



# National Transportation Safety Board

Washington, D.C. 20594  
Safety Recommendation

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Date: March 23, 1990

In reply refer to: I-90-5 through -12

Mr. Travis P. Dungan  
Administrator  
Research and Special Programs Administration  
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About 11:30 a.m., on November 30, 1988, a tractor-flatbed semitrailer operated by Hy Yield Bromine Company overturned at the intersection of two farm roads in a sparsely populated area of Collier County, Florida. The semitrailer was loaded with 32 cylinders of a poisonous and toxic by inhalation mixture, 98 percent methyl bromide and 2 percent chloropicrin. Eleven of the cylinders were full, each containing about 1,500 pounds of the poisonous mixture, and the remainder of the cylinders were partially full or empty except for residue. The driver had completed the second of four scheduled stops when the accident occurred.<sup>1</sup>

As the vehicle overturned onto its left side, the front of the tractor struck a tree and some of the cylinders and sidepanels on the semitrailer were ejected from the vehicle. Several cylinders struck trees in the wooded area adjacent to the accident site and one cylinder was punctured. Several emergency response personnel reported symptoms associated with exposure to methyl bromide and chloropicrin as a result of their activities on and near the accident scene, and were provided medical treatment.

The Collier County 911 dispatcher received timely notification that methyl bromide was involved in the accident and promptly warned all responding county deputies, fire and rescue personnel, and emergency medical services (EMS) personnel about dangers involved with the cargo. Consequently, these response personnel approached the accident site with caution and stayed clear of the accident vehicle until equipped with self-contained breathing apparatus.

However, because there is no radio channel common to Collier County and the Florida Highway Patrol (FHP), two troopers responding to the accident site did not receive timely notification that hazardous materials were

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<sup>1</sup>For more detailed information, read Hazardous Materials Accident Report--"Puncture of a Cylinder Containing a Mixture of Methyl Bromide and Chloropicrin Following the Overturn of a Tractor/Semitrailer, Collier County, Florida, November 30, 1988" (NTSB/HZM-90/01).

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involved and consequently were unnecessarily exposed to a hazardous environment. Had the county dispatcher or responding deputies been able to communicate directly with the troopers, it is likely that they too would have approached the accident site with appropriate caution and avoided the risk of exposure.

While the vehicle was placarded "Poison" in accordance with the DOT's regulatory requirements, none of the warning placards were readily visible to the troopers as they approached the overturned vehicle. Only the placard on the front of the semitrailer was in a position that was somewhat visible, and it was identified only after one of the troopers had climbed between the tractor and semitrailer to help the driver. Following the accident, emergency responders expressed concern that warning placards on the vehicle were not readily visible and suggested that placards be required on the bottom of vehicles. The concern about the effectiveness of the placards for warning responders of the potential threats suggests that the Research and Special Programs Administration (RSPA) should reevaluate its placard placement requirements.

Because placards often serve as the initial means of warning first responders that vehicles contain hazardous materials, it is important that placards be readily visible to minimize exposures of first responders to dangerous materials. However, because of the orientation of vehicles following accidents, warning placards are often difficult to see from the direction of approaching responders. Placards on the front of semitrailers are often hidden from view, behind tractors; placards on the sides of vehicles may face upward and downward when vehicles overturn; and placards attached to removable side and rear panels may be dislodged from vehicles as a result of accident forces. Additionally, because containers may be weakened as a result of accident forces and their integrity unknown, it is especially important that methods of warning first responders of the existence of hazardous materials be effective. Therefore, the Safety Board believes that RSPA should amend its regulations on placarding to improve the visibility and effectiveness of hazardous materials placards, considering the orientation of vehicles after accidents.

Additionally, the lack of markings, tags, labels, or other means of identification on the cylinders to indicate which contained significant quantities of hazardous materials or were empty (except for residue) before the accident, hindered emergency response personnel in their efforts to estimate the amount of product released. If the punctured cylinder had been identified as containing a significant quantity of hazardous material or as empty (except for residue), emergency response personnel could have better assessed the threat posed by the amount of product potentially released. This would have allowed them to better assess the severity of possible exposures to on-scene personnel. Therefore, the Safety Board believes that RSPA should require a means of identification for cylinders and other comparable containers, to distinguish those that contain significant quantities from those that are empty except for residue when in transportation.

