



⚠ Hazard alert

Firefighter training exercise – Hydro-testing self-contained breathing apparatus

Residual nitrogen in a self-contained breathing apparatus (SCBA) cylinder after hydro-testing can dilute oxygen to dangerously low levels. If bottles are filled after testing without being purged, an air-monitoring device may show a full level of oxygen, but the concentration of oxygen is weak enough to cause hypoxic effects or other respiratory trauma.

What happened

On the morning of Dec. 6, 2017, a firefighter experienced a significant medical issue requiring transportation to the local hospital for evaluation. The incident occurred during standard and approved training exercise, simulating fire operations on a single family dwelling. All participating firefighters wore full firefighting personal protective equipment (PPE), including SCBA, and were breathing air. Smoke conditions in the building were simulated using an industrial smoke machine.

After the simulated operation was over and crews left the structure, firefighters noticed one firefighter was having trouble moving and responding to commands – he was disoriented, confused and not acting normal. Crews immediately rendered aid, starting with removing the firefighter's mask, SCBA, and turnout jacket. They performed a full advanced life support assessment and determined he should be transported to the hospital for evaluation. After several hours of tests in the emergency room, the firefighter was released with no significant issues.

Due to the firefighter's symptoms during the incident, immediate concern focused on his SCBA. The shift captain and battalion chief checked the contents of the SCBA cylinder using an air-monitoring device, which read "low oxygen" when the stream of air from the bottle passed the sensor. The bottle was then marked and placed in a locked office until it was sent to Oregon OSHA's lab in Portland, where test results showed the bottle did in fact have low oxygen levels – approximately 7.6 percent when compared to 20.9 percent of the ambient air. Compressed breathing air must meet at least the requirements for Type 1 - Grade D breathing air with an oxygen content of 19.5 percent to 23.5 percent.

Conclusion

The SCBA that the firefighter wore on the morning of Dec. 6, 2017, had decreased levels of oxygen causing a hypoxic event leading to his ashen color, disorientation, and confusion. The decreased levels of oxygen in his bottle was a result of residual nitrogen being left in the bottle after hydro-testing by the third-party testing company. The bottle was then not purged upon return, but was filled using the fire department's SCBA fill station. While the bottle showed it was full, the residual nitrogen in the bottle caused a dilution of oxygen when it was refilled and placed back into service.

The department has taken several immediate steps to make sure an event such as this does not happen again.

Immediately following the incident, the department purged and refilled all of its SCBAs. The department also created a protocol for returning SCBA bottles to service after testing and instituted a department wide training on appropriate steps when refilling SCBA bottles.



Situational awareness

The most important lesson learned from this incident is to continually improve on situational awareness. After the incident, the firefighter described knowing he was having an issue and should call for help, but was unable to do so because of the hypoxic effects on his cognitive ability. Several firefighters who participated in the training noticed the firefighter was not acting normal, either by being slow to react, forgetting steps in his assignment, or not responding to orders given during the exercise. The crew all assumed the firefighter was having an "off" day. It is a great reminder to always check your co-workers, and speak up when you notice unusual behavior.

Contributing factors

- Residual nitrogen in SCBA bottle after testing.
- Department did not have a protocol for returning SCBA bottles to service after testing.
- Department was inconsistent when filling SCBA bottles.
- Firefighter's lack of situational awareness during training.

Key recommendations

- Have a standing protocol for returning SCBA bottles to service, often returned from a third-party vendor, regardless of what was being done to the bottle.
- Have yearly refresher training on safe operation of the SCBA bottle fill station.
- Train on and continue to improve on situational awareness and communication, not just during active incidents.

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