time (H:M:S)
Pressure (psi)
Temperature (°F)
Breathing Rate (lpm)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
200
180
160
140
120
100
80
60
40
20
0
10:55:57
10:56:57
10:57:57
10:58:57
10:59:57
11:00:57
11:01:57
11:02:57
11:03:57
11:04:57
11:05:57
11:06:57
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11:13:57
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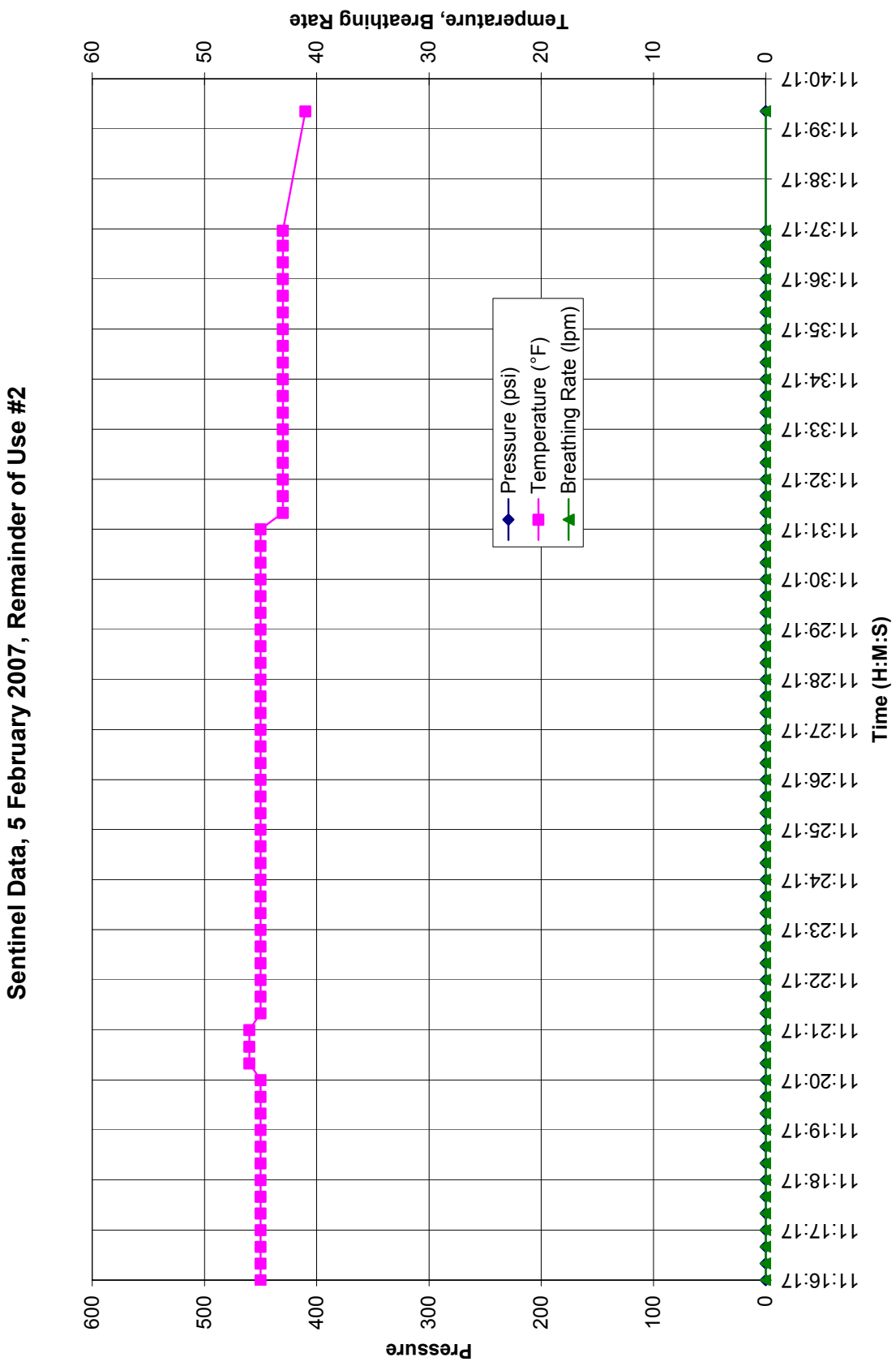
11:15:57


