National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: December 9, 1998

In reply refer to: R-98-72

Mr. Edward R. Hamberger
President
Association of American Railroads
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About 12:00 p.m., central standard time, on November 22, 1997, a frost ring that signified product leakage was discovered on the bottom center of tank car TEAX 3417 at the Georgia Gulf Corporation chemical plant in Pasadena, Texas. When the plant's employees discovered the leak, they were weighing the tank car, which contained 140,377 pounds (29,054 gallons) of a propylene/propane mixture, a liquefied flammable gas. The employees successfully offloaded most of the mixture from the tank car to fixed storage tanks. To transfer the residual cargo, they isolated the tank car. By 7:00 a.m. the next morning, November 23, they had transferred the residual to a cargo tank truck.[1]

No injuries or fatalities were reported as a result of the failure of the tank car. Georgia Gulf estimated that approximately 250 pounds (52 gallons) of the cargo were released. Total damage, including the cost of the clean up, loss of product, and repair of the tank car, was estimated to be slightly less than $9,300.

A postaccident examination revealed that the product had been released through a circumferential crack in the bottom center of the tank. A metallurgical examination of the crack surfaces revealed indications of brittle (cleavage) fracture from a single event that had cooled the tank car to less than -50 °F.

About 6 weeks before the accident, the tank car had arrived at the Bayou Railcar Services, Inc., (Bayou) repair shop in Holden, Louisiana, for routine maintenance and testing. At the request of the owner of the tank car, Bayou purged the tank car on October 17 with cryogenic nitrogen gas because of a change in the product to be carried.

[1] For more information, read Hazardous Materials Accident Report--Failure *of Tank Car TEAX 3417 and Subsequent Release of Liquefied Petroleum Gas, Pasadena, Texas, November 22, 1997* (NTSB/HZM-98/01/SUM).

Because Bayou did not use external cryogenic vaporizers and a low-temperature protection device, the tank car was probably injected with cryogenic nitrogen, including entrained liquid nitrogen. The liquefied nitrogen in the cylinder was under an internal pressure between 123 psig and 237 psig and would, therefore, have had a maximum temperature between -256 °F and -274 °F. Consequently, if the liquefied nitrogen had any contact with the tank shell directly below the eduction line, the result would have been the very rapid super cooling of the tank shell in the area of contact to less than -50 °F.

The National Transportation Safety Board determines that the probable cause of the thermal shock failure and the subsequent leakage of product from tank car TEAX 3417 was the failure of Bayou Railcar Services, Inc., to utilize sufficient safeguards to ensure that the nitrogen was properly warmed before it was injected into the tank car during nitrogen purging.

In 1992, the Compressed Gas Association, Inc., (CGA) issued *Recommended Procedures for Nitrogen Purging of Tank Cars* (CGA Pamphlet P-16-1992). The CGA noted that introducing liquid nitrogen into tank cars not specifically designed for cryogenic service can result in tank failure caused by a phenomenon known as thermal shock (very rapid and severe cooling of the tank). To prevent thermal shock, the CGA recommended using cryogenic vaporizers that are external to the nitrogen cylinders to warm the liquid nitrogen to a gas with a temperature of not less than -20 °F before the nitrogen is injected into a tank car. The CGA also recommended using a low-temperature protection device that stops the flow of nitrogen to the tank car if the temperature of the nitrogen falls below -20 °F.

During the Safety Board's investigation of the accident, the CGA was unable to locate any technical information that might have been used in developing its nitrogen purging procedures. Safety Board investigators contacted some of the CGA committee members who had developed the procedures, including those members who represented tank car manufacturers and owners, in an effort to determine how the -20 °F temperature threshold had been derived. The members contacted could not recall whether the threshold was based on any specific testing or engineering analysis. They indicated that the threshold had most probably been recommended by tank car experts who were drawing on their collective experience and that the committee had, therefore, adopted the recommendation. All the committee members contacted stated they were no longer able to locate any meeting notes that would verify their accounts of how the threshold had been determined. The minimum injection temperature of -20 °F specified in the CGA standard has not been verified through scientific tests or engineering analysis.

Based on the definition of the ductile-to-brittle transition temperature as the temperature at which 50 percent of a fracture exhibits shear features and 50 percent exhibits cleavage features, the transition temperature for the TC-128 steel in tank car TEAX 3417 would be about -5 °F. Because TC-128 steel has been the most commonly used grade of steel in the construction of tank cars over the past 20 or more years, the likelihood is strong that the steel found throughout the tank car fleet will have comparable ductile-to-brittle transition temperatures. The Safety Board is concerned that other grades of tank car steels may also have high transition temperatures. Consequently, because the CGA's minimum injection temperature is not supported by an engineering evaluation and because grades of steel used in tank cars have high ductile-to-brittle

transition temperatures, the Safety Board concludes that the current CGA procedures for nitrogen purging of railroad tank cars do not adequately protect the tank cars from brittle failure.

Therefore, the Safety Board believes that the CGA, with the assistance of the Federal Railroad Administration and the Association of American Railroads, should revise the CGA's *Recommended Procedures for Nitrogen Purging of Tank Cars* to specify a minimum threshold temperature for nitrogen that is based on an engineering analysis of ductile-to-brittle transition temperatures of tank car steels.

Therefore, the National Transportation Safety Board issues the following safety recommendation to the Association of American Railroads:

> Cooperate with the Compressed Gas Association, Inc., in its efforts to revise its *Recommended Procedures for Nitrogen Purging of Tank Cars* to specify a minimum threshold temperature for nitrogen that is based on an engineering analysis of ductile-to-brittle transition temperatures of tank car steels. (R-98-72)

Also, the Safety Board issued Safety Recommendations R-98-70 to the Compressed Gas Association, Inc., and R-98-71 to the Federal Railroad Administration.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633). The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendation in this letter. Please refer to Safety Recommendation R-98-72 in your reply. If you need additional information, you may call (202) 314-6460.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in this recommendation.

[Original Signed]

By: Jim Hall
Chairman