National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: August 1, 1995
In Reply Refer To: H-95-14

Honorable Rodney E. Slater
Administrator
Federal Highway Administration
Department of Transportation
400 Seventh Street, N.W.
Washington, D.C. 20590

On September 6, 1994, a vehicle operated by PENNCO, Inc., (the carrier) was traveling north on Interstate 4 near Deltona, Florida, when the cargo tank semitrailer separated into two pieces, releasing 4,500 gallons of fluorosilicic acid onto the highway. Several vehicles traveled through the spilled acid before the highway was closed. The highway remained closed for about 18 hours, and 1,000 people were evacuated from a 1-mile area around the spill site. Of 82 people treated at local hospitals, 6 were admitted and released after being treated for respiratory distress; no serious injuries resulted from the exposure. The environmental cleanup costs were about $250,000.

The Department of Transportation (DOT) specification MC 312 cargo tank was manufactured by Pullman Trailmobile, Inc., of North Kansas City, Missouri, in February 1980. The 5,000-gallon cargo tank, which had a single compartment lined with synthetic rubber, was constructed of carbon steel; the tank heads and walls had a 3/16-inch nominal thickness. Twelve "hat-shaped" (cross-section) ring stiffeners were welded directly to the outside of the tank shell. The National Transportation Safety Board's investigation revealed that the ring stiffeners had been modified after initial construction by welding a circumferential pad between each stiffener and the tank shell; investigators found no records of the modification.

The cargo tank failure occurred in the tank shell under the ninth ring stiffener (counting from the front of the tank), which is located just ahead of the rear tandem and the top fittings. The tank shell under this ring stiffener was extremely corroded, especially on the bottom half of the tank, where, in some areas, the tank shell had been reduced to islands of corroded metal

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adhering to the rubber lining. The ring stiffener at the bottom of the cargo tank had corroded completely through the material in places; it had been partially patched by welding formed sheet steel over the corroded area.

The Safety Board's metallurgical examination revealed that the corrosion of the tank shell and pad beneath the ninth ring stiffener had penetrated from the outside surface to the inside of the tank shell. There were no signs of corrosive attack originating at the inside surface of the tank shell in the area of the separation. The examination also showed that the separation of the cargo tank was the result of fatigue cracking that initiated from the area of severe corrosion attack to the tank shell material at the bottom of the tank. The fatigue cracking had progressed up each side of the cargo tank, covering slightly more than one-half the tank circumference before the tank separated completely. The remainder of the tank shell separated in overstress.

Because the cargo tank separated under a stiffening ring that was adjacent to the top fittings, the Safety Board considered the possibility that cargo spillage was a factor in the tank failure and examined the exterior of the cargo tank for corrosion at other locations. Investigators found that many ring stiffeners along the length of the cargo tank were corroded completely through the material and that the bottom of several other ring stiffeners had been patched in a manner similar to that used on the ring stiffener at the failure location. A patch on a ring stiffener several feet away from the top fittings was removed for comparison with the failure location. The examination revealed that the ring stiffener under the patch had corroded completely through the material. The pad welded between that ring stiffener and the tank shell was so heavily corroded that it crumbled when touched. Also, the tank shell under this pad had corrosion pitting on the entire area examined.

This cargo tank failure is similar to that of a cargo tank that released its entire load of 5,000 gallons of hydrochloric acid near Beaumont, Texas, on March 9, 1983. In that incident, a rubber-lined DOT specification MC 312 cargo tank failed circumferentially around 8 feet of the bottom of the tank shell, releasing the cargo. The failure occurred under a "hat-shaped" ring stiffener at the approximate midpoint of the tank. While the cargo tank involved in the Beaumont incident did not have corrosion damage completely through the tank shell or ring stiffeners as found on the cargo tank involved in the Deltona incident, Safety Board metallurgical examination of the Beaumont tank showed that the inner surface of the ring stiffener and the outer surface of the tank shell under the ring stiffener were heavily corroded and that corrosion had reduced the tank shell thickness by about 50 percent. The interior surface of the Beaumont cargo tank shell near the failure site was not corroded.

