National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: April 1, 1994

In reply refer to: I-94-2

Honorable Carol M. Browner
Administrator
U.S. Environmental Protection Agency
401 M Street, S.W.
Washington, D.C. 20460

About 2:50 a.m. local time on June 30, 1992, Burlington Northern Railroad (BN) freight train No. 01-142-30 derailed as it approached a bridge over the Nemadji River in the Town of Superior, Wisconsin. The derailment resulted when a preexisting crack (detail fracture) inside the rail caused the rail to break under the train load. Fourteen freight cars derailed, including three tank cars that contained hazardous materials: one contained a flammable liquid mixture of aromatic hydrocarbons (aromatic concentrates) that included benzene; one contained liquefied petroleum gas; and one contained crude butadiene. The three tank cars were pulled off the bridge by derailing freight cars behind them and fell about 71 feet, one landing in the river and two landing in a flood plain adjacent to the river. About 21,850 gallons of aromatic concentrates spilled into the river and were carried downriver. The more volatile constituents of the aromatic concentrates evaporated from the surface of the river and formed a vapor cloud, about 20 miles long and 5 miles wide, that resulted in the evacuation of more than 40,000 people from the Town of Superior, the city of Duluth, Minnesota, and the surrounding areas.[1]

The Wisconsin Department of Natural Resources, one of several agencies and organizations involved with the environmental response to this accident, reported that wild animals of 16 species were found dead near the river or at the accident site shortly after the accident. The Department also reported that the release of the aromatic concentrates into the Nemadji River resulted in the loss of "thousands" of

[1] For more detailed information, read: National Transportation Safety Board. 1994. Derailment of a Burlington Northern freight train and the release of hazardous materials in the Town of Superior, Wisconsin, on June 30, 1992. Hazardous Materials Accident Report NTSB/HZM-94/01. Washington, DC.

fish of several different species. The Department indicated that it was impossible to estimate the portion of the fish population that was killed by the spilled aromatic concentrates and the portion killed by being washed over the river bank into the woods as a result of the flooding of the Nemadji River from heavy rains that occurred during the few days following the accident. Two weeks after the accident, the Wisconsin Department of Natural Resources surveyed the Nemadji River and found it to be populated with fish. The State of Wisconsin is continuing to assess the effects of the spill and to evaluate the aquatic life in the river.

The U.S. Fish and Wildlife Service (FWLS) also studied the chronic and acute effects of the spill on the fish and wildlife by performing chemical analyses on tissue samples from about 69 fish and 11 birds. Fish specimens were collected from the Nemadji River and at the mouth of the river on July 1 and 2. Additional fish were collected between July 6 and July 8 from the Nemadji River and Duluth Harbor. Bird specimens were collected between July 3 and July 7 along the Nemadji River from the accident site downriver to the mouth of the river.

In a report issued May 10, 1993, the FWLS concluded that the release of the hydrocarbons in the aromatic concentrate was "clearly the most likely cause" of the fish kills reported by the Wisconsin Department of Natural Resources and other sources, and that the release of the aromatic concentrates likely resulted in acute injuries to fish located beyond the confines of the Nemadji River. The FWLS stated that although no chronic effects to the fish population from the spill were clearly indicated, the spill may have resulted in sublethal effects that can adversely affect the performance of the exposed fish to forage, escape from natural dangers, and reproduce. Consequently, the FWLS concluded that the size of the fish population may also be reduced. According to the FWLS report, terrestrial wildlife downwind of the spill also were injured based on the analyses of the bird specimens. The FWLS concluded that the vapor cloud resulted in the injury of terrestrial wildlife directly by driving adults away from nests and their young.

Two of the tank cars that were pulled off the bridge, tank cars GLNX 3411 and GLNX 161 (Department of Transportation (DOT) class 112J tank cars), sustained no major damage, but the other tank car, GLNX 3017 (DOT 111A), sustained major crushing damage that resulted in the release of most of its cargo into the Nemadji River.

The momentum from the free fall of the three tank cars as each impacted the ground was comparable because the gross weights of the three tank cars were within 5 percent, and all three tank cars fell vertically about the same distance, about 71 feet. However, tank cars GLNX 3411 and GLNX 161 fell onto soft, level ground and stopped abruptly, whereas tank car GLNX 3017 fell with multiple impacts onto a downhill slope with a harder surface. Consequently, the forces acting on tank cars GLNX 3411 and GLNX 161 differed from the forces acting on GLNX 3017 and cannot be easily compared.

The following factors help to explain the difference in the performance of the tank cars. The thickness of the tank shell and heads of tank car GLNX 3017 (the DOT 111A) was only 70 percent of that for tank car GLNX 3411 and 62.5 percent of that for tank car GLNX 161. Further, the 1/2-inch-thick steel head shields and jackets on tank cars GLNX 3411 and GLNX 161 provided additional protection for the tanks and helped to prevent severe crushing of the B-end of tank car GLNX 161.

