

Fire Marshal's

# COMMUNIQUE

du commissaire des incendies

October 16, 2001



2001-27

## **SAFETY ALERT: SCBA CYLINDERS CONSTRUCTED FROM ALUMINUM ALLOY 6351-T6**

### *(External Distribution)*

The Office of the Fire Marshal (OFM) has been informed of a recent incident involving the explosive failure of a self contained breathing apparatus (SCBA) cylinder in Ontario. The cylinder was being refilled by a firefighter at a filling station when it ruptured. As a result, the firefighter was thrown approximately twenty feet and the filling station sustained considerable structural damage. Fortunately, the firefighter suffered only minor physical injuries due to the fact that he was wearing protective gear, including safety boots, eye protection, hard hat, bunker pants, and hearing protection muffs. He also suffered some hearing impairment, despite the fact that he had hearing protection. The cause of this incident is currently under investigation.

The cylinder involved was constructed of the aluminum alloy 6351-T6 and manufactured in 1976. This is the second report in Canada involving the failure of a SCBA or SCUBA cylinder constructed of this alloy. In the United States, the National Institute for Occupational Safety and Health (NIOSH) and the U.S. Department of Transportation (DOT) are aware of twelve incidents involving the rupture of this type of cylinder. Eleven of these incidents occurred during refilling. Six of the twelve ruptures involved SCBA cylinders. All six ruptured SCBA cylinders were manufactured by Luxfer Gas Cylinders.

In late 1999, NIOSH issued an alert on SCBA cylinders made of 6351-T6. The alert, attached, warns that these cylinders are susceptible to sustained load cracking (SLC) failure in the neck and shoulder area. SLC is a metallurgical phenomenon inherent to 6351-T6 that occasionally develops when the alloy is placed under stress for sustained periods of time. The affected cylinders were manufactured in the United States between 1972 and mid-1988 and are identified by the following DOT exemption numbers:

<b>Seamless Aluminum Cylinders</b>	<b>Aluminum-lined Composite (hoop wrapped) Cylinders</b>
DOT-E 6498	DOT-E 7235
DOT-E 7042	DOT-E 8023
DOT-E 8107	DOT-E 8115

DOT-E 8364 DOT-E 8422	
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On February 18, 2000, the OFM posted on its Web site a link, [www.psc.ca/safetyalerts/sa2007.html](http://www.psc.ca/safetyalerts/sa2007.html), to a safety alert containing additional information on the subject.

The OFM urges all fire departments to inspect their SCBA equipment to determine if they are using any of these cylinders. If so, fire departments should immediately initiate the prescribed precautionary actions described in the attached NIOSH notice.

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

*Attachment/*

*Disponible en français*



*National Institute for  
Occupational Safety and Health*

Phone: 304-285-5907

Fax: 304-285-6030

December 7, 1999

### **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 in 1988, 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. **However, these inspections are only effective when properly performed.** 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](http://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](http://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  
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