U.S. Department
of Transportation

**Federal Railroad
Administration**

Forward Through the 90s:
Selected Issues in the Transportation by Rail of Hazardous Materials

Report to the Senate Committee on Commerce, Science, and Transportation and the House Committee on Energy and Commerce

September 1994

U.S. Department
of Transportation

**Federal Railroad
Administration**

Administrator

400 Seventh St., S.W.
Washington, D.C. 20590

September 20, 1994

The Honorable Ernest F. Hollings
Chairman
Committee on Commerce, Science,
and Transportation
United States Senate
Washington, D.C. 20510

Dear Mr. Chairman:

Under the authority delegated to me by the Secretary of Transportation, the Federal Railroad Administration submits the enclosed report on "Selected Issues in the Transportation by Rail of Hazardous Materials," as required by the Rail Safety Enforcement and Review Act, Public Law 102-365. This report responds to the congressional mandate to report on six issues related to the safety and regulation of railroad hazardous materials traffic.

Railroads perform a vital service to the American economy by moving nearly 1.5 million carloads of hazardous materials each year. Their safety record regarding this traffic continues to improve: in 1992, there were only 27 accidents involving a hazardous materials release, an 85 percent decrease from 1980.

However, even a single hazardous materials release can have serious consequences, and the Department of Transportation is working to reduce the number of releases still further. The enclosed report outlines the Department's current and planned initiatives to improve the safety of railroad hazardous materials transportation.

I look forward to working with the Congress to advance our shared objective of improving safety in the railroad industry.

A copy of this report has also been sent to the Ranking Minority Member of the Senate Committee on Commerce, Science, and Transportation, and to the Chairman and Ranking Minority Member of the Committee on Energy and Commerce of the House of Representatives.

Sincerely,

Jolene M. Molitoris

Jolene M. Molitoris

Enclosure

U.S. Department
of Transportation

Federal Railroad Administration

Administrator

400 Seventh St., S.W.
Washington, D.C. 20590

September 20, 1994

The Honorable John C. Danforth
Ranking Minority Member
Committee on Commerce, Science,
and Transportation
United States Senate
Washington, D.C. 20510

Dear Senator Danforth:

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September 20, 1994

The Honorable John D. Dingell
Chairman
Committee on Energy and Commerce
U.S. House of Representatives
Washington, D.C. 20515

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U.S Department
of Transportation

**Federal Railroad
Administration**

Administrator

**400 Seventh St., S.W.
Washington, D.C. 20590**

September 20, 1994

The Honorable Carlos J. Moorhead
Ranking Minority Member
Committee on Energy and Commerce
U.S. House of Representatives
Washington, D.C. 20515

Dear Congressman Moorhead:

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EXECUTIVE SUMMARY

INTRODUCTION

Railroads play a major role in meeting the American economy's need to transport large volumes of hazardous materials economically and safely. More than 1.4 million carloads of hazardous materials traverse the railroad network each year, frequently traveling great distances between many different sets of origin and destination points. Although railroads carry these goods with an excellent safety record, even a single hazardous materials release has the potential to damage the environment, endanger thousands of people, or even shut down a city. Because of the risks involved, continuously improving the safety of hazardous materials movement is a key transportation policy objective.

The Strategic Plan for the Department of Transportation, announced by Secretary Federico Peña early in 1994, reflects the Clinton Administration's commitment to improving transportation safety and protecting Americans from the harmful release of hazardous materials. Goal 4 of the Plan recognizes the need to "minimize the dangers to communities and industry associated with the transportation of goods." To meet this goal, the Department will "significantly improve the safety of transporting hazardous materials on our air, water, surface, and pipeline transportation network."

Within the Department, the Federal Railroad Administration (FRA) promotes safe, environmentally sound, successful railroad transportation, and FRA and its employees are dedicated to this task, and to improving the railroads' already admirable safety record.

Given the seamless nature of the Nation's railroad system, the safety of railroad hazardous materials transport largely depends on the overall safety of railroad operations. FRA's safety program works to make railroad transportation even safer than it already is; as the safety of the entire railroad network increases, the number of rail accidents involving hazardous materials will decrease.

FRA's overall railroad operations safety program thus improves hazardous materials safety as well. New initiatives, including the Grade Crossing Safety Action Plan, announced by Secretary Peña in June, and the Positive Train Control Action Plan, announced in FRA's "Radio Communications and Train Control" July 1994 report to Congress, support this effort. In recent months, FRA issued final rules on event recorders, random alcohol testing, the reporting of remedial actions, and locomotive conspicuity. Over the next few months, FRA will propose rules strengthening the power brake regulations, bringing the operation of more maintenance of way equipment under the freight car safety standards, and improving track standards, among other areas.

In addition to this overall approach, FRA, in conjunction with the Research and Special Programs Administration (RSPA), focuses specifically on hazardous materials transportation safety concerns. Because tank cars transport 70 percent of all hazardous materials carried by rail, the safety of these cars is of paramount importance for FRA. Over the last 20 years, the work of FRA and RSPA has improved the safety of the Nation's tank car fleet, adding safety improvements first on cars transporting the most dangerous materials and then expanding that coverage to cars carrying commodities with lower hazard rankings. FRA and RSPA recognize the importance of tank car standards to the safety of hazardous materials transport, and both agencies are committed to continuing improvement.

Many hazardous materials incidents are unintentional releases unrelated to railroad operations. These generally result from poor pre-shipment preparation and packaging on the part of the shipper, but fall under FRA's jurisdiction because FRA is charged with enforcing all hazardous materials regulations on railroads. FRA is working to meet this challenge through a focused application of its inspectors. The National Inspection Plan (NIP) establishes methods and schedules that allow inspectors to target the facilities which, because of their transportation safety records, are most likely to be responsible for leaks and other problems.

FRA is also taking the initiative to reduce the impact of hazardous materials incidents when they do happen. Operation Respond, a pilot program in the Houston, Texas, area--an area which sees the highest concentration of hazardous materials movements in the United States--brings together railroads and emergency responders such as fire and sheriff's departments to establish procedures to deal with railroad accidents involving hazardous materials. As part of Operation Respond, the Houston Fire and Police Departments and the Harris County Sheriff's Department have on-line computer access to the hazardous cargo files of the Port Terminal Railroad, the Houston Belt and Terminal Railroad, the Union Pacific Railroad, and the Southern Pacific Railroad. In addition, the fire and police dispatching centers of Pasadena and Galena Park, Texas, are being connected to this information via a dedicated fax machine. These connections will enable emergency responders to identify easily what types of materials may be involved in an incident and, thus, prepare an appropriate response. This pilot program may ultimately provide the model for hazardous materials emergency response partnerships for communities throughout the United States.

THIS REPORT

The Rail Safety Enforcement and Review Act (RSERA) of September 3, 1992 requires the Secretary of Transportation to report on six issues presented by the railroad transportation of hazardous materials:

- Unintentional releases of hazardous materials;
- The in-train placement of hazardous materials cars;
- The standards for moving hazardous materials along routes with sharp curves and steep grades;
- Hot box detectors;
- The tank car rules; and
- The status of planned and pending hazardous materials regulatory projects and the status of rail hazardous materials enforcement activities.

Unintentional Releases of Hazardous Materials

Unintentional releases include releases caused by train accidents, and those involving only the hazardous materials cars or equipment. Train accidents involving hazardous materials releases have dropped from 173 in 1980 to 27 in 1992, an 84-percent improvement, as a result of the improving railroad safety record.

Incidents involving hazardous materials releases are a broader category that includes smaller releases, releases from cars not involved in railroad accidents, and releases from cars standing still, not part of a train. These primarily include releases from safety relief devices and from improperly secured valves and fittings. The number of these incidents has been stable for the past several years at a level of 1,100 to 1,200 annually, out of 1.4 million carloads shipped. Reducing hazardous materials incidents is a difficult challenge. Leaks almost universally originate at parts of the tank car secured by the shipper; shipping points are more widely spread than rail yards, making it harder to reach many of them; and the shipping location of a leaking car may be hundreds of miles from the incident, making it difficult to involve the culpable party.

FRA's inspectors are its prime weapon against such incidents, and the National Inspection Plan focuses their inspections on industries and shippers with the worst records. In addition, FRA inspectors enforce compliance with DOT regulations requiring function-specific training for employees handling hazardous materials; with this type of training, employees are less likely to commit errors that lead to hazardous materials incidents.

The In-train Placement of Hazardous Materials Cars

Current in-train placement rules generally require a "six-deep" separation between a hazardous materials carrying tank car and a locomotive or occupied caboose. These rules began as "good practices" established when railroads used steam locomotives that produced hot cinders and carried freight--including explosives--in wooden box cars. Some separation between hazardous materials cars and the parts of trains occupied by humans is intuitively correct, but research shows that the risk of incompatible chemicals mixing in a derailment is small. Stringent car placement rules would require additional, unnecessary switching--the most dangerous type of railroad operation to the crew--and their effect must be balanced against the risk of crew injuries during the extra switching they would require.

Train makeup, however, involves placing cars in a train such that they balance the forces within the train, taking into consideration the effects of terrain and curvature along the route to be travelled and the different properties of empty and loaded cars, and cars of different length. It was an "unbalanced" train that derailed at Dunsmuir, California on July 14, 1991, spilled agricultural chemicals into the Sacramento River, and killed the resident aquatic life. FRA has sponsored extensive research in track/train dynamics over the past two decades, and the railroad industry has made effective use of that research to develop and implement guidelines for train makeup. FRA's research is also the basis for agreements on operating restrictions--including train makeup--between California railroads and the state Public Utilities Commission as the local governments and industries work together to prevent accidents such as Dunsmuir. FRA has contracted for a review of these practices and will launch formal regulatory action in this area in 1996, following completion of those studies.

Hazardous Materials on Routes with Sharp Curves and Steep Grades

Rail lines in difficult terrain, which can have severe grades and curves, present operating difficulties and dangers greater than rail lines on relatively easy terrain. Sharp curves can force wheels up and over the top of the rail--known as wheel climb--and the severe lateral forces of the wheels themselves can literally knock over the rails, known as rail rollover. Both of these effects cause potentially dangerous derailments.

Nationally, track-caused train accidents have declined steadily over the last decade, from a 1983 total of 1,569 to 849 in 1992, a reduction of 46 percent. Effective Federal track standards played a powerful role in this reduction, as did the railroad industry's success in developing and applying new procedures for operating trains and maintaining track in mountainous country. In addition, the Railroad Revitalization and Regulatory Reform Act of 1976 and the Staggers Rail Act of 1980 helped improve the financial health of United States' railroads and increased their ability to invest in improved, safer rights of way.

FRA's on going rulemaking proceeding exploring revisions to the track safety standards will allow for a thorough review of track issues. FRA received comments in response to the November 1992 Advance Notice of Proposed Rulemaking, and at workshops held with industry and labor representatives in Newark, Atlanta, Denver, and Washington. This input will improve the proposed rules now being drafted and make them more effective.

Hot Box Detectors

"Hot boxes"--overheated journal bearings--were once a major cause of accidents on U.S. railroads, and railroads have paid great attention to improving bearings and to hot box detection. Better technology has reduced accidents caused by hot boxes to only 2 percent of all accidents caused by mechanical failure. However, they are dangerous, accounting for a much larger percentage--about 20 percent--of the damage from those accidents.

Roller bearings get hot as they begin to fail, and hot bearing detectors, installed about every 20-30 miles along mainline track, can warn train crews before the bearings suddenly "burn off." These detectors work well, but they are expensive to install (nearly $90,000 each) and to maintain ($11,000 to $20,000 per unit per year). A requirement that hot box detectors be installed on all routes carrying hazardous materials is not cost effective.

Tank Car Rules

Tank cars carry 70 percent of all hazardous materials shipments by rail. As with all freight cars, tank cars are controlled by several different sets of rules, some governmental and some industry. For example, FRA's freight car and power brake rules govern the operating and safety features of all railroad freight cars. The interchange rules of the Association of American Railroads (AAR) include certain standards required for the operation by railroads of tank cars owned by other railroads, shippers, or car lessors.

Because of their role in hazardous materials transport, tank cars are also covered by RSPA's hazardous materials rules--enforced against railroads by FRA--which treat them as a packaging and govern safety features and construction materials.

Improving the tank car fleet is an ongoing process that FRA and RSPA first entered in the early 1970s. Their first efforts concentrated on the cars carrying the most volatile products; the program has advanced so that, now, the role of the DOT class 111 tank car--the most basic nonpressure car--is being perceptibly reduced in hazardous materials transport. FRA and RSPA have proposed amendments to the Federal tank car rules that will continue the improvement process and final rule revisions are now being considered, to be published before the September 1995 date requested by Congress.

Pending Regulations and the Status of Enforcement Activity

RSPA and FRA work as partners on railroad hazardous materials regulations. Two final FRA/RSPA rules, now under development, will regulate the transportation of hazardous materials in railroad tank cars. The first, Docket HM-175A, will improve the crashworthiness of tank cars by requiring proven design features, such as head protection systems, on classes of tank cars where they are not now required. The second, Docket HM-201, will replace obsolete low-pressure hydrostatic testing of tank cars with modern nondestructive testing methods.

FRA promotes compliance with the hazardous materials regulations through a vigorous enforcement program, one increasingly focused on shippers. Civil penalties for violations of the Federal hazardous materials transportation regulations are collected promptly, adding credence to the effort. Reports from the field indicate that the enforcement effort is working and that subsequent visits to a company's facility often find conditions much improved. The improving safety record of railroad hazardous materials transport--train accidents with a hazardous materials release happen one-sixth as often as a decade ago--is further evidence of an effective enforcement program.

FRA'S SYSTEMIC APPROACH

In order to improve safety *before* accidents happen, FRA is reorienting its entire safety program to concentrate on systemic safety problems, reviewing the railroad system as a whole to detect dangerous situations and practices, and directing resources to address the most dangerous problems before they cause accidents.

FRA's stub sill inspection program is a good example of a systemic approach. Beginning early in 1990, FRA learned of 10 noncontinuous center sill tank cars (stub sill cars) that had pulled apart, experiencing a complete failure in the draft sill area. No deaths or injuries were caused and no hazardous materials were released, but FRA pursued the matter and discovered more draft sill failures. Through FRA's liaison with the Association of American Railroads Tank Car Committee, more inspections were encouraged. These inspections, and further separations, lead to an AAR Early Warning Letter on May 2, 1991.

Similar failures occurred in Canada and, on June 13, 1991, FRA and Transport Canada signed a joint letter to AAR, urging more speed in the investigation of the stub sill failure problem. On July 17, members of the Tank Car Committee met with FRA and Transport Canada. Frequent meetings ensued and private industry and governmental agencies cooperated in defining the problem and its solutions. A sample of the stub sill tank car fleet was called in for inspection. Defects were catalogued and priority inspections ordered for the worst of them.

On July 15, 1992, under pressure from FRA and Transport Canada, the AAR issued a circular letter to all railroads and car owners establishing a priority inspection program based on accumulated mileage and car design. FRA issued Emergency Order No. 17 to enforce the inspection program. Stub sill tank cars without jackets--thinner gage metal coverings typically designed to hold insulation in place and protect it from the elements--will be inspected within 5 years and jacketed cars within 7 years. To ensure that these thorough inspections continue, AAR's Interchange Rules, which govern the use of cars among all North American railroads, have been amended to require stub sill inspections every 10 years throughout the life of a car.

The systems approach that led to Emergency Order No. 17 examined both the car structure and its operating environment. While the car inspections were gaining momentum, FRA inspectors armed with radar guns investigated the possibility that the stub sill failures were due to overspeed switching impacts rather than design flaws. It involved the cooperation, involvement, and encouragement of U.S. and Canadian governmental agencies, and it used the skills and talents of car builders, chemical shippers, and railroads. The end product was not just Emergency Order No. 17, but a cooperative inspection effort, an inspection protocol recognizing special priorities within the car fleet, and an amended Interchange Rule to maintain fleet quality for the future. Future products will include finite element modeling, so that tank car designs can be stress tested before they are built.

FRA ACTIONS

Operating Safety Improvements

FRA has undertaken several initiatives to improve railroad operating safety and prevent train collisions and derailments, which cause many of the worst hazardous materials releases. It has also recently issued several rules and is working on several more directed at improving overall operating safety. These include:

1. The Grade Crossing Action Plan, which sets out initiatives to prevent accidents caused by cars and trucks blocking crossings. In conjunction with the Federal Highway Administration, the National Highway Traffic Safety Administration, and the Federal Transit Administration, the FRA will begin major efforts to educate the public on grade crossing safety, enhance the enforcement of traffic laws at grade crossings, promote systematic corridor reviews of grade crossings, increase safety at private crossings, improve data collection and analysis, and promote research on new safety technologies.

2. The Railroad Communication and Train Control Action Plan sets out an 18-item agenda to improve radio communications and institute Positive Train Control, a computer/communication system to prevent collisions, overspeed derailments, and roadway worker injuries. One of the first steps will be to determine which

corridors may warrant PTC application, and hazardous materials traffic will be one criterion for that review.

3. Recently issued final rules governing:

- Locomotive Event Recorders, to be required by May 5, 1995, in the lead locomotive of all trains going faster than 30 miles per hour. These will monitor crew performance and provide an unbiased, accurate record of the operations of a train prior to a derailment.

- Alcohol and drug regulations, to prevent the operation of trains by crews under the influence of controlled substances.

- Remedial action reporting, to require a follow-up report to FRA of the actions taken to correct a violation of railroad safety standards discovered by an inspector.

- Locomotive conspicuity, to make locomotives more visible and, thus, reduce grade crossing accidents and head-on collisions.

4. Proposed rules to be issued after September 1, 1994, include:

- Revisions to the power brake regulations.

- Revised operating regulations for maintenance of way equipment, to increase the coverage of this equipment by the freight car safety standards.

- Improved track standards.

5. In addition, FRA continues to improve the effectiveness of its inspection and enforcement program through:

- Judicious exercise of its authority to penalize individual as well as corporate offenders.

- Disqualification, where appropriate, of individuals from safety-sensitive service.
- An increased emphasis on training FRA and state inspectors, and sharing that knowledge with the personnel of FRA's customer industries.
- The timely collection of civil penalties.

Hazardous Materials Actions

FRA will take the following actions to improve further the safety of railroad hazardous materials transportation:

1. FRA will assess the ongoing results of Operation Respond in the Houston area and use the lessons learned from the program to improve the multimodal DOT/RSPA *Emergency Response Guidebook* for emergency first responders. FRA will also apply "lessons learned" from Operation Respond to provide a model for hazardous materials emergency response partnerships for communities throughout the United States.

2. Upon completion of research on optimum train makeup criteria, FRA will analyze the costs and benefits of amending the current regulations and, as appropriate, institute regulatory proceedings to implement the research findings.

3. FRA will conclude the stub sill inspection program started under Emergency Order 17, with all cars inspected and repaired as necessary. Nonjacketed cars will be completed by September 1997, and jacketed cars, 2 years later.

4. FRA will complete action on the tank car crashworthiness proceeding (HM-175A) within congressionally specified deadlines.

5. FRA will complete action on the rule that will establish modern non-destructive testing methods (NDT) to ensure that tank cars

are safe to continue in service (HM-201), within congressionally specified deadlines.

6. FRA will complete action on the proposed rules regarding human attendance at tank car unloading sites.

7. FRA will complete action on new rules, recognizing the advances in intermodal securement for hazardous materials in COFC/TOFC service (HM-197), easing the growth of that dynamic segment of freight railroad traffic.

In addition, FRA has recently published two hazardous materials guidance documents:

- *Field Product Removal from Tank cars*, an updated research report on the field transfer of hazardous materials from tank cars damaged in derailments. (DOT/FRA/ORD 92-27, February, 1993.)

- *Hazardous Materials Emergency Response Plan Guidance Document for Railroads*, providing assistance in the development and review of emergency response plans. (DOT/FRA/ORD 93-09, March, 1993.)

CONCLUSION

Despite the inherent risks in moving hazardous materials, railroads have achieved a good safety record while undertaking this vital service to the American economy, thanks both to the railroads' commitment to safety and to FRA and RSPA's research and regulatory efforts. Further improving this record will require FRA, other agencies, and the railroads to recognize problems at the earliest possible moment, and to handle the necessary adjustments with the priority and dispatch they deserve. The actions listed above--both those specific to hazardous materials and general to railroad safety--will continue the trend of improvements in the safety of transporting hazardous materials by rail.

REPORT TO THE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION OF THE UNITED STATES SENATE AND TO THE COMMITTEE ON ENERGY AND COMMERCE OF THE HOUSE OF REPRESENTATIVES REGARDING ISSUES PRESENTED BY THE TRANSPORTATION BY RAIL OF HAZARDOUS MATERIALS

INTRODUCTION

The Rail Safety Enforcement and Review Act[1] (RSERA) became law on September 3, 1992; it authorized activities under the Federal Railroad Safety Act of 1970 for fiscal years 1992 through 1994. In addition, RSERA directed the Secretary of Transportation to submit a report "regarding issues presented by the transportation by rail of hazardous materials." A copy of the section of RSERA calling for this report follows.

RSERA required the Secretary to address:

- Data on unintentional releases of hazardous materials, whether as a result of train accidents or from other causes;
- A description and evaluation of the regulations regarding the in-train placement of hazardous materials cars;
- An assessment of the standards relevant to railroad hazardous materials transportation through territory with high degrees of curvature or significant grades;
- An assessment of wayside bearing failure detectors;
- An assessment of railroad tank car rules; and

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[1] P.L. 102-365.

- A report on the status of planned and pending regulations that address the safe transportation of hazardous materials by rail, including the status of rail hazardous materials enforcement activities.

In addition, the Secretary is invited to include additional relevant information.

To fulfill these requirements, this report will draw on data and information from the Federal Railroad Administration, Research and Special Programs Administration, and sources within the railroad and railroad supplier industries.

THE MANDATE:

Rail Safety Enforcement and Review Act

Sec. 16: Report on the Safety of Hazardous Materials Transportation by Rail

Within one year after the date of enactment of this Act, the Secretary shall report to the Committee on Commerce, Science and Transportation of the Senate, and the Committee on Energy and Commerce of the House of Representatives regarding issues presented by the transportation by rail of hazardous materials. The report shall include the following information:

(1) For the years 1989, 1990, 1991, and to the extent available, 1992, relevant data concerning each unintentional release of hazardous materials resulting from rail transportation accidents, including the location of such release, the probable cause or causes of each such release, and the effects of each such release.

(2) For the years 1989, 1990, 1991, and to the extent available, 1992, a summary of the relevant data concerning unintentional releases of hazardous materials resulting from rail transportation incidents.

(3) A description of current regulations governing hazardous materials rail car placement (including buffer cars) and an evaluation of their adequacy in light of experience and emerging traffic and commodity patterns.

(4) An assessment of regulations, rules, orders, or standards that address rail operations procedures associated with carrying hazardous materials on rights-of-way having significant grades or high degrees of curvature.

(5) An assessment of the effectiveness and associated costs of requiring deployment of wayside bearing failure detectors for trains carrying hazardous materials.

(6) An assessment of rail tank car rules, regulations, orders, or standards affecting hazardous materials transportation.

(7) The status of all planned or pending regulatory activities of the Secretary (including the status of all regulations required by statute) that seek to address the safe transportation of hazardous materials by rail, and the status of rail hazardous materials enforcement activities.

(8) Such other information as the Secretary determines relevant to the safe transportation of hazardous materials by rail.

BACKGROUND

Railroad hazardous materials transportation must be considered in the context of rail freight operations generally. Any approach to hazardous materials safety first must address general railroad safety issues, since only about 5 to 6 percent of all railroad traffic consists of hazardous materials regulated by the Department of Transportation.

While a train derailment with a hazardous materials fire may lead the 6 o'clock news, it is also true that the hazardous materials cars almost never cause the derailment. Railroad transportation safety experts know, however, that even hazardous materials shipments in full compliance with Federal regulations pose a significant threat if the track, equipment, signals, or operating practices that affect those shipments are unsafe. Nearly all of the Federal Railroad Administration's (FRA) regulations and most of its inspection and enforcement efforts are designed to minimize the frequency of train accidents, which pose the greatest threat of a catastrophic release of hazardous materials in the rail mode. Rail borne hazardous materials move in and through an intermodal transportation system, and FRA's entire safety program contributes to hazardous materials safety.

As shown in the next section, the extent and diversity of the railroad safety laws FRA administers highlight the agency's railroad safety program. Legislation enacted July 5, 1994 (P.L. 103-272) repealed and recodified Federal transportation laws, including the Federal Railroad Safety Act and the Hazardous Materials Transportation Act. Provisions of the former statutes were recodified in Title 49 of the United States Code. Where this report refers to an act, such as the Federal Railroad Safety Act, by its former name, it is for convenience and historical continuity. Citations in this report will list both the recodified section and the former reference.

Federal Railroad Safety Legislation:

Older Railroad Safety Laws: In 1893, Congress began enacting laws to deal with discrete railroad safety issues:

- The Safety Appliance Acts[2] require the use and maintenance of specific, standardized appliances (such as handholds) on rail cars to protect railroad employees, especially those involved in switching operations. Safety appliances allow a railroad employee to mount or dismount a rail car using ladders and footholds that are the same or very similar on any car. The Safety Appliance Acts also began the process of standardizing railroad power brake systems and rail car coupling systems.

- The Locomotive Inspection Act[3] prohibits the use of unsafe locomotives and provides the foundation for FRA locomotive safety standards.

- The Accident Reports Act[4] requires railroads to report accidents to FRA and authorizes the agency to investigate accidents.

- The Hours of Service Act[5] sets maximum work hours for railroad employees who operate trains, work on signal systems, or direct train operations, and gives FRA authority over employee sleeping quarters.

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[2] 49 U.S.C. § 20301 *et seq.*, formerly 45 U.S.C. §§ 1-16.

[3] 49 U.S.C. § 20701 *et seq.*, formerly 45 U.S.C. §§ 22-34.

[4] 49 U.S.C. § 20901 *et seq.*, formerly 45 U.S.C. §§ 38-43.

[5] 49 U.S.C. § 21101 *et seq.*, formerly 45 U.S.C. §§ 61-64b.

- The Signal Inspection Act[6] gives FRA the authority to regulate the maintenance, testing, removal, or modification of railroad signal systems.

Each of these Acts is the basis of a portion of FRA's regulations and violations of the statutes or the regulations issued under them can subject the violator to civil penalties ranging from $500 to $20,000 for each day of violation.

The Federal Railroad Safety Act of 1970:[7] Following the transfer of rail safety functions to FRA from the Interstate Commerce Commission (ICC) as part of the formation of the Department of Transportation in 1966, Congress enacted the Federal Railroad Safety Act of 1970 (FRSA). This Act affords the Secretary of Transportation comprehensive rulemaking authority (subsequently delegated to the Administrator of the FRA) over all areas of railroad safety.

FRA has issued rules under FRSA concerning track, freight cars, operating rules, operating practices (including control of alcohol and drug use), engineer qualifications, bridge worker safety, event recorders, radio use, rear end markers, and glazing of windows on locomotives, cabooses, and passenger cars. In some cases, FRSA and the older laws have been used as joint authority to issue regulations.

In addition, Title III of FRSA, known as the Hazardous Materials Transportation Control Act was the basis for the establishment of a facility and staff, a central reporting system, and a review process for hazardous materials accidents. Title III was

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[6] 49 U.S.C. § 20501 *et seq.*, formerly 49 App. U.S.C. app. § 26, also known as § 25 of the Interstate Commerce Act.

[7] 49 U.S.C. Subtitle V, Part A, formerly P.L. 91-458, 84 Stat. 971, 45 U.S.C. §§ 421, 431 *et. seq.*

repealed and replaced by the Hazardous Materials Transportation Act in 1974.

The Hazardous Materials Transportation Act:[8] Enacted as part of the Rail Safety Improvement Act of 1974, the HMTA provides the Secretary of Transportation the authority to promulgate regulations to protect against the risks to life and property inherent in the transportation of hazardous materials in commerce. The Act provides civil penalties for anyone who knowingly violates the statute or any regulation involving the transportation of a hazardous material and criminal penalties for willful violations. The Secretary's regulatory authority under the act has generally been delegated to RSPA; FRA and other DOT administrations have been delegated enforcement authority over their respective modes.

The Rail Safety Improvement Act of 1988:[9] This legislation amended FRSA and the older railroad safety laws, increasing civil penalty amounts and authorizing assessments of penalties against individuals for willful violations[10]. This Act also required event recorders, licensing and certification of locomotive engineers, installation of automatic train control on portions of the Northeast

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[8] 49 U.S.C. § 5101 *et seq.*, formerly P.L. 93-633. Under the Code of Federal Regulations, 49 CFR § 1.49(s), the FRA Administrator is delegated the power to enforce the HMTA so far as it applies

> to the transportation or shipment of hazardous materials by railroad, including the manufacture, fabrication, marking, maintenance, reconditioning, repair or test of containers which are represented, marked, certified, or sold for use in the bulk transportation of hazardous materials by railroad.

[9] 49 U.S.C. § 5101 *et seq.*, formerly P.L. 100-342.

[10] The Act authorized assessment of civil penalties against individuals for willful violations involving safety areas other than Hazardous Materials. Individual liability under the HMTA had existed since passage in 1974, no doubt in part due to the original criminal basis of hazardous materials statutes since the Explosives and Combustibles Act of 1908.

Corridor, and expanded protection of railroad employees against discrimination.

