**DEPARTMENT OF TRANSPORTATION**

**Research and Special Programs Administration**

**49 CFR Part 178**

**[Docket No. HM-176A]**

## DOT 3AL Aluminum Cylinders; Safety Problems

**AGENCY:** Research and Special Programs Administration (RSPA), DOT.

**ACTION:** Safety advisory and advance notice of proposed rulemaking.

**SUMMARY:** Cylinders made of aluminum alloy 6351 manufactured by Luxfer USA Limited in accordance with DOT Specification 3AL (49 CFR 178.46) have developed cracks during service, which occasionally result in leakage and the loss of cylinder contents. The purpose of this notice is to inform all persons that possess DOT 3AL cylinders of the problems, to identify those cylinders at risk, to suggest steps that should be taken to minimize risks, and to request comments concerning the extent of the problem and how to resolve it.

**DATE:** Comments must be received by August 10, 1987.

**ADDRESS:** Address comments to: Dockets Unit (DHM-30), Office of Hazardous Materials Transportation, RSPA, U.S. Department of Transportation, Washington, DC 20590. Comments should identify the docket and be submitted, if possible, in five copies. Persons wishing to receive confirmation of receipt of their comments should include a self-addressed stamped postcard. The Dockets Unit is located in Room 8426, Nassif Building, 400 Seventh Street SW., Washington, DC 20590. Public Dockets may be reviewed between the hours of 8:30 a.m. and 5:00 p.m., Monday through Friday.

**FOR FURTHER INFORMATION CONTACT:** Charles H. Hochman, Technical Division, Office of Hazardous Materials Transportation (OHMT), Research and Special Programs Administration, U.S. Department of Transportation, 400 Seventh Street SW., Washington, DC 20590, (202) 366-4545. Office Hours are 8:30 a.m. to 5:00 p.m.

**SUPPLEMENTARY INFORMATION:** RSPA is aware of incidents of cracks in the neck and threaded areas of DOT 3AL cylinders manufactured by Luxfer USA Limited (Luxfer) from aluminum alloy 6351. The cracking was first brought to RSPA's attention by persons retesting cylinders under the periodic retest procedures of 49 CFR 173.34.

Five cylinders suspected of having cracks were sent by RSPA to the National Bureau of Standards (NBS) for analysis. They had marked service pressures ranging from 1800 through 2200 pounds per square inch gauge (psig) and were made of both high lead content (100 parts per million or more) and low lead content (less than 100 ppm) varieties of aluminum alloy 6351. The NBS inspection and examination confirmed that each of the five cylinders

exhibited crack-like indications which were at least 0.050 inch deep.

Following the NBS analysis, RSPA requested that Luxfer provide available information concerning leaks or cracks in DOT 3AL cylinders. Luxfer provided information on the number of cylinders returned because of cracks or leakage. This information revealed the following:

(1) Of 3,278 cylinders made of high lead aluminum alloy 6351 and with tapered threads, at least 33 (1.0%) are known to have leaked or had neck or shoulder flaws (i.e., cracks).

(2) Of 60,000 cylinders made of low lead aluminum alloy with tapered threads, 23 (0.038%) are known to have leaded or had neck or shoulder flaws.

(3) Of 312,000 cylinders made of high lead aluminum alloy 6351 with straight threads, 268 (0.086%) are known to have leaked or had neck or shoulder flaws.

(4) Of approximately 5.02 million cylinders made of low lead aluminum alloy 6351 with straight threads, 106 (0.002%) are known to have leaked or had neck or shoulder flaws.

RSPA believes that the above statistics underrepresent the extent of the cracking and leakage problems since NBS noted in its report that identification of cracking is very difficult even when an individual is specifically looking for cracks.

Work performed by Luxfer on neck cracking of DOT exemption hoop wrapped composite cylinders made of aluminum alloy 6351 (which have neck and shoulder areas identical to DOT 3AL cylinders but operated at a higher operating stress level) indicated that cracking is a time dependent phenomenon that is accelerated when the lead content of the alloy exceeds 100 ppm. Further, it was found that the probability of cracking increases with an increase in stress level. Analysis of the stress levels present in the necks of DOT 3AL cylinders indicated that higher stress levels are present in cylinders with tapered threads. This analysis, confirmed by the in-service data, shows that the probability of neck cracking is much higher in DOT 3AL cylinders with tapered threads. Based on Luxfer's analysis and testing, it is anticipated that the frequency of cracks and leakage will increase with the length of time these cylinders are in service. Analysis and testing performed by Luxfer also shows that, for typical DOT 3AL cylinders made of aluminum alloy 6351 (service pressure less than or equal to 3000 psig), the failure mode is by leakage of the cylinder contents and not by bursting. It should be noted that at the present time, only DOT 3AL cylinders made by Luxfer of aluminum alloy 6351 have been reported to RSPA as having leaked or had neck or shoulder flaws (cracks). Other manufacturers of DOT 3AL cylinders made of aluminum alloy 6351 using different manufacturing processes have reported no leaks or neck or shoulder flaws in a total population in excess of 1 million cylinders. Further, all of the information available to RSPA indicates that cylinders made of aluminum alloy 6061, the other alloy authorized by specification DOT 3AL, are not susceptible to the cracking problems that have arisen in cylinders made aluminum alloy 6351.