Ten of the 32 Department of Transportation 4BW cylinders involved in the accident were manufactured by the Manchester Tank and Equipment Company, Inc., (Manchester), of Lynwood, California, at its facility in Lubbock, Texas. All 10 Manchester cylinders were from a lot of 200 cylinders manufactured in July 1988. The cylinder punctured during the accident was a Manchester cylinder, serial number G-479. Serial numbers for the other nine Manchester cylinders were G-512, G-517, G-540, G-567, G-615, G-639, G-616, G-656, and G-661. The remaining 22 cylinders on the vehicle were manufactured by Trinity Industries, Inc., (Trinity), of Jacksonville, Florida. None of the Trinity cylinders were breached.

Manchester cylinder G-479 was punctured by a sharp object externally impacting the side body, most likely by the corner of a saddle-type foot on another cylinder, after the vehicle overturned and ejected the cylinders. While there is no regulation that prohibits the attachment of feet with sharp projections, feet with rounded corners and edges or made of softer materials would have reduced the potential for puncture.

Ejection of the cylinders from the semitrailer also caused severe damage to other cylinders, including dents, gouges, and deformation to the sidewalls, heads, valve protection collars, and valve caps. The lack of an adequate cargo restraint system not only made the vehicle more susceptible to overturn but it increased the exposure of cylinders to damaging forces by allowing the cylinders to be thrown from the vehicle.

The Safety Board investigated an accident that occurred near Gretna, Florida, on August 8, 1971, involving an automobile and a tractor/semitrailer transporting 20 full cylinders of a mixture of methyl bromide and chloropicrin.<sup>2</sup> As a result of the accident, nine unrestrained cylinders penetrated the front wall of the semitrailer and were ejected. One cylinder sustained a punctured head, believed to have been made by an angle bar skid (foot) attached to another cylinder and a second cylinder sustained a punctured sidewall, possibly from an angle bar skid also. Additionally, four cylinders sustained damage to the valves resulting in the loss of product. As a result of that accident, four persons in the automobile died from the inhalation of methyl bromide.

Following its investigation of the Gretna accident, the Safety Board concluded that the principal hazard associated with the cylinder skids, the configuration of the ends of the skids, was not adequately addressed by 49 CFR 178.51 and 178.61. The Board further concluded that there was a need to design cylinder skids to reduce the likelihood of puncturing adjacent cylinders by the elimination of sharp projections or edges, or the use of relatively softer skid materials. The Safety Board also concluded that damage to the cylinders would have been less severe and the accident would have been survivable if the cylinders had been properly secured. Although the Safety Board issued recommendations to administrations within the DOT to address a number of regulatory deficiencies, the shipment of hazardous materials containers and the data bases for storing data on accidents

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<sup>2</sup> Highway Accident Report NTSB-HAR-72-3.

involving hazardous materials, the Safety Board did not specifically address the problem associated with cylinder skid design and cylinder restraint.

However, the findings from this investigation demonstrate that the DOT regulations still lack sufficient design safeguards to protect cylinders from external punctures and lack vertical restraint requirements to prevent the ejection of cargo. Therefore, the Safety Board believes that RSPA should require that attachments to cylinders be designed to reduce to a minimum the risk of puncturing other cylinders during transportation. The Safety Board also believes that RSPA should require hazardous materials cargo to be secured in transportation with adequate cargo restraint systems to prevent ejection of cargo from vehicles.

Although the Manchester cylinders involved in the accident were marked as DOT specification 4BW cylinders, neither physical test procedures nor specimen gauge lengths required by Federal regulations were used to conduct the physical tests. Therefore, construction compliance with minimum yield strength requirements and minimum elongation requirements cannot be determined from the physical tests performed, and the use of tensile strength results in determining minimum wall thickness requirements would be invalid. Nevertheless, those tests were used by Manchester to "certify that all these cylinders proved satisfactory in every way and comply with the requirements of Department of Transportation specification No. 4BW."

Design, material, fabrication, inspection, and test requirements for new DOT specification 4BW cylinders are contained in 49 CFR 178.61. Under Section 178.61-15, "Physical Tests," specimens must be taken from one cylinder chosen at random, from each lot of 200 or fewer cylinders, and tested to determine the yield strength, tensile strength, and elongation performance of the test specimens. The regulation specifies dimensions for test specimens, acceptable test methods as prescribed in ASTM Standard E8-78, and other parameters. The acceptable test methods prescribed in the ASTM standard are the "off-set" method<sup>3</sup> and the "extension under load" method.<sup>4</sup>

In the summer of 1988, Manchester was using Terra Testing, Inc., of Lubbock to perform the testing required by Section 178.61-15. However, Terra Testing lacked equipment necessary to conduct the tests required and sent the test specimens to the Texas Technical University's Civil Engineering

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<sup>3</sup> The "off-set" method is determined by securing data (autographic or numerical) from which a stress-strain diagram may be drawn and then compared to specified values.