The Hazardous Materials Transportation Uniform Safety Act of 1990:[11] HMTUSA amended the HMTA to require additional regulation in several important areas, among them:

- The training of hazardous materials employees by their employers,

- A prohibition against tampering with the marking or placarding of a hazardous materials packages or vehicles, and

- The establishment of a program of registering shippers and transporters of certain hazardous materials, both as a means of establishing the identity of the hazardous materials regulated community and to gather funds for a program of grants for the hazardous materials emergency response training of public sector employees.

In addition, HMTUSA called for studies of the tank car design, approval, and building process and of several aspects of the transportation of radioactive materials. Finally, railroad tank cars constructed prior to January 1, 1971, could no longer have air brake support brackets welded directly to the tank; tank car owners would be required to install a pad on the tank and to weld the brackets to that pad.[12]

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[11] 49 U.S.C. § 5101 *et seq.*, formerly P.L. 101-615. The acronym of the name of the act is pronounced "Hum-too-sah."

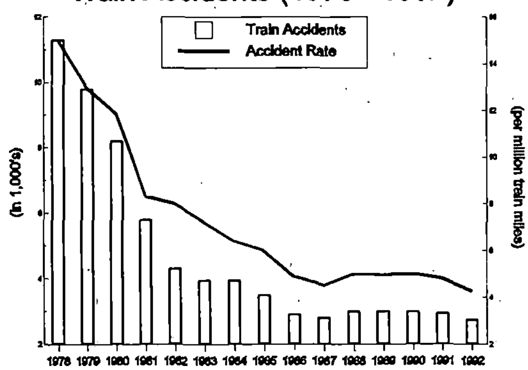
[12] FRA Docket RHMT-1, 56 FR 50664, October 8, 1991. Tank cars built after January 1, 1971 had been required to have such pads from the date of their original construction. RSPA Docket HM-90, 36 FR 21346, November 6, 1971.

The Rail Safety Enforcement and Review Act:[13] In addition to calling for this report, RSERA increased minimum penalties for violations of the railroad safety regulations from $250 to $500, and added FRA enforcement personnel to those protected under Federal criminal laws against the assault, intimidation, etc., of law enforcement officials. Regulation in several specific areas was mandated, including revisions to the power brake and track regulations and, to give greater oversight over the "follow-up" given by a railroad to an FRA inspector's recommendation of a violation, the Act also called for regulation requiring the reporting of remedial actions taken by the railroads.

<u>The State of Railroad Safety -- A Snapshot</u>:

By almost any measure, railroad safety is improving.

Train Accidents (1978 - 1992)



Train accidents are usually due to a failure in one of three areas:[14] track, human factors, or equipment. Since 1978, the rate of track-caused accidents has dropped to less than one-fourth of its former level, failures in human factors have been cut by nearly two-thirds, and equipment-caused accidents are less than a fifth of their 1978 rates.

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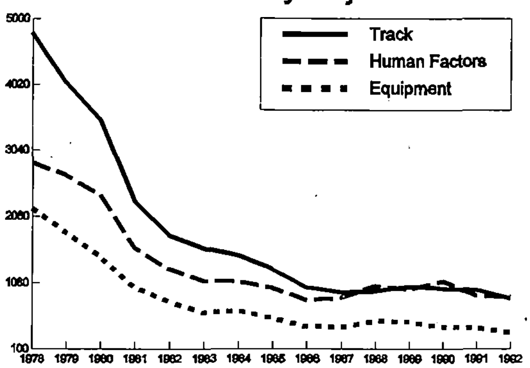
[13] P.L. 102-365.

[14] Highway/rail crossing accidents are a fourth tragic cause of death, injury, and property damage each year. They are not discussed in this report because they are too tangentially related to the transportation of hazardous materials by rail. However, thanks in large measure to programs like OPERATION LIFESAVER, safety is improving in this area, too.

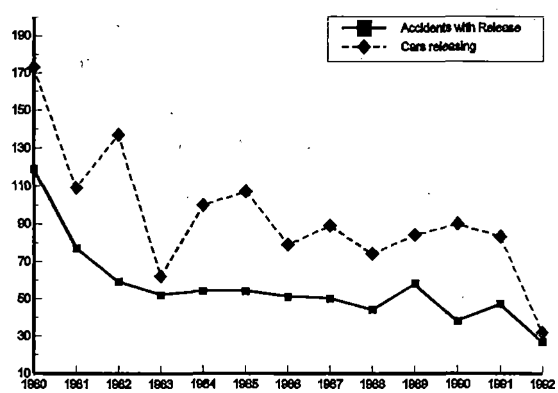
Hazardous materials safety has also benefitted from the advances made in overall railroad safety and the FRA railroad safety program. In 1980, there were 119 train accidents involving a release of hazardous materials, a figure that was reduced to 27 for 1992. Nearly 1.5 million railroad carloads of hazardous materials moved in 1992, almost a million of them tank cars. When the year was out, 32 cars had lost part or all of their loads due to a train accident, or about .002 percent. While any release of a hazardous material poses significant risk, the impressive success rate of America's railroad industry in the safe transportation of hazardous materials is an important fact to keep in mind when considering how safety might be enhanced.

Train Accidents By Major Cause



The Department of Transportation and several of its agencies, including FRA and RSPA, work hard to carry out the Federal hazardous materials safety program. Similar efforts are underway in several states, and the railroad companies, hazardous materials shippers, and their employees are a vital and innovative part of the team. Does it work? Consider this: more people will die from alcohol-related traffic deaths between breakfast and lunch on any given day than

Hazardous Materials Releases



have died due to the railroad transportation of hazardous materials since the beginning of 1980.[15] This perspective does not detract from the very real dangers in transporting regulated materials -- they are called "hazardous" for a reason -- but it does show that, measured in terms of risk, the transportation of hazardous materials by rail is very safe.

[15] There have been three fatalities in railroad hazardous materials accidents and incidents since the start of 1980. About half the traffic fatalities each year (some 22,000) are alcohol related; these deaths happen at a rate of about 2.5 per hour, 24-hours per day.

HAZARDOUS MATERIALS RELEASES AND ACCIDENTS

SUMMARY: Train accidents involving a hazardous materials release have dropped from 173 in 1980 to 27 in 1992. Despite the improving statistics, individual accidents, such as the June 30, 1992, derailment near Superior, Wisconsin / Duluth, Minnesota, can shut down cities and place thousands of people in danger. The causes of such accidents vary from year to year, typically based on factors other than any inherent instability in the chemicals themselves.

The Research and Special Programs Administration collects information on hazardous materials releases due to rail transportation incidents. As opposed to train accidents, "incidents" more broadly includes much smaller releases, releases from cars not involved in railroad accidents, and even releases from cars standing still, not part of a train. For the past several years, the number of hazardous materials releases from railroad cars has hovered around 1,100 to 1,200 annually, even as train accidents have declined significantly.

FRA's railroad safety program aims to cut the chances of a hazardous materials release in a rail accident. Reducing hazardous materials incidents is a harder task. Almost always, leaks originate at parts of the tank that were last touched by the shipper; shipping points are more widely spread than rail yards, making it harder to reach many of them, and the specific shipping location originating a particular leaking car may be hundreds of miles from the incident, making it hard to involve the culpable party. FRA meets this challenge through a focused application of its hazardous materials inspectors, as reflected in the National Inspection Plan (NIP). In addition, FRA inspectors enforce compliance with the DOT regulations requiring function-specific training for employees handling hazardous materials; trained employees are less likely to commit the errors that lead to hazardous materials incidents.

REPORT: As good as the overall railroad hazardous materials safety record is, it is scant comfort to those who have been evacuated from their homes because of a release of a dangerous chemical from a rail car, or to a railroad employee who has been splashed with a hazardous material that escaped from a freight car during what otherwise looked like normal operations.

There are two major sources of data relevant to the rail transportation of hazardous materials: FRA's train accident database, and RSPA's data on hazardous materials releases. FRA's data measure only those releases that result from train accidents (derailments and collisions that result in a certain minimum amount of damage to railroad property).

RSPA's data on hazardous materials releases are not limited to train accidents. They include all releases, including those from cars not involved in train accidents and, in fact, releases from cars that are standing still. The overwhelming majority of the incidents in RSPA's data base are releases of very small quantities of hazardous materials due to improper securement of a tank car by the shipper. Of course, given the dangers presented by any hazardous materials release, even the releases unrelated to train accidents can have severe consequences.

Hazardous Materials Releases due to Train Accidents, 1989-1992:

FRA defines the term "train accident" as a collision, derailment, fire, explosion, act of God, or other event involving on-track equipment in which damage to railroad equipment and property exceeds a monetary threshold established, and readjusted periodically by regulation.[16] Environmental damages and the cost of damaged or lost lading are not included.

For example, if a freight train transporting 50 cars of hazardous materials derails 5 cars of sulfuric acid with no release of product and the damage to equipment, track, and structures

[16] *FRA Guide for Preparing Accident/Incident Reports*. The full text of FRA's regulations for reporting accidents is found in 49 CFR Part 225.

amounts to $12,000, the incident must be reported to FRA because the dollar amount exceeds the current $6,300 threshold.

There has been a dramatic reduction in the number of train accidents involving hazardous materials release since 1980, when 173 such accidents occurred. In response to RSERA's requirement that this report focus on the period from 1989 through 1992, the table to the right summarizes the data on train accidents involving a release of hazardous materials since 1989. Clearly, the number of train accidents accompanied by a hazardous materials release is declining even faster than are train accidents generally. As was discussed above, nearly every element of FRA's rail safety program plays a role in reducing the number of train accidents.

Train Accidents Involving a Release of Hazardous Materials, 1989-1992

Year	Accidents with HM Release	Cars Releasing Hazardous Materials	Persons Evacuated	Damage (Millions)
1989	56	84	11,995	$16.8
1990	36	90	2,434	$9.7
1991	47	83	1,488	$17.9
1992	27	33	20,430	$5.9

Accidents represented in this table also yield the following additional data over the four-year target period:

- The sudden increase in evacuations in 1992 is accounted for in a single accident, June 30, 1992, at Superior, Wisconsin / Duluth, Minnesota. A summary of that accident appears with other significant rail accidents, below.

- Hazardous materials releases occurred on 35 different rail carriers.

- While three carriers, CSX Transportation reporting 30 accidents, Union Pacific reporting 27, and Burlington Northern reporting 24, accounted for most of the releases, these data are not normalized for traffic flow and they cannot be used to comment on the hazardous materials safety programs of these or any other carriers.

- Accidents involving the release of a hazardous material were reported from 40 different states. The leading states were Texas (26), Illinois (10), Pennsylvania (9), and California and Missouri (8 each). Not surprisingly, these states are also among the top origins and destinations for hazardous materials.

RSERA required that this report include data on all train accidents involving the release of a hazardous material in the 1989-1992 period, including the location, probable cause or causes, and effects of each release. Immediately following in chart form is a comprehensive list, covering the period 1989-1992, of rail transportation accidents that involved a release of hazardous materials. For each accident, the chart includes the railroad and location, the date of the accident, the hazardous materials released (where that information is available), the probable cause, the number of persons evacuated, the number of persons injured, and the damages to equipment and to way and structures.

Railroad Accidents Involving Release of Hazardous Materials 1989 - 1992

Location and Railroad	Date of Accident	Commodity Released	Probable Cause	Persons Evacuated	Persons injured	Damages: Equipment/ Way & Structure
Fredericksburg, VA. R F & Potomac	1/4/89	Ethyl Alcohol	Interaction of lateral/vertical forces	0	0	$15,500/ $4,281
Gurdon, AR. Union Pacific	1/14/89	*[17]	Shoving movement, man on or at leading end of movement, failure to control	0	0	$16,000/ $1,900
Goffre, NM. ATSF RY.	1/15/89	*	Truck, stiff, improper lateral or swivelling	0	0	$145,300/ $28,500
East St. Louis, IL. Chicago, Missouri & Western	1/16/89	Ammonium Nitrate Fert.	Switch point worn or broken	0	0	$36,500/ $0
Natchez, MS. Illinois Central RR.	1/19/89	Caustic Soda	Wide gage (defective or missing crossties)	0	0	$17,570/ $500
Strang, TX. Southern Pacific	1/27/89	Vinyl Acetate	Switch damaged or out of adjustment	0	0	$2,625/ $3,800
Helena, MT. Montana Rail Link	2/2/89	Hydrogen Peroxide & Isopropanol	Failure to apply sufficient handbrakes	3500	2	$802,500/ $118,000
Pando, CO. Denver & Rio Grande RY.	2/7/89	Sulfuric Acid	Speed and failure to apply sufficient no. of hand brakes	0	2	$3,000,000/ $60,000
Starnes, VA. CSX Trans.	2/10/89	*	Head and web separation (outside joint bar limits)	0	0	$195,700/ $80,000

[17] Because FRA accident investigations focus on determining the cause of the accident, and because hazardous materials are almost never the "trigger" that initially causes an accident, certain FRA investigation reports do not include commodity information. This chart compiles data from both FRA and RSPA sources.

Location and Railroad	Date of Accident	Commodity Released	Probable Cause	Persons Evacuated	Persons injured	Damages: Equipment/ Way & Structure
Bordulac, ND. Soo Line	2/20/89	Anhydrous Ammonia	Vertical split rail head	50	2	$643,503/ $17,500
Akron, OH. CSX Trans.	2/26/89	Butane	Truck components: side bearing clearance improper	1500	0	$521,000/ $0
Jal, NM. Union Pacific	3/9/89	Molten Sulfur	Cross level of track irregular (not at joints)	0	0	$50,000/ $2,600
Denison, TX. Union Pacific	3/11/89	*	Switch point worn or broken	0	0	$42,681/ $4,500
Houston, TX. Houston Belt Terminal RY.	3/25/89	*	Worn flange	0	1	$222,092/ $33,123
Douglasville GA. Southern RY.	3/25/89	*	Derail, failure to apply or remove	0	0	$62,871/ $1,500
Galva, Il. Burlington Northern	4/1/89	*	Rigging down or dragging	0	0	$441,000/ $32,000
Sand Hill, TX. Union Pacific	4/3/89	*	Track profile improper	0	0	$163,640/ $113,000
Crockett, TX. Union Pacific	4/6/89	*	Side bearing clearance improper	0	0	$9,000/ $27,000
Englewood, TX. Southern Pacific	4/13/89	*	Malfunction of hump retarder	0	0	$25,000/ $50,000
Clearing Yard, IL. Belt Railway of Chicago	4/23/89	Butadiene	Retarder did not slow car sufficiently	0	0	$122,000/ $0
Solsberry, IN. Indiana Railroad Co.	4/24/89	*	Track alignment irregular (buckled)	0	0	$160,000/ $45,000
Highland, MI. CSX Trans.	4/25/89	*	Center plate disengaged from truck (car off center)	25	0	$150,000/ $2,000
Willard, OH. CSX Trans.	4/29/89	*	Overloaded car	0	0	$10,000/ $1,600

Location and Railroad	Date of Accident	Commodity Released	Probable Cause	Persons Evacuated	Persons Injured	Damages: Equipment/ Way & Structure
Cassville, WI. Burlington Northern	4/30/89	*	Interaction of lateral/ vertical force-rock off	0	0	$771,000/ $100,000
Livonia, LA. Union Pacific	5/10/89	*	Truck components	0	0	$193,578/ $24,000
Meehan, MS. Midsouth Rail Corp.	5/11/89	Caustic Soda	Joint bar broken, noninsulated	100	0	$1,000,000/ $60,000
Milpitas, CA. Union Pacific	5/26/89	*	Switch movement, excessive	0	0	$29,400/ $5,000
Nelson, LA. Midsouth Rail Corp.	6/19/89	Sodium Hydroxide	Journal (plain) failure from overheating	200	0	$263,000/ $12,000
Columbus, OH. CSX Trans.	6/26/89	*	Wide gage (defective or missing crossties)	0	0	$14,725/ $0
Ruth, PA. Conrail	7/14/89	*	Journal (plain) failure from overheating	0	0	$25,880/ $19,648
Freeland, MI. CSX Trans.	7/22/89	Multiple flammable and corrosive materials	Wheel lift	1000	0	$390,000/ $19,000
Vista, MT. Burlington Northern	7/31/89	Fuel Oil	Center plate broken or defective & truck, stiff, improper lateral or swivelling	0	0	$500,000/ $57,000
Aalberg, MO. Burlington Northern	8/7/89	Calcium Carbide	Roadbed settled or soft	0	0	$22,000/ $500
Duluth, MN. Burlington Northern	8/19/89	*	Switch damaged or out of adjustment	0	0	$22,100/ $3,000
Camden, NJ. Conrail	8/22/89	Vinyl Chloride	Passed couplers	40	0	$6,000/ $250
Tucson, AZ. Southern Pacific	8/22/89	*	Wide gage (defective or missing crossties)	800	0	$61,700/ $22,000

Location and Railroad	Date of Accident	Commodity Released	Probable Cause	Persons Evacuated	Persons injured	Damages: Equipment/ Way & Structure
Reduction, PA. CSX Trans.	8/23/89	*	Forces of nature	0	0	$391,000/ $0 * Two reports
Cypress, FL. CSX Trans.	9/4/89	*	Journal (plain) failure from overheating	350	0	$317,00/ $25,000
Rison, AR. St. Louis Southwestern RY.	9/6/89	*	Excessive Speed	600	1	$516,000/ $750,000
Bristol, VA. Norfolk & Western	9/10/89	*	Switch not latched or locked	0	0	$13,100/ $250
Byron, CA. Southern Pacific	9/13/89	*	Broken wheel rim	0	0	$323,000/ $850,000
Hume, IL. CSX Trans.	9/14/89	*	Switch rod worn, bent, broken, or disconnected	150	0	$451,500/ $5,600
Louisville, KY. Paducah & Louisville	9/15/89	Calcium Carbide	Multiple potential causes	35	1	$28,000/ $0
Ontario, OR. Union Pacific	9/23/89	*	Excessive speed	0	0	$33,940/ $60,078
Jamesburg, NJ. Conrail	10/2/89	*	Derail, failure to apply or remove	0	0	$9,000/ $0
Rotterdam Jct., NY. Springfield Terminal RY.	10/12/89	Hexane	Load shifted	3500	0	$65,000/ $8,971
Pulga, CA. Union Pacific	10/23/89	*	Forces of nature	0	0	$207,000/ $259,985
Towanda, KS. Union Pacific	11/7/89	Sodium Hydroxide	Transverse / compound fissure in rail	0	0	$188,010/ $25,544
Payne, VA. Norfolk & Western	11/9/89	Hexamethyl-enediamine	Wide gage (defective or missing crossties	0	0	$95,550/ $500
Cowan, PA. Buffalo & Pittsburgh	11/19/89	Methyl-methacrylate	Track geometry defects	30	0	$57,000/ $19,253

Location and Railroad	Date of Accident	Commodity Released	Probable Cause	Persons Evacuated	Persons Injured	Damages: Equipment/ Way & Structure
Salix, LA. Southern Pacific	12/1/89	*	Shoving movement, absent man on or at leading end of movement	75	0	$81,725/ $60,000
Brooks Avenue, NY. Rochester Southern RR.	12/3/89	*	Wide gage	0	0	$56,000/ $5,238
Lawrenceburg TN. Tennessee Southern RR.	12/12/89	*	Transverse/ compound fissure in rail	40	0	$75,000/ $25,000
Addis, LA. Union Pacific	12/21/89	*	Wide gage (defective or missing spikes or other rail fasteners	0	0	$22,800/ $2,000
C&M Junction PA. Buffalo & Pittsburgh RR.	12/27/89	*	Journal (roller bearing) failure from overheating	0	0	$65,000/ $5,342
Vanderbilt, TX. Union Pacific	1/8/90	Multiple products, incl. hexamethyl-enediamine, monoethanol-amine	Journal (roller bearing) failure from overheating	0	0	$409,623/ $20,000
Parkwood, AL. CSX Trans.	1/22/90	*	Other acts of God	0	4	$508,300/ $3,000
Page, WA. Union Pacific	2/9/90	Methyl alcohol	Journal (plain) failure from overheating	9	0	$434,600/ $293,914
Bardwell, TX. Burlington Northern	2/17/90	Sodium chlorate	Truck bolster broken	15	0	$420,000/ $47,328
Ottawa, IL. CSX Trans.	2/23/90	*	Bolt hole crack or break in rail	0	0	$25,000/ $0
Valley, Jct., TX. Union Pacific	3/15/90	*	Shoving movement, absent man on or at leading end of movement	0	0	$13,500/ $0
Gibson, TN. CSX Trans.	3/17/90	Styrene Monomer	Improper train makeup	100	0	$301,000/ $15,000

Location and Railroad	Date of Accident	Commodity Released	Probable Cause	Persons Evacuated	Persons Injured	Damages: Equipment/ Way & Structure
East St. Louis, Il. Gateway Western RY.	3/26/90	*	Wide gage (defective or missing crossties)	0	0	$15,000/ $2,500
Oliver, GA. Central Of GA. RR.	4/20/90	Calcium Hypochlorate	Collision with highway user at grade crossing	0	0	$112,000/ $7,500
Craigsville, PA. Buffalo & Pittsburgh RR.	4/22/90	Sodium hydroxide, Crude oil	Side bearing clearance improper	200	0	$569,000/ $184,000
Pedernal, NM. ATSF RY.	4/25/90	*	Truck, stiff, improper lateral or improper swivelling	0	0	$113,600/ $45,000
Pee Dee, NC. CSX Trans.	4/28/90	*	Object on or fouling track	200	0	$389,000/ $195,000
Ashland, KY. CSX Trans.	5/7/90	*	Head and web separation (within joint bar limits)	0	0	$61,700/ $500
Englewood Yard, TX. Southern Pacific	5/15/90	*	Retarder, improper manual operation	0	0	$30,000/ $2,400
Stockton, CA. Union Pacific	5/19/90	*	Switch improperly lined	0	0	$12,000/ $10,451
Covington, TN. Illinois Central RR.	5/24/90	*	Journal (roller bearing) failure from overheating	1000	0	$368,000/ $60,000
Dunbar, AK. Alaska RR.	5/28/90	Fuel oil	Switch point worn or broken	0	0	$360,000/ $70,000
Spofford, TX. Southern Pacific	6/16/90	*	Air hose uncoupled or burst	0	0	$188,200/ $75,000
Commerce City, CO. Denver Rio Grande & Western	7/26/90	Caustic soda	Brake valve malfunction, stuck brake and other brake components damaged, etc.	40	0	$15,000/ $1,000
Tucson, AZ. Southern Pacific	8/5/90	Sulfuric acid	Hand brake (including gear) broken or defective	50	2	$68,300/ $0
Englewood, TX. Southern Pacific	9/10/90	*	Failure to properly secure engine(s)	0	0	$55,000/ $0

Location and Railroad	Date of Accident	Commodity Released	Probable Cause	Persons Evacuated	Persons injured	Damages: Equipment/ Way & Structure
Fontana, KS. Burlington Northern	9/15/90	*	Cross level of track irregular (not at joints)	0	0	$284,200/ $130,573
Chidester, AR. Union Pacific	9/17/90	Nitric acid & Ammonium nitrate fertilizer	Side bearing clearance improper and truck stiff, improper lateral or improper swivelling	200	4	$159,013/ $238,976
Columbus, OH. CSX Trans.	9/24/90	*	Transverse/compound fissure in rail	0	0	$47,200/ $5,000
St. Louis, MO. Burlington Northern	10/2/90	Ammonium nitrate fertilizer	Car(s) shoved out and left out of clear	0	0	$10,000/ $250
Sevier Yard, TN. Southern RY.	10/9/90	*	Retarder did not slow car sufficiently	0	0	$26,000/ $0
Marshville, NC. CSX Trans.	10/10/90	*	Washout/rain/slide/flood/snow/ice damage to track	0	0	$38,300/ $65,000
Lewisburg, TN. CSX Trans.	10/15/90	Chloroform	Interaction of lateral/ vertical force-rock off	20	0	$732,000/ $14,800
McCormick, SC. CSX Trans.	10/19/90	Xylene & Toluene	Journal (roller bearing) failure from overheating	600	0	$358,400/ $13,000
Washington, IL. Toledo, Peoria & Western	10/20/90	Diesel Fuel	Collision with highway user at grade crossing	0	0	$650,000/ $10,000
Whiting, IN. Elgin, Joliet & Eastern RY.	11/8/90	Corrosive liquids	Wide gage (worn rail)	0	0	$8,000/ $2,000
Essex, CA. ATSF RY.	11/26/90	Combustible liquid, nos & Methyl-ethyl-ketone	Special operating instruction, failure to comply	0	0	$690,662/ $80,000
Keith, NE. Union Pacific	12/9/90	*	Broken flange	0	0	$220,407/ $100,994
Quitman, GA. CSX Trans.	12/12/90	*	Improper operations of train air brake system	0	0	$232,499/ $10,000

* 2 reports

Location and Railroad	Date of Accident	Commodity Released	Probable Cause	Persons Evacuated	Persons Injured	Damages: Equipment/ Way & Structure
Alvarado, TX. ATSF RY.	12/14/90	*	Use of brakes and special operating instruction, failure to comply	0	0	$88,400/ $19,000
Broadview, MT. Burlington Northern	1/2/91	*	Load fell from car	0	0	$176,700/ $14,600
Memphis, TN. Burlington Northern	1/31/91	Ammonium nitrate fertilizer	Knuckle broken or defective	0	0	$64,000/ $0
Wickliffe, KY. Illinois Central RR.	2/9/91	Petroleum oil	Rigging down or dragging	0	0	$295,000/ $70,000
Diboll, TX. Southern Pacific	2/11/91	*	Collision with highway user at grade crossing	30	0	$251,250/ $63,000
Navasota, TX. Southern Pacific	2/19/91	*	Dynamic Brake, improper	0	0	$504,728/ $51,000
Wooldridge, MO. Union Pacific	2/20/91	White phosphorous	Broken wheel flange	200	0	$485,276/ $224,311
Copperhill, TN. CSX Trans.	3/5/91	*	Horizontal split head	0	0	$41,000/ $4,000
Sudden, CA. Southern Pacific	3/19/91	*	Washout/rain/slide/ flood/snow/ice damage to track	0	0	$1,4000,00 0/ $150,000
Alberg, MO. Burlington Northern	3/29/91	Combustible liquid	Buffing or slack action excessive	0	0	$489,800/ $85,400
Strang, TX. Southern Pacific	4/7/91	*	Interaction of lateral / vertical force-rock off	0	0	$62,100/ $22,000
Homly, OR. Union Pacific	4/12/91	Phosphoric acid	Buffing or slack action excessive and dynamic brake, improper use	0	2	$379,592/ $190,865
Edgewood, IL. Illinois Central	4/13/91	Caustic soda	Detail fracture from shelling or head check	50	0	$635,200/ $100,000
Exeter, NE. Burlington Northern	4/23/91	Ferrous chloride	Journal (roller bearing) failure from overheating	0	0	$404,000/ $367,391

Location and Railroad	Date of Accident	Commodity Released	Probable Cause	Persons Evacuated	Persons Injured	Damages: Equipment/ Way & Structure
Tascosa, TX. Burlington Northern	4/29/91	Methanol	Detail fracture from shelling or head check	0	0	$866,700/ $98,674
Geismar, LA. Illinois Central RR.	5/4/91	*	Vertical split head	0	0	$128,300/ $3,500
Tulsa, OK. Burlington Northern	5/6/91	*	Buffing or slack action excessive	0	0	$27,000/ $250
Vanderbilt, TX. Union Pacific	5/16/91	Liquefied petroleum gas	Truck components and roadbed settled or soft	0	0	$289,000/ $130,393
Englewood, TX. Southern Pacific	5/25/91	*	Other frog, switch or track appliance causes	0	0	$14,500/ $7,000
Carrier, OK. Burlington Northern	5/26/91	*	Journal (plain) failure from overheating	125	0	$426,600/ $81,200
Ingle, IN. CSX Trans.	6/12/91	Anhydrous ammonia	Interaction of lateral/ vertical force-rock off	0	0	$131,500/ $25,750
Potomac Yard, VA. R F & Potomac	6/23/91	Potassium hydroxide	Worn flange	0	0	$85,400/ $6,000
Heagy, MO. Union Pacific	6/23/91	Corrosive liquids	Defective snubbing	450	0	$462,724/ $0
Willbridge, OR. Burlington Northern	7/8/91	*	Instruction to train/yard crew improper	0	0	$4,800/ $2,500
Bovina, TX. ATSF RY.	7/14/91	*	Broken locomotive axle	0	0	$1,300,000/ $120,000
Dunsmuir, CA. Southern Pacific	7/14/91	Metam sodium	Interaction of lateral/ vertical force rock-off	0	53	$274,280/ $5,000
Walcott, WY. Union Pacific	7/14/91	Naphtha	Object on or fouling track	0	0	$355,750/ $180,000
Butler, PA. Buffalo & Pittsburg RR.	7/17/91	Methyl-methacrylate	Side bearing clearance improper	100	0	$52,190/ $29,220