The Safety Board found that the corrosion of the material on the inside of the Beaumont cargo tank ring stiffener "was initiated by trapped water and/or water vapor within the air cavity." The Safety Board concluded:

> The presence of extensive rusting on external surfaces of the cargo tank sheet material at locations that are inaccessible to normal inspection techniques

prescribed by Federal regulations is hazardous, that additional cargo tank failures may occur, and that immediate corrective action should be taken. This concern relates specifically to all mild and high strength, low alloy steel cargo tanks where air cavities are formed not only by ring stiffeners but also by upper couplers, suspension subframes, trailer support mountings, or the attachment of other appurtenances.

As a result of the investigation of the incident near Beaumont, the Safety Board recommended on May 10, 1983, that the Research and Special Programs Administration (RSPA):

H-83-29

Revise 49 CFR Section 178.340-6, "Supports and Anchoring," and 49 CFR Section 178.340-7, "Circumferential Reinforcements," of 49 CFR Section 178.340, "General Design and Construction Requirements," to prohibit appurtenance design configurations that create air cavities adjacent to external cargo tank sheet material and to eliminate exceptions based on provisions for venting or draining.

On June 12, 1989, RSPA published major revisions to cargo tank construction requirements[1] that addressed, in part, Safety Recommendation H-83-29. The amended regulations prohibit the use of "hat-shaped" or open-channel ring stiffeners that prevent visual examination of the tank shell on cargo tanks made of carbon steel. However, the amended regulations do not prohibit the use of other appurtenance configurations that create air cavities adjacent to the exterior cargo tank sheet material, nor do they eliminate exceptions based on provisions for venting or draining. Further, the effective date of these changes was postponed several times, authorizing manufacturers to continue making cargo tanks with "hat-shaped" ring stiffeners until August 31, 1995. Because RSPA also failed to address this issue in subsequent rulemakings pertaining to the design and inspection of cargo tanks,[2] Safety Recommendation H-83-29 was classified "Closed--Unacceptable Action" on January 31, 1994.

As a result of the investigation of the incident near Beaumont, Texas, the Safety Board also recommended that RSPA:

H-83-30

Revise 49 CFR Section 177.824, "Retesting and Inspection of Cargo Tanks," to:

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[1] Docket No. HM-183, 183A, *Federal Register*, Vol. 54, No. 111, dated June 12, 1989, page 24982.

[2] Docket No. HM-183, 183A, revisions, and HM Docket No. HM-183C, *Federal Register*, Vol. 59, No. 212, dated November 3, 1994, page 55162.

(1) Require that all hazardous materials cargo tanks of mild and high strength, low alloy steel be subjected to several periodic external visual inspections annually.

(2) Require that the thickness of cargo tank sheet material be inspected once a year using ultrasonic or equivalent techniques.

(3) Require measurement of the thickness of appurtenances [including ring stiffeners] once each year that form air cavities adjacent to external cargo tank sheet material. If the thickness of the appurtenance material has corroded to a predetermined percentage of its manufactured thickness, require that access to the tank sheet material within the air cavity be made and that the thickness of the tank sheet material be measured.

(4) Require that cargo tanks be placed out of service when the thickness of the tank sheet material has corroded to a specific predetermined percentage (consistent with stress levels that will insure operational safety) of its manufactured thickness.

On June 12, 1989, RSPA issued a final rule, effective December 31, 1990,[3] that significantly improved the inspection and test requirements for cargo tanks. The changes included reducing the inspection interval for external visual inspections on cargo tanks from 5 years to 1 year or less; reducing the inspection interval for internal visual inspections of cargo tanks in corrosive product service from 5 years to 1 year; requiring measurement of the thickness of a cargo tank shell when corrosion is observed on the tank shell during a visual inspection; requiring biannual thickness measurements of a cargo tank in corrosive product service; and requiring the removal of those cargo tanks that fail to meet the prescribed specifications for thickness from hazardous materials service (49 CFR 180.407 and 180.405(j)). In a letter dated November 30, 1989, RSPA advised the Safety Board that the new cargo tank inspection and testing requirements would require cargo tank thickness tests every 2 years for all cargo tanks in corrosive service and that the thickness tests would include appurtenance attachments. Because these changes improved cargo tank inspection and testing requirements, Safety Recommendation H-83-30 was classified "Closed--Acceptable Action" on December 21, 1990.