DOT 3AL cylinders are authorized to be manufactured from two aluminum alloys, 6061 and 6351. Based on information presently available to DOT, the overwhelming majority of DOT 3AL cylinders produced have been made of aluminum alloy 6351. However, the number identifying the alloy used is not required to be stamped on the cylinder. The only way to determine which alloy was used to manufacture a DOT 3AL cylinder is through the cylinder manufacture using the serial number applied by the manufacturer when the cylinder was made.

DOT 3AL cylinders are authorized and used for the transportation of a number of extremely hazardous materials. These include poisonous and flammable gases, liquids which are toxic by inhalation (see 49 CFR 173.3a) and oxygen. It should be noted that tapered threads are required on cylinders used for Poison A materials, but not for other toxic gases that are not identified as Poison A materials such as diborane or hydrogen selenide.

RSPA is initiating rulemaking to correct any regulatory deficiencies concerning the manufacture, maintenance and use of cylinders made under specification DOT 3AL. In the interim, this notice serves to inform all persons in possession of DOT 3AL cylinders of the cracking problem, and recommends that those persons take the following steps to minimize risks:

### DOT 3AL Cylinders Made of High Lead Aluminum Alloy 6351 With Tapered Threads

DOT 3AL cylinders made of high lead (greater than 100 ppm) aluminum alloy 6351 manufactured by Luxfer USA Limited in 1982 and 1983 bearing the serial numbers which appear in Appendix A to this document should not be refilled or used in hazardous materials service. Both RSPA and Luxfer have been in contact with the original purchasers of these cylinders and requested that the cylinders be removed from service and returned to Luxfer as soon as practicable. Persons in possession of a cylinder listed in Appendix A should contact the cylinder supplier for proper disposition of the cylinder.

### All DOT 3AL Cylinders Made of Aluminum Alloy 6351

DOT 3AL cylinders which presently contain Poison A materials, flammable gases, pyrophoric liquids or gases, liquids toxic by inhalation or highly toxic gases other than Poison A should be stored in well ventilated areas. Additionally, DOT 3AL cylinders containing oxygen, if stored or used in confined spaces, should be checked for leakage to prevent the possibility of an oxygen enriched environment.

Each person possessing a leaking DOT 3AL cylinder which contains a Poison A material, a flammable gas, a pyrophoric liquid or gas, liquids toxic by inhalation or a toxic gas other than Poison A, should contact the material supplier (the name and address of the supplier is found on the shoulder decal of the cylinder) or the cylinder manufacturer. Leaking cylinders may not be offered for transportation.

### Advance Notice of Proposed Rulemaking

RSPA is requesting additional information from manufacturers and users of DOT 3AL cylinders. RSPA requests that anyone having information on cracked or leaking DOT 3AL cylinders provide this information to RSPA in written form. Additionally, comments are solicited on ways to address the cracking problem in DOT 3AL cylinders and controls that may be necessary for the continued use of existing cylinders.

Issued in Washington, DC, on July 6, 1987 under authority delegated in 49 CFR Part 106, Appendix A.

**Alan I. Roberts,**

*Director, Office of Hazardous Materials Transportation.*

## PART 178—[AMENDED]

APPENDIX A—DOT 3AL CYLINDERS MADE OF HIGH LEAD ALUMINUM ALLOY 6351 WITH TAPERED THREADS

| Serial No. | Cast code |
|---|---|
| ALQ 11–64 | 897–898 |
| ALQ 92 | 897 |
| SG 201–301 | 129–132 |
| SG 303–368 | 131–133 |
| SG 377 | 934 |
| SG 381–382 | 934 |
| SG 392 | 934 |
| SG 395–396 | 933–934 |
| SG 416 | 934 |
| SG 421 | 934 |
| SG 429–431 | 933–934 |
| SG 433–449 | |
| SG 451–453 | |
| SG 455–459 | |