Location and Railroad	Date of Accident	Commodity Released	Probable Cause	Persons Evacuated	Persons injured	Damages: Equipment/ Way & Structure
Manchester, TX. Port Terminal RR.	7/26/91	Sulfuric acid	Passed couplers	0	0	$12,000/ $0
Seacliff, CA. Southern Pacific	7/28/91	Hydrazine, hydrated	Journal (roller bearing) failure from overheating	300	0	$826,500/ $37,910
Karen, TX. Burlington Northern	7/30/91	Methanol	Train order or timetable authority, failure to comply	0	3	$1,900,000/ $35,229
Evansville, IN. CSX Trans.	7/31/91	*	Track profile improper	70	0	$46,500/ $0
Beaver Jct., KY. CSX Trans.	8/6/91	*	Side bearing clearance improper	0	0	$39,000/ $5,000
Bellefonte Yard, PA. Nittany & Bald Eagle	8/15/91	*	Truck, stiff,improper swivelling	0	0	$3,000/ $200/ $30,000 cleanup
Granite City, IL. Norfolk & Western	8/18/91	*	Super elevation improper, excessive or insufficient	0	0	$40,030/ $0
Gilmer, TX. St. Louis Southwestern RY.	8/24/91	*	Dynamic brake, improper use	16	0	$133,250/ $56,000
Bucklim, MO. Burlington Northern	8/28/91	Denatured alcohol	Rigging down or dragging	15	0	$652,000/ $178,613
Joliet, IL. Southern Pacific	9/5/91	Phosphoric acid	Guard rail loose/broken or mislocated	0	0	$19,000/ $28,835
Knox, IN. Norfolk & Western	9/17/91	Molten sulfur	Block signal, failure to comply	12	3	$419,162/ $0
Orchard, ID. Union Pacific	9/22/91	Argon	Other rail and joint bar	0	0	$127,000/ $170,000
Weathers, AL. CSX Trans.	10/27/91	Fluorosilicic acid	Combination of track geometry violations and slight overspeed	20	0	$35,000/ $500
Capa, SD. Dakota, Minnesota & Eastern RR.	10/31/91	*	Cross level of track irregular (not at joints)	0	0	$47,500/ $16,500

Location and Railroad	Date of Accident	Commodity Released	Probable Cause	Persons Evacuated	Persons injured	Damages: Equipment/ Way & Structure
Oil City, PA. Conrail	12/17/91	*	Transverse/ compound fissure in rail	0	0	$9,950/ $3,000
Kenton, OH. Conrail	12/19/91	*	Wide gage (defective or missing crossties	0	0	$8,500/ $450
Cottondale, FL. CSX Trans.	12/20/91	Ammonium nitrate	Failure to properly secure handbrake on car(s)	0	0	$800,000/ $10,000
English, WA. Burlington Northern	12/25/91	*	Journal (roller bearing) failure from overheating	100	2	$240,000/ $112,454
Elkhart, IN. Conrail	12/28/91	*	Use of brakes	0	0	$27,400/ $0
Bates City, MO. Gateway Western	12/30/91	Flammable liquid, nos	Rail and joint bar defects	0	0	$225,000/ $11,500
Dragon, MS. Norfolk Southern	1/18/92	Liquefied petroleum gas	Other body defects, (car)	0	0	$113,000/ $6,250
Harwood, IN. CSX Trans.	3/1/92	Isopropanol	Side bearing clearance insufficient	45	0	$306,500/ $28,000
Mullins, KY. CSX Trans.	3/7/92	Ammonium nitrate	Vandalism of on-track equipment, e.g., brakes released	0	0	$20,000/
Good Hope, LA. Illinois Central Gulf	3/14/92	Molten Sulfur	Switch damaged or out of adjustment	0	0	$49,150/ $1,500
East Brighton, VT. St. Lawrence & Atlantic	3/14/92	Sodium hydroxide	Broken base of rail	0	0	527,909/ $80,000
Ashland, NE. Burlington Northern	3/26/92	*	Hand signal, failure to comply	0	0	$40,000/ $1,000
Whitefish, MT. Burlington Northern	4/17/92	*	Coupling speed excessive	0	0	$61,500/ $1,400
Maxwell, SC. CSX Trans.	4/23/92	*	Failure to apply sufficient number of handbrakes on car(s)	0	0	$15,000/

Location and Railroad	Date of Accident	Commodity Released	Probable Cause	Persons Evacuated	Persons Injured	Damages: Equipment/ Way & Structure
Avondale, LA. Southern Pacific	5/5/92	*	Automatic brake, insufficient	0	1	$415,487/ $15,000
Wilisland, NE. Union Pacific	5/18/92	Hazardous substance, nos	Improper train inspection	0	0	$279,688/ $104,500
Marceline, MO. ATSF RY.	5/19/92	*	Car body defect	0	0	$192,895/ $152,900
Pembine, WI. Wisconsin Central	5/20/92	Sodium chlorate	Wide gage (due to defective or missing crossties)	0	0	$41,500/ $1,981
Rosenberg, TX. ATSF RY.	6/1/92	Acrylic acid	Derail, failure to apply or remove	300	0	$6,000/
Superior, WI. Burlington Northern	6/30/92	Flammable liquid	Detail fracture from shelling or head check	20000	0	$253,300/ $271,000
Julliard, TX. ATSF RY.	7/7/92	*	Improper train make-up at initial terminal	0	0	$233,080/ $13,000
Evanston, WY. Union Pacific	7/26/92	Petroleum naphtha	Other coupler and draft system defects (locomotive)	0	0	$424,300/ $178,224
Bosler, WY. Union Pacific	8/8/92	Corrosive liquid	Improperly loaded car	0	0	$182,400/ $105,000
Brooklyn, WV. CSX Trans.	8/25/92	*	Failure to apply sufficient number of handbrakes on car(s)	0	0	$12,000/
Towanda, PA. Conrail	9/13/92	*	Interaction of lateral/vertical forces	0	0	$73,500/ $9,231
Omar, WV. CSX Trans.	10/7/92	*	Derail, failure to apply or remove	0	0	$11,000/
Mattawamkeag, ME. Springfield Terminal	10/7/92	Sodium chlorate	Load shifted	0	0	$96,714/ $4,546
Lucerne, WY. Burlington Northern	10/16/92	Methanol	Transverse/ compound fissure in rail	35	0	$90,000/ $25,000
Alden Bridge, LA. St. Louis Southwestern	11/5/92	*	Detail fracture from shelling or head check in rail	0	0	$899,363/ $150,000

Location and Railroad	Date of Accident	Commodity Released	Probable Cause	Persons Evacuated	Persons injured	Damages: Equipment/ Way & Structure
Idafalls, ID. Union Pacific	11/19/92	Diesel fuel	Damaged wheel flange	0	0	$3,000/ $45,000
Hybart, AL. Burlington Northern	12/1/92	*	Highway user inattentiveness	50	3	$221,500/ $23,400
Strang, TX. Southern Pacific	12/7/92	*	Failure to apply hand brakes on car(s)	0	0	$10,000/
Enampa, ID. Union Pacific	12/15/92	Ethyl acrylate, inhibited	Improper train make-up	0	1	$67,000

As can be seen from the preceding chart, the causes of train accidents involving hazardous materials releases vary from year to year. From the data, no single area emerges on which FRA could concentrate its efforts to further reduce this type of accident. Instead, continued vigorous enforcement and refinement of all of FRA's regulations are necessary to help reduce train accidents generally.

Significant Rail Accidents Involving Hazardous Materials:

In order to provide more context for the discussion of the safety record for the transportation by railroad of hazardous materials, this section summarizes the key facts about a number of significant accidents shown in summary fashion in the preceding chart. The accidents chosen for this portion of the report are all those between 1989-1992 on which both FRA and the National Transportation Safety Board conducted investigations. Nine accidents met the criterion during the four-year period.

■ February 2, 1989: Montana Rail Link, Helena, Montana

Summary: On February 2, 1989, a cut of 49 cars (part of BN Extra 8061 West) standing on the main track rolled free while the locomotive consist was being changed. The free rolling cars collided with a 3 locomotive helper assignment, derailing 1 locomotive and 15 cars. One of the derailed cars, GATX 14247, was a tank car load of hydrogen peroxide, a strong oxidizing agent; it ruptured and the hydrogen peroxide mixed with spilling diesel fuel, causing fires and explosions.

Facts: BN train Extra 8061 West, consisting of 3 locomotives, 3 additional locomotives (as Helper Assignment No. 2), and 49 cars, departed Helena at 3:25 a.m. en route to Missoula, Montana. Shortly after leaving Helena, the lead locomotive, MRL 208, became uninhabitable because the cab heaters failed. The crew obtained permission from the dispatcher to move the road locomotive consist ahead of the helper locomotive consist at the Austin siding (13 miles west of Helena). The helper crew uncoupled the helper locomotives from the road locomotives and operated them over the west switch and then backed into the siding. A member of the crew turned the angle cock behind the rear locomotive and then turned the angle cock ahead of the first car of the cut of 49 cars, thus attempting to preserve the air brake setting on the cars. He then uncoupled the road locomotives from the standing train of 49 cars and the engineer operated them forward over the west switch and then backed into the siding to couple to the helper locomotives.

While the crews were coupling the hoses to rejoin the 2 groups of locomotives, the 49 cars that were left standing on the main track rolled free in an eastwardly direction toward Helena. The crews realized almost immediately what had happened and they attempted to pursue the runaway cut of cars while, at the same time, calling the

MRL dispatcher on the radio to report that they were attempting to catch the runaways heading down the mountain. They also attempted to notify the BN dispatcher but could not, and the MRL dispatcher contacted him by phone.

The runaway cars continued down the mountain grade, reaching speeds estimated at 70 mph, slowing on an upgrade as they approached the eventual accident site to 20-25 mph.

The BN dispatcher tried to divert the cut of cars to the No. 1 main at Tobin, but electrical problems prevented him from doing so. In the meantime, the crew of Helper Assignment No.1, called to assist another west bound train, was stopped on the tracks and its crew was in the process of changing operating ends of the three locomotive consist.

At approximately 4:30 a.m., the runaway cars struck Helper Assignment No. 1 at about 20 mph, pushing the locomotives 300 feet eastward, overriding the control compartment of the unoccupied west locomotive, and slightly injuring the two crew members. Fifteen of the 49 cars derailed, including GATX 14247, a tank car load of hydrogen peroxide. The tank car ruptured, spilling its cargo, and allowing the hydrogen peroxide to mix with spilled diesel fuel from the locomotives. The fires and explosions that resulted damaged a main electrical power line serving Helena, causing an electrical outage. About 3500 persons were evacuated within a three-quarter of a mile radius of the derailment, starting at 5 a.m.

Later, at 1:30 p.m., the size of the evacuation was reduced and finally, at 10 a.m. on February 3, it was canceled. A total of 17 people were injured and there was damage to track, structures, signals, and equipment amounting to $919,000. Private property damage, including damage to a private college and other private property, was estimated at $3.1 million.

Probable cause: The failure of the crew of Extra BN 8061 to apply a sufficient number of handbrakes on the cars left standing without being attached to locomotives.

■ February 20, 1989: Soo Line, Bordulac, North Dakota

Summary: On February 20, 1989, Soo Line freight train Extra 4514 East, consisting of 3 locomotives and 75 cars, hit a broken rail at 40 mph and derailed 2 locomotives and 26 cars. Ten of the derailed cars, the 10th through the 19th cars from the locomotives, contained hazardous materials and three of them, loaded with anhydrous ammonia, were punctured or ruptured.

Facts: After an air brake test, Extra 4514 departed Harvey, North Dakota, at 6:50 a.m. and had an uneventful trip for the first 53 miles. As the train approached the accident site, at about 40 mph, the crew heard unusual sounds coming from the underside of the locomotive and felt an abnormal ride as the train moved over the east turnout at Bordulac, North Dakota. The rear brakeman, riding in the second locomotive, stated that, when the locomotive passed over the turnout he looked back and saw the third locomotive and a flatcar derail. Very soon thereafter, the train went into an emergency brake application.

The derailment forces were high enough that three tank cars of anhydrous ammonia suffered punctures and released their contents into the atmosphere. A vapor cloud formed and drifted away from the derailment site to the north east. Tank car GATX 93336 lost its entire load (158,180 pounds) after it ruptured and separated into two sections. The largest section catapulted over a county road and into an open field 235 feet to the south of the track. Tank car PROX 81180 lost its entire cargo (158,462 pounds) through an "A-end[18]"

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[18] For convenience, railroad freight cars are described in terms that, in many cases, have their roots in history. Because freight cars have a handbrake (continued...)

seam weld that was torn open and tank car GATX 49230 lost approximately 60 percent (127,358 pounds) of its anhydrous ammonia when the coupler assembly of another car punctured a hole, 3'X 3', into the side of its tank shell near the top of the car. Another tank car, GATX 88179, was suspected to be leaking at the gauging device and lost about 6,000 pounds of another hazardous material.

The anhydrous ammonia vapor cloud covered an area approximately 1-1/2 miles wide and it drifted in a northeasterly direction. Emergency response personnel notified and advised approximately 50 farm residences to evacuate the area in the path of the plume for a distance of 35 miles. Several small communities near the path of the plume were also alerted but did not require evacuation. The occupants of each of the residence that had been evacuated were allowed to return as soon as the vapor cloud had dissipated or moved through the area. The evacuation order was lifted at 1:30 p.m. on the day of the accident.

The engineer and conductor received injuries as a result of the derailment and two farm residents suffered injuries from inhaling anhydrous ammonia fumes. Damages to track, structures, signals, and equipment amounted to $661,003.

The ground adjacent to the derailment site was contaminated with anhydrous ammonia and 1,000 gallons of diesel fuel that had leaked from a punctured fuel tank of Soo Line locomotive 4510. Seventy-five truck loads of top soil, "contaminated" with anhydrous ammonia, were hauled to nearby farm fields and spread as fertilizer. A total of 117 truck loads of soil contaminated with diesel fuel and other debris from the derailment were removed from the site and

[18](...continued)
control wheel at one end, that end has come to be called the "B-end," or brake end; the other end came to be known as the "A-end."

disposed of in an approved landfill. Some of the anhydrous ammonia that was spilled is suspected to have seeped into an underground aquifer near the derailment site. The amount of contamination to the aquifer has been determined to be slight and is not considered a major problem. The water supplied to area residents for human consumption was taken from a source that would not be affected. The state of North Dakota and the railroad plan to monitor the aquifer to determine if further action will be required.

Probable cause: A broken rail with a vertical split head.

- **February 26, 1989: CSX Transportation, Akron, Ohio.**

Summary: On February 26, 1989, CSX freight train No. 6124N, consisting of 4 locomotives, 49 cars, and a caboose, derailed at 43 mph. Nine of the 21 derailed cars contained Butane, a flammable gas; two butane cars were punctured and caught fire. The area within a one-half-mile radius was evacuated.

Facts: The train departed Willard, Ohio, at 5:10 p.m. headed eastward toward Akron. The train stopped at Sterling, Ohio, for a stop signal, then proceeded to Easton, Ohio after the signal displayed a "clear" aspect. Cars were switched at Easton and at Warwick, Ohio, and the required brake test was performed after both stops. After Warwick, the train entered the Consolidated Rail Corporation's Akron Branch right-of-way, moving northward on Main track No. 1 (Milepost 27.2). The train continued past audible dragging equipment detectors at Milepost 23 and Milepost 16.7 with no exceptions noted.[19]

At about 7:25 p.m., the train was approaching Milepost 16.1 on .73 percent descending grade on a 1-degree 30-minute curve at a speed of 43 mph when the crew felt and noted an undesired

[19] Mileposts on this branch count down when traveling northward as CSX 6124N was.

emergency brake application. The undesired emergency occurred because the train had separated and derailed about 500 feet south of Milepost 16.

Two of the nine hazardous material cars involved in the derailment ruptured, resulting in a major fire and evacuation of the area for a one-half-mile radius. There were no reported injuries; however, 1,750 people were evacuated. The Akron Police Department, Fire Department, and Emergency Response Unit arrived within minutes of the derailment, with the first units on scene beginning at 7:26 p.m.

Total damages to track, structures, signals, and equipment exceeded $500,000. Investigation revealed no residual environmental damage. A neighboring B. F. Goodrich Chemical Company plant sustained fire damage to its building and outside storage area.

Probable cause: Inadequate rebuild and quality control procedures of the Northern Rail Car Corporation car repair facility and the inadequate inspections of car WSOR 501003 (a covered hopped car) by designated car inspectors permitted the car to enter and continue in service with excessive gib clearance and out-of-limits side bearing clearance.

- **April 23, 1989: Belt Railway Company, Bedford Park, Illinois.**

Summary: On April 23, 1989, at approximately 6:05 a.m., two covered hopper cars loaded with sand, traveling too fast for a smooth coupling, emerged from a hump yard group retarder, struck a standing empty hopper car and propelled it into DOWX 3354, a loaded tank car of butadiene. The butadiene car was punctured and its spilling contents caught fire. The fireball rose as high as 400 feet and damaged or destroyed the track and 13 freight cars in the immediate area.

Facts: Tank car DOWX 3354, loaded with butadiene, was switched over the hump, through the No. 2 main retarder, and on to Track 45 of the Belt Railway Company of Chicago's Clearing Yard at about 5:47 a.m. on April 23, 1989. Shortly thereafter, empty covered hopper car CABX 350084 was also "humped" onto the same track, but the two cars (DOWX 3354 and CABX 350084) did not couple.

At 6:02 a.m., tank car ACFX 82591 was hump switched and passed through the Number 2 main retarder on its way to Track 55. ACFX 82591 was loaded with tallow, an animal oil/grease by product of the meat packing industry. There was an accumulation of tallow on the exterior of the tank car and on its wheels, so that, when it passed through the master retarder, grease from its wheels got onto the retarder brake shoes, rendering them less effective than they were designed to be. Grease also coated the group retarder shoes for Track 55, leaving the group retarder that served Track 45 uncontaminated.

Special handling requirements are issued by the railroad's operating department to avoid contaminating the retarder brake shoes. Standing instructions require carmen to notify (by yard telephone) the hump yardmaster and the yard office clerk when the retarder brakes have been contaminated. On this occasion, the system failed because the carmen did not call the hump yardmaster. In an interview during the investigation of the accident, they said that the hump yardmasters historically refuse to accept this information and instruct the carmen to give it to the yard clerk. One of the hump yard carmen did notify the yard office clerk that tank car ACFX 82591 had greasy wheels and was bad ordered because of a defective handbrake.

Another problem surfaced when the computerized switch list printout was reviewed. A clerk had entered both the bad order (defective handbrake) notation and the greasy wheel notation, but the computer would only accept one notation and the greasy wheel notice did not print when the computer generated the hump switch list.

At 6:05 a.m., two covered hopper cars, BN 441553 and BN 431118, loaded with sand, were sent over the hump together and down towards Track 45. The cars passed through the Number 2 master retarder with their speed essentially unchecked because of the tallow on the retarder brake shoes. The cars then passed through the group retarder serving Track 45; this retarder was able to slow the cars, but because of their combined loaded weight, could not adequately reduce their speed. The covered hoppers exited the group retarder at approximately 17 mph, moved about 1800 feet, and impacted standing empty covered hopper CABX 350084. The impact thrust the distant end of the covered hopper upward, towards the head of the tank car DOWX 3354, and the hopper car coupler punctured the head shield and the tank head about one-third up from the bottom of the tank.[20]

A massive leak of butadiene was immediately followed by a fire large enough that the fireball reached an altitude of 400 feet. The track and 13 freight cars in the immediate area were damaged or destroyed by fire. There were no injuries or evacuation, most likely because Clearing Yard is in an industrial district.

The Bedford Park Fire Department and Illinois Emergency Services responded within minutes of each other (6:15 a.m. and 6:35 a.m., respectively) and stabilized the situation. Damage to track, structures, signals, and equipment amounted to $280,600. Lading damage was $636,000.

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[20] The head protection system on DOWX 3354 complied with the requirements at 49 CFR § 179.100-23.

Probable cause: Overspeed impact resulting from tallow contamination of the brake shoes on hump retarder number 2.

- **July 22, 1989: CSX Transportation, Freeland, Michigan.**

Summary: On July 22, 1989 at 11:20 a.m., CSX freight train No. R-331-22, consisting of 2 locomotives and 32 cars and traveling approximately 14 miles per hour, derailed 14 cars while moving southward in the vicinity of Freeland, Michigan. Six of the 14 cars were tank cars containing a variety of hazardous materials, including styrene monomer, acrylonitrile, acrylic acid, petroleum naphtha, and various flammable liquids and corrosive materials. The chemical fire that started almost immediately following the derailment lasted 6 days.

Facts: CSX freight train number R-331-22 received an initial terminal brake test and departed Port Huron, Michigan, for Midland at 5:45 a.m. on July 22, 1989. West of Port Huron, the train experienced an undesired emergency brake application; the conductor and the brakeman found that the air hose between the 18th and 19th cars had broken and separated. After the crew replaced the hose, the train continued en route, entering CSX trackage at North Kearsley, headed for Flint.

At Flint, the crew set out 14 cars and picked up an additional 23 cars, including ATSF 90005, a heavy-capacity, depressed-center flat car with 8 trucks (16 wheels), loaded with a heat recovery steam generator module. An intermediate brake test was performed and the train departed Flint at 9:45 a.m. As the train approached and passed Freeland, it was traveling about 37 miles per hour with the throttle set in run 8. The train crew members stated that they felt a "slight lurch or tug" followed by an emergency application of the air brakes. After the derailing train came to a halt and the fires started, the conductor sent an emergency radio message to the CSX dispatcher and then, with the brakeman, went from house to house advising residents to leave the area at once. At the same time, the engineer was alerting motorists on the adjacent Highway 47.

Emergency response personnel from several departments began arriving on the scene at about 11:30 a.m., within about 10 minutes of the accident. Next, a command post was established and included public agencies as well as emergency responders from the hazardous materials response teams at Dow Chemical, Dow Corning Corporation, and Rohm and Haas. The chemical fire lasted for approximately 6 days and the evacuation order affecting about 1,000 people was finally lifted on July 29, 1989, at 8:56 p.m.

Damages amounted to $1.3 million in lading, $1.2 million in wreck clearing, $1 million in environmental cleanup, $390,000 to equipment, and $19,000 to track. One nearby residence was destroyed by the fire.

Probable cause: While the single, exact cause of a complex derailment like Freeland is hard to state in a single sentence, the experts have concluded that a combination of factors resulted in wheel lift and the subsequent derailment of ATSF 90005, the heavy duty flatcar. Inadequate car inspection by ATSF and CSX, combined with track conditions that were less than ideal, were contributing factors.

■ **July 14, 1991: Southern Pacific, Dunsmuir, California.**

Summary: On July 14, 1991, at approximately 9:40 p.m., Southern Pacific train Extra 9693, made up of 4 locomotives and 97 cars, moving upgrade and around curves at 10 miles per hour, derailed 1 locomotive and 7 cars. The fifth car to derail was loaded with metam sodium, an agricultural insecticide; the tank shell sustained three punctures and most of the product was lost in to the Sacramento River.

Facts: Southern Pacific Extra R-9693 was operating on 136-pound continuous welded rail in a mountainous area. The derailment occurred at the west end of a 14° right hand curve. Approaching the accident area, the grade was 2.2 percent ascending, compensated by a .93 percent grade through the curve. The maximum authorized speed is 20 mph; the train was operating at about half that.

Tank car GATX 19764, a Class DOT Specification 111A100W1 tank car, was the fifth car to derail; it fell 30 feet from the bridge and came to rest in the Sacramento River. The car held just under 200,000 pounds of metam sodium.[21] The impact the tank experienced during the accident resulted in two breaches in the tank shell located on the "A" end and a third one located on the bottom, approximately one third the distance from the "A" end. After the derailment, the tank car was found partially submerged and upside down with the manway and safety relief valve assembly completely submerged and stuck in the mud on the river bottom. In addition to the punctures, the tank manway cover and bolts were damaged, resulting in the loss of additional commodity.

Following the accident, the Shasta County Sheriff's Department issued an advisory to the general public in the accident area that amounted to a voluntary evacuation. Traffic proceeding on California Interstate 5 was detoured by the California Highway Patrol for a brief period of time the day after the accident. There were no fatalities as

[21] Metam sodium was not regulated as a hazardous material at the time of the derailment. Soon thereafter, however, RSPA completed work implementing a maritime treaty; metam sodium, in common with many other chemicals, became regulated as a Marine Pollutant. As defined at 49 CFR § 171.8: "Marine Pollutant" means a hazardous material which is listed in appendix B to § 172.101 of this subchapter ....

a result of the accident. Five persons claimed injuries requiring them to be admitted to local hospitals for treatment and observation. In addition, there were 848 visits to medical professionals recorded for the 706 people affected by the spill. While the short-term effect on the Sacramento River above Lake Shasta was devastating, metam sodium is not a persistent chemical and the animal and plant life in the river began restoring itself within a matter of weeks. Restoration of the lost tourist and fisherman trade will take longer.

Probable cause: Excessive lateral in-train forces as a result of high trailing tonnage behind a long, empty car coupled to a short car near the front end of the train which was moving through a 14º right hand curve on an ascending grade.

- **July 28, 1991: Southern Pacific, Seacliff, California.**

Summary: On July 28, 1991, at approximately 12:10 p.m., Southern Pacific Transportation symbol freight train 1 LABAF-28, consisting of 3 locomotives and 39 cars, moving westward near Seacliff, California, at approximately 56 mph, derailed 14 cars. Among the cars off the track was an intermodal flat car carrying a container loaded with 76 drums of hydrazine, aqueous solution, a corrosive material. About 440 gallons of the product was lost and authorities ordered an evacuation of about 300 homes near the derailment area.

Facts: The derailment occurred at milepost 388.6 of Southern Pacific's Santa Barbara district, Los Angeles Division, near the small community of Sea Cliff after an uneventful trip to that point. Flat car TTWX 991891 was the 23rd car from the engine and carried a load of two containers. One of them, GSTU 390062, contained 76, 55 gallon drums of hydrazine, aqueous solution, a corrosive material. The container was ripped open in the derailment, and 23 drums of hydrazine were damaged and subsequently released about 440 gallons of their contents.

Shortly after the accident, the Ventura County Fire Department and California Highway Patrol responded, obtained the necessary information regarding the commodity, and initiated an evacuation that ultimately involved approximately 300 residences near the derailment area. In addition, the California Highway Patrol shut down about 15 miles of Interstate Route 101.

There were no reported injuries and, on July 29, 1991, at around 2:30 p.m., the Fire Department's Hazardous Materials Team began to neutralize the spill by spraying a solution of 8 to 10 percent calcium hydrochloride mixed with water on the spill.

On July 31, 1991, at 4 a.m., the Unified Command lowered the status of the accident site to level "D," which finally allowed investigative agencies to enter the accident area. The SP conducted cleanup operations on July 31, 1991 and the evacuation was lifted on August 1, 1991.

Probable cause: A burned off (failed) roller bearing journal on the trailing truck of flat car WTTX 157103.

- **January 18, 1992: Norfolk Southern, Dragon, Mississippi.**

Summary: On January 18, 1992, at 12:40 p.m., Alabama Great Southern (AGS) freight train Extra 9018 North, consisting of 4 locomotives, 84 cars, and no caboose, was pulling out of the siding at Dragon, Mississippi, when tank car CONX 9101, transporting a load of liquefied petroleum gas, experienced a sudden, total shell failure, losing its entire contents.

Facts: On January 18, 1992, the crew members of Extra 9018 North went on duty at 7:30 a.m. at New Orleans, LA. The crew consisted of an engineer, conductor, and brakeman. They had received the required rest according to the Hours of Service Act prior to going on duty and were transported by taxi to Dragon Yard, arriving at 10:30 a.m. They set to work making up a train by first switching the three locomotives around so that the locomotive in the lead would be equipped to communicate with the end of train device. The train was then assembled from cars on three tracks.

Extra 9018 North departed Dragon Yard through the crossover to a siding north of the Mobile crossing. As the train proceeded through the crossing, the dispatcher advised the crew that they would have to wait in the siding until southbound Train 221 passed. A portion of the waiting train was uncoupled to clear the Enterprise grade crossing so that automobile and truck traffic could use the crossing while Extra 9018 was waiting for the southbound train to pass. During this process, the brakeman found a hand brake applied on one of the cars and he walked from the crossing to the rear of the train inspecting for hand brakes. The conductor walked from the crossing to the front of the train, inspecting for hand brakes that had not been released. Neither crew member noticed any odor or anything unusual.

Once the southbound train passed and Extra 9018 received a clear signal indication, they proceeded through the north siding spring switch to the main track. The engineer stopped the train at a grade crossing to pick up the crew members who had been on the ground inspecting it and the train then proceeded slowly towards the main track. As the second locomotive reached the grade crossing, the air brakes applied in emergency. A carman, located on the east side of the train, saw a large white cloud in the vicinity of the Enterprise grade crossing. The white cloud covered both sides of the train and eventually moved westward above the trees. Moments later, the cloud turned into a flash that lasted several seconds. The crew notified the dispatcher and the dispatcher instructed the crew to uncouple the locomotives from the train and move a safe distance away from the site.

Further investigation by the carman revealed that a local storage and distributing company was on fire and three cars were derailed in the siding. The 72nd car in the train, CONX 9101, had separated and was derailed at about a 130º angle to the track structure and was leaning southward at about a 110º angle.

Damage to equipment amounted to $113,000, track $750, and signals $5500, for a total of $119,000.