The crushing damage sustained by both the A- and B-ends of tank car GLNX 3017 and the lack of crushing damage to the barrel of the tank indicate that GLNX 3017 struck something or was struck by something at each end of the tank. The tank car slid or bounced down the rocky north bank on its A-end and continued moving forward until the top of the B-end struck the south bank of the river. The south bank had rock fill, was hard, and sloped upward. Therefore, when the B-end struck the south bank, the tank car stopped and the B-end was severely crushed inward toward the center of the tank. This caused the crease and tear in the top of the tank (now underwater as the tank came to rest) and resulted in the release of the aromatic concentrates from the tank. The Safety Board concludes that although the tank shell of tank car GLNX 3017 was thinner than either tank cars GLNX 3411 or GLNX 161, full head shield protection on tank car GLNX 3017 probably would have reduced the severity of the crushing damage and deformation to the B-end of tank car GLNX 3017, and may have lessened the release of aromatic concentrates into the Nemadji River from a breach in the tank shell below the water line.

This train derailment and the train derailment in Dunsmuir, California, on July 14, 1991, in which a derailed DOT class 111A tank car transporting about 20,000 gallons of metam sodium, a pesticide, released its entire load into the Sacramento River, demonstrate that the environment is at risk when transportation accidents occur and cargo is released into a body of water. Further, chemicals released into the environment are often difficult to recover, and may pose a long-term threat to fish and wildlife, water and soil resources, and public health. The DOT historically has focused on regulating hazardous materials that pose acute health hazards to humans. However, materials being transported by tank car may pose acute, environmental, or long-term public health hazards, or any combination of these. The determination of appropriate packaging and minimum levels of performance for all bulk containers, including railroad tank cars, must consider not only the acute health hazards of the cargo transported, but also environmental and long-term public health hazards.

Packaging requirements must be based on a process that considers (1) the consequences from a release of the cargo, (2) the risk of the cargo being released if its packaging is involved in an accident, and (3) the level of such a risk that is unacceptable. The probability of release is dependent upon the performance or survivability of the packaging in different accident conditions.

In 1992, the Environmental Protection Agency's (EPA) Hazardous Substances Task Force determined that the DOT's hazardous materials regulations do not apply to many materials that pose primarily environmental hazards because the DOT had focused on immediate or acute health hazards to humans. Materials that are environmentally harmful or pose a long-term threat to the public health, but that are not listed as hazardous substances under the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA; Public Law 96-510) or as marine pollutants under Annex III of MARPOL 73/78, may not meet the criteria for any DOT-designated hazard class. As a result, these materials may be transported in a tank car or other bulk packaging that is not authorized for the transportation of DOT-regulated hazardous materials. When DOT-regulated hazardous materials are also designated hazardous substances or marine pollutants, the suitability of the tank car to transport that cargo is generally based on the acute health hazards posed by the cargo rather than on its threat to the environment or long-term threat to public health, even though such threats may be greater. Thus, the Safety Board concludes that the DOT hazardous materials regulations need to more adequately address the consequences to the environment and long-term consequences to public health that may result from a release of cargo in a transportation accident.

On January 31, 1992, the Research and Special Programs Administration (RSPA) stated (in its advance notice of proposed rulemaking, Docket HM-211) that it "may also propose adoption of criteria to define environmentally hazardous materials that are not listed by EPA under CERCLA or RCRA [the Resource Conservation and Recovery Act (Public Law 94-580)] and that are not listed by name in the list of marine pollutants." In October 1992, the EPA, in response to recommendations of its Hazardous Substances Task Force, developed quantitative criteria to define environmentally harmful materials and submitted four options to the RSPA. The EPA also proposed subjective criteria for materials that pose long-term threats to public health.

The Safety Board also notes that the RSPA is also working for the harmonization of classification criteria internationally through the U.N. Committee of Experts on the Transport of Dangerous Goods, and commends the RSPA for initiating this effort. The Safety Board supports RSPA's efforts to work within the international community for the harmonization of standards. Although the U.N. Committee has deferred discussion of this issue, the Safety Board believes that the RSPA should proceed to implement criteria that apply to bulk domestic shipments of these materials. Because of the quantities involved, transportation of these materials in bulk presents the greatest risk and typically involves domestic shipments in railroad tank cars, highway cargo tanks, tank barges, or intermodal tanks.

Quantitative and subjective criteria, if adopted, will enable the DOT to better determine the risks of release that are unacceptable, and the packaging needs of

materials that pose environmental and long-term health hazards. Therefore, the Safety Board believes that the DOT should establish, in cooperation with the EPA, criteria to identify materials that are harmful to the environment or pose long-term threats to public health, and to evaluate the severity of harm posed by the release of these materials from bulk containers, including tank cars, in transportation.