APPENDIX A—DOT 3AL CYLINDERS MADE OF HIGH LEAD ALUMINUM ALLOY 6351 WITH TAPERED THREADS—Continued

| Serial No. | Cast code |
|---|---|
| SG 461–474 | 932–934 |
| SG 476 | 934 |
| SG 480–482 | 934 |
| SG 484 | 934 |
| SG 486–487 | 934 |
| SG 489 | 933 |
| SG 503–510 | 933–934 |
| SG 520–521 | 934 |
| SG 525–529 | 934 |
| SG 531–532 | 934 |
| SG 534–535 | 934 |
| SG 538 | 934 |
| SG 544 | 933 |
| SG 548–582 | 931–932 |
| SG 584 | 931 |
| SG 586–589 | 932 |
| SG 591–594 | 931–932 |
| SG 596–620 | 129–132/931–932 |
| SG 622–635 | 129–133 |
| SG 637–661 | 130–133 |
| SG 665 | 931 |
| SG 667 | 934 |
| SG 689 | 934 |
| SG 703 | 934 |
| SG 706–725 | 131–132 |
| AL 554 | 932 |
| AL 577–589 | 932–933 |
| AL 591–593 | 933 |
| AL 595–617 | 932–933 |
| AL 619 | 934 |
| AL 621–623 | 934 |
| AL 628–631 | 934 |
| AL 633–635 | 934 |
| AL 675 | 934 |
| AL 677–678 | 934/129 |
| AL 681 | 132 |
| AL 683 | 129 |
| AL 685–686 | 129/132 |
| AL 688–692 | 120/132 |
| AL 698 | 934 |
| AL 701 | 130 |
| AL 704 | 934 |
| AL 706–735 | 129–130 |
| AL 738 | 129 |
| AL 740–741 | 130 |
| AL 743 | 130 |
| AL 745 | 129 |
| AL 748 | 130 |
| AL 753 | 130 |
| AL 756 | 130 |
| AL 766 | 129 |
| AL 768–722 | 129 |
| AL 774–776 | 129 |
| AL 88001–88013 | 897–898 |
| AL 88015–88041 | 897–898 |
| AL 88043–88048 | 897–898 |
| AL 88050 | 897 |
| AL 88091–88093 | 898–899/64 |
| LL 1142–1149 | 950/807 |
| LL 1151–1177 | 897 |
| LL 1270 | 898 |
| LL 1287 | 34 |
| LL 1290 | 33 |
| LL 1294–1295 | 952/32 |
| LL 1303 | 953 |
| LL 1312 | 897 |
| LL 1314–1315 | 897 |
| LL 17990–18010 | 897–898 |
| LL 18012–18015 | 898 |
| LL 18018–18031 | 897–898 |
| LL 18106 | 898 |
| LL 18158–18160 | 897 |
| LL 18172–18251 | 897–898/850 |
| LL 18253–18276 | 897–898 |
| LL 18280–18290 | 897–898/850 |
| LL 18292–18315 | 897–898/850 |
| LL 18318–18321 | 897–898/850 |
| LL 18323–18328 | 897–898/850 |
| LL 18330–18334 | 897–898 |
| LL 18336–18350 | 897–898/850 |
| LL 18352–18359 | 897–898/850 |
| LL 18361–18368 | 897–898 |
| LL 18453–18459 | 897–898/850 |
| LL 18463–18478 | 897–898/850 |
| LL 18481–18496 | 897–898/850 |
| LL 18498–18500 | 897–898 |
| LL 18502–18507 | 897–898 |
| LL 18510–18512 | 898 |

