DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

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NIOSH Respirator User Notice

The National Institute for Occupational Safety and Health (NIOSH) wishes to inform users of self-contained breathing apparatus (SCBA) that certain high-pressure aluminum seamless and aluminum composite hoop-wrapped cylinders made of aluminum alloy 6351-T6 are susceptible to sustained load cracking (SLC) in the neck and shoulder area. If such cracks are not detected during visual inspection, cylinder rupture can occur, especially during filling. These ruptures can result in serious injury, death, and/or property damage. The Institute is therefore recommending that these cylinders be given special attention in order to eliminate the risks associated with such cylinder ruptures. These affected cylinders are used on a number of NIOSH-approved SCBA and are available in a number of sizes and durations ranging from 5 to 30 minutes.

It is important to note that only a small percentage of cylinders made of aluminum alloy 6351-T6 have actually been found to exhibit sustained load cracking. Moreover, out of several million cylinders manufactured from this alloy by various companies, NIOSH and the US Department of Transportation (DOT) are aware of only 12 ruptures within the United States. Eleven of the 12 ruptures occurred during refilling. Six of these 12 ruptures involved SCBA cylinders while the others involved cylinders used for SCUBA diving, medical oxygen, or carbon dioxide storage. Forensic analysis has determined that most of these cylinders failed due to SLC failure. However, in some cases, evidence of other factors such as external mechanical damage was also present.

All six of the SCBA cylinders in question were manufactured by Luxfer Gas Cylinders. Luxfer discontinued the use of aluminum alloy 6351-T6 in the United States in1988, and Luxfer cylinders manufactured in the United States after this date are not believed to be susceptible to SLC failure. Therefore, Luxfer cylinders manufactured in the United States after 1988 are not subject to this notice.

The DOT specification for the suspect cylinders is DOT-3AL. Prior to 1989, aluminum alloy 6351-T6 was used in the manufacture of cylinders identified by the following DOT exemption numbers:

Seamless Aluminum Cylinders	Aluminum-lined Composite (hoop-wrapped) Cylinders
DOT-E 6498 DOT-E 7042 DOT-E 8107 DOT-E 8364 DOT-E 8422	DOT-E 7235 DOT-E 8023 DOT-E 8115

These DOT exemption numbers should be clearly marked on the cylinder label. The DOT has published additional information about this cylinder problem in Federal Register Notices dated October 18, 1999 (Volume 64, Number 200, pages 56243-56244) and July 26, 1994 (Volume 59, Number 142, pages 38028-38030).

The most recent SCBA cylinder rupture occurred at the Summerfield, North Carolina, Fire District on May 2, 1999. While no injuries were reported, the charging station in which the cylinder was enclosed sustained considerable damage. The cylinder was manufactured by Luxfer under DOT exemption DOT-E 6498, in June, 1977. Subsequent analysis revealed that cracks in the neck region of the ruptured cylinder were more than eight years old. The investigation further established that the cylinder had been leaking prior to the rupture.

The Institute has consulted with DOT, SCBA manufacturers, and Luxfer, and has determined that in order to reduce the risk of death, serious injury, or property damage, the following safety precautions should be taken with regard to all seamless aluminum DOT-3AL and composite aluminum hoop-wrapped cylinders manufactured of 6351-T6 alloy:

1. **Increase the frequency of internal visual inspections.** An internal visual inspection should be performed on an annual basis, as recommended by DOT. The internal visual inspection, which is performed by removing the cylinder valve, inserting a high-intensity light probe and an angled mirror into the cylinder and examining the inner surfaces of the cylinder, is useful in identifying SLC defects in the inner surfaces of the neck and shoulder area. This internal inspection should be performed by a qualified inspector in accordance with comprehensive inspection guidelines for high pressure aluminum cylinders. Examples of recognized inspection guidelines include the Compressed Gas Association (CGA) C-6.1 *"Standards For Visual Inspection of High Pressure Aluminum Compressed Gas Cylinders"*, and Volume 1 of *"Luxfer's SCBA Cylinder Visual Inspection Guide"*. Any discovered evidence of a crack, defect, or damage requires the cylinder to be removed from service. Some SCBA manufacturers have their own inspection guidelines.