Sentinel Data, 5 February 2007, Remainder of Use #2
Temperature, Breathing Rate
Pressure
Time (H:M:S)
Pressure (psi)
Temperature (°F)
Breathing Rate (lpm)
0
10
20
30
40
50
60
0
100
200
300
400
500
600
11:16:17
11:17:17
11:18:17
11:19:17
11:20:17
11:21:17
11:22:17
11:23:17
11:24:17
11:25:17
11:26:17
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11:30:17
11:31:17
11:32:17
11:33:17
11:34:17
11:35:17
11:36:17
11:37:17
11:38:17
11:39:17
11:40:17

Appendix III

SCBA Test Results

National Institute for Occupational Safety and Health

NIOSH

National Personal Protective Technology Laboratory / Technology Evaluation Branch

SCBA Test Report

Task Number:	15057
Manufacturer:	Dräger Safety
NIOSH Approval Number:	TC-13F-378
Tests Performed by:	Eric Welsh and Vance Kochenderfer
Date of Report:	January 18, 2008

I. Background

On March 21, 2007, a package from the Washington Police Department was delivered to NIOSH. Following an initial download of data from the Sentinel device, the package was taken to the Firefighter Self-Contained Breathing Apparatus (SCBA) Evaluation Lab (building 108) for secured storage. The SCBA was removed from its box and inspected on October 2, 2007. The SCBA inspection process was videotaped. It was determined that the SCBA was manufactured by Dräger Safety under NIOSH approval number TC-13F-378. It was found to be in a condition where it could be safely pressurized and tested. A series of performance tests was conducted on October 3, 4, 9, and 17, 2004. All performance tests, with the exception of the Exhalation Resistance Test and Static Pressure Test, were videotaped. The Positive Pressure Test and Rated Service Time Test are conducted simultaneously.

II. Test Outlines

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./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 – Tested on October 3, 2007, with SCBA in as-received condition.

The SCBA ran out of air before the end of the rated service time, causing the inhalation portion of the breathing curve to drop below ambient pressure. The SCBA **did not** meet the test requirement. The inhalation resistance prior to cylinder exhaustion also dropped below ambient to -0.30 INWC.

Inhalation Breathing Resistance:	**n/a**	INWC

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 – Tested on October 3, 2007, with SCBA in as-received condition.

The measured service time (adjusted to correspond with the recorded breathing cycles) was less than the rated service time of 30 minutes. The SCBA **did not** meet the test requirement.

Measured Service Time:	**28**	Minutes	**57**	Seconds

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 – Tested on October 9, 2007, with SCBA in as-received condition.

The SCBA met the NIOSH requirement for static facepiece pressure.

Facepiece Static Pressure:	**0.90**	INWC

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 – Tested on October 3, 2007, with SCBA in as-received condition.

The SCBA achieved the required flow rate at both test points.

Applied pressure	Flow	
2216 psig	**246**	liters per minute
500 psig	**244**	liters per minute

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 – Tested on October 9, 2007, with SCBA in as-received condition.

The difference between the exhalation breathing resistance and static pressure for the SCBA fell within the NIOSH required range.

Exhalation Breathing Resistance:	**1.95**	INWC
Static Pressure:	**0.90**	INWC
Difference:	**1.05**	INWC

F. 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 October 4, 2007, with SCBA in as-received condition. As this SCBA does not have a remote gauge shutoff, the test requirement is 25% ± 2%. This unit incorporates two alarms—a whistle and an electronic alarm.

Both alarms activated within the required range (between 1035 and 1215 psig).

Test #	Whistle Alarm Point (psig)	Electronic Alarm Point (psig)
1.	1140	1200
2.	1140	1190
3.	1140	1190
4.	1140	1200
5.	1140	1200
6.	1140	1200
Avg.	**1140**	**1197**

Comment:

The SCBA also incorporated a heads-up display in the facepiece, which did not function during this or any other test.