Because of the sudden and catastrophic failure of tank car CONX 9101, an indepth investigation began to learn why the car had come apart. CONX 9101 was a Specification DOT 112J340W tank car of stub sill design, 32,878 gallons in capacity tank car and, on the day of the accident, was loaded with 30,195 gallons of liquefied petroleum gas. The car was designed and built by General American Transportation Corporation in 1965 as a "dual diameter" tank car, larger in the midsection than at the ends over the trucks. (Thus, the "dual diameter" description.) The car was 1 of 34 built on the same Certificate of Construction. Conversion from an "A" specification to a "J" took place in 1979 and involved application of half-head shields, thermal protection, and a jacket.[22]

<u>Probable cause</u>: Failure occurred when the tank separated in the heat-affected zone of the weld joining the large diameter section

[22] DOT type 112 tank cars with an "A" designation are not required to have head protection systems, insulation, jacketing, or thermal protection. Cars with a "J" descriptor have head protection and thermal protection. Unless the thermal protection is one of the approved spray-on systems, the cars will have an 11-gauge metal jacket to hold the thermal protection system.

with the sloped, transition sheet at the "A" end of the tank. The preliminary examination of the circumferential break disclosed a discolored crescent region, typically indicative of a large preexisting crack. In this case, the crack was about 21 inches long and centered at the bottom centerline of the tank. It began along the inside diameter surface of the tank at the weld/transition sheet junction. At its deepest point, the crack had extended through 95 percent of the tank wall thickness before eventual separation. Metallurgical examination by the NTSB's materials laboratory showed that the crack fracture surface was extensively oxidized, thus indicating a crack with long-term exposure to the atmosphere. Oxidization was so extensive that the original fracture surfaces were obliterated.

Several cars built on the same certificate of construction were examined and found to have similar cracking. As a result, FRA issued an emergency order calling for the rapid inspection of all dual diameter tank cars.[23] That program has now finished and has verified that the systemic problem of cracking in the transition sheet is limited to one car design.

■ June 30, 1992: Burlington Northern, Superior, Wisconsin.

Summary: On June 30, 1992, at 2:40 a.m., Burlington Northern Train 01-142-30, consisting of 3 locomotives and 57 cars, (54 loads and 3 empties) moving approximately 35 mph, derailed 14 cars, the 27th through the 40th. Three tank cars derailed, and one of them, GLNX 3017, fell from a trestle into the Nemadji River, almost 100 feet below. GLNX 3017 was loaded with a flammable liquid, did not survive the fall into the river, and lost its entire contents. Atmospheric conditions combined with the chemical fumes forced the evacuation, eventually, of nearly 20,000 persons along the Minnesota / Wisconsin border.

[23] FRA Emergency Order No. 16, 57 FR 11900, April 7, 1992.

Facts: The day of the accident, a crew consisting of conductor, engineer, and two brakemen went on duty a 1 a.m., on June 30 1992, at BN 28th Street yard, Superior, Wisconsin. They were properly rested in accordance with the Federal Hours of Service Act.

The train departed Duluth, Winnipeg, and Pacific yard in Superior at 2:15 a.m. and, as it approached the bridge, the engineer reduced the speed of his train and later stated that he felt a "jog" approximately one-eighth mile prior to the bridge. Very soon afterwards, at about 2:40 a.m., the train experienced an undesired emergency brake application as the lead locomotive crossed onto the bridge structure. The lead locomotive stopped between the west end of the bridge and the road crossing beyond. The brakemen walked back to inspect the train, observed railroad cars down in the ravine, and detected a chemical odor. The BN 28th street yardmaster was notified.

Further investigation by the crew revealed that 4 cars had fallen from the trestle into the ravine 97 feet below. One of them, GLNX 3017, a tank car loaded with a flammable liquid, nos, aromatic concentrates, benzene dicyclopentadiene, released approximately 21,000 gallons into the Nemadji River.[24]

Once apprised of a hazardous materials release, the Douglas County Sheriff ordered an evacuation of the immediate area. As the product reached the mouth of the river it formed a gaseous cloud which migrated slowly through the Superior/Duluth region before dissipating. The initial evacuation included an area within a one-half mile radius, but ultimately affected approximately 20,000 persons in Douglas County, Wisconsin, and St. Louis County, Minnesota. At

[24] According to its movement waybill, GLNX 3017 was loaded with "aromatic concentrates, benzene dicyclopentadiene." Two other tank cars were also in the derailment but they lost no lading: GLNX 161, a load of liquefied petroleum gas and GLNX 3411, a load of butadiene.

6 p.m., on July 3, 1992, all residents were notified they could return to their homes.

Area hospitals reported that a total of 103 persons came in complaining of headache, dizziness, and bronchial irritation resulting from their exposure to the chemical fumes. Damage to track, structures, signals, and equipment totaled $524,300. Significant numbers of fish were killed.

Probable cause: Neither FRA nor the NTSB has released a final statement on the cause of this derailment, however FRA has proceeded on the basis that the accident was caused by a broken rail and had conducted a review of the BN internal rail flaw detection program. As this report was being written, FRA had extended the review to other carriers.

Hazardous Materials Releases Due to Rail Transportation Incidents:

As previously noted, RSPA's data on hazardous materials releases are not limited to train accidents. They count all releases, including those from cars not involved in train accidents and, in fact, releases from cars that are standing still.[25] The July 1993 release of hazardous materials in Richmond, California, was such a release.

[25] RSPA's accident reporting regulations, at 49 CFR § 171.16, state:

> Each carrier who transports hazardous materials shall report in writing, ..., on DOT Form F 5800.1 (Rev.6/89) to the Department within 30 days of the date of discovery, each incident that occurs during the course of transportation (including loading, unloading, and temporary storage) in which ... there has been an unintentional release of hazardous materials from a package (including a tank) or any quantity of hazardous waste has been discharged during transportation. Certain incidents, involving fatalities, injuries, more than $50,000 in damage, evacuations, blocking a transportation artery or a flight pattern, must reported immediately and followed up with a more detailed, written report.

There, the tank car was being prepared for unloading on the property of a chemical company when its contents began to escape from the safety vent.[26] The result was a massive evacuation and great inconvenience to many people in the San Francisco Bay Area. FRA believes that the release was caused when the fuming sulfuric acid in the car was heated beyond its optimum unloading temperature. Thermal expansion of the liquid raised internal pressures beyond the setting of the safety vent and it opened (thus performing its intended function). Tank car unloading procedures are the subject of a regulatory proceeding now in development at RSPA.

The overwhelming majority of the railroad-related incidents reported to RSPA are releases of small quantities of hazardous materials due to the improper securement of a tank car by the shipper.[27] Of course, given the dangers posed by any release of a dangerous chemical, even a release unrelated to a train accident can result in severe consequences, as the Richmond, California, incident demonstrates. The next table summarizes the incident release data since 1989.

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[26] Safety valves and safety vents are installed on tank cars to prevent internal pressures from exceeding design parameters, with the consequent risk of sudden, catastrophic failure of the tank. Because safety valves will reclose after the excess pressure has escaped, they are the preferred, and most common of the safety devices. Safety vents use a disc with a specified pressure rating to retain the cargo in the tank car until the internal pressure exceeds the "burst" strength of the disc. After the venting, the disc must be replaced for the car to be fully secured. Safety vents are necessary on cars transporting materials that deteriorate or clog valves but, as valve design and materials technology have advanced, more and more former vent-equipped cars can be given safety valves. The relevant regulations are at 49 CFR § 179.200-18.

[27] Also called "Offerors," shippers offer hazardous materials for transportation and are responsible for properly securing the chemical inside the packaging.

Incidents Involving a Release of Hazardous Materials From a Railroad Car, 1989-1992

Year	Incidents with HM Release	Incidents Meeting FRA Accident Threshold / Percent	Package Failures (#/%)	Damage Total, Including Cleanup (Millions)
1989	1193	56 / 5%	268 / 20%	$10.6
1990	1275	36 / 3%	391 / 31%	$11.9
1991	1152	47 / 4%	385 / 33%	$8.5
1992	1128	27 / 2%	345 / 31%	$7.3

The hazardous materials releases represented in this table occurred on 32 different railroads, in 41 different states. Carriers reporting the most incidents include Union Pacific, Burlington Northern, Southern Pacific, and CSX but the raw numbers do not necessarily reflect on the safety performance of these, or any other, specific carriers. Hazardous materials releases in nonaccident situations most often happen because someone fails to tighten the valves or other closures on a tank car securely. And, almost always, the leaking fitting is on a part of the car last accessed by an employee of a shipper.

Since 1975, the Association of American Railroads' (AAR) Bureau of Explosives has maintained its own data base for railroad incidents involving hazardous materials. Using information developed from the reports filed with FRA and RSPA, augmented by information from Bureau of Explosives inspectors, railroad officials, and CHEMTREC,[28] the Bureau attempts to pinpoint the specific fitting on the tank car that leaked. The table below is a compilation of data by the AAR/Bureau of Explosives; following the table is a brief explanation of technical terms.

[28] CHEMTREC, the Chemical Transportation Emergency Center, is a 24-hour chemical information emergency response service provided by the Chemical Manufacturers Association.

Locations of Tank Car Leaks[29]
1989-1992

YEAR	SAFETY VALVE / SAFETY VENT	BOTTOM FITTINGS	MANWAY	LIQUID LINE	OTHER TOP FITTINGS	SHELL OR HEAD
1989	91 / 336	172	323	126	120	39
1990	79 / 388	152	362	141	144	34
1991	56 / 334	139	253	97	98	21
1992	51 / 369	141	285	105	116	31

Safety Valve / Safety Vent: Together, these fittings are known as safety relief devices. They relieve excess pressure within the tank car. Safety valves reseat, or close, themselves; when safety vents open, it is through a single-use bursting disc that must then be replaced. In either case, a release of internal pressure is the intended result, to reduce the possibility that the tank will rip open from over pressure.

Bottom Fittings: These fittings, as the name implies, are located on the bottom of the car and are part of a system that typically relies on gravity to unload the cargo. The most common failure here is the simple failure of not sufficiently tightening the valve or valve closure.

Manway: A manway is an opening in the top of a tank car that permits access to the interior of the car in much the same way that a sewer cover permits access to pipes and conduits below the street. Leaks coming from the manway are generally the result of improper gasket fit or improper tightening.

[29] The totals for individual rows in this table may be greater than the total number of incidents reported in the previous table because some tank cars have multiple leaks.

Liquid Line: One of the "top fittings," the liquid line, is capped by a two-inch (in diameter) valve located on top of the tank car and is used for loading and unloading liquid materials. Top fittings are especially useful for gases and relatively light density liquids. Leaks from these valves can occur through deterioration of the various valve gaskets or of the valve seat or because it is not tightened properly. Modern liquid line valves are designed so that they can be easily repaired in the field. In common with other fittings, they must be designed so that, when closed, they will not come open and leak.[30]

Other Top Fittings: This group includes air connection fittings, sampling lines, vapor valves, and gauging devices. Leaks occur in these attachments in the same way as with other valves: Improper securement and incompatible or worn gasket material.

Shell or Head: Nonaccident failures in the basic structure of the tank are typically attributable to lining failures; with the lining or coating no longer intact, the cargo in the tank corrodes its way through the shell.

The trend with respect to hazardous materials incidents is obviously not as favorable as in the train accident area. While train accidents involving hazardous materials releases are often more dramatic and newsworthy, these incidents are far more numerous and potentially just as catastrophic. This is why FRA has, in recent years, focused an increased portion of its hazardous materials enforcement efforts on ensuring that shippers comply with the rules. Moreover, FRA and RSPA have focused increased attention on

[30] The regulatory standard, at 49 CFR § 173.24(b) states:

> Each package used for the shipment of hazardous materials under this subchapter shall be designed, constructed, maintained, filled, its contents so limited, and closed, so that under conditions normally incident to transportation ... there will be no identifiable (without the use of instruments) release of hazardous materials to the environment.

regulations concerning tank car integrity and inspection, as will be discussed in greater detail in following sections.

THE IN-TRAIN PLACEMENT OF HAZARDOUS MATERIALS CARS

SUMMARY: Current in-train placement rules generally require a "six-deep" separation between a hazardous materials carrying tank car and a locomotive or occupied caboose. These rules grew out of "good practices" established at a time when railroads used steam locomotives that produced hot cinders and carried freight, including explosives, in wooden box cars. Some separation between hazardous materials cars and the parts of trains occupied by humans is intuitively correct, but research by FRA and others points out that the risk of incompatible chemicals mixing in a derailment is small and must be balanced against the risk of crew injuries during any extra switching required by stringent car placement rules.

Train makeup, on the other hand, involves placing cars in a train such that they balance the forces within the train. Here, relevant considerations include empty versus loaded cars, short versus long cars, and the effects of terrain and curvature. FRA sponsored extensive research in this area over the past two decades and the railroad industry applied that research to develop and implement guidelines for train makeup. FRA becomes involved where necessary to encourage more conservative guidelines. FRA will launch formal regulatory action in this area in 1996, following completion of contract studies in support of program development.

REPORT: Regulations: Just after the turn of the 20th century, Congress directed the Interstate Commerce Commission to formulate and publish "Regulations For The Transportation Of Explosives" to promote the safe transportation in interstate commerce of explosives and other dangerous articles. As the only nation-wide transportation system, the railroads played a large role in the early framing of the rules and created the Bureau for the Safe Transportation of Explosives and Other Dangerous Articles (later called the Bureau of Explosives) to inspect shipments and methods of manufacture and packing.

Impetus for the early laws and regulations was provided by a number of accidents relating to shipments of black powder. It is thus not surprising that the first train placement rules dealt with cars containing explosives. These early regulations required cars of explosives to be placed near the center of the train, and at least 16 cars from the engine and 10 cars from the caboose, when the length of train would permit. The "16 deep" rule was chosen because it was considered to be a "safe distance" during a time when railroads used steam locomotives that produced hot cinders and carried freight, including explosives, in wooden box cars.

By 1922, regulations were in effect to require cars placarded INFLAMMABLE[31] to be placed in trains at least five cars from the engine and five cars from the caboose. When the length of the train did not permit this placement, the hazardous materials car was to be placed near the middle of the train, separated from the engine or an occupied caboose by at least one car, and the engine crew was to be informed of its presence and location in the train. Under no circumstances could an INFLAMMABLE car be placed next to a car transporting explosives.

The current in-train placement requirements[32] are founded on no more rigorous a scientific basis than were the original. They are, rather, based on the empirical evidence of history and on a sense of what "ought" to be, driven by concerns for the safety of crew members. This is not intended as criticism. The current in-train placement and separation regulations seem to have served the cause of safety well and no body of evidence has emerged from the analysis

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[31] The term "INFLAMMABLE" was confused with "unflammable" or "non-flammable" and the class name was changed to FLAMMABLE.

[32] The current regulations, at 49 CFR § 174.85, use a table to graphically display requirements that, until December, 1990, were contained in §§ 174.85 through 174.93.

of accidents or incidents to suggest the need for sudden or drastic overhaul.

Position in Train of Placarded Cars Transporting Hazardous Materials

RESTRICTIONS	Placard Group 1	Placard Group 2		Placard group 3		Placard Group 4
	Rail Car	Tank Car	Rail Car	Tank Car	Rail Car	Rail Car
1. When train length permits, placarded car may not be nearer than the sixth car from the engine or occupied caboose.	X	X		X		
2. When train length does not permit, placarded car must be placed near the middle of the train, but not nearer than the second car from an engine or occupied caboose.	X	X		X		
3.An open-top car when any of the lading protrudes beyond the car ends or if shifted would protrude beyond the car ends.	X	X		X		
4. Loaded flat car except closed TOFC/COFC equipment, auto carriers, and other specially-equipped cars with tie-down devices for handling vehicles. Permanent bulk head flat cars are considered the same as open-top cars.	X	X		X		
5. Any rail car, transport vehicle, or freight container with temperature control equipment or internal combustion engine in operation.	X	X		X		
6. Placarded cars may not be placed next to each other based on the following:						
Placard Group 1		X	X	X	X	X
Placard Group 2	X			X	X	X
Placard Group 3	X	X	X			X
Placard Group 4	X	X	X	X	X	

Placard Group:
Group 1: Divisions 1.1 and 1.2 (Class A explosive) materials.
Group 2: Division 1.3, 1.4, 1.5 (Class B and C explosive), Class 2 (compressed gas; other than Div 2.3, PG I, Zone A), Class 3 (flammable liquid), Class 4 (flammable solid), Class 5 (oxidizing), Class 6 (poisonous liquid; other than Div 6.1 PG I, Zone A), and Class 8 (corrosive) materials.
Group 3: Divisions 2.3 (PG I, Zone A; poisonous gas) and 6.1 (PG I, Zone A; poisonous liquid) materials.
Group 4: Class 7 (radioactive) materials.

* Where an "X" appears at the intersection of a Placard Group column and a Restriction row, the corresponding restriction applies.

The regulations now specify a 6-deep / middle of the train / buffer car requirement. That is, loaded placarded cars (other than those placarded combustible) may not be placed nearer than the sixth car from the locomotive or occupied caboose, if the length of the train permits it. If 6 deep is not possible, then loaded placarded cars must be placed in the middle of the train and separated from the locomotives or occupied caboose by at least one nonplacarded car. The regulations also require the segregation of certain cars from other cars. The chart, reproduced above from § 174.85, provides the details.

In some limited cases, hazardous materials transportation has been permitted without a "buffer" or "spacer" car. Unit trains transporting sulfuric acid are currently operating in Canada[33] without buffer cars under specific regulatory endorsement. However, in the United States there are a very few nearly-unit trains of hazardous materials, and they operate with a buffer between the loaded placarded cars and the occupied locomotive and caboose.

Cabooseless train operations are now common and FRA is considering whether or not to require segregation of loaded placarded hazardous materials cars from the rear of such trains. At least part of the impetus for an amendment is a recommendation (R-87-17) to that effect from the National Transportation Safety Board. The purpose of the recommendation was to protect the engine crew on following trains from striking hazardous material cars that could be positioned on the rear-end of a leading train.

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[33] Unit trains, so named because they move one commodity in a single train directly from shipper to consignee, have been successful in moving tremendous tonnages of grain and other agricultural products, lumber, and coal. More recently, beginning in 1967, a major Canadian producer of sulfuric acid has proven that unit trains can move large quantities of this basic industrial chemical safely. The hazardous materials regulatory body in Canada granted this unit train an exception; regulations in effect in both Canadian and the United States at the time were nearly identical in requiring at least one buffer car.

Issues: In-train placement of hazardous materials presents at least three categories of issues: (1) employee versus public safety, (2) the potential for chemicals to mix with adverse reactions versus the proximity of chemical-laden cars to sources of ignition, and (3) train placement versus train makeup. The following section is a brief description of some of the dimensions of the issues, including a discussion of supporting research studies.

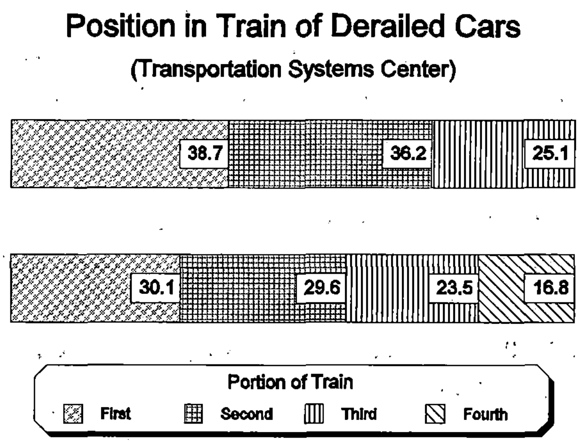
The safety of the public is enhanced when the number of accidents is reduced or when the consequences of any given accident are lessened. "Optimum" performance of a system for placing hazardous materials cars in trains, then, would be achieved when these cars were so marshalled that an accident to one would not affect another. For instance, if 10 cars of liquefied petroleum gas were scheduled to be moved in a 110-car train, they could be inserted as every tenth car. This would separate each one from all others and would require the derailment of more than 10 cars before 2 such cars would become involved. However, this plan would require 10 times more switching than moving the cars as a solid block and, if any part of the train derailed, this plan would essentially guarantee that a liquefied petroleum gas car would be involved.

On the other hand, switching railroad cars involves the risk of accidents and employee injury. If the goal is a reduction in accidents and injuries during switching operations, railroad workers would be protected, and "optimum" performance would thus be achieved, when the cars are marshalled to reduce the number of switching movements. Because the whole system for moving hazardous materials safely by railroad has such a good safety record, FRA is reluctant to attempt to "improve" safety by issuing regulations that will markedly increase the switching movements for cars of hazardous materials. Maximum total safety is not achieved by asking one group of "at risk" people to accept more risk so that another group will endure less. Despite the controversy woven throughout this issue, there is, effectively, universal agreement that the hazardous materials in a train should be separated from the portions of the train carrying people.

A hazardous materials train derailment theoretically could create a "witches brew" of chemicals that react to produce reactions more volatile, and fumes more toxic, than any of the individual products. In-train placement regulations do consider both reducing the likelihood of a tank puncture -- by prohibiting a hazardous materials tank car next to a load of telephone poles, for instance -- and reducing the lethal effects of the post accident scene -- by requiring, for instance, that poison gas and explosives cars not be coupled to each other.

Finally, while the statutory request is clear, that this report should be concerned with hazardous materials car placement, the related issue of train makeup is so closely allied with car placement that clarification now may prevent confusion later. Essentially, train makeup is not an issue that focuses on hazardous materials but on the distribution of power, braking effort, and weight throughout a train and the effect of each on train handling. From the point of view of train makeup, whether or not heavy cars belong at the front of a train is independent from whether or not those cars are carrying hazardous materials, just as, from the perspective of hazardous materials safety, whether or not hazardous materials cars belong at the rear of the train is independent from how many empty cars are in the front of the train. The reality, of course, is that both considerations are vital and FRA's stewardship of railroad safety requires that rules written in one area not overlap into another, to the detriment of either.

Research: The Transportation Systems Center[34] published a study in March of 1979 exploring the idea that most derailments involve cars placed towards the front of a train.[35] TSC's analysis grew from a determination of the in-train location of all derailed units in reportable accidents for the years 1975, 1976, and 1977. After eliminating what it called "bad data," for instance, reports where the number of cars derailed equaled a greater number than the length of the train, TSC was left with over 22,000 derailments over the three-year period.

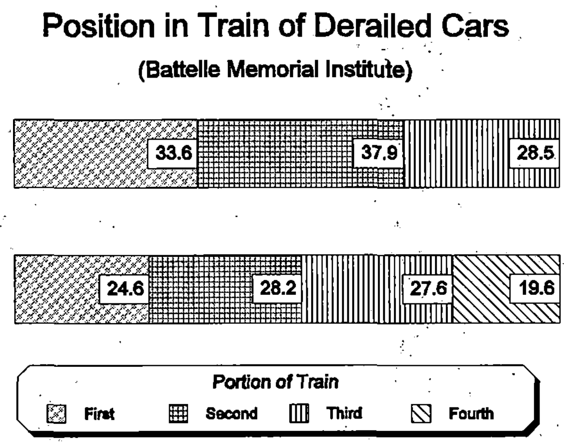


Dividing the train into thirds, TSC found that 38.7 percent of the cars derailed were in the first third of the train, 36.2 percent were in the middle third, and 25.1 percent were in the last third. Splitting the train into quarters showed 30.1 percent of the cars derailed were in the first quarter, 29.6 in the second, 23.5 in the third, and 16.8 in the last quarter of the train. The data also appear here as a bar graph. The study concluded that the risk of derailment is higher in the forward section of the train than in the rear third or rear quarter of the train.

[34] Now known as the Volpe National Transportation Systems Center.

[35] Fang, Paul Ching-I and Reed, H. David, "Strategic Positioning Of Railroad Cars To Reduce Their Risk Of Derailment," Internal Staff Study, Transportation Systems Center (DOT/TSC), March 1979.

Under contract with FRA, Battelle has completed a more recent study.[36] Because Battelle concentrated on identifying opportunities for reducing the number and severity of hazardous materials car derailments, it selected only derailments on "main track" involving "freight trains" and "mixed trains," and it eliminated any derailment associated with a "short train," that is, a train with 10 or fewer cars and locomotives. As with TSC, Battelle weeded out "bad data" and developed a final total of 5,451 derailments in 1982 through 1985.[37] The three- and four-section analysis of derailments in this study is similar to the earlier TSC project, and appears in the accompanying bar graph. Both studies show that the risk of derailment is significantly less in the rear of the train. The Battelle study also shows that the next safest section of the train is the front and the four section analysis indicates that, except for the rear of the



[36] Thompson, R.E., Zamejc, E.R., and Ahlbeck, D.R., *Hazardous Materials Car Placement In A Train Consist*, Final Report, Technical Task No. 6, Contract No. DTFR53-86-C-00006, 1989. The study is in two volumes: Volume I, Review and Analysis, and Volume II, Appendices.

[37] An analysis by Battelle, within its report, demonstrates that mainline, long-train derailments constitute approximately the same percentage of incidents during the years included in the TSC study as in the years examined by Battelle. The more recent study simply focuses on a subset of the overall statistics.

train, "...there is little difference in the relative safety of the first three quarters."[38]

If mainline track operations were all that needed to be considered and, if avoiding derailments were the overwhelming priority, a hazardous materials placement strategy concentrating on the rear portion of the train would seem wise. However, train marshalling (to use the Canadian term) is not that simple. Another FRA study,[39] concluded that the preferred location for loaded cars is towards the front of the train because, under braking, they decelerate slower than empty cars and would "push" the more rapidly decelerating empty cars in front of them, thus causing high buff forces. Another danger of placing extended strings of light cars ahead of loads is the "clothesline," or "stringline" effect. Analysis of the July 14, 1991 accident at Dunsmuir, California,[40] shows that the pulling force of the engines combined with the drag of heavy loads may cause a group of light cars (especially long, light cars) to be pulled off the tracks and towards the inside of a curve. The tighter the curve, the more pronounced the possible effect.[41]

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[38] Battelle study, Vol. I, p. 11. Battelle attributes the relatively minor statistical differences between its study and the TSC work to the examination by TSC of derailments on all types of track, rather than on mainline track only. Battelle also excluded "short" trains and this may well have given a clearer picture of the relationship between each of the thirds or quarters of the train. (The average length in Battelle's study was 81 cars and locomotives, in the VNTSC work, it was 65.)

[39] Nayak, P.R. and Palmer, D.W., "Issues and Dimensions of Freight Car Size: A Compendium," Report No. FRA/ORD/-79/56, January 1980.

[40] An earlier example is the November 9, 1977, accident at Pensacola, Florida where a derailment, at least partly attributable to the "clothesline" effect, lead the puncture of a tank car of anhydrous ammonia and the resulting gas cloud caused 2 deaths, many injuries, and the evacuation of 1,000 people.

[41] In the opposite situation, where the train is under dynamic braking, forces pushing towards the front of the train can derail cars off the curve to the

(continued...)

Problems with pulling (draft) forces and pushing (buff) forces can also happen to trains where the cars are either all loaded or all empty. Experience with the Tropicana Orange Juice unit train and with unit trains of coal or grain proves the proposition.[42] In uneven terrain (and railroads that are table-top flat are the extreme exception), the rolling of the land can induce significant draft and buff force peaks at almost any point in the train which, if they get high enough to overcome the inertial forces holding the train on the track, can lead to derailments.

Yet another set of complications arises in the consideration of hazardous materials incompatibility. Battelle reviewed the top 100 hazardous materials transported by rail, ranked by number of tank car shipments.[43] Each commodity on the list was paired with every other and the pairs were considered "incompatible" if the combination produced greater lethal effects than either of the individual components. The research chemists evaluating the commodity pairs regarded the following effects as particularly dangerous:

- Toxic chemical releases,
- Fireballs,

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[41](...continued) outside.

[42] Recognized references include: Powers, R.G. and Stephenson, J.G., "Train Action Measurements in the Tropicana Unit Train," ASME Paper No. 73-WA/RT-9, November 1973 and Fahey, W.R., et al., "Derailments on a Heavy Haul Railway," Session 315, Paper 3.4, Heavy Haul Railways Conference, Perth, Western Australia, September 1978.

[43] A list is published each year by the Bureau of Explosives of the Association of American Railroads. The Battelle study used the 1986 list; the most recent is contained in *Annual Report of Hazardous Materials Transported by Rail, Year 1992*, Report BOE 92-1, Bureau of Explosives, Association of American Railroads, Washington, D.C., June 30, 1993. From year to year, the rankings of the commodities are remarkably consistent. The report uses data garnered from the second generation of the AAR's TeleRail Automated Information Network (TRAIN II), the industry's railcar interchange data base.

- Unconfined vapor cloud explosions,
- Condensed phase explosions, or
- Pool fires - thermal radiation hazards, toxic combustion products.

Battelle ranked the pairs of chemicals on the basis of both their potential consequences and their risk. Chemical mixtures with the worst consequences include:

- Oleum with organic chemicals: Can produce toxic emissions, fire balls, and unconfined vapor cloud explosions;
- Fuming nitric acid with organic chemicals: Can yield toxic emissions, fire balls, and unconfined vapor cloud explosions;
- Hydrogen peroxide with organic chemicals: Can give off toxic emissions and undergo condensed-phase explosions;
- Sodium metal with commodities containing water: May result in fire ball or unconfined vapor cloud explosion; and
- ASTM Group 1 (Nonoxidizing mineral acids) with ASTM Group 2 (oxidizing mineral acids): Toxic emission consequences.

Consequence-based ranking yielded an interesting sidelight, especially so in a "real world" transportation situation where safety and risk decisions are interlaced with economic and traffic-flow decisions and the overall safety of the rail borne hazardous materials transportation system is already very good. According to the report,

> It is interesting to note that mixing of chemicals will generally mitigate the toxic emission consequences of highly toxic chemicals such as hydrocyanic acid,

chlorine, anhydrous ammonia, and hydrogen fluoride. An exception is the combination of hydrocyanic acid with chlorine, which may form cyanogen chloride, a tear gas. In the case of hydrogen fluoride, all combinations resulted in either the same or reduced consequences as compared with the unmixed chemicals.