2. **Inspections should be performed by qualified individuals.** A fire department or other SCBA user may choose to perform these annual inspections in-house, or may contract with a qualified outside inspector. In any case, individuals inspecting for evidence of SLC or any other cylinder damage or imperfection must be able to follow visual inspection guidelines competently and should be trained by accomplished instructors experienced in visual inspection of cylinders.

   A fire department or other SCBA user choosing to out-source the inspection process should verify the qualifications and capability of the contracted inspector. Internal visual inspection has been shown to be highly effective in the discovery of SLC defects. **<u>However, these inspections are only effective when properly performed</u>**. Therefore, emphasis should be placed on inspector training and diligence in the inspection process.

US DOT requires that hydrostatic retesting and requalification be conducted by registered agents who have been certified by the DOT and who have been issued a valid Retester's Identification Number (RIN) by the DOT Research and Special Programs Administration (RSPA). The recommended annual visual inspection does not have to be conducted by a DOT certified RIN holder. However, as stated above, the visual inspection should be conducted by someone who has been trained, qualified, and shown to be competent in conducting visual internal inspection.

3. **Submit cylinders for non-destructive testing at regular intervals between the required requalification testing.** While DOT requires the requalification (hydro-testing) of DOT-3AL seamless aluminum cylinders every 5 years, and of aluminum-lined composite (hoop-wrapped) cylinders every 3 years, it is recommended that cylinders be submitted for ultrasonic testing, eddy current testing, or some other form of non-destructive testing in between the normal required hydro-tests. Non-destructive testing should be performed only by qualified and competent inspectors who understand the proper use of such equipment. The qualifications of any cylinder inspector or tester should be verified prior to contract negotiations.

4. **Do not refill any cylinder that has lost internal pressure for no apparent reason.** Unexpected loss of cylinder pressure may be an indication that SLC defects have developed in a cylinder. Any cylinder that is found to have lost pressure for no apparent reason should be immediately removed from service, and an internal visual inspection should be conducted to evaluate the cylinder. This recommendation also applies to any cylinder, regardless of construction.

5. **Cylinders should only be refilled in a manner which limits risk to personnel and property.** It is recommended that all seamless aluminum DOT-3AL and composite aluminum hoop-wrapped cylinders manufactured of 6351-T6 alloy be filled or "topped off" inside a suitable enclosure or in a way that prevents injury and property damage. A number of compressor manufacturers, as well as other companies produce and market enclosed cylinder refilling stations designed for this purpose.

6. **Use proper cylinder filling equipment and procedures and refrain from fast-filling.** SLC growth occurs over several years, but such growth and the likelihood of cylinder rupture are accelerated when the cylinders are over-pressurized, filled without regulators and the proper filling apparatus, or fast-filled. As noted, 11 of 12 DOT-3AL cylinder failures have occurred during the filling process. The Luxfer recommended fill rate for DOT-3AL cylinders made of alloy 6351-T6 is below 600 psig per minute. Therefore, users should refrain from fast-filling cylinders constructed of alloy 6351-T6 aluminum.

   A just-filled cylinder should not feel warm or hot to the touch. The cylinder must never be filled to a pressure above the service pressure stamped on the cylinder.

7. **Check for valid re-test date before filling**. No cylinder, regardless of construction type, should be filled if it has exceeded the valid service life or re-test (re-qualification) dates specified by DOT.

Procedures on inspecting high pressure aluminum cylinders can be obtained by contacting:

Luxfer Gas Cylinders
Customer Service Department
3016 Kansas Avenue
Riverside CA 92507

(909) 684-5110 (phone)
(909) 781-6598 (fax)
www.luxfercylinders.com (Internet)

Compressed Gas Association
1725 Jefferson Davis Highway
Suite 1004
Arlington VA 22202-4102

(703) 412-0900, ext. 799 (phone)
(703) 412-0128 (fax)
www.cganet.com (Internet)

For further information, please contact Mr. Tim Merinar or Mr. Tom McDowell at NIOSH by calling (304) 285-5907 or by contacting the NIOSH Technical Information Hotline at 1-800-35-NIOSH.

Sincerely,

Richard W. Metzler
Chief, Respirator Branch
Division of Respiratory Disease Studies