<sup>4</sup> The "extension under load" method is determined by securing data by (1) autographic or numerical devices so that a stress-strain (or load elongation) diagram may be drawn from which the value of the stress occurring at the specified value of extension may be ascertained; or (2) by a device attached to or part of an extensometer that indicates when the specified extension occurs so that the stress then occurring may be ascertained.

Laboratory in Lubbock. Yield and ultimate strength tests were conducted using the "halt-of-pointer" method,<sup>5</sup> which is not an authorized method under DOT regulations. Terra Testing documents dated May 5, 1988, and August 10, 1988, recorded yield and ultimate tensile strength values for two sets of top head, bottom head, and side body specimens. The values were subsequently recorded on a Manchester form, "Record of Physical Tests of Material for Cylinders," dated July 1988, as representing the results of the physical tests required under 49 CFR 178.61-15. The values taken from the May 5 tests were reported for cylinders G-474 through G-600, and the values taken from the August 10 tests were reported for cylinders G-600 through G-673. (All Manchester cylinders involved in the accident are marked tested July 1988; shipping records show that some of the cylinders were shipped to Hy Yield Bromine Company August 3, 1988, 7 days before some required physical tests were performed.)

According to RSPA representatives, test specimens must be prepared to one of the three following gauge lengths,<sup>6</sup> prescribed in 49 CFR 178.61-15(b):

- o gauge length 8 inches with width not over 1.5 inches;
- o gauge length 2 inches with width not over 1.5 inches; and
- o gauge length at least 24 times thickness with width not over 6 times thickness when cylinder wall is not over 3/16-inch thick.

The RSPA representative also noted that Section 178.61-15(b) appears to contain a typographical error and is confusing; the second and third gauge lengths listed are not readily identified as two distinct gauge lengths. The test specimen requirements for other DOT specification cylinders, such as the DOT 4L (49 CFR 178.57-15(b)), clearly provide three distinct gauge lengths for test specimens.

The results of postaccident tests on the punctured cylinder demonstrate that the side body material could have passed the test requirements for elongation depending on which of the three allowable specimen sizes had been chosen. The 2-inch gauge length specimen failed to meet minimum elongation requirements, while the 8-inch and 24T-6T size specimens passed. Because the

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<sup>5</sup> The "halt-of-pointer" method is determined by applying an increasing load to the specimen at a uniform deformation rate. When the yield point of the material is reached, the increase of the load stops. At that time, there is a halt or hesitation of the load-indicating mechanism.

<sup>6</sup> A gauge length is the distance between two marks placed on a specimen.

24T-6T size specimen was determined to be the most likely to generate elongation values that meet requirements, that size specimen was selected for physical tests on the bottom head specimen taken from the punctured cylinder. The elongation value generated was significantly below the minimum required for specification 4BW cylinders.

In further reviewing Manchester's testing procedures, tests conducted on 4BW cylinders in different lots were examined. On those cylinders, authorized specimen sizes and authorized physical test procedures were used. However, the three test specimens, taken from the side body, top head, and bottom head, all failed to meet minimum elongation requirements. Additionally, the tensile strength for the top head was less than that required for the stated minimum wall thickness. Nevertheless, Manchester certified that the cylinders met DOT specification requirements.

Records at RSPA indicate a history of significant problems involving Manchester's inspection and testing procedures. Those problems include marking cylinders as DOT specification cylinders that failed to meet minimum wall thickness requirements; that failed weld bend test requirements; that failed to meet minimum elongation requirements; that failed to have appropriate hydrostatic tests conducted; and that failed to have appropriate physical tests conducted. Many of these problems were identified by RSPA in an enforcement case concluded in July of 1988; however, while fining Manchester for the violations, RSPA did not order a recall of cylinders that failed required tests and did not order Manchester to retest those cylinders in accordance with RSPA's established procedures.

Additionally, while none of the cylinders manufactured by Trinity failed during the accident, the Safety Board found that in January 1988, RSPA had identified irregularities with Trinity Industries' cylinder testing procedures. However, while a warning letter was sent to Trinity, no apparent action was taken to determine that cylinders tested under questionable procedures, in fact, met the minimum regulatory requirements.