Similarly, mixing will generally mitigate the consequences (fireballs and UVCE's) of highly flammable chemicals including hydrocyanic acid, acetaldehyde, and ethylene oxide.[44]

When calculating the risk-based rankings, Battelle combined the consequences of mixing an incompatible chemical pair with the yearly number of tank car movements of the commodities. The reasoning was that the volume of movements gives an indication of the potential frequency for the chemicals to be involved in the same derailment; this reasoning is admittedly imperfect because it does not allow for different patterns of distribution for various chemicals or for seasonal patterns in their transportation volumes.[45]

Normalized risk was established by dividing the risk of each pair by the risk of the lowest contributor in the pair.[46] Of the commodity pairs in the study, the lowest combination was hydriodic acid and acrylic acid, and this was assigned a normalized risk equal

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[44] Battelle study, p. 76.

[45] As just two examples, anhydrous ammonia, an important agricultural fertilizer, moves most heavily during the growing season and the largest volumes of liquefied petroleum gas move during the heating season for homes and industries.

[46] "Risk," for these purposes, is a concept developed by combining the consequences of a particular chemical and the surface area over which those consequences are likely to be felt. A more complete discourse is given in the Battelle study.

to one. All other combinations were ranked relative to how much greater their risk was than the two lowest. The combination of hydrochloric acid with sulfuric acid has the greatest risk, and it is over five times the risk of hydriodic acid with acrylic acid. According to the Bureau of Explosives's annual report of hazardous materials transportation, over 70,000 tank cars of sulfuric and hydrochloric acids moved in 1992, compared with fewer than 4,000 for the pair with the lowest risk ranking. The Battelle reports attributes more than 50 percent of the risk to the following combinations:

- Oleum with sodium hydroxide, methyl alcohol, denatured alcohol, or fuel oil;
- Sulfuric acid with hydrochloric acid, methyl alcohol, denatured alcohol, vinyl chloride, hydrofluorosilicic acid, carbon tetrachloride, or benzene;
- Sodium hydroxide with styrene, acetic acid, or carbon tetrachloride; and
- Chlorine with anhydrous ammonia or hydrocyanic acid.

Based on its findings thus far, Battelle went on to consider car-to-car separation within a train. "The minimum segregation distance," according to the report, "is the spacing distance between HAZMAT rail tank cars which is required to prevent mixing of incompatible chemicals during train accidents involving derailments."[47] The distance cannot be defined precisely because of the varying effects of terrain, natural and constructed drainage systems, and the surface adsorption of liquids. Individual hazardous materials spills can also be affected by the weather at the time of the accident. Recognizing these limitations, Battelle concludes that a complete spill of a 100-ton tank car onto flat, "normally" adsorptive soil would affect a roughly circular area with a radius of about 40 meters (±132 feet).

[47] Battelle report, p. 78.

During derailments, tank cars often turn at right angles to the track and stack up - not unlike a stack of firewood.[48] The September 28, 1982, derailment on the Illinois Central Gulf Railroad at Livingston, Louisiana,[49] is considered by the Battelle study as a "worst case" example. In that accident, 42 railroad cars, nearly all of them tank cars loaded with hazardous materials, derailed and most of them lost all or part of their contents. The tank cars stacked up so severely that 30 were compressed into an area about 265 feet long, or only about 5 car lengths. A spill from the first car in the stack could, assuming Battelle's 40-meter affected area, have mixed with a spill from the 30th car. If the spill from each car affected a 40-meter circle, then the separation distance <u>after a derailment</u> would have to be 80 meters, and to accomplish that at Livingston would have required a separation distance of 30 cars.

Because Livingston is considered a worst case, the study determined the average maximum number of derailed cars is 13 and concluded that a 15-car separation would provide the 40-meter post-derailment clear zone to minimize commingling of incompatible chemicals.

Canadian authorities have also evaluated risks to train crews and the general public associated with position and separation distances of hazardous materials in a train. A March 1991 research study reported an investigation made by the Institute of Guided Ground Transport[50] to determine:

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[48] These derailments are also called "accordion" derailments.

[49] The National Transportation Safety Board report on the accident is number NTSB/RAR/83/05, "Derailment of Illinois Central Gulf Railroad Freight Train Extra 9629 East (GS-2-28) and Release of Hazardous Materials at Livingston, Louisiana, September 28, 1982.

[50] English, G.W., Cattani, T.K., and Schweir, C., "Assessment of Dangerous Goods Regulations in Railway Train Marshalling," a working paper prepared for (continued...)

(1) the extent to which regulatory restrictions governing the train placement of hazardous materials interfere with the recommended practices of train makeup for safe train handling; and

(2) whether more compatible regulations involving train handling will improve the overall safety and efficiency of the movement of hazardous materials by railroad.

As noted, the Canadian regulations are similar to those promulgated by RSPA. The most notable exceptions deal with unit trains of placarded tank cars--no buffer cars are required--and with a five-car separation requirement between cars carrying Division 2.1 (flammable gases) and loaded tank cars transporting chlorine, anhydrous ammonia, or sulfur dioxide.[51]

Neither of the Canadian railroads has had an incident where hazardous materials placement specifically contributed to a train handling derailment. Canadian National Railways, with relatively flat and straight routes, pointed out that, while a concentration of heavy cars at the rear of the train might be troublesome, a concentration of empty cars there is not necessarily preferred, and might cause more problems than randomly distributed empty cars. The Canadian study also noted that the separation requirements for hazardous

[50](...continued)
Transport Canada by the Canadian Institute of Guided Ground Transport, Queen's University at Kingston, Ontario, March 1991.

[51] The major railways operating in Canada have argued that this requirement to separate Division 2.1 from the other named gases is a knee-jerk reaction to a massive derailment and fire at Mississauga, Ontario, (near Toronto) in which the presence of a tank car of chlorine in the midst of a conflagration of liquefied petroleum gas cars led to an evacuation of nearly 500,000 people. It was later determined that the chlorine car had indeed been breached and most of its contents had escaped in the thermal plume.

materials cars required extra switching moves and a consequent increased exposure to accidents or injuries when performing them.

Canada's Institute of Guided Ground Transport took a long look at the segregation analysis made by Battelle and noted that the risk rankings there do not consider the frequency at which commingling might be expected to occur. Some idea of the frequency of a specific hazardous material being involved in a specific derailment, sometimes known as the exposure risk, can be gathered using the following steps:

> Divide the hazardous materials carloads by the total carloads, multiply that result by the average ratio of loaded car moves to total car moves, then multiply by the probability of release upon derailing, then multiply by the average number of cars derailing in a derailment.

Making the calculations, the Institute determined that the probability of two common acids both being present and both releasing is on the order of 5.5×10^{-8} or about 55 chances per billion. Performing the same calculations on Battelle's highest risk pair, hydrochloric acid and sulfuric acid, creates a combined probability 2,643 times smaller than the individual probabilities. The Institute also notes that these rough assessments have not considered the probability of effective mixing of the two commodities, nor the probability that the derailment would happen anywhere near a populated area.

Using actual traffic patterns through an area of suburban Toronto and using any "oxidizing or poisonous substance" combined with any other hazardous materials shipment, the Canadian study calculated that the chances of a derailment with a combined release are between 0.0042 per million and 0.0017 per million.

Finally, the Canadian study noted that many of the worst consequence combinations carry the same placard (hydrochloric acid and sulfuric acid are both in Class 8, formerly corrosive materials) and current regulations in either Canada or the United States do not require buffer cars between commodities of the same class. By contrast, the Canadian restriction of five-car separation between Flammable Gases (Class 2.1) and chlorine, anhydrous ammonia, and sulfur dioxide is enforced on commodities not considered incompatible (in that the combination was not more lethal than either individual chemical), while chlorine and anhydrous ammonia themselves were not required to be separated even though they are considered to present an explosion hazard.

The Canadian Institute of Guided Ground Transport study mentions a British Railways study[52] performed by Bowring Protection Consultants. The purpose of the British study was to identify the risks associated with the existing segregation requirements for dangerous goods and to explore the possibility of either relaxing or strengthening them. In some instances the British regulations are less restrictive than those of Canada and the United States. For instance, no buffer car is required between occupied rail cars and cars transporting hazardous materials. British regulations, however, tend to be more restrictive in the area of compatibility requirements. For example, there are more combinations which require single car buffers and, under some conditions, hazardous materials cannot be transported in the same train regardless of separation. The study concluded that the probability of dangerous combinations happening on British Rail is low enough under a random marshalling strategy that it is not an immediate cause for concern.

[52] Considine, M., A Risk Based Approach to the Segregation of Dangerous Goods on the Railways, Bowring Protection Consultants, prepared for British Railways Board, Contract No. RE21090, March, 1988. The Canadian Institute notes that this is a confidential report and it was furnished by Transport Canada. FRA has not read and evaluated the report text itself, the comments included here are those of the Canadian Institute of Guided Ground Transport.

Analysis: Each year, railroad switchmen are injured, equipment is damaged, and hazardous materials are released in switching accidents, and at least some of that switching happens in order to satisfy the requirements for positioning placarded rail cars in trains. "In-train placement" involves issues of separating hazardous materials cars from parts of the train occupied by people and segregating hazardous materials cars, one from the other; it differs from train makeup, where the goal is to place cars into a train such that they balance the forces within the train. This latter issue involves empty/loaded cars, short/long cars, and terrain and curvature; it is significantly broader than just a hazardous materials issue. Depending upon circumstances, train makeup may be more or less important for safety than hazardous materials car placement. FRA will be exploring the issue of in-train placement in a rulemaking proceeding now under active development, at the pre-ANPRM stage.

The issue of train makeup to control improper weight distribution and the consequent imbalance of forces within the train present complex technical problems that have been the subject of extensive research supported by FRA over two decades. The railroad industry has used the products of FRA's research to develop and implement guidelines for train makeup, and FRA intervenes to encourage more conservative train makeup practices where necessary. FRA has identified the issue of controls for train makeup as one that warrants strong regulatory development over the next several years. Given the present workload of higher priority rulemakings (including those mandated by statute), the complexity of the train makeup issue, and available resources, FRA would not expect to begin a formal regulatory development effort in this area until FY 96, following completion of contract studies in support of program development.

A State Perspective on Train Makeup:

In July 1991, railroad derailments at Dunsmuir and Seacliff, California, both involving dangerous commodity releases, heightened concern about the movements of hazardous materials by railroad in that state. The Public Utilities Commission of California responded to concerns expressed by the state General Assembly and instituted rulemaking "to provide for mitigation of local rail safety hazards within California."[53] Because a significant portion of the PUC regulatory effort lies in the area of train makeup, FRA has included a discussion of it here; a more complete presentation of California's proceeding is presented as an appendix to this report as an example of a non-Federal response to problems of hazardous materials transportation safety.

This report is neither a forum for determining issues of Federal/state preemption nor comment by FRA about any aspect of the California Commission's proceeding. As Congress intended in RSERA 1992, this is a report "regarding issues presented by the transportation by rail of hazardous materials." FRA is not a participant in PUC's proceeding and this report is not intended to influence the deliberations of the PUC.

The PUC notes that excessive draft and buff forces[54] can lead to accidents and that proper distribution of car weight and length can reduce destabilizing forces within a train. The primary basis for this

[53] California Public Utilities Commission, Order Instituting Rulemaking, (Rulemaking on Commission's own motion to provide for mitigation of local rail safety hazards within California), R.93-10-002, filed October 6, 1993, San Francisco office.

[54] Draft forces develop when the locomotives are pulling the cars, as on an upgrade; buff forces develop when the cars are, in effect, pushing the locomotive, as on a down grade. In rolling terrain, it is likely that both draft and buff forces will exist along the length of a single train, aided by the slack that is a natural part of the coupling system of railroad cars.

assertion lies in the work of the International Government-Industry Research Program on Track Train Dynamics. In 1973, the program published the second edition of its report R-185, *Track Train Dynamics to Improve Freight Train Performance.* The purpose of the study is explained in its introductory material:

> The Track Train Dynamics Program encompasses studies of the dynamic interaction of a train consist with track as affected by operating practices, terrain, and climatic conditions.
>
> Trains cannot move without these dynamic interactions. Such interactions, however, frequently manifest themselves in ways climaxing in undesirable and costly results. While often differing and sometimes necessarily so, previous efforts to reasonably control these dynamic interactions have been reflected in the operating practices of each railroad and in the design and maintenance specifications for track and equipment.
>
> Although the matter of track-train dynamics forces is by no means a new phenomenon, the increase in train lengths, car sizes, and loadings has emphasized the need to reduce wherever possible excessive dynamic train action. This, in turn, requires a greater effort to achieve control over the stability of the train as speeds have increased and railroad operations become more systematized.[55]

The guidelines issued by the Track Train Dynamics program dealt with train handling, train makeup, track and structures, and locomotive engineer training. It was recognized that any compilation of experience might omit significant experience that, while at variance

[55] Report R-185, *Track Train Dynamics to Improve Freight Train Performance,* 2nd Edition, International Government/Industry Track Train Dynamics Research Program, Washington, D.C., p. iv.

with one or more particular guidelines, was nevertheless successful in its own right. Recommendations in the publication about, for instance, the concentration of the heaviest cars at the front of the train in terrain with significant grades were adopted by most railroads as guidelines rather than hard and fast rules, with individual trains marshalled as directed by the personnel in charge at a given railroad terminal.

In its order instituting rulemaking, the PUC identified a series of railroad segments in California as "local safety hazards sites." This designation was based on the consideration of four factors: Accident history, the potential effect of an accident, the recommendations of various studies, and the Commission's own recommendations to DOT following the Dunsmuir and Seacliff accidents. For each of 33 railroad segments, a series of regulations is proposed, including those dealing with train makeup.

The proposed rules are a codification of guidelines from the Track Train Dynamics program, as they were adopted by the rail carriers, and change would be allowed only on advance written notice to the Commission. As to particular railroad segments, limits would be placed on train tonnage, with different limits for each direction and adjustments for articulated cars. The addition of helper locomotives would lead to further adjustments in allowable tonnages. Car weights and lengths are considered as in the following examples taken from the Commission's proposals:

> *3. When the total weight of the train exceeds 3600 actual tons each of the first five cars behind the locomotive must weigh 50 tons or more.*
>
> *4. When the total weight of the train exceeds 4000 actual tons each of the first five cars behind the locomotive must be 73 feet or less in length.*
>
> *5. When the total weight of the train exceeds 3000 actual tons the following train makeup requirements apply:*

a. The following cars must be no closer than the eleventh car behind the locomotive:
(1) Empty car exceeding 73 feet in length.
(2) Trailer on flat car/container on flat car loaded on one end only.
(3) Double stack (articulated) car having one or more empty loading platforms.

b. The following cars must be entrained with no more that 300 actual tons trailing:
(1) Empty car exceeding 73 feet in length.
(2) Trainer on flatcar/container on flat car loaded on one end only.
(3) Articulated (hinged) double-stack car having one or more empty loading platforms.
(4) Loaded two-axle car.
(5) Loaded or empty multi loading platforms articulated (hinged) spine car (car not equipped with a deck but center beams only).

6. Empty tank cars measuring less than 35 feet in length must be entrained with no more than 4,000 trailing tons.

7. Two-axle intermodal cars ... weighing less than 25 tons must be entrained with no more than 1500 trailing tons.

8. Trains containing a solid block of 20 or more loaded multi-level cars must not exceed 6,500 feet in length excluding engines.

9. The following train makeup restrictions apply to restricted OTTX cars:

....

10. Cabooses are to be entrained at the rear of the train except when handling 25 or fewer cars in local or road switcher service.

11. Following train makeup restrictions apply to locomotive crane-pile drivers:

....

12. Scale test cars and cars designated as rear-ender (RE) must be entrained within the rear five cars of train. A scale test car must not be handled as the read car of train.

13. Loaded continuous-welded-rail (CWR) trains must be handled separately from other trains.

....

14. Trailing tonnage handled behind rail pick-up cars ... must not exceed 1,000 tons.

15. Cars [bearing particular, listed, reporting marks] must not be operated.

16. Cars [bearing particular, listed, reporting marks] are to be moved only in unit trains.

....

18. Unless otherwise instructed, placement of helper engine will be governed by the number of powered axles in the helper as shown below.

AXLES	*PLACEMENT REQUIREMENTS*
8 or less	*Behind caboose or on rear of cabooseless train.*
12 or less	*Ahead of caboose or on rear of cabooseless train.*
More than 12	*Must be cut in ahead of one-half the tonnage rating for helper locomotive.*

EXCEPTIONS:

....

19. A helper engine exceeding the number of axles specified may be used on rear of train provided excess locomotives are isolated. A maximum of two locomotives may be isolated.

20. When rear-of-train or entrained helper has more than eight axles of power, the following restrictions apply to the first five cars ahead of the helper.

a. Each car must weigh 50 tons or more; and
b. A car over 73 feet in length must not be coupled to a car less than 42 feet in length. (Note) For application of this restriction, two consecutively loaded double-stack platforms

are to be considered the equivalent of one car weighing 50 tons or more and less than 55 feet in length.

21. An entrained helper engine must not exceed 36 axles.

22. A two axle car ... or a multi-platform articulated spine car ... must not be nearer than the tenth car ahead of a helper engine.

23. Helper engine must be entrained ahead of two-axle cars [bearing particular, listed, reporting marks] weighing less than 25 tons, rail pick-up cars [bearing particular, listed, reporting marks], scale test cars or cars designated as rear-enders.

24. If necessary, placement of helper engine may be varied a few cars in either direction to comply with above restrictions or to provide separation from restricted cars.[56]

These examples, or variations of them, would apply to the designated segments as deemed necessary by the Commission. In its order, the PUC directed that interested persons to file comments by November 5, 1993, or as determined by the assigned Administrative Law Judge. As FRA's report was under review, no further action had been announced by the PUC.

[56] PUC Order Instituting Rulemaking, R.93-10-002, pp. 1-2 - 1-5.

AN ASSESSMENT OF THE CURRENT TRACK STANDARDS RELATIVE TO GRADES AND DEGREES OF CURVATURE

SUMMARY: *Derailments on hilly, twisting rail lines are most often caused by wheel climb and rail rollover. Wheel climb can be treated by reducing the speed of grade-descending trains (to more closely match the speeds of ascending trains) and, then, generally reducing superelevation. Second, improved surface geometry reduces the harmonic rocking of cars and, thus, wheel lift. Strengthening the track structure markedly reduces rail rollover. Together, these FRA-encouraged practices contribute to a reduction in track-caused accidents.*

Nationally, track-caused train accidents have declined steadily from a 1983 total of 1,569 to 849 in 1992, a reduction of 46 percent. Effective Federal track standards played a powerful role in this increased safety, as did the railroad industry's success in developing and applying new procedures for operating trains and maintaining track in mountainous country. The Railroad Revitalization and Regulatory Reform Act of 1976, and the Staggers Rail Act of 1980 helped improve the financial health of United States' railroads and increased their ability to invest in rights of way, thereby contributing to the improvement.

FRA's Docket RST 90-1 provides a vehicle for a thorough review of the track standards. Comments in response to the November 1992 advance notice of proposed rulemaking add to the agency's knowledge and inform the proposed rules, now being drafted. To the extent train operations over routes with sharp curves and steep gradients may be improved by revising Federal track standards, FRA will fully consider such revisions.

REPORT: Federal track safety standards require the progressive refinement of railroad track quality as a function of increasing train speed.[57] Specific reference to the movement of hazardous materials occurs only in the discussion of "excepted track,"[58] because hazardous materials shipments do not interact with track in any way essentially different from other freight. Cars transporting hazardous materials can appear in virtually any freight train and are, thus, covered by track safety regulations addressing common passenger and freight rail traffic.

FRA's track regulations establish standards requiring track components (ties, spikes, joint fasteners, and the like) to hold the rails within set limits for gage, alignment, and surface.[59] While individual railroads operating in mountainous terrain may have adopted certain techniques specifically to maintain track geometry on significant grades, the regulations do not consider the influence of route gradient as a separate category.

Degree of curvature enters the standards in the prescription of superelevation on curved track, taking into account a range of train

[57] 49 CFR Part 213, §§ 213.1 through 213.241, plus appendices. FRA has started a regulatory proceeding to consider amending the track standards, Docket RST-90-1, 57 FR 54038, November 16, 1992. Comments have been received to the advance notice of proposed rulemaking and development work has begun on proposed rule changes.

[58] 49 CFR § 213.4(e)(3). Excepted track is a category at the lowest level of the track quality spectrum. On excepted track, a train may have a maximum of 5 placarded hazardous materials cars and may not be operated at a speed in excess of 10 miles per hour. Such a limited reference to hazardous materials is entirely consistent with the purpose of the track standards.

[59] Gage is, generally, the distance between the rails; § 213.53 states, "Gage is measured between the heads of the rails at right angles to the rails in a plane five-eights of an inch below the top of the rail head." Alignment is the "straightness" of the pair of rails from side to side; required measurements are listed in § 213.55. Surface includes both the end to end "straightness" of the rail and its cross level, or the difference in height across the gage. An explanation of these, and many other track-related terms, is collected in "A Glossary of Terms," *The Track Cyclopedia*, ©1978, Simmons-Boardman Publishing Corporation, Omaha, NE.

speed values and associated track curvatures.[60] Superelevation, the raising of the outer track in a curve relative to the inner track, is a matter of balancing probable train speed with curvature. In perhaps overly broad terms, if the train goes around the track faster than the superelevation "allows," it will derail to the outside; theoretically, if it goes around the same curve too slowly, it will derail to the inside -- but the track standards limit the magnitude of superelevation so that even a stopped train cannot simply "fall off."

There can be no doubt that running trains successfully through mountainous terrain is more difficult than operating across the prairie. It can be accomplished even though there is little that can be done in a cost effective way to modify the railroad grades or route alignments that traverse rugged country. In only the most exceptional cases can a railroad today even consider sustaining the capital costs associated with line and grade changes in the mountains. What can and is being done, though, is the accomplishment of relatively minor changes in existing track and a tailoring of train operations to specialized terrain and track characteristics.

In recent years, the railroad industry has made dramatic improvement in reducing the frequency of track-related train derailments in mountainous territories. Analysis of a series of track-caused derailments on hilly, twisting rights-of-way identified three common elements. First, almost invariably the derailments happened at a curve. This is not surprising; curves often form the overwhelming majority of route alignment in rugged terrain. Second, the presence of relatively large superelevation values were noted and this was a direct result of the track having to accommodate fairly wide differences in speeds between ascending and descending trains.

[60] §§ 213.57 and 213.59. A chart, showing maximum allowable operating speeds for curved track at various degrees of curvature and inches of superelevation, illustrates the formula expressed in § 213.57.

Sometimes, in such cases, a railroad had attempted to compromise by having too little elevation for faster trains and too much for slower traffic. Third, the track-related derailment causes were generally confined to wheel climb or rail rollover.

Industry response to the recognition of these common elements was to reduce superelevation and accept the consequent accelerated wear of the outer (guiding) rail caused by increased wheel flange forces. Rail lubrication brought some relief from increased wear, as did reducing the speed of grade-descending trains, thus narrowing the differences in comparative train speeds. Mountain territory derailments were also reduced by paying close attention to the ways in which loaded and empty cars were assembled into trains. Finally, greatly strengthening the track structure helped reduce the incidence of rail roll-over, and with improved surface geometry came a reduction in the harmonic rocking of cars. These measures were not related to the transport of hazardous materials, *per se*, but were applied to all traffic moving over trackage having significant grades and high degrees of curvature.

Nationally, track-caused train accidents have declined steadily from a 1983 total of 1569 to 849 in 1992, a reduction of 46 percent. To no small degree, this outcome was influenced by the railroad industry's success in developing and applying new procedures for operating trains in mountainous country and for maintaining track in those regions. Also playing a powerful role in the evolution of this salutary trend is the effectiveness of the Federal track safety standards in establishing a qualitative floor that Class 1 railroads constantly try to surpass. Credit must also be given to the Railroad Revitalization and Regulatory Reform Act of 1976,[61] and to the

[61] P.L. 94-210, February 5, 1976. Also known as the 4R Act, its provisions have been codified in Title 49, U.S.C..

Staggers Rail Act of 1980,[62] and their salutary effect on the financial health of the railroads in the United States, and on the increased ability of the railroads to invest in their rights of way.

The railroads have found the use of continuous welded rail (CWR) and "direct fixation" track fasteners especially helpful in coping with the stresses caused when heavy trains negotiate sharp curves or steep grades. CWR eliminates the bolted joints necessary to join individual 39-foot rail lengths and reduces the dips in track profile that often appear as a result of vertical wheel impacts at the joint. As track running surface contour gets farther from ideal, it can excite high center of gravity cars towards increasingly severe rocking motions and, eventually, derailment. Direct fixation rail/tie fasteners provide a far more secure connection of the rails to the ties than was possible with conventional track spikes. This, in turn, makes the track more resistant to rail rollover induced by the lateral wheel loads generated when rail cars round curves.

Track defect caused derailments, as noted above, are now about half the level of 10 years ago. The contribution of the Federal track safety standards to that continuing decline is undeniable. It is perhaps best characterized by thinking of the Federal standards in terms of defining the parameters for a safe track environment and then using the presence of Federal and state track inspectors to focus the attention of railroad maintenance officials on the priority of complying with these requirements. In FRA's experience, a track-safety mindset exists in the industry today that was notable through its absence 20 years ago.

The record proves it is possible to operate trains safely over tracks that include significant grades and high degrees of curvature. But, to do this with consistent success demands close adherence to

[62] P.L. 96-448, October 14, 1980; 49 U.S.C. § 10101 *et seq.*, formerly 45 U.S.C. § 231f, *et seq.*

train operating and track maintenance methods that have been proven to work. The margin of error, when railroading in the high country, is not very broad.

THE EFFECTIVENESS OF WAYSIDE BEARING FAILURE DETECTORS

SUMMARY: *Technology has so advanced the capabilities of freight car roller bearings that the Association of American Railroads Mechanical Division no longer keeps its special record of cars set out of trains due to bearing problems. Nevertheless, roller bearing failures still cause about 2 percent of the accidents due to mechanical failures and account for about 20 percent of the accident damage from mechanical failures.*

Roller bearings get hot as they begin to fail and hot bearing detectors, installed about every 20-30 miles along mainline track, can warn railroads before the bearings suddenly fail. The most common type of detector is an infrared scanner that receives the "energy" transmitted by an overheating bearing and sends a signal to warn the train crew.

Hot box detectors work, and they work well. However, they are expensive to install (nearly $90,000 each) and to maintain (annual maintenance runs some $11,000 to $20,000 per unit). What is not certain is that they are always the best way to spend the next safety improvement dollar. FRA believes that any mandate to install overheated bearing detectors should be selective, based on population, traffic, the presence of waterways or other environmentally sensitive areas, and other risk factors.

REPORT: Nearly all of the track in the general railroad system of transportation[63] carries hazardous materials, and the same is true of the freight trains moving over that track. As a consequence, the

[63] The "general railroad system of transportation" is "the network of standard gage railroads over which the interchange of goods and passengers throughout the Nation is possible--including even certain railroads not physically connected to the continental system, such as a freight railroad in Alaska with which other American railroads interchange cars by means of intermediate modes of transport. "The Extent and Exercise of FRA's Safety Jurisdiction," Appendix A to 49 CFR Part 209.

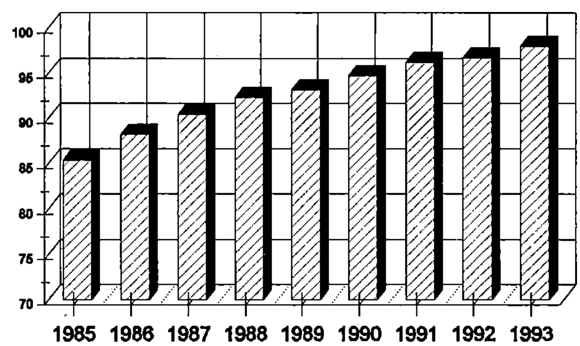
ability to detect overheated wheel bearings before they progress to failure affects railroad safety on a broader front than just hazardous materials transportation.

"Journal bearing" is the general term used to describe the load bearing arrangement at the ends of each axle on a railcar truck. Roller bearings are sealed assemblies of rollers, races, cups, and cones pressed onto axle journals and generally lubricated with grease.[64] Because plain bearings (the type in use before the development of the roller bearing) were in box-like enclosures in the truck side frame, an overheated journal bearing came to be called a "hot box." The term remained even as the structure changed.

The roller bearing was introduced for freight cars more than 35 years ago in the United States. In the 1950s, less than 1 percent of the new cars were equipped with roller bearings and a majority of railroad cars continued to rely on the old cast bronze bearing with an antifriction liner lubricated by oil. By the end of 1965, about a quarter million freight cars had been equipped with roller bearings; in that year, over 90 percent of the new cars built had roller bearings as

Cars Equipped with Roller Bearings

(Percentage of Fleet)



[64] *The Railroad Dictionary of Car and Locomotive Terms*, Revised Edition, Simmons-Boardman Publishing Corporation, Omaha, NE.

original equipment.[65] Since August 1, 1968, it has been mandatory that all new cars be equipped with roller bearings and, by the end of 1969, the population of roller bearing equipped cars had risen to about a half million freight cars. Now, essentially all freight cars have roller bearings.

