

that leaked, and many additional cylinders have been found with cracks in the cylinder's neck during the normal requalification process. Manufacturers of cylinders made from the 6351-T6 alloy have performed research, testing and analysis to determine whether there is any correlation between SLC and the probability of a cylinder rupture. The data indicated that the cylinders would leak but not rupture when operated at marked service pressure. It was also found that the probability of cracking increases with an increase in stress levels. We performed additional metallurgical analysis on several ruptured cylinders to verify the cause of failure and failure mode. (See the metallurgical analysis reports at http://hazmat.dot.gov/3al_cyls_info.htm.) Those metallurgical analyses revealed that SLC caused the cylinder ruptures, but the results were inconclusive as to why the cylinders abruptly ruptured instead of leaked. United States manufacturers discontinued using aluminum alloy 6351-T6 in mid-1990, replacing it with aluminum alloy 6061-T6, which is not susceptible to SLC. We estimate that approximately four million U.S. cylinders manufactured from aluminum alloy 6351-T6 are in use in SCUBA, SCBA, and oxygen services.

The primary domestic manufacturers of DOT 3AL cylinders currently in service are Luxfer USA; Walter Kidde Co.; Cliff Impact Division of Parker Hannifin Corporation; and Catalina Cylinders. The majority of the cylinders are being used in six major services: (1) SCUBA, (2) SCBA, (3) carbon dioxide, (4) oxygen, (5) industrial gases, and (6) fire extinguishers.

Cylinders manufactured of aluminum alloy 6351-T6 prior to July 1990 include seamless aluminum cylinders marked "DOT 3AL", including those marked with "DOT 3AL" above or near one of the following exemption or special permit numbers: 6498, 7042, 8107, 8364, and 8422. In addition, unless determined otherwise, affected individuals should assume that a DOT 3AL or DOT-E 7235 cylinder manufactured outside the United States is constructed of aluminum alloy 6351-T6.

On August 8, 2002, we published a final rule (Docket HM-220D, 67 FR 51626) that amended the requirements of the HMR applicable to the maintenance, requalification, repair, and use of DOT specification cylinders. In that final rule, we added the following amendments pertaining to DOT specification cylinders made with aluminum alloy 6351-T6:

- We removed the authorization for the manufacture of DOT specification

cylinders from aluminum alloy 6351-T6 because cylinders manufactured with this aluminum alloy have a greater risk of failure than other aluminum cylinders.

- We prohibited these cylinders for Hazard Zone A materials effective on October 1, 2002. After that date, cylinders made of aluminum alloy 6351-T6 may not be filled and offered for transportation in toxic inhalation hazard service.

- We prohibited the use of cylinders manufactured of aluminum alloy 6351-T6 for gases having pyrophoric properties.

- We required a DOT specification or exemption cylinder made of aluminum alloy 6351-T6 to be inspected for evidence of sustained load cracking in the neck and shoulder area.

As stated earlier, the majority of the SLC-related ruptures occurred in SCUBA, SCBA and oxygen services. Additionally, for these services, the probability of cracking increases due to the increased frequency with which cylinders in these services are filled. We recognize that cylinders used in beverage service are also filled on a frequent basis. However, beverage service cylinders typically are filled to lower pressures than cylinders used in SCUBA, SCBA, and oxygen services, thereby reducing the stress levels to which beverage service cylinders are subjected. Moreover, in SCUBA and SCBA services, the cylinder is attached to the back of a diver or firefighter, which substantially increases the risk of injury or fatality in the event of a rupture. Similarly, an oxygen cylinder may be placed close to a patient in the hospital or home. SLC could also result in an oxygen leak that may cause an explosion. Therefore, because of the higher risk in SCUBA, SCBA and oxygen services, this rulemaking (HM-220F) proposes to adopt a standard for early detection of SLC to reduce the risk of a cylinder rupture.

We performed an analysis of costs associated with operating cylinders manufactured of aluminum alloy 6351-T6. The economic evaluation considered and compared the costs of three possible alternatives: (1) Leaving the cylinder in service without taking any additional measures to reduce the risk, (2) removing all cylinders made of aluminum alloy 6351-T6 from service, or (3) performing a non-destructive examination (NDE) at the time of the cylinder's periodic requalification and requiring additional operational controls (OC) during the cylinder filling process. Estimating the societal cost of injuries or fatalities that would otherwise be avoided if SLC were

eliminated is complicated. The uncertainties due to the unpredictability at which ruptures occur and the likelihood that aging cylinders may be progressively more prone to SLC makes option three to most prudent of the three options. It also addresses a known safety problem without imposing excessive costs.

DOT 3AL cylinders must be requalified every five years (twelve years for fire extinguishers) in accordance with § 180.205 of the HMR. The requalification performed under § 180.205 includes a visual inspection (internal and external) and a volumetric expansion test. The requalification does not include a specific NDE of the cylinder neck or crown areas for detection of SLC. However, we understand that in addition to the visual inspection and volumetric expansion test, many users and requalifiers are currently performing an eddy current examination. Approximately 2,000 eddy current devices have been purchased by various cylinder requalifiers to examine aluminum cylinders for SLC. Cylinder manufacturers report that a large number of affected cylinders have been removed from service because of flaws discovered during eddy current examinations.

We evaluated three NDE methods—visual examination (VT), eddy current examination (ET), and ultrasonic examination (UT)—to detect a critical-size crack. A cylinder with a critical-size crack must be removed from service upon detection of the crack. Under the direction of RSPA, Texas Research Institute (TRI) evaluated these three NDE (VT, ET, UT) methods by performing blind examinations that were applied by individuals of varying skill levels (See the Nondestructive Inspection of High Pressure Aluminum Gas Cylinder, Final Report, dated September 2000, at <http://hazmat.dot.gov/ohmforms.htm#other>). TRI determined that each NDE method was capable of detecting SLC, but the detectability using VT was limited by external factors, such as the inspector's eye sight, lighting, position of the crack, and alertness of the examiner. TRI also determined that UT must be applied by a certified technician to produce accurate results in detecting SLC. TRI concluded that ET combined with a visual inspection (VT) provides the most accurate and practical examination for detecting SLC. Both ET and VT can be conducted by a requalifier with minimal training.

In this NPRM, we propose to require cylinders manufactured of aluminum alloy 6351-T6 used in SCUBA (diving), SCBA (firefighting), and oxygen service