Once definitions and criteria are developed for materials that pose environmental and long-term public health hazards, safety analysis methods need to be applied to evaluate the risk of such cargo being released from tank cars involved in accidents and to determine the performance of the tank cars necessary to prevent unacceptable consequences.

Following the derailment of a freight train in Helena, Montana[2] on February 2, 1989, the Safety Board concluded that safety analysis methods were needed to identify unacceptable levels of risk in transporting hazardous materials. Consequently, the Safety Board recommended that the DOT:

> Evaluate present safety standards for tank cars transporting hazardous materials by using safety analysis methods to identify the unacceptable levels of risk and the degree of risk from the release of a hazardous material, and then modify existing regulations to achieve an acceptable level of safety for each product/tank car combination. (R-89-80)

On June 13, 1990, the DOT replied that a safety analysis method would be initiated using deterministic risk analysis methods to classify high-risk materials, to analyze tank car integrity from postaccident histories, and to evaluate the relative risks imposed on society. The DOT further stated that the results of the safety analysis would determine if amendments to the existing hazardous materials regulations were needed. Based on the DOT's response, Safety Recommendation R-89-80 was classified as "Open--Acceptable Response."

Following its response to Safety Recommendation R-89-80, the FRA issued a contract for development of a safety analysis methodology to evaluate risks associated with transporting hazardous materials in tank cars. The contractor's report was completed in February 1993 and released by the FRA in May 1993.[3] A computer model developed in conjunction with the report considers the consequences of a release of flammable materials and those poisonous by inhalation, and the risks associated with transporting these materials in tank cars. According to the report,

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[2] National Transportation Safety Board. 1989. Collision and derailment of Montana Rail Link freight train with locomotive units and hazardous materials release, Helena, Montana, February 2, 1989. Railroad Accident Report NTSB/RAR-89/05. Washington, DC.

[3] Raj, Phani K.; Turner, Clayton K. 1992. Hazardous materials transportation in tank cars: analysis of risks., Part 1. DOT/FRA/ORD-92/34. Washington DC: Office of Research and Development, Federal Railroad Administration, U.S. Department of Transportation.

the probability of release can be reduced by as much as a factor of 10 for a tank car with head shields, shelf type couplers, thermal insulation jackets and increased shell thickness. Also, the report states that the risk assessment model and computer model developed in the study can be used to evaluate the relative risks of transporting the same chemical in different classes of tank cars or to compare the relative risks posed by different chemicals.

On February 2, 1993, the FRA issued a second contract for research, which will utilize the methodology developed in the first study to evaluate about 20 selected hazardous materials that are most frequently carried in railroad tank cars. The FRA projected that the second study will be completed by June 1994, with results released by October 1994.

Safety Recommendation R-89-80 addresses the use of safety analysis methods to determine acceptable acute risks for transporting hazardous materials in tank cars, but it does not specifically address materials that pose environmental or long-term public health risks. Although the Safety Board previously expressed concern about the level of protection provided to materials that can harm the environment in its May 1991 safety study on the transportation of hazardous materials by rail,[4] the Safety Board believes that the safety analysis methods used to assess the acute risks under Safety Recommendation R-89-80 also need to be applied to help evaluate the risks to the environment and the long-term public health from the release of these materials. Therefore, the Safety Board has urged the DOT, after establishing criteria to define materials that are environmentally harmful or pose long-term threats to the public health, to determine the risk of release of environmentally harmful materials from bulk packagings, including tank cars, and then modify the existing regulations to achieve an acceptable level of safety for the transportation of these materials.

Therefore, as a result of this accident investigation, the National Transportation Safety Board recommends that the Environmental Protection Agency:

> Establish, in cooperation with the Department of Transportation (DOT), criteria to identify materials that are harmful to the environment or pose long-term threats to public health, and evaluate, with the DOT, the severity of harm posed by the release of these materials from bulk containers, including tank cars, in transportation. (Class II, Priority Action) (I-94-2)

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[4] National Transportation Safety Board. 1991. Transport of hazardous materials by rail. Safety Study NTSB/SS-91/01. Washington, DC.

Also as a result of this accident investigation, the Safety Board issued safety recommendations to the Federal Railroad Administration, the Association of American Railroads, the American Short Line Railroad Association, and the U.S. Department of Transportation.

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 actions taken as a result of its safety recommendations and would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter. Please refer to Safety Recommendations I-94-2 in your reply.

Chairman VOGT, Vice Chairman COUGHLIN, and Members LAUBER and HAMMERSCHMIDT concurred in this recommendation. Member HALL did not participate.

By: Carl W. Vogt
Chairman