A series of rules has been adopted by the AAR to promote the use of roller bearings. Field Manual[66] Rule 88.A.17. states that, effective January 1, 1991, all tank cars in hazardous materials service had to be equipped with journal roller bearings and not with friction bearings. Effective January 1, 1994, <u>all</u> cars must be equipped with journal roller bearings and may not be equipped with friction bearings. Field Manual Rule 90 prohibits in interchange tank cars in hazardous materials service with converted friction bearing truck side frames. (This requirement was effective January 1, 1992.) The same prohibition, but applicable to all cars, becomes effective January 1, 1995.

Roller bearings have so drastically improved journal performance that the AAR's Mechanical Division no longer keeps records of freight car set-offs (taking a car out of a train and putting it into a siding) due to bearing problems. By way of contrast, in the early 1950s, when the railroads relied on plain bearings, the industry averaged 1 set-off per 150,000 car-miles due to bearing failure. In the mid-1960s, with 15 percent of the freight car fleet on roller bearings and improvements in plain bearings, the failure rate had

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[65] *Car and Locomotive Cyclopedia*, ©1966, Simmons-Boardman Publishing Corporation, New York, NY.

[66] The *Field Manual of the A.A.R. Interchange Rules*, as adopted by the Association of American Railroads, Mechanical Division, Operations and Maintenance Department, Washington, DC. The *Field Manual* and a companion *Office Manual* (dealing primarily with car repair billing rates and procedures) are published annually by AAR. The rules in these manuals establish the conditions under which one railroad can and must use the cars of another railroad or private car owner.

dropped to one set-off for every 1.5 million car-miles, a ten-fold improvement in 15 years.

However good the news has become, roller bearing failures still cause accidents, about 2 percent of those due to mechanical failures in 1992, and they are still most expensive of the accidents caused by mechanical failures. In 1992, damages from accidents caused by overheated roller bearings cost the railroads nearly 20 percent of all the accident damage resulting from mechanical failures and nearly 4 percent of the damage from all causes.[67]

As railroads go to higher speeds and heavier loads per car, the potential for roller bearing failures theoretically increases. Fortunately, research and development efforts by FRA and the railroad supply industry have advanced the capabilities of wayside detectors to spot overheated journals before failure.

All wheel journals generate some heat; it is the product of normal friction between the axle and the rollers, races, and other components of the bearing. If the bearing uses up all its grease--a very rare occurrence--or if a roller or some other crucial part develops a flaw or is not able to perform its intended function, the bearing will begin to generate abnormal heat. If not detected and repaired in time, the entire bearing structure may be destroyed and all the parts either welded together and locked or melted away (burned off). Either failure mode usually leads to a derailment.

Warm objects (any object above absolute zero is a "warm" object) radiate infrared energy. The higher the temperature, the more energy is radiated. The detection of infrared energy and its

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[67] Damage and accident statistics are taken from Tables 19 and 21, "Accident/Incident Bulletin," No. 161, Calendar Year 1992, Office of Safety, Federal Railroad Administration, Department of Transportation, Washington, DC.

conversion through electronic circuitry to an electrical output enables the temperature of a warm object to be read on a gauge (or other device). But hot box detectors must be capable of "reading" the temperature of bearings only, and not of other objects on the train, and then "alarming" only at abnormally high readings.

Early testing of hot box detectors showed that less than half the heat generated is dissipated by the box and the remaining portion is transmitted into the wheel hub. This dissipation is dependent on a number of factors, including wind movement, how tightly the major components of the bearing fit, and the heat transfer between the box and the side frame of the truck assembly.

To focus the infrared scanner on the bearing, and away from other parts of the car, manufacturers "gate" the detector by limiting the signals reaching it. This is accomplished both physically, by optically aligning or focusing the window through which the infrared detector sees the bearing, and electrically, by using transducers to detect the presence of a wheel and only turning on the detector when the wheel bearing is within range of the scanner. Following detection, the signal is compared to the infrared reading of a "reference point," such as the truck side frame, and an electronic determination is made about whether the bearing reading just taken is within or beyond normal parameters.

In addition to wayside infrared hot bearing detectors, developmental work is being done on acoustic detectors and on-board systems. One system uses a heat sensitive bolt to replace one of the roller bearing end cap bolts; when the bearing exceeds a predetermined temperature, the detection bolt releases a visual indicator, plainly marking the hot bearing for subsequent closer inspection. Burlington Northern has installed over 2,000 detector bolts on cars in its fleet. (For full coverage, a standard freight car would need eight bolts, one for each wheel/bearing set.) Another system uses a heat sensitive element in the roller bearing adapter that produces a distinctive odor if the bearing becomes overheated. A recent new system uses a thermal sensor-bolt to replace the bearing end cap screw. If the bearing overheats, the thermal sensor and a transmitter in the bolt are activated and emit a radio-frequency alarm that can be monitored in the locomotive cab.

An October 1993, AAR survey of 13 Class 1 freight railroads and Amtrak shows that over 4,400 hot box detectors are installed, or 1 about every 20 to 30 miles on mainline track. The approximate cost of installing an overheated bearing detector varies from $80,000 to $90,000 depending on type of detector being used. Each installation must be maintained at a cost of between $11,000 and $20,000 per year. In addition to ensuring that detectors will take note of an overheated journal, maintenance is essential to avoid false positive readings. Not only do alarms cost the railroad in train and crew delays, but a hot box detector that "cries wolf" reduces the impact of any true positive reading it gives.

Some railroads relay the results of a hot box detector inspection to the crew, by means of a trackside display, but more of them receive the data at a central location, review it for abnormally high readings, and then notify the train crew. Readouts are accurate enough that the crew can be told to stop and to check a particular end of a particular axle on a set car. ("Crew of Train X2398, check the north end of the number 2 axle on ABCX 145632 for an overheated bearing.")

Optimum spacing and location of hot box detectors on each segment of track depends on a number of train operating parameters, including tonnage, speed, grade, track curvature, and the type of equipment. The AAR survey found that the average spacing between detectors is about 20 to 30 miles.

Together with the shift from friction to roller bearings, improvements in roller bearing design, and better quality control of roller bearing assembly at the wheel shops, wayside bearing detectors have been very effective in reducing the number of burned off journals. AAR statistics show that, for the year 1991, there was a favorable change in the rate of overheated journals per billion ton miles of approximately 34 percent and a decrease in burn offs per billion ton miles of approximately 4 percent, when compared to the year 1990. AAR data reflects a decreasing trend for each of the 10 years, 1981 through 1991. The average decrease based on AAR data is 67 percent for burn offs and 60 percent for hot boxes.

Wayside bearing failure detectors work and have made a positive contribution to improve the safety of hazardous materials transportation safety by railroad. It is not certain that hot box detectors are always the most efficient way to increase safety. They are expensive to install and to maintain and they create additional costs when they do not work properly. (Responding to an inquiry of the Canadian Government, one major railroad said it experienced, on average, four false alarms for every verified hot box.) FRA believes that any mandate to install overheated bearing detectors should be selective, based on traffic, population, the presence of waterways or other environmentally sensitive areas, and other risk factors. Further, any mandate cannot ignore other alternatives, including further emphasis on improved bearing design and quality control.

To answer your specific question with respect to the maintenance of records and Federal access, I need to expand and clarify my February 9, and October 15, 1998 letters. The approvals issued by the Association of American Railroads' (AAR) Bureau of Explosives (BOE) generally authorized the shipment of explosive materials and devices and to a limited degree handling requirements for shipments by tank car. Unrelated to the BOE approvals, but related to it by organization, the AAR Tank Car Committee approves tank car design drawings; the construction of the tank, including valves and fittings; tank car facility equipment requirements; and the qualification of facility personnel. The AAR Tank Car Committee consists of industry representatives that meet certain academic and professional requirements. Nearly all of the members have a mechanical engineering degree and represent the railroad, shipping, car builder, or a trade association. The AAR Tank Car Committee, as a third-party, approves the design of the tank, valve, or fitting when in its opinion the design conforms to the Federal requirements. The AAR, in addition to the Federal Railroad Administration (FRA) audits tank car facilities for compliance with both Federal and industry rules and standards. During the audit, an inspector may ask for any drawing to compare it with actual production. It is the car owner, not the AAR that must ensure that all design requirements are met. See for example 49 CFR 179.1 Z(d), (e), and (f).

Design drawings, and any related paper work are generally held at the corporate office or some other central location. Car owners, not the AAR, are required by regulation to maintain the design drawings and related documents throughout the period they own the car. See for example 49 CFR 180.517. FRA has enforcement authority over bulk packagings, including tank cars, transported by railroad. As part of the Department's statutory authority under the Hazardous Materials Transportation Law, the FRA inspectors have the right to request any document related to railroad safety, including tank car drawings. In discussions with the FRA, that agency has never had a problem in obtaining the records it needs from the car owner to oversee its safety program. The records are available by simply contacting the car owner.

With respect to the car owner, each tank car is required by regulation and by industry rules to display a reporting mark and number. The owner of any railcar by reporting mark is traceable through the Universal Machine Language Equipment Register (UMLER) administered by the AAR. The Official Railway Equipment Register, a publisher of the UMLER record, also provides information on the car owner, and maintenance and car accounting points of contact.

I hope this answers your concerns with respect to the availability of car records.

AN ASSESSMENT OF RAILROAD TANK CAR RULES

SUMMARY: *Tank cars are designed, built, and operate under an intricate and complementary set of rules. FRA's freight car and power brake rules deal with the tank car as they would any other railroad freight car. RSPA's hazardous materials rules (enforced against railroads by FRA) treat the tank car as a packaging and mandate safety features and permissible materials of construction. Industry rules, in the form of the AAR interchange rules, provide for the use by one entity (a railroad) of equipment belonging to another (a chemical shipper) and the standards for keeping the car up to current maintenance requirements.*

The tank car is a time-proven, efficient hazardous materials packaging, which has proven safe for its intended function, but the fleet needs improvement. Accident experience and improvements in tank car construction suggest a hierarchy of tank car survivability in derailments, with noninsulated class 111 cars the least resistant to product loss in an accident scenario. FRA and RSPA have engaged in a progressive program of improvements to the hazardous materials tank car fleet since the 1970s. Early efforts concentrated on the cars carrying the most volatile products and the program has advanced so that, now, the role of the DOT 111 car is being perceptibly reduced as a transportation vehicle for hazardous materials. FRA and RSPA have proposed amendments to the Federal tank car rules that will continue the improvement process and final rule revisions are now being considered.

Eliminating risk frequently requires effort of a different order of magnitude than merely reducing risk. Even fully jacketed and shielded pressure tank cars have lost product in accidents. Future improvements are most likely with a systems approach, examining the commodity, the packaging, and the movement conditions as a whole and then acting to reduce overall risk and exposure.

REPORT: There are about 213,000 tank cars in the North American rail car fleet, including about 22,000 which may move across the borders from Canada and Mexico under the industry's interchange rules. Comprising just over 13 percent of the freight car fleet, tank cars move 70 percent of rail-hauled hazardous materials.

Industrial shippers and car leasing companies own essentially all U.S. tank cars. Because of the products likely to be carried, tank cars get, and deserve, extra scrutiny in the name of safety. It should be recognized, however, that tank cars carrying hazardous materials are rarely the cause of railroad accidents; since the first tank cars were built in the Pennsylvania oil fields in the years just before the Civil War, they have compiled a good safety record.

FRA, working with RSPA, reported in 1990 on the relationship between DOT and the AAR Tank Car Committee.[68] The 1990 report includes a summary of the history of the tank car in this country and, because an understanding of that history is essential to an understanding of how Federal tank car regulations developed and why they are structured as they are, FRA has adapted it as Appendix A to this report.

By the time the Interstate Commerce Commission (ICC) began to regulate hazardous materials transportation early in this century, the industry had set its own standards for the design, construction, alteration, and repair of tank cars. The ICC adopted industry standards and, by regulation, required the Committee on Tank Cars of the American Railway Association[69] to approve applications for construction, alteration, or repair of tank cars if the design met the ICC standard. Setting the basic safety standards and specifications is properly the role of the Government, but the ICC became extremely

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[68] *A Report on Tank Cars: Federal Oversight of Design, Construction, and Repair*, Federal Railroad Administration and Research and Special Programs Administration, Department of Transportation, Washington, DC, 1990.

[69] The predecessor of the Association of American Railroads, the present industry association.

reliant on the industry's recommendations for changes in the specifications.

Two key pieces of legislation make the Department of Transportation responsible for regulating the design, construction, and repair of railroad tank cars: The Federal Railroad Safety Act of 1970 and the Hazardous Materials Transportation Act.[70] Under FRSA, the Secretary of Transportation is directed to prescribe regulations "for all areas of railroad safety." The HMTA grants the Secretary authority to issue regulations which "govern any safety aspect of the transportation of hazardous materials." The Secretary has delegated implementation and enforcement of these acts and their regulations to the Federal Railroad Administration and the Research and Special Programs Administration.

While DOT is now more active in matters relating to tank cars, Governmental/industry operating patterns remain much influenced by the patterns established prior to the creation of the Department in 1966. The tank car specifications are issued by DOT, although proposed changes fostered by the private sector often emerge from the considerable expertise of the Tank Car Committee of the AAR. Before a car enters service, its builder must issue a Certificate of Construction certifying that the car complies with all applicable DOT and AAR requirements, including specifications, regulations, the interchange rules, and the DOT Railroad Safety Appliance Standards.[71]

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[70] 49 U.S.C. Subtitle V, Part A, formerly 45 U.S.C. § 421, et seq. and 49 U.S.C. § 5101 *et seq.*, formerly 49 U.S.C. App. § 1801 et seq.

[71] 49 CFR Part 231.

Rules, Regulations, Orders, and Standards:

Tank cars are built and operate under four primary sets of rules or standards:

- Regulations and orders issued under the Federal railroad safety laws (other than the HMTA), including emergency orders;
- Regulations issued under the HMTA, as amended;
- The AAR Tank Car Manual; and
- The AAR Interchange Rules.

Regulations issued under the Federal railroad safety laws: Federal railroad safety legislation[72] was discussed in the first part of this Report; regulations issued under those laws form a comprehensive scheme of Federally mandated safety programs, essentially all of them affecting hazardous materials transportation by railroad tank car.

FRA's safety regulations extend from Part 200 through Part 245 of Title 49, Code of Federal Regulations. Because all of these sections are related to railroad safety, all of them are, naturally, related to railroad hazardous materials transportation safety. These regulations impact hazardous materials transportation by railroad tank car from three broad perspectives: Human factors regulations,

[72] The HMTA, as it pertains to the railroad transportation of hazardous materials, is considered to be one of the railroad safety laws. *Public Utilities Commission of Ohio v. CSX Transportation, Inc.*, 901 F.2d 497 (6th Cir.), cert. denied. However, regulations promulgated under HMTA are sufficiently different in organization and in agency genesis from regulations promulgated under FRSA that it makes more sense in this report to discuss them separately.

equipment regulations, and regulations affecting the railroad operating and business environment.

Human factors regulations: Within this category are regulations seeking the optimum performance from the people who operate trains, whether or not they actually sit in the locomotive.

- Parts 217 and 218 cover operating rules and operating practices and prohibit, for instance, tampering with a safety device on a locomotive. Other rules in this group require blue signals to be displayed when workmen are on, under, or between rolling equipment.
- Part 219 prescribes minimum Federal safety standards for the control of alcohol and drug use by railroad workers.
- Part 220 establishes requirements governing the use of radio communications in connection with railroad operations.
- Part 228 sets forth the reporting and recordkeeping requirements with respect to the hours of service of railroad employees.
- Part 240 prescribes minimum qualifications for locomotive engineers, to ensure that only qualified persons operate locomotives or trains.

Equipment regulations: These standards cover the tank car as it exists as a railroad car, while the regulations issued under the hazardous materials acts cover the tank car as a container of dangerous commodities.

- Part 215 contains the Federal safety standards for railroad freight cars. This part describes the safety limits for freight car components such as wheels, axles, bearings, coupling systems, and car bodies. In addition, this part describes conditions under which defective freight cars may be moved and establishes requirements for stencilling cars with their reporting mark and other necessary information.

- Part 221 sets standards for highly visible marking devices for the trailing end of the rear car of all passenger, commuter and freight trains; its purpose is to help prevent rear end collisions.

- Part 229 defines Federal safety standards for all locomotives (except those propelled by steam).

- Part 231 contains the safety appliance standards, such as the requirements for steps, ladders, handholds, hand brakes, and uncoupling levers.

- Part 232 requires power brakes on freight cars, sets the standard height for drawbars, and establishes the rules for inspection, testing, and maintenance of power brake systems.

Regulations affecting the railroad operating environment: This group of regulations involves the structural network through which tank cars move.

- Part 213 imposes minimum requirements for track that is part of the general railroad system of transportation.

- Part 225 sets forth requirements for reporting accidents in order to provide FRA with information concerning hazardous conditions on the Nation's railroads.

- Parts 233, 234, 235, and 236 encompass FRA's regulation of railroad signal systems.

Emergency orders: Emergency orders, issued under FRSA, comprise an additional facet of the Department's regulation of hazardous materials transportation by tank car. FRA is authorized to issue emergency orders where an unsafe condition or practice creates "an emergency situation involving a hazard of death or injury to persons."[73] As of the publication of this report, FRA has issued 17 emergency orders. Four of the emergency orders act directly to restrict the operation of tank cars or take certain of them out of service:

Order/ Publication	Summary
No. 2 37 FR 28311 12/22/72	Affected 3 series of DOT 112A400W tank cars built by UTLX susceptible to cracking in the bolster area.
No. 5 39 FR 38230 10/30/74	Affected DOT 112A and 114A tank cars not equipped with headshields; prohibited cutting off in motion (required shove to rest), required shipping paper declaration.
No. 16 57 FR 11900 4/7/92	Required inspection and repair of dual diameter tank cars due to shell cracking problem.
No. 17 57 FR 41799 9/11/92	Requires priority-based inspection program to detect cracks and defects in the stub sill area, reaching essentially all stub sill tank cars built before 1984. High mileage cars, and those assigned to AAR Priority Inspection Program to be inspected within 18 months; others within 5 years (jacketed cars) or 7 years (non-jacketed cars).

Five other emergency orders directly impact hazardous materials, either through restrictions on particular kinds of dangerous materials, such as explosives that do not move in tank cars, or by restricting or prohibiting the passage of hazardous materials over all or a part of a railroad's tracks. That over half of FRA's emergency orders relate to hazardous materials is understandable in light of the constant, immediate threat they pose.

[73] 49 U.S.C. § 20104, formerly 45 U.S.C. § 432(a). Emergency orders may immediately impose "restrictions and prohibitions ... that may be necessary to abate the situation."

Regulations issued under the hazardous materials transportation acts: Regulations issued under the HMTA and its amendments form the basis for the DOT's multimodal hazardous materials safety program. Although FRA does a significant part of the developmental work on railroad-related hazardous materials regulations, these regulations are issued by RSPA.

RSPA Regulations: Other than regulations pertaining chiefly to program administration, RSPA's hazardous materials regulations run from Part 171 through Part 180 of Title 49, Code of Federal Regulations. Because RSPA's regulations are intermodal, not all of them pertain to railroad transportation. Those that do are found in the following Parts:

- Part 171 contains the basic definitions used throughout the regulations, the rule for regulatory construction and the requirements for filing incident reports.
- Part 172 contains the hazardous materials table, listing more than 2,500 separate commodities as well as generic names, such as flammable liquid, nos[74]). Columns in the table lead to other sections in Part 172 such as those on proper documentation and marking, labeling, and placarding.
- Part 173 is primarily concerned with the duties of shippers and the preparation of hazardous materials for transportation. This part contains all of the hazard class definitions and the packagings necessary for each.
- Part 174 prescribes the principal requirements for the transportation of hazardous materials by railroad. It is

[74] "Nos" is a term borrowed from commercial tariffs. It is a short hand expression for "not otherwise specified." Most nos commodities must also have the technical name of the hazardous material appended to the generic entry.

concerned with the inspection of cars carrying dangerous materials, the documentation required to be on the train, and the placement within the train of cars transporting hazardous materials. This part also contains rail-specific requirements for each of the classes of hazardous materials.

- Part 179 contains the tank car specifications; the AAR Tank Car Committee uses these specifications as the measure for approving or disapproving applications for the construction of tank cars.[75]

Selected regulatory proceedings affecting tank cars: While RSPA has issued scores of *Federal Register* notices concerning tank car regulations, a few regulatory proceedings deserve explanation because of their major impact on tank car safety. Significant rulemaking dockets (shown by RSPA docket number) affecting tank cars include the following[76]:

- HM-109 -- Tank Car Tank Head Shields. Growing concern over tank car accidents involving uninsulated pressure tank cars prompted the FRA to commission the Railroad Tank Car Safety Research and Test Project[77] to study the design of a railroad tank car head protective device that would reduce the

[75] The FRA/RSPA *Report on Tank Cars*, referenced above, contains a lengthy discussion of the workings of the AAR Tank Car Committee and how it functions in "approving" applications to construct tank cars.

[76] An extensive summary of HM Docket proceedings can be found in Bierlein, Lawrence W., *Red Book on Transportation of Hazardous Materials*, ©1988, Van Nostrand Reinhold Company, Inc., New York. Mr. Bierlein has kept the *Red Book* up to date and later editions are available.

[77] The Railroad Tank Car Safety Research and Test Project is an ongoing cooperative research program of the AAR and the Railway Progress Institute. It has compiled an extensive data base on tank car accidents and accomplished impressive work in the advancement of hazardous materials transportation safety in tank cars.

frequency of head puncture in accidents. The Project report on this topic, titled "Hazardous Materials Tank Cars - Tank Head Protective Shield or Bumper Design," was completed in August 1971. The study showed most punctures to the heads of DOT Specification 112A and 114A tank cars occurred in the lower half of the head. The cost/benefit analysis for applying head shields was favorable. Shortly after the study was released, an accident occurred in the Alton and Southern yard at East St. Louis involving the head puncture of a DOT Specification 112A tank car containing liquefied petroleum gas. A vapor cloud was released and created a fireball. Approximately 230 people were injured and damages were estimated at $7.5 million. Based on the findings of the study and the incident at East St. Louis, a Notice of Proposed Rulemaking appeared in the Federal Register on May 29, 1973, under Docket HM-109. The final rule, published July 30, 1974, established a requirement that DOT Specification 112A and 114A tank cars be equipped with a protective head shield by December 31, 1977.

- HM-144 -- Specifications for Pressure Tank Car Tanks. On November 29, 1976, following a petition from the Railway Progress Institute, DOT proposed rules that would require shelf couplers, thermal protection systems, and head shields on DOT 112 and 114 cars transporting flammable gases. Head shields and shelf couplers would be required for nonflammable compressed gases, such as anhydrous ammonia. Finally, shelf couplers were proposed for all DOT 112 and 114 tank cars. Pressure for these proposals came from the ongoing studies being done by the Railroad Tank Car Safety Research and Test Project, and by a series of tragic hazardous materials accidents. HM-144 became a final rule on September 15, 1977.

- HM-174 -- Specifications for Tank Cars. In HM-144, DOT added safety features to DOT 112 and 114 tank cars because they were deemed a greater hazard than the jacketed DOT 105 specification tank cars. In HM-174, the same attention was focused on the DOT 105 tank car, one equipped with a jacket and product protection insulation as part of its original design. The final rule in this proceeding, published January 26, 1981, required shelf couplers on existing DOT 105 cars within a year, head protection for newly built 105 cars transporting flammable gases, anhydrous ammonia, and ethylene oxide, and thermal protection for newly built 105 cars transporting flammable gases and ethylene oxide. There was also a safety relief valve sizing requirement effective for new 105 cars transporting flammable gases and ethylene oxide.

- HM-175 -- Specifications for Railroad Tank Cars Used to Transport Hazardous Materials. This proceeding focused on retrofitting existing tank cars. Continuing the progress of improving safety design requirements through the North American tank car fleet, DOT promulgated a final rule in this docket on January 27, 1984, and required existing DOT 105 cars exceeding 18,500 gallons and transporting flammable gases, anhydrous ammonia, or ethylene oxide to be equipped with head protection; existing 105 cars transporting flammable gases and ethylene oxide were also to be equipped with thermal protection. Existing DOT 111 cars transporting ethylene oxide or flammable gases would have to be equipped with thermal insulation and head shields. Both the 105 cars and the 111s affected by the rule would be required to be equipped with large capacity safety relief valves sized according to the specifications for DOT 112 and 114 tank cars.

- HM-181 -- Performance-Oriented Packaging Standards. DOT sought through this proceeding to align United States "specification packaging" regulations with the international community "performance standard" packaging requirements. While the subject matter of this docket extended well beyond tank cars, the final rule, published on December 21, 1990, narrowed the choices of tank cars for the transportation of liquid materials that are poisonous by inhalation. Stronger tank shells, thermal protection, insulation, and head protection are now required. For poisonous gases, the final rule generally required the use of tank cars with at least a 300 psi tank test pressure, thermal protection, insulation and head protection. While the rules concerning packagings for PIH materials are now considerably more stringent than under the previous regulations, the toxicity of the materials justifies the stricter standards. A related proceeding, HM-181F, published September 24, 1993, authorizes stainless steel plate for the construction of DOT 105, 112, and 114 tank cars and provides an option for insulation or jacketed thermal protection for PIH liquids.

- HM-196 -- Packaging and Placarding Requirements for Liquids Toxic by Inhalation. As published in the *Federal Register* for October 8, 1985 [50 FR 41092] DOT established the new "poisonous by inhalation" hazardous materials grouping and, in this proceeding, set conditions that improved communication about PIH materials by requiring, for example, that tank cars transporting them be stenciled INHALATION HAZARD.

Pending regulatory proceedings affecting tank cars will be discussed in a subsequent section of this report.

The Association of American Railroads Tank Car Manual: In DOT hazardous materials regulations, the term "approved" almost always means "approval issued ... by the Department ...."[78] The exception is in Part 179, the "Specifications For Tank Cars," where "approved" means "approval by the AAR Committee on Tank Cars."[79] The Tank Car Committee has two distinct types of "approval" authority under the regulations: one is largely ministerial and the other relies heavily on the expertise of the Committee members.

When an application for approval of designs and materials for the construction, conversion or alteration of tank car tanks is submitted to the Committee, it grants approval when, in its opinion, "such tanks ... are in compliance with effective regulations and specifications of the Department ...."[80] This "generic" approval, to ensure that plans to construct, alter, or convert tank car tanks comply with the DOT regulations, is primarily a ministerial function.

The Committee's other authority--and virtually every application involves the exercise of both--seeks to tap the collective expertise of its members and calls for a great degree of discretion. At more than 100 places in Part 179, the TCC must approve designs, fittings, methods, and materials.[81] To illustrate, in section 179.103-2(a), manway covers "shall be of approved design." According to section 179.201-9, "a gaging device of an approved design must be applied to permit determining the liquid level of the lading." Section 179.10 states, "The manner in which tanks are attached to the car structure shall be approved"; and section 179.100-4(a) says, "If insulation is applied, the tank shell and manway nozzle must be

[78] 49 C.F.R. § 171.8.

[79] 49 C.F.R. § 179.2(a)(2). There is also a reference to AAR Tank Car Committee approval in § 174.314(a)(4); it points back to Part 179.

[80] 49 C.F.R. § 179.3.

[81] The full listing of these sections is in Appendix C of the FRA/RSPA *Report on Tank Cars.*

insulated with an approved material."[82] For these and for the nearly 100 other "specific" approvals in Part 179, there are no precisely worded standards and no engineering specifications. This does not mean the Federal regulations lack substance. The general requirements for *all* packagings are stated in § 173.24 and many subparagraphs of it are stated in performance standard-type language, for example, at § 173.24(f)(1):

> Closures on packagings shall be so designed and closed that under conditions (including the effects of temperature and vibration) normally incident to transportation ... the closure is secure and leakproof.

The reliance on lessons learned, and on developing technologies, has deep roots in history, and is more fully discussed in the FRA/RSPA *Report on Tank Cars.*

The primary document containing the standards of the Tank Car Committee is the AAR Specifications for Tank Cars.[83] Popularly known as The Tank Car Manual, the work contains 6 chapters and 13 appendices, summarized briefly below.

Chapter l, Introduction, Approvals and Reports: This chapter lists abbreviations and definitions and establishes the procedures for securing approval for the new construction of tank cars.

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[82] Underscore added.

[83] Association of American Railroads, Operations and Maintenance Department, Mechanical Division, Manual of Standards and Recommended Practices; Section C - Part III, "Specifications for Tank Cars, Specification M-1002," (revised annually), Washington, D.C. Often called the Tank Car Manual, or the Manual, this is actually only part of a comprehensive and inclusive work on standards published by AAR's Mechanical Division. The entire Manual of Standards has 11 sections, many of them with multiple parts.

Chapter 2, AAR Special Requirements for DOT Tank Cars: This chapter contains specific commodity requirements, over and above those in the regulations, for hydrogen sulfide, chloroprene, anhydrous hydrogen fluoride, chlorine in multiunit tanks, flammable liquids, ethylene oxide, vinyl chloride, and flammable gases. In addition, several commodities are specifically prohibited from aluminum tank cars. This chapter also establishes standards for items such as acid car fittings, frangible discs, vacuum relief valves, and interior protective coatings and linings.