G. NFPA AIR FLOW PERFORMANCE TEST

NFPA 1981 (2002 Edition) Reference: Chapter 7, Performance Requirements, Sec. 7.1.1

Requirement:

SCBA shall be tested for air flow performance as specified in Section 8.1, Air Flow Performance Test, and the SCBA facepiece pressure shall not be less than 0.0 mm (0.0 in.) water column and shall not be greater than 89 mm (3½ in.) 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 8.1.4 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 – Tested on October 17, 2007, with SCBA in as-received condition.

The facepiece pressure remained within the required range for the duration of the test. The SCBA met the NFPA test requirements.

Maximum Facepiece Pressure:	**3.25**	INWC
Minimum Facepiece Pressure:	**0.25**	INWC

III. Disposition:

Following testing, the SCBA was returned to the package in which it was shipped to NIOSH. It was returned to the Washington Police Department on December 13, 2007.

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

TABLE ONE – Summary of NIOSH Test Results

Task Number: 15057

Manufacturer: Dräger Safety

NIOSH Approval Number: TC-13F-378

Tests Performed By: Eric Welsh and Vance Kochenderfer

Dates of Tests: October 3, 4, 9, and 17, 2007

TEST / 42 CFR PART 84 REFERENCE	STANDARD	RESULT	PASS	FAIL
A. POSITIVE PRESSURE TEST **Reference:** Subpart H, § 84.70 (a)(2)(ii)	> 0.00 INWC	Cylinder exhausted		**X**
B. RATED SERVICE TIME TEST **Reference:** Subpart F, § 84.53 (a), Subpart H, § 84.95 (a) and (b)	≥ 30 min.	28 min, 57 s		**X**
C. STATIC PRESSURE TEST **Reference:** Subpart H, § 84.91 (d)	≤ 1.50 INWC	0.90 INWC	**X**	
D. GAS FLOW TEST (at Full Cylinder Pressure) **Reference:** Subpart H, § 84.93 (b) and (c)	≥ 200 lpm	246 lpm	**X**	
D. GAS FLOW TEST (at 500 psig) **Reference:** Subpart H, § 84.93 (b) and (c)	≥ 200 lpm	244 lpm	**X**	
E. EXHALATION RESISTANCE TEST **Reference:** Subpart H, § 84.91 (c)	Difference ≤ 2.00 INWC	1.05 INWC	**X**	
F. REMAINING SERVICE LIFE INDICATOR TEST (whistle) **Reference:** Subpart H, § 84.83 (f) and Subpart G, § 84.63 (c)	Between 1035 and 1215 psig	1140 psig	**X**	
F. REMAINING SERVICE LIFE INDICATOR TEST (electronic alarm) **Reference:** Subpart H, § 84.83 (f) and Subpart G, § 84.63 (c)	Between 1035 and 1215 psig	1197 psig	**X**	

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
G. NFPA AIR FLOW PERFORMANCE **Reference:** NFPA 1981 (2002 Edition), Section 5-1.1	≤ 3.50 INWC Exhalation Resistance	3.25 INWC	**X**	
G. NFPA AIR FLOW PERFORMANCE **Reference:** NFPA 1981 (2002 Edition), Section 5-1.1	≥ 0.00 INWC Inhalation Resistance	0.25 INWC	**X**	

Appendix IV

Images

IMAGES

One Self-Contained Breathing Apparatus
Submitted by the Washington Police Department
Washington, Pennsylvania

NIOSH Task No. 15057

List of Figures:

Figure 1 – SCBA as Received from the Washington Police Department

Figure 2 – SCBA Ready for Inspection

Figure 3 – Facepiece

Figure 4 – Visibility through Facepiece Lens

Figure 5 – Facepiece Demand Valve Port

Figure 6 – Nosecup Interior

Figure 7 – Lung Demand Valve

Figure 8 – Side View of Lung Demand Valve

Figure 9 – Rear View of Lung Demand Valve

Figure 10 – Separation of Barrel from Lung Demand Valve Housing

Figure 11 – Pressure Reducer

Figure 12 – Pressure Reducer

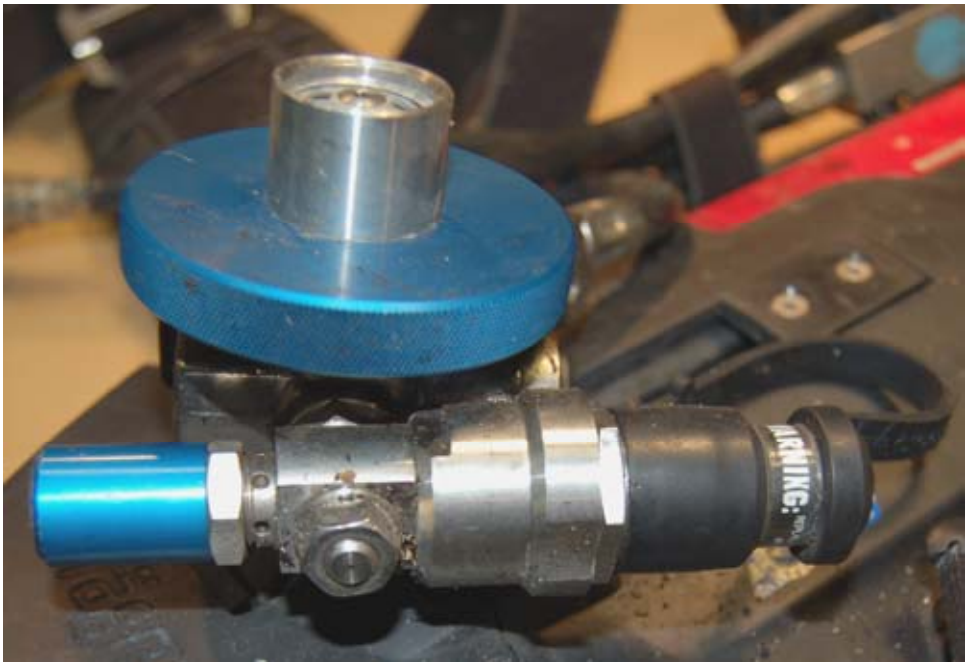

Figure 13 – Cylinder Connector Nut