The Safety Board has reviewed advisory notices previously issued by RSPA warning that some DOT 4 series cylinders may not be in full compliance with specifications, and that RSPA has required some cylinders to be recalled. But, the Board is concerned that some compliance orders have required cylinder manufacturers to correct testing and inspection procedures without requiring those manufacturers to recall cylinders approved under those deficient procedures and determine if those cylinders met minimum DOT specification requirements. Anytime RSPA identifies containers marked as meeting the DOT's specification requirements when RSPA has evidence indicating that the containers do not, RSPA should require and determine that the containers are removed from use in the transportation of hazardous materials until tested and approved in accordance with its procedures. Therefore, the Safety Board believes that RSPA should require all manufacturers of DOT specification containers that were not tested and inspected in accordance with regulatory requirements, and all that were properly tested but that failed to meet regulatory requirements to retest randomly selected containers from each lot of these identified containers in accordance with DOT regulatory procedures; and to notify the owners of

containers in lots that fail tests to remove DOT specification markings. The Safety Board also believes that RSPA should modify the compliance program to determine that containers are removed from use in transportation of hazardous materials when those containers are identified as not meeting specification requirements.

Proper testing and inspection of cylinders is critical to determine if the cylinders meet minimum safety requirements and to minimize the risk of failure in transportation while filled with hazardous materials. However, the RSPA enforcement division has identified a significant problem with inadequate testing and inspection procedures for series 4 (including 4BW) cylinders industry-wide, and on August 24, 1988, the enforcement division recommended that RSPA require the independent inspection of low pressure cylinders. While unable to explain the cause of problems identified, the division chief noted that competition had led many companies to manufacture cylinders closer to minimum DOT standards. This may explain why the Manchester cylinders manufactured about July 1988, are 27 to 50 pounds lighter than the older cylinders on the vehicle that were manufactured by Trinity Industries. Because of the importance of proper testing and inspection procedures to insure that cylinders meet minimum safety requirements, the apparent lack of industry compliance, and RSPA's limited staff available for monitoring the industry, the Safety Board believes that RSPA should require new and reconditioned pressure cylinders to pass independent inspection for a condition of marking the cylinders as meeting DOT requirements. The Board also recommends that RSPA amend inspection and testing requirements for pressure cylinders to make the requirements clear and consistent.

Therefore, the National Transportation Safety Board recommends that the Research and Special Programs Administration:

Require all manufacturers of Department of Transportation (DOT) specification containers that were not tested and inspected in accordance with regulatory requirements, and all that were properly tested but that failed to meet regulatory requirements to retest randomly selected containers from each lot of these identified containers in accordance with DOT regulatory procedures; and to notify the owners of containers in lots that fail the tests to remove DOT specification markings. (Class II, Priority Action) (I-90-5)

Modify the compliance program to determine that containers are removed from use in transportation of hazardous materials when those containers are identified as not meeting specification requirements. (Class II, Priority Action) (I-90-6)

Require that attachments to cylinders be designed to reduce to a minimum the risk of puncturing other cylinders during transportation. (Class III, Longer Term Action) (I-90-7)

Require hazardous materials cargo to be secured in transportation with adequate cargo restraint systems to prevent ejection of cargo from vehicles. (Class III, Longer Term Action) (I-90-8)

Require independent inspections of new and reconditioned low pressure cylinders that are consistent with the present independent inspection requirements for high pressure cylinders. (Class III, Longer Term Action) (I-90-9)

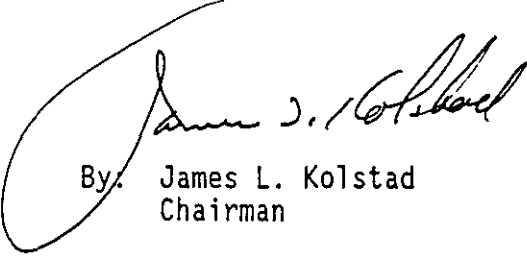
Amend inspection and testing requirements for pressure cylinders to make the requirements clear and consistent. (Class III, Longer Term Action) (I-90-10)

Develop and implement requirements for improving the visibility and effectiveness of hazardous materials placards, considering the orientation of vehicles after accidents. (Class III, Longer Term Action) (I-90-11)

Require a means of identification for cylinders and other comparable containers to distinguish those that contain significant quantities of hazardous materials from those that are empty (except for hazardous materials residue), when in transportation. (Class III, Longer Term Action) (I-90-12)

Also, the Safety Board issued Safety Recommendations H-90-8 and -9 and I-90-1 to the Hy Yield Bromine Company; I-90-2 through -4 to the Manchester Tank and Equipment Company, Inc.; I-90-13 through -15 to Collier County, Florida; and I-90-16 and -17 to the Florida Highway Patrol.

KOLSTAD, Chairman, COUGHLIN, Acting Vice Chairman, and LAUBER and BURNETT, Members, concurred in these recommendations.

  
By: James L. Kolstad  
Chairman