Section 2.3, "Special Requirements," sets forth the revisions to the regulations recommended by TCC but not yet promulgated by DOT. The interchange rules state:

> Tank cars (empty or loaded) will not be accepted in interchange unless they comply with the AAR Specification for Tank Cars and DOT Regulations.[84]

The railroad industry has thus built a requirement to haul any owner's compatible cars into a standard which gives nearly the effective force of law to a body of nongovernmental regulations. To explain: in addition to satisfying the requirements of 49 C.F.R. Part 179, a railroad tank car must also satisfy the interchange rules (which can be more stringent than Federal requirements) if it is to be guaranteed "free access" to any point served by the general system of railroad transportation. The Tank Car Committee may not, under section 179.3(b), refuse to approve construction of a car meeting all Federal requirements.[85] However, a tank car which does not also meet all the applicable requirements of the AAR specifications will

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[84] Association of American Railroads, Interchange Rules, published in a "Field Manual" and an "Office Manual," revised annually, Washington, D.C., referenced edition effective January 1, 1992, Rule 88.A.26.

[85] There is anecdotal evidence that this has happened; the writers of the FRA/RSPA *Report on Tank Cars* could not document any specific examples.

only move if a separate agreement can be reached with each carrier involved in the haul. It must be clearly understood that DOT does not imply a violation of law or policy based on AAR's adoption of section 2.3 of the Tank Car Manual or Interchange Rule 88.A.26; both are a developed response of many years' standing to a requirement of the Interstate Commerce Act. It does, however, explain the importance given to DOT oversight of TCC functions: both the facts and the appearance of TCC regulatory implementation activities must be of the highest caliber.

Chapter 3, Specifications for AAR Tank Car Tanks: With a few exceptions, tank cars built to AAR specifications cannot be used for hazardous materials; the AAR construction standards are very similar to the DOT specifications but usually do not include radioscopic examination of the welded seams or full post-weld heat treatment. Included in this chapter are specifications for AAR-203W, -211W, -204W, -206W, -207W, and -208W tanks; the specification numbers follow the DOT scheme.

Chapter 4, Acceptability of Tank Containers and Tank Trailers: This chapter contains industry standards for intermodal portable tanks, and for highway tank trailers to be moved in trailer-on-flatcar (TOFC) service.[86]

Chapter 5, General Design and Test Requirements: AAR's general requirements cover items such as tank car heater systems, placard holders, lifting provisions, tank anchors, head shields, and auxiliary compressed gas cylinders.

[86] While 49 C.F.R. § 174.61(c) allows cargo tanks containing hazardous materials in TOFC service "under conditions approved by the Federal Railroad Administrator," AAR's TOFC/COFC Interchange Rules (Rule 9) prohibit such movements. As this report was being written, a final rule in HM-197, Hazardous Materials in COFC and TOFC Service, was under active review in FRA and RSPA. See below for further discussion.

Chapter 6, Car Structure Design and Test Requirements: This chapter cross-references the tank car standards with the general freight car standards; it also describes the methods for testing design loads.

Appendix A, Tank Car Valves and Fittings: This appendix contains requirements for the design, testing, construction materials, and marking of tank car valves and fittings. Because the design of valves and fittings must be approved by the Tank Car Committee, this appendix also provides a reference to the applicable approval procedures.

Appendix B, Certification of Facilities: AAR requirements relating to the certification of facilities for fabrication, assembly, alteration, conversion, repair, and associated testing of completed tank car tanks are in this appendix. Certified facilities are listed according to the category of work and the materials of construction for which they are approved.

Appendix C, Marking of Tank Cars: This appendix describes the AAR requirements for stenciling and stamping tank cars. "Stamping" requirements include a list of the regulatory elements that must be physically metal stamped into a tank, including tank specification, material, tank builder's initials, date of original test, and the water capacity in gallons or liters for nonpressurized cars and in pounds or kilograms for pressure cars.

Appendix D, Retest and Reinspection Requirements: The majority of this appendix is a reprint of 49 CFR Section 173.31; additional material includes a form ("Certificate of Test Form") for recording retests.

Appendix E, Design Details: This appendix includes standard dimensions and tolerances, the design of manway covers, vertical curve clearance requirements, joint efficiencies, bottom discontinuity protection, and the limiting dimensions for placard holders.

Appendix H, Basic Philosophy and Principles For the Metrication of the AAR Specifications for Tank Cars: This appendix contains guidelines for converting the specifications from conventional units to SI units. (SI is the official abbreviation for the International System of Units, a modernized version of the centimeter-gram-second system.)

Appendix L, Interior Cleaning, Lining and Coating: Appendix L describes industry requirements for the application, stripping, and cleaning of interior linings for tanks and coatings.

Appendix M, Specifications for Materials: This appendix includes a listing of materials approved for various tank car applications. The appendix also establishes the procedure for obtaining approval of a specification material proposed for tank car construction.

Appendix P, Tank Car Committee Procedures: This appendix describes procedures to be used by the Tank Car Committee in conducting its business. The existence and purpose of the Accident Review Working Group is formalized in this appendix.

Appendix R, Repair, Alteration and Conversion to Tank Car Tanks: In these specifications, "repair" means the reconstruction of a tank to its original design; "alteration" is a change in the tank or its fittings that does not change the specification but does change the certificate of construction, and "conversion" means changes in the tank or fittings that change the specification. Appendix R defines these terms and sets the standards for their application. The specification also explains the requirements for welding and for repairs of various types.

Appendix S, Loading Appurtenances for Tank Cars: The appendix describes requirements for ladders, platforms, railings, and handholds for use by personnel loading and unloading tank cars; it supplements material contained in the safety appliance standards, 49 CFR Part 231.

Appendix W, Welding of Tank Car Tanks: Appendix W sets the standard for tank car fusion welding and for judging facilities seeking status as certified welding shops. The standard is comprehensive and includes guidelines on radioscopy, penetrameter use, and fabrication techniques. Welding shops are required to maintain records of the qualifications of their welders, and each welder is assigned a number; the tests given by one shop do not qualify a welder to work for another without a retest.

Appendix X, DOT Regulations: As a convenience to those whose major contact with the Hazardous Materials Regulations is through matters affecting tank cars, the Tank Car Committee reprints relevant sections in this appendix.

Appendix Y, Selected AAR Circular Letters: During the conduct of its business with the railroad industry, AAR has occasion to write letters to members and private car owners (the generalized name of that group of interests directly affected by the Interchange Rules). Certain of those letters contain information not in the Specifications for Tank Cars, but believed to be of long-term relevance. They are copied into this appendix.

The AAR Interchange Rules: As noted above, the Interstate Commerce Act requires railroads to interchange[87] equipment. This

[87] The following definitions appear in *The Railroad Dictionary of Car and Locomotive Terms*, Revised Edition, Simmons-Boardman Publishing Corporation, Omaha, NE: "Interchange." The transfer of cars from one road to another at a (continued...)

requirement led to a nationwide rail network that functions as a single system. It also, in effect, forced the railroads to develop a set of standards, so that the cars of one railroad would fit with the cars of another, and a set of "rules for usage," so that a railroad could repair "foreign" cars and get paid for them while not getting billed for unnecessary repairs to its own cars.

The "rules of usage" are the Interchange Rules, adopted by the AAR Mechanical Division. They appear each year in two volumes, the Field Manual and the Office Manual. Generally, the rules for the acceptability and use of freight cars are in the Field Manual and the rules for repair billing, together with the costs of each repair procedure, are in the Office Manual. General Rule A of the Interchange Rules states:

> These rules are formulated ... as a guide to the fair and proper handling of all matters contained therein for the interchange of freight traffic, with the intent of:
>
> a. Making car owners responsible for and therefore chargeable with the repairs to their cars necessitated by ordinary wear and tear in fair service, Safety Requirements, and by the Standards of the Association of American Railroads.
>
> b. Placing responsibility with and providing a means of settlement for damage to any car, occurring through unfair usage or improper protection by the handling company.

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[87](...continued)
common junction point. "Interchange Rules." A set of regulations adopted by the Association of American Railroads governing the care and handling of freight cars operating in interchange service.

c. Providing an equitable basis for charging such repairs and damages.

d. Providing for acceptance or rejection of these rules as a whole, with no exception to an individual rule or rules being valid.

e. Establishing that rules contained herein are not intended to cover other independent agreements entered into by parties concerned. Nothing in these rules shall interfere with the rights of any subscribers to enter into an independent agreement with any other subscriber.

f. Rules and amendments shall not apply retroactively from their effective dates.

Because tank cars are freight cars, all the interchange rules apply to them. In addition, tank cars are specifically mentioned at several points in the interchange rules:

Rule 1.3.c. requires a leaky tank car to be stenciled and the owner notified. The owner must then give disposition in 15 days. (This rule is an example of the railroads amplifying a Federal requirement about inspecting tank cars and giving it practical application by requiring the owner to tell the railroad what to do with the leaky car. The Federal rule, § 174.50(d), only requires the owner to be notified.)

Rules 16, 17, and 18 allow railroads to charge car owners for replacing standard couplers with shelf couplers.

Rule 81 relates to the correct repairs of safety railings and other appliances, to the replacement of outlet caps and safety valves, and to the need for certification of shops performing welded repairs.

Rule 88 contains the mechanical requirements for interchange and requires an extensive mechanical inspection, including the sills and trucks, "before or at the time of tank retest."

Rule 92 allows the owner to be billed for transferring or adjusting a car transporting hazardous materials if it was not loaded in compliance with the hazardous materials regulations.

An Assessment and Overview:

Almost a million and a half cars of hazardous materials were transported by the railroads in 1992, 70 percent of them tank cars.[88] Less than one-tenth of 1 percent of those shipments lost any product in transit. The railroad and chemical industries have an excellent safety record in transporting hazardous materials but, as impressive as the bare statistics might be, they cannot deny the potential for disruption to life, health, and property whenever the hazardous materials transportation safety system breaks down.

The tank car is one of a number of packagings suitable to carry hazardous materials. The Hazardous Materials Regulations (49 CFR Parts 171 - 180) contain detailed requirements for selecting the proper package (including rail cars and highway vehicles) for each of the several thousand commodities classified as hazardous.

[88] "Annual Report of Hazardous Materials Transported by Rail," published annually by the Bureau of Explosives of the Association of American Railroads, Washington, DC. The AAR reports that the percentage of hazardous materials moving by tank car has fallen over the past several years. In 1982, 82 percent of rail-hauled hazardous materials moved in tank cars and as recently as 1988, nearly three-quarters of the dangerous goods traffic moved by tank car. The decline is due primarily to the increasing use of TOFC/COFC (Trailer-on-flatcar and container-on-flatcar) services and intermodal portable tanks.

Commodity/package combinations are assigned by RSPA, acting in cooperation with FRA for tank cars, on the basis of the dangers posed by the commodity and the degree of securement offered by the package. As a general rule:

> Each package used in the shipment of hazardous materials ... shall be designed, constructed, maintained, filled, its contents so limited, and closed, so that under conditions normally incident to transportation ... there will be no identifiable (without the use of instruments) release of hazardous materials into the environment.[89]

A recent summary of the tank car fleet registered in UMLER[90] showed that some 212,891 tank cars of several different specifications make up the North American fleet. Of these, 157,349 are low-pressure DOT 111A cars. They have recently received significant adverse publicity, but they remain a critical resource for the movement of industrial chemicals and other materials.

Class 111 cars are constructed of a minimum of 7/16 inch American Society for Testing Materials (ASTM) type 516 carbon steel plate, formed and joined to exacting Federal specifications under 49 CFR Part 179. Most DOT Class 111 tank cars have insulation and tank jackets as an aid to maintaining product temperature during transportation. However, most do not have head shields or high temperature thermal protection. Class 111 tank cars are sometimes

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[89] 49 CFR § 173.24(b).

[90] Universal Machine Language Equipment Register, maintained by AAR, is described in its data specification manual as

> a computer file which contains specific details on the internal and external dimensions, carrying capacities expressed in gallons/cubic feet capacity, equipment weight, as well as special equipment on all railcars and highway trailers and containers that are used in interchange or commercial service.

referred to as general service or low pressure cars. "Low pressure" cars also include the DOT 103, an older type that allowed for product expansion in the dome of the car rather than through "outage" in the tank itself.[91]

Low pressure tank cars carry nonregulated products as well as regulated hazardous materials with relatively low vapor pressures. As a general matter, only those hazardous materials that pose low-to-moderate hazards[92] are allowed to be transported in DOT 103 or 111 tank cars. Where high hazard commodities are authorized in these cars, it is usually because of a special characteristic of the material. For instance, nitric acid is authorized in a DOT 111 tank car, but only one made of aluminum or stainless steel, materials of construction not seen in pressure tank cars.[93] As of October 1, 1993, all poison-by-inhalation liquid materials, that could formerly have been transported in DOT 111 cars are required to be transported in "pressure" tank cars that offer greater protection in accidents.

Pressure tank cars, Classes 105, 109, 112, and 114, are constructed of thicker- and higher-strength steels, are required to have their valve arrangements enclosed within a protective housing, and may not, except for the small 109 and 114 fleets, have bottom openings. These cars transport certain pyrophoric liquids (Division 4.2), dangerous-when-wet materials (Division 4.3), poisonous liquids

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[91] Outage refers to the space remaining between the top of the product level in the car and the tank shell. Sufficient outage, generally 1 to 5 percent, prevents the car from becoming totally full (shell full) as the product warms and expands following loading.

[92] "Low to moderate" hazard materials are those listed in the commodity table (49 CFR § 172.101) that are referenced to bulk packaging sections 173.240, .241, .242, and .243.

[93] The amendments to Docket HM-181 published September 24, 1993, now permit DOT 105, 109, 112, and 114 tank cars to be constructed of specifically designated stainless steels.

(Division 6.1), and a variety of compressed gases (Division 2.1, 2.2 and 2.3). Most pressure tank cars have tank head protection, and cars carrying flammable gases also must be equipped with high-temperature thermal protection. Class 105 pressure cars are equipped with ambient temperature insulation, while Classes 112 and 114 are not.

FRA has examined the accident history of tank cars in two major studies.[94] The reports confirm that the number of tank car accidents is small compared to the total tank car population and to the total quantity of hazardous materials moved by tank car.

However, considering accident experience, and mandated improvements in tank car construction, the research suggests a rough hierarchy of tank car survivability, taking into consideration such events as head punctures, shell punctures, and thermal failure (the major catastrophic events associated with train accidents involving hazardous materials). Within that hierarchy, noninsulated Class 111 cars are the least resistant to loss of product in accidents.[95]

Based on the information available from research and on FRA's own accident investigation experience, it appears that the following

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[94] The primary studies are Hazel, Morrin E., Jr., Tank Car Accident Data Analysis, June, 1991, and Analysis of Tank Cars Damaged in Accidents, 1965 through 1985, Report RA-02-6-55, 1989, RPI-AAR Railroad Tank Car Safety Research and Test Project, Washington, D.C. Hazel analyzed the characteristics of individual tank cars in 654 reported train accidents between 1981 and 1985 that involved hazardous materials; the 1989 report of the Tank Car Project also examined tank cars in accidents and used the number of tank car movements to normalize the data. Additional sources of tank car data analysis, including discussions of both the potential danger of a release of chemicals and the risk of release actually taking place, are referenced in the section of this Report covering the in-train placement of hazardous materials cars.

[95] The number of DOT 103 tank cars remaining in service is very small and is, thus, not separately analyzed here.

attributes enhance the likelihood of survivability, albeit not necessarily in the order presented:

- Increased tank shell wall thickness (normally associated with pressure tank cars);
- Jacketed design (i.e., the presence of a steel jacket surrounding insulation, high temperature thermal protection, heating coils, etc.);
- Presence of high temperature thermal protection (with respect to commodities requiring this feature);
- Tank head protection (head shields); and
- Shelf couplers.

Of these attributes, noninsulated 111 cars typically have only shelf couplers and, perhaps, tank walls significantly thicker than required, and the accident experience reflects that fact. Jacketed (insulated) 111 cars perform better in accidents, but not nearly as well as jacketed pressure cars equipped with head shields and thermal protection.

Because of these considerations, since the early 1970s, FRA and RSPA have been engaged in a program of progressive improvement in the crashworthiness of the hazardous materials tank car fleet. This program has proceeded from cars used for the most hazardous commodities to those carrying commodities posing relatively less serious hazards. While this process of regulatory change has been underway, four trends have complicated the analysis:

- The frequency of serious railroad accidents has declined (i.e., the service environment has improved, hazardous materials accidents have decreased, and so the statistical data pool has shrunk);

- The types of chemicals transported have changed somewhat;

- As the knowledge of the short- and long-term effects of unintentional chemical releases has improved and as more is known about acute health hazards and about the hazards of catastrophic explosion or fire, some commodities have been added to "priority" lists and others have had their priorities elevated; and

- Environmental legislation enacted in 1980 required the Department to add to the list of hazardous materials thousands of environmentally hazardous compounds for which long-term health risks are not well known, greatly complicating the regulatory task.

Early efforts to improve tank car crashworthiness focused on uninsulated DOT 112 and 114 pressure tank cars with the installation of tank head protection and high temperature thermal protection on flammable gas cars required by the final rule in RSPA Docket No. HM-144. Insulated DOT 105 pressure cars transporting the same products and ethylene oxide were required to be fitted with head protection and thermal protection under Docket HM-175. These two rules also required the installation of head protection for tank cars transporting anhydrous ammonia. As a result of the implementation of international packaging standards in Docket HM-181, liquid materials are poisonous by inhalation must be transported in Class 105, 112, or 114 tank cars constructed of higher-strength steels and equipped with head protection and tank jackets.

This program of improvements is both gradually reducing the role of the DOT 111 tank car in transporting hazardous materials and requiring modifications to that car where warranted. FRA's Office of Research and Development, is continuing to study tank car/commodity combinations for further improvements. Following receipt of the tank car design process and criteria study called for in § 21 of the Hazardous Materials Transportation Uniform Safety Act of 1990 (HMTUSA), completion of ongoing research, and completion of the rulemaking in Docket HM-175A, FRA and RSPA may propose additional measures to improve tank car survivability.

FRA is concerned with the pace of tank car improvement, even though accident exposure is down and the commodities posing the most serious risks have been addressed. Certain factors still argue against hasty action:

- Risk reduction is not the same as risk elimination. Even jacketed and fully retrofitted DOT 105, 112, and 114 tank cars have lost product.

- Tank car construction capacity is limited and most of that capacity will be fully occupied over the next few years due to existing regulatory mandates (including inspection and repair of stub sill tank cars under Emergency Order No. 17).

- Disallowing use of the DOT 111 tank car for hazardous materials service could have countervailing adverse impacts that must be weighed against improved accident survivability. For instance --

- Adding tank jackets and head shields adds weight to a car and decreases its capacity.[96] Much of the traffic in Class 8 materials (corrosives) is in DOT 111 cars. Shippers argue that, because these materials tend to be heavy (dense), they are already travelling at maximum gross weight and every extra pound added to the car comes out of the lading. Current DOT 111 tank cars offer the greatest product capacity per movement, reducing the number of loadings/unloadings, switching movements, and tank car trips associated with the movement of the lower hazard commodities they transport.

- For some products, the additional number of trips (and associated transportation charges) associated with a heavier tank car will translate into higher costs for shippers and consumers, possibly leading to diversion of some shipments to the highway mode.

Further improvements in hazardous materials transportation by tank car are always possible. Final rules are being developed in two major rulemaking proceedings: HM-175A, concerning improvements to the crashworthiness of tank cars and HM-201, concerning modern nondestructive testing methods to qualify tank cars for continued service; both rules will be discussed in more detail in the next section. Future improvements will best be realized by examining the

[96] 49 CFR § 179.13 states:

Tank car capacity and gross weight limitation. Tank cars built after November 30, 1970, must not exceed 34,500 gallons capacity or 263,000 pounds weight on rail. Existing tank cars may not be converted to exceed 34,500 gallons capacity or 263,000 pounds gross weight on rail.

safety system (commodity, packaging, and operations) as a whole and acting to reduce both risk and exposure on a systems basis.

STATUS: PENDING RULEMAKING ACTIVITIES

SUMMARY: The safety of railroad hazardous materials transportation depends on the underlying safety of the rail carriers themselves. FRA is fully engaged in a railroad safety rulemaking program. Track standards and the power brake rules are under consideration on the broadest scale in a decade and bridge workers and utility employees will benefit from on-going regulatory activity. A final rule in the event recorder proceeding will mean better data for accident review and reconstruction.

RSPA and FRA are working as partners on railroad hazardous materials regulations. Two final rules, now under development, relate specifically to the transportation of hazardous materials in railroad tank cars. The first, Docket HM-175A, will improve the crashworthiness of tank cars by extending proven design features, such as head protection systems, to classes of tank cars where they are not now required. The second, Docket HM-201, will replace obsolete low-pressure hydrostatic testing of tank cars with modern non-destructive testing methods.

REPORT: Regulations that "seek to address the safe transportation of hazardous materials by rail"[97] gather under two broad headings:

- Those directly aimed at <u>hazardous materials</u> transportation--setting standards for documentation, marking, packaging, and the like, and

- Those specifically directed towards <u>railroad</u> transportation--directing standards for track, equipment, operating practices, and so on.

FRA has the lead regulatory development role under the railroad safety acts, while regulations based on the hazardous materials laws

[97] RSERA, § 16(7).

are developed under the auspices of RSPA, with FRA as a copartner on rail-specific projects.[98] Regardless of whether FRA or RSPA leads the team, the goal is the same: "Promote Safe and Secure Transportation," by minimizing "the dangers to communities and industry associated with the transportation of goods."[99]

An earlier chapter described significant railroad accidents involving hazardous materials during the period 1989-1992. From Helena, Montana, to Dragon, Mississippi, from Akron, Ohio, to Sea Cliff, California, *none* of those accidents was caused by the hazardous materials on board the train. The key factor in the safety of hazardous materials transportation by rail is the safety of the railroad environment. FRA promotes its rail safety mission across a broad front of railroad safety regulations.

<u>Railroad Safety Regulations</u>

Human factors regulations: These regulations seek the optimum performance from people who affect the movement of trains, whether or not they actually sit in the locomotive.

- <u>Alcohol and Drug Regulations</u>: FRA's rules for keeping alcohol and drugs[100] away from the transportation workplace fill Part 219 of Title 49, CFR. Under the mandate of the Omnibus Transportation Employee Testing Act of 1991, FRA amended its standards to incorporate new procedures and safeguards for

[98] RSPA's delegations of authority are in 49 CFR § 1.53(b); the primary statutory authority is found in 49 U.S.C. § 5103, formerly 49 U.S.C. app. § 1804. FRA's delegations of authority are in 49 CFR § 1.49; the primary statutory authority is 49 U.S.C. § 20103, formerly 45 U.S.C. § 431.

[99] Strategic Plan, US Department of Transportation, Goal 4, January 1994.

[100] Most of FRA's rules relating to alcohol and drug prevention are promulgated under FRA Docket No. RSOR-6.

breath and body-fluid testing and for "reasonable suspicion" testing for both alcohol and drugs. FRA is also conducting a closely monitored experiment to determine the optimum rate for random testing of covered employees.

- Protection of Utility Employees: FRA's "blue signal" regulations[101] prescribe minimum requirements for the protection of railroad employees engaged in the inspection, testing, repair, and servicing of rolling equipment. Because these activities may require employees to work in dangerous positions -- on, under, or between heavy equipment -- the employees need protection against movement of the equipment. FRA regulations require that the tracks on which such activities take place be "blue flagged" so that locomotives are blocked from coupling with the cars.

  Train and yard crews are excluded from blue flag protection because their working relationship with the engineer insulates them from accidental injury. Where railroads moved long trains into older-design, "short" rail yards, the blue flag rule posed a practical problem. Safety demanded an extra crew member for the yard move, but efficiency demanded that the extra person not be added to the line-haul crew. Working with both the employees and management, FRA on August 16, 1993, issued a final rule permitting the road crew to be augmented with a "utility" employee, protected by other safety requirements as alternatives to the blue flag.

- Bridge Worker Safety Standards: To foster uniform safety standards for bridge workers throughout the railroad industry,

[101] FRA Docket No. RSOP-11.

FRA published safety standards[102] in June 1992 applicable to both railroad employees and employees of railroad contractors. The rules require railroads to provide, and employees to use, fall protection and personal protective equipment, including head, hand, eye, face, and foot protection. In addition, the new regulations set standards for scaffolding and established additional protection for working adjacent to water.

The railroad industry challenged, in court, the provision in the rule that acknowledges the authority of the Occupational Safety and Health Administration. Arguments in that case will be heard in the fall of 1994.

- Additional Worker Safety Standards: FRA is beginning the development of roadway worker safety standards; the new mandate will establish protection from train movements for maintenance-of-way and other workers on or near tracks. In addition, FRA will address the safety of locomotive working conditions, focusing on the relationship between environmental, sanitary, and other conditions in the cab and their effect on productivity, health, and safety.

- Railroad Radio Communications: Under RSERA, FRA was required to conduct a safety inquiry on voice radio communication and advanced train control systems and to submit a report to Congress by July 1994. FRA convened three roundtables on next-generation train control systems and conducted a safety inquiry on communication issues. Additionally, FRA commissioned a review of technical specifications for Advanced Train Control Systems and proposed several actions improving radio communications and

[102] FRA Docket No. ROS-2.

promoting Positive Train Control systems to prevent collisions. The report was submitted to Congress in July 1994.

- Locomotive Engineer Qualifications: FRA's regulations require railroads to have a formal process for evaluating prospective locomotive engineers and determining that they are competent before permitting them to operate a locomotive or train. On April 19, 1993,[103] FRA published amendments to its rule, clarifying the procedures railroads use to make a series of determinations about a prospective engineer's competency. The amendments also require standardized methods for identifying qualified locomotive engineers and monitoring their performance.

Railroad equipment regulations: These regulations cover the "hardware" of railroading, the cars that carry the freight and passengers and the locomotives that move them.

- Event Recorders: On July 8, 1993, FRA published a final rule[104] requiring that trains moving faster than 30 miles per hour be equipped with event recorders. The regulations also mandate inspection and maintenance of the black boxes and require the capture and preservation of data following an accident.

  The difficulty of post-accident investigation increases with train speed. The event recorder rule will provide the public with an impartial witness to the kind of train accidents likely to produce difficulties in investigation. Event recorders will also provide an additional means for the evaluation of crew and equipment performance in normal operations.

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[103] 58 FR 18928.

[104] FRA Docket No. LI-7, 58 FR 36605.

- Locomotive Conspicuity: More conspicuous locomotives have a better chance of alerting motorists and pedestrians to the approach of a train; more conspicuous locomotives should reduce the number and severity of highway/rail grade crossing accidents. As required by section 14 of the Amtrak Authorization and Development Act, in January 1993 FRA published an interim final rule[105] identifying certain widely used auxiliary lighting arrangements as acceptable current practice: crossing lights, ditch lights, oscillating lights, and strobe lights. FRA took this step to encourage the installation of the additional lighting. The interim rule allows railroads to choose from among various lighting arrangements and to have those chosen "grandfathered" for a period of four years from the date of the final rule.

- Locomotive Crashworthiness: FRA is collecting crashworthiness performance data through a structured approach to accident investigation and has commissioned additional research to evaluate the performance of Association of American Railroads (AAR) Specification 580: Improved crashworthiness features for new construction of locomotives.

  Making locomotives safer in crashes" is a complex undertaking. Not only are locomotives heavy, and thus packed with energy to dissipate in a crash, they can crash into each other (at least doubling the energy) and into an untold number of structures and environments. The new AMTRAK locomotive that led the train across the bridge in the horrible accident near Mobile, Alabama in September 1993 crashed end-on into a bank of mud. When it was lifted from the bayou, it was evident the structure had survived the impact but that the head-end crew had perished when the cab was filled with mud.

[105] 58 FR 6899, FRA Docket No. RSGC-2.

FRA is performing additional field data collection and will move ahead on locomotive crashworthiness as quickly as the broad scope of the project and the available resources permit.

- Power Brakes: Late in 1992, FRA published the opening regulatory notice[106] in its proceeding to revise the power brake rules; following that publication, four days of public workshops, in various cities across the country, gave the public a chance to have a direct part in shaping the emerging rule. FRA will be examining and amending the current requirements for locomotive and train brakes, including requirements for two-way end-of-train devices and the proper standards for dynamic brakes.

  A separate focus within the regulatory docket will treat issues surrounding commuter and intercity passenger train braking performance, including brake requirement standards for high speed rail srvice. The formal notice of proposed rulemaking was published September 16, 1994.[107]

- Additional Equipment Safety Regulations: FRA's current safety regulations do not address operations at speeds greater than 110 miles per hour; Amtrak's 125 mph speeds in the Northeast Corridor are permitted under a waiver of existing track regulations. FRA intends to amend many of its regulations to address issues unique to high speed rail operations at speeds up to 160 mph. Some of these issues will be covered under regulations now in progress on track and on power brakes, but FRA plans to deal with issues such as equipment, communications systems, employee qualifications, pre-revenue testing, and grade crossings in a comprehensive rulemaking

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[106] FRA Docket No. PB-9, 57 FR 62456.

[107] NPRM, 59 FR 47676.

setting generic standards for high speed train sets. A proposed rule could be developed during 1995.

Many railroads, operating under a 1979 revision to the Freight Car Safety Standards, have designated as "maintenance of way" cars those used in company service, such as hopper cars of locomotive sand, flat cars moving railroad wheels, and tank cars of diesel fuel, thereby excepting them from the Federal freight car safety standards. When inspecting cars designated "MOW," FRA found that the percentage of cars with safety problems was significantly higher than for the national fleet. Where such cars are not hauled in trains moving at mainline speeds, there may not be any detriment to safety, but the growing pattern is to couple MOW cars into through freights, and move them at mainline speeds. FRA has proposed[108] that the MOW designation be restricted to cars not used in revenue service and not moved faster than 20 mph.