APPENDIX A—DOT 3AL CYLINDERS MADE OF HIGH LEAD ALUMINUM ALLOY 6351 WITH TAPERED THREADS—Continued

| Serial No. | Cast code |
|---|---|
| LL 18516–18567 | 897–898 |
| LL 18589–18636 | 897–898/850 |
| LL 18638–18639 | 897–898 |
| LL 18641–18653 | 897–898 |
| LL 18655–18657 | 897–898 |
| LL 18757 | 898 |
| LL 18760–18763 | 898–899 |
| LL 18765 | 899 |
| LL 18772–18773 | 899 |
| LL 18775 | 899 |
| LL 18787–18788 | 899/953 |
| LL 18792–18793 | 898 |
| LL 18811 | 953 |
| LL 18818 | 899 |
| LL 31845 | 132 |
| IL 2038 | 931 |
| IL 2041–2042 | 931–932 |
| IL 2044 | 931 |
| IL 2051 | 931 |
| IL 2064 | 932 |
| IL 2070–2071 | 931–932 |
| IL 2098 | 932 |
| IL 2168 | 932 |
| IL 2170–2173 | 931 |
| IL 2177 | 931 |
| IL 2183 | 931 |
| IL 2188 | 931 |
| IL 2193 | 931 |
| IL 2198–2199 | 931–932 |
| IL 2287 | 931 |
| IL 2291–2292 | 931 |
| IL 2294–2295 | 931 |
| IL 2297 | 931 |
| IL 2300 | 931 |
| IL 2307 | 931 |
| IL 2614 | 934 |
| IL 2629 | 934 |
| IL 2633–2634 | 934 |
| IL 2643 | 934 |
| IL 2645–2648 | 934 |
| IL 2650–2652 | 934 |
| IL 2654 | 934 |
| IL 2657–2659 | 934 |
| IL 2662 | 934 |
| IL 2666 | 934 |
| BAL 3007 | 64 |
| BAL 3023 | 953 |
| BAL 3202 | 897 |
| BAL 3280 | 953 |
| AAL 10256–10295 | 931–932 |
| AAL 10306–10313 | 931–932 |
| AAL 10321–10322 | 931 |
| AAL 10325 | 931 |
| AAL 10340–10367 | 931 |
| AAL 10369 | 932 |
| AAL 10374 | 932 |
| AAL 10376–10455 | 931–933 |
| AAL 10463 | 932 |
| AAL 10475–10476 | 931 |
| AAL 10528–10567 | 931–933 |
| AAL 10569–10570 | 932–933 |
| AAL 10572 | 933 |
| AAL 10575–10578 | 933 |
| AAL 10579–10584 | 933 |
| AAL 10587 | 933 |
| AAL 10589–10637 | 932–933 |
| AAL 10639–10691 | 931–933 |
| AAL 10693–10707 | 932–933 |
| AAL 10709–10807 | 931–933 |
| AAL 10809–10814 | 933 |
| AAL 10816–10905 | 931–933 |
| AAL 10909 | 934 |
| AAL 10911–10913 | 934 |
| AAL 10920 | 934 |
| AAL 10927–10928 | 934 |
| AAL 10946 | 932 |
| AAL 10966 | 934 |
| AAL 10975 | 934 |
| AAL 10982 | 934 |
| AAL 10991 | 934 |
| AAL 10993 | 934 |
| AAL 11001 | 934 |
| AAL 11004 | 934 |
| AAL 11009 | 934 |
| AAL 11019 | 934 |
| AAL 11025 | 934 |
| AAL 11032 | 934 |
| AAL 11043 | 934 |
| AAL 11045–11046 | 934 |

APPENDIX A—DOT 3AL CYLINDERS MADE OF HIGH LEAD ALUMINUM ALLOY 6351 WITH TAPERED THREADS—Continued

| Serial No. | Cast code |
|---|---|
| AAL 11048–11050 | 934 |
| AAL 11053–11058 | 934 |
| AAL 11060–11061 | 934 |
| AAL 11070 | 934 |
| AAL 11072–11073 | 934 |
| AAL 11076–11080 | 934 |
| AAL 11082–11097 | 934 |
| AAL 11100 | 934 |
| AAL 11102–11113 | 934 |
| AAL 11119 | 934 |
| AAL 11121 | 934 |
| AAL 11128–11131 | 934 |
| AAL 11133 | 934 |
| AAL 11135 | 934 |
| AAL 11141 | 934 |
| AAL 11143–11146 | 934 |
| AAL 11170 | 934 |
| AAL 11184 | 934 |
| AAL 11187–11188 | 934 |
| AAL 11190–11191 | 934 |
| AAL 11193 | 934 |
| AAL 11197 | 934 |
| AAL 11199–11200 | 934 |
| AAL 11204 | 934 |
| AAL 11208–11209 | 934 |
| AAL 11214 | 934 |
| AAL 11217–11219 | 934 |
| AAL 11228–11229 | 934 |
| AAL 11255 | 934 |
| AAL 11278–11280 | 934 |
| AAL 11282 | 934 |
| AAL 11286–11289 | 934 |
| AAL 11291–11297 | 934 |
| AAL 11299 | 934 |
| AAL 11305 | 934 |
| AAL 11308 | 934 |
| AAL 11310–11314 | 931–934 |
| AAL 11316–11329 | 932–934 |
| AAL 11336–11337 | 934 |
| AAL 11340 | 934 |
| AAL 11342–11346 | 934 |
| AAL 11351 | 934 |
| AAL 11364–11411 | 129–132 |
| AAL 11413–11420 | 129–130 |
| AAL 11422–11431 | 129–130/934 |
| AAL 11433 | 130 |
| AAL 11435–11470 | 130/933 |
| AAL 11472–11478 | 129–130 |
| AAL 11480–11481 | 130 |
| AAL 11483–11484 | 130 |
| AAL 11486 | 932 |
| AAL 11488 | 130 |
| AAL 11490 | 130 |
| AAL 11492 | 130 |
| AAL 11494–11498 | 129–130 |
| AAL 11502–11504 | 132/932 |
| AAL 11506 | 931 |
| AAL 11512–11515 | 130/931/937 |
| AAL 11517–11541 | 129/133/932–933 |
| AAL 11543–11545 | 129 |
| AAL 11549–11553 | 129 |
| AAL 11556–11583 | 129–130/132–133/934 |
| AAL 11586–11590 | 934 |
| AAL 11604–11627 | 129/131–133/932–933 |
| AAL 11629–11771 | 129/131–133/169–172 |
| AAL 11774 | 129 |
| AAL 11780 | 130 |
| AAL 11787 | 130 |
| AAL 11790 | 129 |
| AAL 11792 | 130 |
| AAL 11795 | 129 |
| AAL 11802–11881 | 168–172 |
| AAL 12068–12092 | 168–172 |
| AAL 12097–12099 | 170–171 |
| AAL 12106–12119 | 168–171 |
| SX 16567–16573 | 931–932 |
| SX 16579 | 931 |
| SX 16581 | 931 |
| SX 16584–16587 | 927/931 |
| SX 16597 | 931 |
| SX 16607 | 931 |
| SX 16612 | 931 |
| SX 16615 | 932 |
| SX 16617–16618 | 932 |
| SX 16620 | 932 |