However, the cargo tank incident in Deltona points out a deficiency in the recent revisions to cargo tank inspection and testing requirements. The revised cargo tank periodic thickness testing requirements only apply to unlined cargo tanks that are used in corrosive

[3] Initial effective date for the sections on cargo tank testing and inspection was December 12, 1989. Amendments to HM-183,183A, published on September 7, 1990, postponed the effective date until December 31, 1990.

service; lined cargo tanks, such as those involved in the Deltona and Beaumont incidents, are not required to have periodic thickness tests. According to the manager of the Federal Highway Administration's cargo tank inspection program, the periodic thickness test requirements were intended to address concerns pertaining to reduced thickness of unlined cargo tanks from internal corrosion caused by the cargo transported. Thus, while the changes in the regulations addressed most aspects of Safety Recommendation H-83-30 concerning the inspection of cargo tanks, the new regulations do not adequately address the need to identify corrosion in areas hidden from view by appurtenances (including ring stiffeners).

The Safety Board is concerned that while the DOT has recognized the safety problem with the design of the "hat-shaped" ring stiffener, manufacturers may continue to make cargo tanks with this type ring stiffener until August 31, 1995. Moreover, cargo tanks with such ring stiffeners can be used indefinitely to transport hazardous materials on public highways without being inspected to determine that the thickness of the tank shell under the ring stiffeners is adequate to ensure the tank's integrity. The Safety Board believes that all parts of a trailer carrying hazardous materials should be subject to required periodic verification of integrity, especially areas of the tank shell that are hidden by ring stiffeners or other appurtenances. The Beaumont and Deltona incidents demonstrate the possible adverse consequences of the failure to detect tank shell deterioration.

The Safety Board is aware of the difficulty and expense associated with cutting ports in or removing ring stiffeners and other appurtenances to perform thickness testing on the tank shell. The Board noted during its laboratory examination of the cargo tanks involved in the Deltona and Beaumont incidents that corrosion on the internal surface of the ring stiffeners at the failure sites resulted in a loss of material thickness of the ring stiffener. The Safety Board therefore believes that loss of material thickness in a ring stiffener or other appurtenance is a strong indication that corrosion in the air cavity under an appurtenance may be resulting in a comparable loss of thickness in the tank sheet material. Therefore, where the cargo tank shell under a ring stiffener or other appurtenance is not accessible through inspection ports, a measured loss in material thickness of a predetermined percentage of an appurtenance's manufactured thickness should be sufficient justification to require access to the tank sheet material within the air cavity to ensure that the tank is structurally sound.

To prevent similar catastrophic tank failures and subsequent release of hazardous materials, the Safety Board believes that any cargo tank constructed of mild- and high-strength, low-alloy steel and equipped with ring stiffeners or other appurtenances that create air cavities adjacent to a tank shell and do not allow for inspection of the tank shell for indications of external corrosion should be subject to periodic thickness tests to ensure the integrity of the tank.

Therefore, the National Transportation Safety Board recommends that the Federal Highway Administration:

> Revise inspection and testing requirements for all cargo tanks constructed of mild- and high-strength, low-alloy steel that are used to transport hazardous materials to require at least once each year, or immediately when visual inspections indicate corrosion, measurement of the thickness of appurtenances (including ring stiffeners) that form air cavities adjacent to external cargo tank sheet material when the cargo tank sheet material cannot be visually inspected. If the thickness of the appurtenance material has corroded to a predetermined percentage of its manufactured thickness, require that access to the tank sheet material within the air cavity be made and that the thickness of the tank sheet material be measured. (Class II, Priority Action) (H-95-14)

Chairman HALL, Vice Chairman FRANCIS, and Member HAMMERSCHMIDT concurred in this recommendation.

By: Jim Hall
Chairman