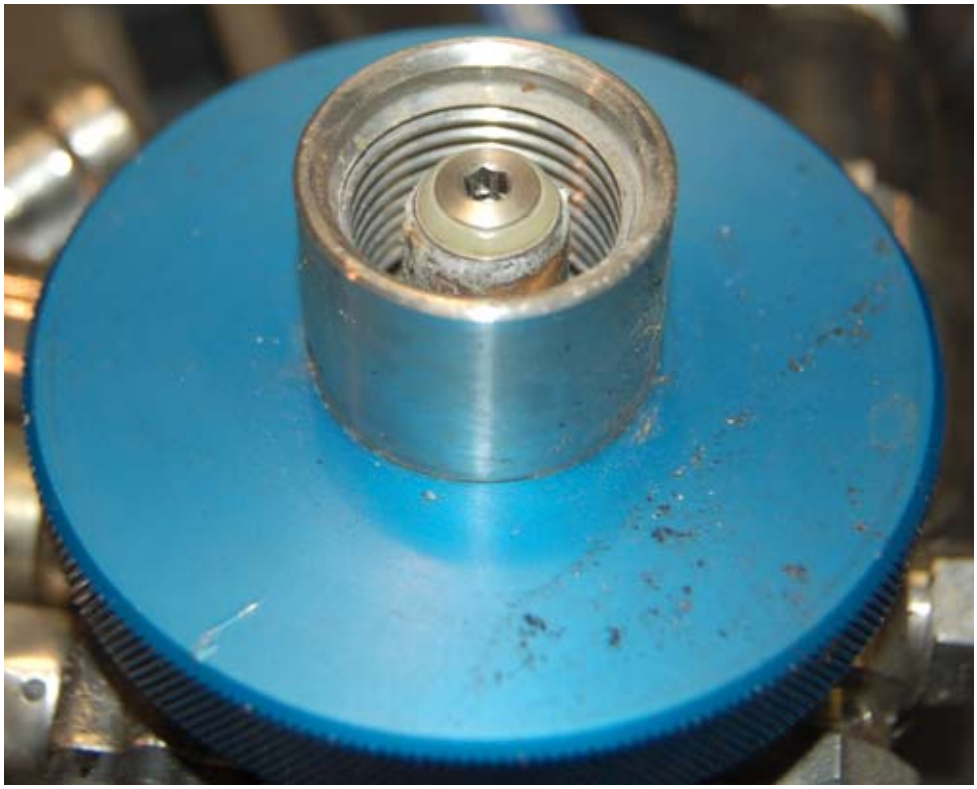

Figure 14 – Remote Pressure Gauge/PASS Device

Figure 15 – Heads-Up Display Transmitter

Figure 16 – Backframe

Figure 17 – NIOSH Approval Label

Figure 18 – NFPA Certification Label

Figure 19 – Left Side Waistbelt

Figure 20 – Cylinder Mounted on SCBA

Figure 21 – Cylinder Mounted on SCBA

Figure 22 – Cylinder DOT Label

Figure 23 – Gouge in Cylinder Dome

Figure 24 – Gouge in Cylinder Sidewall

Figure 25 – Gouge in Cylinder Sidewall

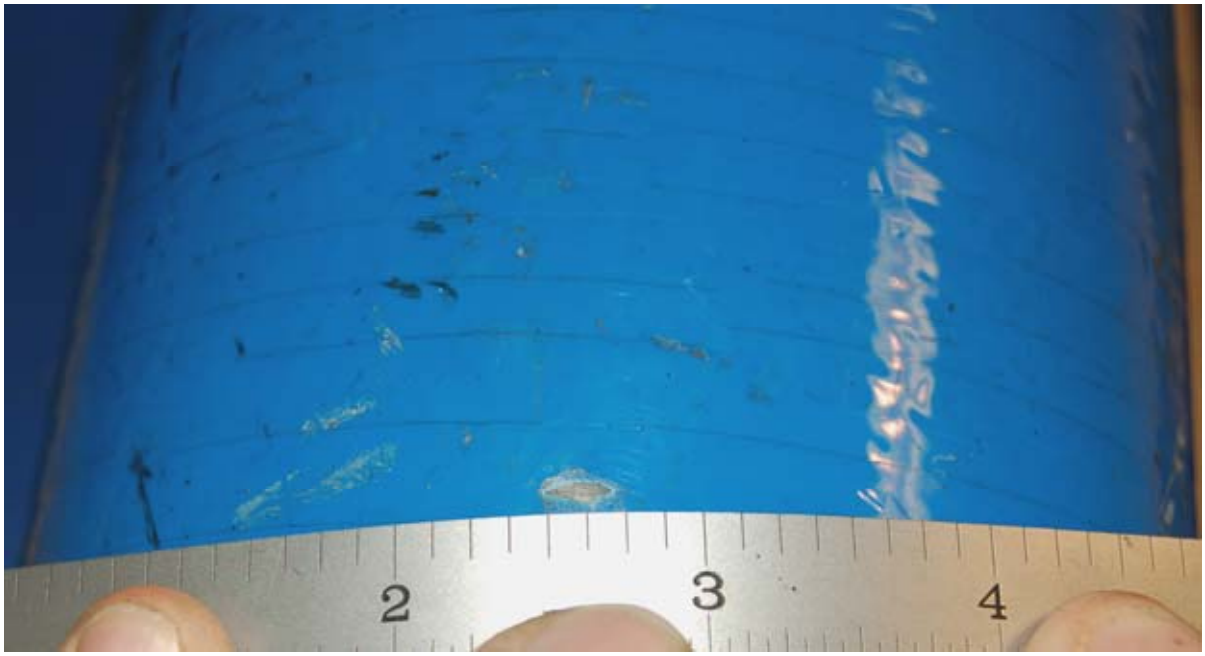

Figure 26 – Cylinder Valve