APPENDIX A—DOT 3AL CYLINDERS MADE OF HIGH LEAD ALUMINUM ALLOY 6351 WITH TAPERED THREADS—Continued

| Serial No. | Cast code |
|---|---|
| SX 16623 | 932 |
| SX 16627-16757 | 129-133/932-932 |
| SX 16759-16841 | 129-133/931-932 |
| SX 16843-16966 | 129-130/132/169-172/934 |
| SX 17003 | 133 |
| SX 17629 | 898 |
| SX 17631 | 898 |
| SX 17833-17839 | 897-898 |
| SX 17841-17845 | 897-898 |
| CC 30704-30705 | 931 |
| CC 30708-30709 | 931 |
| CC 30712-30714 | 931 |
| CC 30716-30729 | 931-932 |
| CC 30774-30748 | 931-932 |
| CC 30750 | 931 |
| CC 30752-30754 | 931 |
| CC 30756-30758 | 931-932 |
| CC 30969 | 934 |
| CC 31003-31007 | 934 |
| CC 31032-31033 | 933-934 |
| CC 31040 | 934 |
| CC 31048 | 934 |
| CC 31051 | 934 |
| CC 31054 | 934 |
| CC 30158 | 934 |
| CC 31062 | 934 |
| CC 31066-31067 | 934 |
| CC 31070-31072 | 934 |
| CC 31074-31076 | 934 |
| CC 31082 | 934 |
| CC 31084-31090 | 934 |
| CC 31092 | 934 |
| CC 31103 | 934 |
| CC 31107 | 934 |
| CC 31124-31126 | 934 |
| CC 31128-31130 | 934 |
| CC 31132 | 934 |
| CC 31135 | 934 |
| CC 31137-31138 | 934 |
| CC 31142-31144 | 934 |
| CC 31146 | 934 |
| CC 31180 | 934 |
| CC 31182 | 934 |
| CC 31186 | 934 |
| CC 31712 | 934 |
| CC 31715-31717 | 934 |
| CC 31719 | 934 |
| CC 31722-31725 | 933-934 |
| CC 31727-31729 | 934 |
| CC 31732-31735 | 934 |
| CC 31846-31857 | 131-132/932/934 |
| CC 31860-31861 | 933-934 |
| CC 31863 | 934 |
| CC 31866 | 934 |
| CC 31921-31940 | 129-130/132 |
| CC 31942-32020 | 129-130/132 |
| CC 32022-32051 | 130-132/934 |
| CC 32070 | 129 |
| CC 32899 | 131 |
| CC 32939 | 131 |
| CC 36643-36667 | 169-171 |
| CC 36673-36772 | 169-172 |
| CC 36774-36780 | 169-171 |
| CC 36782-36835 | 169-172 |
| CC 36837-36840 | 170 |
| CC 36842-36847 | 170-171 |
| CC 36849-36922 | 169-171 |
| MM 217833-217857 | 1/4/998 |
| MM 220349-220350 | 262 |
| MM 220353-220354 | 262 |
| MM 220356 | 262 |
| MM 220362-220365 | 262 |
| MM 220367-220371 | 261-262 |

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