Operating Environment Regulations: These regulations govern the structural network on which trains operate and the procedural network by which railroads control train operations.

- Track Standards: In November 1992, FRA began the formal regulatory process for the first comprehensive review of the track standards in the past decade.[109] FRA will incorporate the latest research on internal rail defects and on continuous welded rail in this review. This review will also investigate excepted track (marginal track with extremely limited traffic and maximum operating speeds of less than 10 miles per hour) and standards appropriate for operations of 150 to 160 miles

[108] FRA Docket No. RSFC-7, 59 FR 11238, March 10, 1994.

[109] FRA Docket No. RST-90-1, 57 FR 54038, November 16, 1992.

per hour. Draft proposed rules are in the staff review process within FRA.

- Bridge Standards: Following the tragic accident near Mobile, Alabama, in September 1993, FRA announced an examination of the feasibility of requiring the installation of detector systems to warn of bridge misalignment. The research and fact-gathering phase of this effort is under way.

- Remedial Action Reporting: Recently published rules close a significant gap in the follow-through required when an inspector discovers certain railroad safety violations. The railroads now must report actions taken to bring themselves into compliance. Launched with the publication of proposed rules in June 1993, FRA recently published the final rules in the *Federal Register*.[110]

- Railroad Accident Reporting: Following four open meetings, FRA is drafting proposed rules to revamp its accident reporting regulations.[111] The new proposals will consider issues raised by electronic reporting and the appropriate methods for establishing reporting thresholds.

- Highway-Rail Grade Crossing Regulations: The Grade Crossing Action Plan, announced by Secretary Peña in June 1994, sets out initiatives to prevent accidents caused by cars and trucks blocking crossings. In conjunction with other modal administrations, FRA will begin major efforts to educate the public on grade crossing safety, enhance the enforcement of

[110] FRA Docket No. RSEP-7, August 24, 1994, 59 FR 43666.

[111] FRA Docket No. RAR-4, Advanced Notice of Proposed Rulemaking, March 14, 1990, 55 FR 9469; the four meetings were held June 13, 1991, August 21, 1991, October 22, 1991, and August 18, 1992.

traffic laws at grade crossings, promote systematic corridor reviews of grade crossings, increase safety at private crossings, improve data collection and analysis, and promote research on new safety technologies. Grade crossing safety is part of hazardous materials safety: all too often, the evening news graphically illustrates the tragedy of a derailment caused by a blocked crossing.

On the regulatory front, FRA has proposed maintenance, inspection, and testing requirements for active grade crossing warning systems.[112] In addition, the revised regulations would mandate improved performance in the maintenance of grade crossing warning devices. Final rules text is under development within FRA. FRA's Emergency Order No. 15 prevented towns in Florida from silencing the railroad whistles and horns required at grade crossings, and FRA is reviewing data gathered there for possible national impact.

Hazardous Materials Safety Regulations

The Research and Special Programs Administration issues the Department's Hazardous Materials Regulations.[113] As a practical matter, the detailed drafting work on railroad-specific hazardous materials regulations starts at FRA, in consultation with RSPA.[114] Early policy coordination between the agencies creates the basis on which a rule will be proposed and the Hazardous Materials Division within FRA's Office of Safety assembles the necessary research and technical background information and establishes the framework for implementing the policy guidance. Following an opportunity for

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[112] FRA Docket No. RSGC-5, January 20, 1994, 59 FR 3051.

[113] Generally considered as 49 CFR Parts 171-180.

[114] 49 CFR § 1.53(b). The primary statutory authority is found in 49 U.S.C. § 5103, formerly 49 App. U.S.C. § 1804.

public comment and participation, the drafting of proposed regulatory text and preamble language is accomplished through a close liaison between the Office of Safety and FRA's Office of Chief Counsel. Once these staff drafts are readied at FRA, RSPA technical and editorial expertise are again consulted to ensure Departmentally coordinated regulations that are also acceptable to the presentation and format requirements of the *Federal Register.*

Significant Pending Regulations: Several major advances in the Hazardous Materials Regulations are in progress:

- Crashworthiness Protection Requirements for Tank Cars: The Notice of Proposed Rulemaking[115] (NPRM) was published in the *Federal Register* of October 8, 1993, at 58 FR 52574. A hearing was held in January 1994. At this writing, FRA and RSPA are reviewing the testimony at that hearing and the written comments of interested persons.

  In this proceeding, DOT is proposing revisions to the hazardous materials regulations to improve the crashworthiness of tank cars and restrict the continued use of tank cars no longer meeting current safety requirements. Included are proposals to expand the use of thermal protection systems and head protection on tank cars used for transporting certain hazardous materials; add new requirements for bottom discontinuity protection; prohibit the use of self-energized manways located below the liquid level of the cargo; revise "grandfather" provisions that allow certain uses of tank cars; and require the use of pressure tank cars for all poisonous-by-inhalation (PIH) materials and certain other environmentally sensitive materials.

[115] RSPA Docket No. HM-175A.

- Hazardous Materials in COFC and TOFC Service: This proceeding proposes to permit the use of certain portable tanks to transport hazardous materials that pose a low to moderate degree of hazard in container on flatcar and trailer on flatcar service, without obtaining prior approval from the FRA Associate Administrator for Safety.

  The NPRM[116] was published in the *Federal Register* of May 7, 1993, at 58 FR 27257. Comments were due July 12, 1993. FRA and RSPA have reviewed all the comments received and are in the closing stages of preparing the staff draft for review.

- Detection and Repair of Cracks, Pits, Corrosion, Lining Flaws, Thermal Protection Flaws, and Other Defects of Tank Car Tanks: The NPRM[117] was published in the *Federal Register* of September 16, 1993, at 58 FR 48485. Comments were due in March 1994, and FRA and RSPA are reviewing the materials submitted.

  The proposed rules would

  - require the development and implementation of Quality Assurance Programs at facilities that build and repair tank cars;

  - require the use of non-destructive testing techniques in lieu of the current hydrostatic pressure tests for fusion welded tank cars to more adequately detect critical cracks;

  - require thickness measurements on tank cars;

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[116] RSPA Docket No. HM-197.

[117] RSPA Docket No. HM-201.

- allow the continued use of tank cars with reduced shell thicknesses;
- revise the inspection and test intervals for tank cars; and
- clarify the inspection requirements relating to tank cars prior to and during transportation.

These proposals are made because FRA and RSPA believe that it is necessary to increase the confidence that critical tank car defects will be detected.

- Unloading of Tank Cars and Loading of Cargo Tank Motor Vehicles; Use of Electronic Surveillance and Monitoring Equipment: The NPRM[118] was published in the *Federal Register* of September 14, 1992, at 57 FR 42466. Comments have been received and a final draft is under review within DOT.

  This proposal would allow the use of electronic signalling systems to satisfy the attendance requirements for unloading tank cars and for loading cargo tank motor vehicles. The rule would also revise the tank car unloading requirements, remove obsolete and unnecessary provisions, and allow tank cars containing hazardous materials to remain standing with their unloading connections attached when no product is being transferred.

- Improvements to Hazardous Materials Identification Systems[119] is at the fairly early stages of development and is drawing upon

[118] RSPA Docket No. HM-212.

[119] RSPA Docket No. HM-206, ANPRM published June 9, 1992, 57 FR 24532.

the expertise of the regulated community and other interested parties to seek ways to improve systems for identifying hazardous materials.

Pending Regulatory Possibilities

In addition to all the proceedings summarized above, FRA has a number of ongoing investigations, research efforts, and inquiries. Some of them, as illustrated by regulatory projects already final or formally pending, may lead to rulemaking actions. Others do not, often because even a known problem has not yet yielded a solution that can be written into a regulation.

It was announced in the preamble to the HM-175A proceeding, for instance, that:

> Based on comments made to some of the issues raised ..., and research done by the FRA, RSPA and FRA concluded that several topics raised in these earlier notices are either too technically complex or insufficiently developed to be resolved by regulatory proposals now. RSPA will consider action on safety relief devices, top fitting protection, and gasket specifications in separate rulemaking action. Also, consideration will be given to making certain operational changes, for instance, restricting train placement, in lieu of tank car design or specification changes under a future rulemaking docket.

Recognizing a problem, getting committed to solve it, and reaching a solution that is translatable into regulations under the authority of HMTA or FRSA is a multi-step process. In general, only when one step is completed can the next one begin. Interim progress, however, can be achieved through the exemptions program. In the field of safety relief devices, for instance, RSPA and FRA are granting requests to raise the test pressure of frangible discs used in safety vents. This simple step may prevent numerous employee injuries.

Current regulatory developmental projects at FRA include an examination of the process by which railroads electronically transfer data about the freight cars they interchange. Safety demands that emergency responders have accurate descriptions of the hazardous materials on a derailed train. Because almost all the major railroads are adopting "paperless" systems for data transmission, FRA is concerned that the lack of traditional documentation on the train may hamper emergency efforts. The large, and growing, volume of railroad traffic originating overseas complicates the problem. For now, FRA is pursuing a voluntary effort in meetings with industry and progress is being made towards a satisfactory protocol.

Finally, FRA is reviewing and considering ways to clarify the requirements for when hazardous materials documentation must be carried by a crew, that is, determining when the crew is operating a "train" and when they are merely "switching." A rulemaking proceeding already in the planning stages will address that issue as well as the previously discussed issue of the proper placement of hazardous materials cars within a train.

STATUS: RAIL HAZARDOUS MATERIALS ENFORCEMENT ACTIVITIES

SUMMARY: FRA promotes compliance with the hazardous materials regulations through a vigorous enforcement program. The timely collection of civil penalties for HMTA violations provides a forceful complement to FRA's overall railroad inspection program, where the hazardous materials inspections are increasingly focused on shippers. Field inspectors report that the enforcement effort is working and, often, the subsequent visit to a company's facility finds conditions much improved. The generally improving safety record of railroad transportation of hazardous materials is further evidence of an effective enforcement program.

REPORT: FRA has demonstrated its commitment to the enforcement of all railroad safety regulations. In the fiscal years that are the focus of the statutory mandate for this report (1989-92), FRA collected $10,238,686 in civil penalties from railroads and hazardous materials shippers for violations of the hazardous materials regulations and $40,689,173 for violations of regulations issued under the other railroad safety acts.

During FY 93 FRA conducted several task force inspection activities with Federal, Canadian, Mexican, state, and other DOT agencies to improve compliance in intermodal and global transportation services. FRA recently completed an assessment of electronic data exchange on a major railroad, identifying for correction structural deficiencies in the way hazardous materials information--vital to emergency response--is transmitted and kept available for use during transportation.

In cooperation with Transport Canada, FRA conducted inspections at tank car facilities in that country to oversee tank car repairs that may affect transportation safety. Further, FRA worked with 9 participating states to qualify 13 hazardous materials inspectors in the newest element of our state participation program.

An additional state inspector will complete FRA's training program soon.

FRA'S Enforcement of the HMTA:

The Hazardous Materials Transportation Act[120] provides the Secretary of Transportation with regulatory and enforcement authority to protect against the risks inherent in the transportation of hazardous materials. The Secretary has delegated rulemaking authority under the HMTA to the Administrator of RSPA and enforcement authority in their respective areas to the Coast Guard, Federal Aviation Administration, Federal Highway Administration, FRA, and RSPA. RSPA has issued the hazardous materials regulations which set generic standards for all modes of transportation and, working with the other agencies, specific requirements for each mode.[121]

Section 110 of the HMTA[122] provides for civil and criminal penalties for violations of the Act or the regulations. With the 1990 amendments under the Hazardous Materials Transportation Uniform Safety Act, civil penalties now range from $250 to $25,000 per violation per day. (Prior to the 1990 amendments, the maximum civil penalty was $10,000 and there was no minimum.) Section 110(a) requires that the person charged be provided notice and an opportunity for a hearing prior to the final assessment of a civil penalty. The Secretary may compromise the civil penalty prior to referral to the Attorney General for collection of the penalty. In determining the amount of the penalty, the Secretary is required to consider

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[120] 49 U.S.C. § 5101 *et seq.*, formerly 49 App. U.S.C. § 1801 *et seq.*

[121] The authority is found at 49 C.F.R. §§ 1.46(u), 1.47(k), 1.48(u), 1.49(s), and 1.53(b); the regulations appear at 49 C.F.R. Parts 171-180.

[122] 49 U.S.C. §§ 5123, 5124, formerly 49 App. U.S.C. § 1809.

the nature, circumstances, extent, and gravity of the violation committed and, with respect to the person found to have committed such violation, the degree of culpability, any history of prior offenses, ability to pay, effect on ability to continue in business, and such other matters as justice may require.

FRA has published procedures for the collection of civil and criminal penalties under the HMTA.[123] As is true with respect to all of the civil penalty statutes FRA enforces, HMTA civil penalty actions begin with a field inspection by an FRA or state inspector. Weighing various criteria discussed in the hazardous materials field manual,[124] the inspector decides whether any noncompliance detected warrants formal enforcement action. The more serious, repetitious, or purposeful is the noncompliance, the more likely it will result in an enforcement action, ordinarily a civil penalty.

Where the inspector determines that a civil penalty should be sought, he or she prepares a violation report summarizing the facts and including all necessary evidence. The report is sent to FRA's regional office for review beginning with the regional specialist and, unless that office returns the report for technical or policy reasons, it is submitted to FRA's Office of Chief Counsel with a recommendation for the commencement of a civil penalty action.

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[123] 49 C.F.R. Part 209, Subpart B. Criminal penalty cases are so rare that this report will make no further mention of them. The HMTA replaced hazardous materials legislation that was essentially criminal in nature; one of the primary reasons for the replacement was burden caused by the extra constitutional and procedural safeguards in criminal prosecution cases. They proved both unnecessary and counter-productive in fostering safety amidst the dynamic needs of transportation.

[124] *Hazardous Materials Enforcement Manual,* Office of Safety Enforcement, Federal Railroad Administration, Washington, D.C., 1991 (updated as needed). Each of the major divisions within the Office of Safety Enforcement has an enforcement manual to guide and assist inspectors: Hazardous Materials, Motive Power and Equipment, Operating Practices, Signal and Train Control, and Track.

The Safety Law Division of the Office of Chief Counsel reviews incoming violation reports for legal sufficiency. In the vast majority of situations, the report states a violation and is supported by sufficient evidence.[125] The FRA attorney assigned to the case determines the initial penalty for each violation by referring to internal penalty guidelines, which set standard penalties for typical violations, and applying the statutory assessment criteria to increase or decrease the guideline amount.[126] At this stage, of course, FRA does not usually have complete information on mitigating factors or defenses that may subsequently be presented by the respondent. A copy of the violation report is sent to the respondent under the NOPV, which states the initial penalty demand for all reports in the case.

The respondent has 30 days (or, for good cause shown, a longer period) to pay the initial penalty demand or submit a response that requests either informal handling or a formal hearing. Most respondents reserve their right to a hearing but indicate a preference for informal resolution of the case. In their written responses, telephone conferences, and/or face-to-face discussions, the

[125] In an average year, fewer than 5 percent of the reports submitted to the Office of Chief Counsel are declined because they either do not state a claim or because there is insufficient proof of the claim alleged. In either case, if the defect can be cured, the report can be resubmitted for prosecution. FRA's lawyers are available to consult with inspectors to eliminate problems before the case is forwarded to the regional specialist.

[126] Penalties for violations under FRSA are published in the Code of Federal Regulation, as an appendix following each part. Hazardous materials penalty guidelines have not yet been published because the nature of dangerous chemicals themselves creates more possible multiple variables for appropriate penalties than, say, a flat wheel on a locomotive. To illustrate, consider the differing threat offered by an insecure closure on a car containing only a residue of an acid with no vapor pressure and the threat if the loose closure were on a car loaded with poison gas. On September 29, 1993, the Senate Appropriations Committee issued Report 103-150, (Report of the Committee on Appropriations on Department of Transportation and Related Agencies Appropriations Bill, 1994) directing FRA and RSPA to publish hazardous materials penalty guidelines during 1995. (p. 163) FRA is working with RSPA to meet the deadline.

respondents (usually through their counsel) present mitigating factors and/or defenses. Often, the respondent presents evidence of remedial action, addresses the circumstances or gravity of the violation, or argues that its compliance history and/or low level of culpability warrant a reduction of the penalty. Sometimes, the respondent completely disputes the facts or the application of law to the facts.

The FRA attorney, seeking technical advice from FRA's Office of Safety where necessary and interpretive assistance from the hazardous materials expert attorney where relevant, applies the HMTA assessment criteria to all of the facts presented. With the approval of the Assistant Chief Counsel for Safety, the attorney conveys to the respondent a dollar amount for which FRA is willing to close the case. Where the respondent agrees to pay that amount and forgo a hearing, FRA issues the final order assessing the civil penalty at that point.

If a hearing is requested and informal discussions fail to produce an agreement, the Chief Counsel arranges a hearing before one of the Department's administrative law judges. At the hearing, which is conducted much like a trial (including the cross-examination of witnesses), FRA has the burden of proving the allegations in the NOPV. The judge can dismiss the notice in whole or in part; if not dismissed in whole, the judge issues an order assessing a civil penalty. The procedures require the judge, like the FRA, to consider the statutory penalty assessment criteria. Any party aggrieved by the judge's decision may appeal to the FRA Administrator, who renders a final decision or remands the case to the administrative law judge for further proceedings.

Failure to pay a final order within the specified time subjects the respondent to a suit by the Attorney General, upon referral from FRA, to collect the amount of the final assessment. Of course, a respondent who wishes to contest a final decision by the Administrator may bring suit for review of that decision in United States district court. In such a suit, the court would determine whether the Administrator's decision was supported by substantial evidence in the record.

The Effectiveness of Enforcement:

There are a number of possible criteria for weighing the effectiveness of FRA's implementation of the HMTA. Because the entire purpose of the HMTA is to protect against the risks to life and property that are inherent in the transportation of hazardous materials, the safety record of the community affected by FRA's enforcement effort is certainly germane. Railroads carrying hazardous materials and shippers offering hazardous materials for railroad transportation are, overall, in harmony with the safety goals of the Department of Transportation.

Perhaps the most important measure of that safety record is that, since the beginning of 1980, only three deaths have occurred as a result of a release of a hazardous material in a train accident. However, releases and threatened releases continue to occur with sufficient frequency to incur significant societal costs. In remarks made at the Centennial Celebration of Railroad Safety[127], AAR Vice President - Operations and Maintenance C.E. Dettman noted significant decreases in derailments and train accidents in the past decade, despite increases in revenue ton miles and freight train miles.

Naturally, FRA does not claim sole credit for the improvement in the rail transport of hazardous materials that has occurred in

[127] This celebration of the 100th year of the Federal railroad safety program took place at Washington Union Station on September 23, 1993. The remarks mentioned in the text were made at a workshop entitled, "Future Direction for Freight Railroad Safety."

recent years, nor does FRA contend that there is no room for further improvement. FRA would like to see the number of train accidents involving releases decline further, and there is considerable room for improvement concerning the number of unintended releases from rail cars. These incidents often occur when a rail car is standing still and are usually a result of the shipper's failure to secure all of the car's closures properly. Shippers often defend themselves against penalties for failure to secure closures by producing a "check list" or other pretrip inspection report, prepared and signed by the employee performing the loading. Check lists are a good safety tool, but rote reliance on them is misplaced. The regulatory standard is that package closures must be secure and leakproof "under conditions (including the effects of temperature and vibration) normally incident to transportation."[128] FRA's shift of inspection resources toward greater emphasis on shippers is intended to reduce the number of nonaccident releases that happen each year. When FRA inspectors go to a shipper's facility, they spend considerable time explaining the regulations and the need to act safely. Their first priority is to foster compliance, not to write violations.

Industry safety initiatives, improving railroad finances, and the daily efforts of railroad employees and management have had a significant impact on the situation. These factors have helped reduce the train accident rate overall, decreasing the chance of a train accident causing a release. However, FRA believes its joint regulatory efforts with RSPA, and FRA's own inspection and enforcement efforts in all areas, have contributed significantly to the improvements in both train accidents overall and hazardous materials releases. Even hazardous materials shipments in full compliance with the HMTA regulations pose a significant threat if the track, equipment, signals, or operating practices that affect those shipments are unsafe. Nearly all of FRA's regulations and most of its inspection and enforcement

[128] 49 CFR § 173.24(f)(1).

efforts are designed to minimize the frequency of train accidents, which pose the greatest threat of a catastrophic release of hazardous materials in the rail mode. Therefore, FRA's entire safety program contributes to hazardous materials safety.

Meaningful criteria for evaluating a civil penalty program include (1) how well it is targeted toward truly important enforcement matters; (2) how much is actually collected in penalties overall; (3) how timely the enforcement action is; and (4) how successful the enforcement process is in actually effecting responsive action by the violator.

FRA's Office of Safety has recently taken steps to focus its hazardous materials inspectors on the most important enforcement targets. This has meant increased emphasis on inspection of shipper facilities in an effort to reduce the type of violations that are the most frequent causes of hazardous materials releases. In January 1991, FRA issued a revised hazardous materials enforcement manual (cited earlier) that, among other things, provides field forces with improved guidance on how to select the more important violations for enforcement action. A continuing series of Hazardous Materials Notices (12 were issued in 1993) keep regional specialists and inspectors current on issues and policies. Activity by FRA inspectors, for instance, has contributed significantly to monitoring the inspection activities and of tank car owners required under Emergency Order No. 17. National and regional inspection plans and an accounting of inspection resources against those plans, not only increase the degree to which FRA's hazardous materials enforcement actions are directed at truly important matters, they allow an objective measure of the effort necessary to accomplish the goals.

Civil Penalties Collected for HMTA Violations (1987-1992)
(Amounts in dollars)

Fiscal Year	1987	1988	1989	1990	1991	1992
FRA	647,195	393,425	636,460	3,358,865	3,501,781	2,741,580
FAA	305,900	154,100	282,850	136,050	986,800	1,063,350
FHWA	292,300	218,650	311,923	613,753	564,675	1,181,590
RSPA	126,625	335,900	408,600	668,800	728,234	401,369
USCG	83,150	87,900	118,600	179,783	287,787	270,150
DOT	1,455,170	1,189,975	1,758,433	4,957,251	6,069,277	5,658,039

Aggregate totals of penalties collected are one measure of an enforcement program's effectiveness and FRA is proud of its history as an aggressive enforcer of the HMTA. In fact, for at least the last several fiscal years, FRA has set the pace for DOT agencies in collecting penalties under the HMTA. While total dollar collections will fluctuate from year to year, their volume over time is a good measure of the agency's enforcement presence in the regulated community. By this measure, FRA's HMTA enforcement is, and has long been, second to none.

FRA Total Civil Penalty Collections (All Statutes)	
Year	Amount
1987	$3,375,115
1988	2,556,430
1989	4,622,928
1990	8,455,674
1991	10,951,123
1992	16,659,448
1993	15,583,915

FRA's ability to be timely in assessing and collecting civil penalties under the HMTA and the other railroad safety statutes suffered greatly in the recent past. This problem's primary cause was the imbalance between the Office of Chief Counsel's growing safety workload and its limited safety resources. With the availability of resources, FRA has essentially corrected the problem: Inspector's reports received by the Office of Chief Counsel are reviewed and transmitted well within the agency's 120-day internal guideline and, except for certain cases held for thorny interpretive issues or pending the outcome of on-going litigation, cases transmitted before 1992 have been settled and closed.

FRA's HMTA enforcement program is successful in prompting responsive action by the violators. Respondents frequently cite procedural and/or personnel changes they have made in response to the charges stated in the NOPV. Shippers, for example, often explain how they have tightened pretrip inspection procedures for tank cars in a manner designed to avoid specific types of violations. Respondents also point to new training programs, remedial training, or employee disciplinary actions that have been taken as a result of the penalty assessment. It is clear that responsive actions are frequently taken because of penalty assessments and there is reason to believe that the overall level of penalties is deterring noncompliance.

A new tool is under development for FRA's safety enforcement program. In rules published August 24, 1994, persons notified of violations are requiired to notify, in turn, the agency of the actions taken to correct those violations.[129] If this program succeeds, remedial action reporting could further enhance railroad safety by quickly focusing the attention of an alleged violator on the unsafe condition and, because remediation will be required, by eliminating the hazard to safety. The new rules will also make it harder to treat violations of the railroad safety regulations as just another cost of doing business.

[129] This action was mandated by section 3 of the Rail Safety Enforcement and Review Act, P.L. 102-365, 106 Stat. 972. FRA's "Remedial Actions Reporting" rulemaking is designated Docket No. RSEP-7 and the final rules appear in the *Federaal Register* at 59 FR 43666.

The good, and improving, safety record in railroad hazardous materials transportation and FRA's aggressiveness in enforcing the HMTA demonstrate that this is a Federal program with teeth that gets results.

CONCLUSION

DOT's goal of zero hazardous materials releases in railroad transportation has not yet been achieved, but shippers and railroads are close. US railroads moved more than 1.4 million carloads of hazardous materials in 1992. In that year, 33 rail cars lost some, or all, of their cargo as a result of a derailment. Hazardous materials incidents, a broader category including releases from cars not involved in railroad accidents (some of them not even in trains), affected another 1128 cars.

Even though the resulting "error rate" is only eight-hundredths of 1 percent (.08%), that is small comfort to the residents of Dragon, Mississippi or Duluth, Minnesota / Superior, Wisconsin. In Dragon, on January 18, 1992, a "dual diameter" tank car separated and lost over 30,000 gallons of liquified petroleum gas in a fireball that burned small businesses and damaged homes. In Duluth/Superior, on June 30, 1992, a derailment led to a release of essentially all the contents of one tank car of volatile materials and the resulting vapor cloud required the evacuation of nearly 20,000 persons along the Wisconsin/Minnesota border.

Accomplishing FRA's mission of "rising to the challenge of safety" requires more than just responding to accidents like these. It requires a constant systems focus, to stop accidents before they happen.

The Dragon accident happened in the year FRA launched a new approach to tank car structural inspections through Emergency Order No. 17, enforcing a priority-based program developed in partnership among the railroads, the shippers, the tank car builders, Transport Canada, and DOT. For now, the tank car fleet is receiving a thorough end sill inspection to find defects before they fail; for the future, these inspections will happen once every ten years, in accordance with written procedures, specialized for each individual type of stub sill design. Moreover, the need to detect flaws at the earliest possible moment in a car's life energized FRA's investigations into the "system" of a tank car, its structure, and the publication in September 1993 of proposed rules to require modern non-destructive testing methods in place of outmoded hydrostatic tests.

The Duluth/Superior derailment came as FRA was developing the early regulatory notice for the first comprehensive review of the track regulations in the past decade. FRA held public workshops in four cities around the country and is now developing proposed rules to meet tomorrow's needs for standards for railroad rights-of-way.

FRA has sought, in this report, to highlight two principles: First, that hazardous materials safety is inseparable from total railroad safety and, second, that FRA's has taken significant steps towards its goal of diminishing the barriers between the traditional disciplines in transportation, so that the whole system is held up to examination rather than each of its separate parts.

RESPONSE TO THE CONGRESSIONAL MANDATE

The Rail Safety Enforcement and Review Act (RSERA) of September 3, 1992 requires the Secretary of Transportation to report on issues presented by the railroad transportation of hazardous materials, including:

(1) For the years 1989, 1990, 1991, and to the extent available, 1992, relevant data concerning each unintentional release of hazardous materials resulting from rail transportation accidents, including the location of such release, the probable cause or causes of such release, and the effects of each release.

(2) For the years 1989, 1990, 1991, and to the extent available, 1992, a summary of the relevant data concerning unintentional releases of hazardous materials resulting from rail transportation incidents.

- Unintentional releases fall into two categories: those caused by train accidents and those involving only the hazardous materials cars or equipment.

- Train accidents involving hazardous materials releases dropped from 173 in 1980 to 27 in 1992. (The 27 accidents in 1992 resulted in total or partial lading loss from 33 separate cars.)

- Nonaccident hazardous materials releases include minor releases, releases from cars not involved in railroad accidents, and releases from cars standing still, not part of a train.

    - Nonaccident releases include releases from safety relief devices and from improperly secured valves and fittings.

    - For the past several years hazardous materials incidents have been relatively stable at 1,100 to 1,200 annually, even as train accidents have declined significantly.

        - Hazardous materials leaks almost always originate at parts of the tank car secured by the shipper.

        - Shipping points are more widely spread than rail yards, and distance often means it is difficult to involve the culpable party.

    - FRA is increasingly targeting its prime weapon, the field inspector, against hazardous materials incidents through the National Inspection Plan.

        - Through the NIP, FRA is working to focus inspections on industries and shippers with safety records showing them most likely to cause incidents.

- FRA inspectors also enforce compliance with DOT regulations requiring function-specific training for employees handling hazardous materials because educated employees are less likely to commit the errors that lead to hazardous materials incidents.

(3) A description of current regulations governing hazardous materials rail car placement (including buffer cars) and an evaluation of their adequacy in light of experience and emerging traffic and commodity patterns.

- Current in-train placement rules, dating from the era of steam locomotives and wooden box cars hauling explosives, generally require a "six-deep" separation between a hazardous materials-carrying car and a locomotive or occupied caboose.
  - Separation between hazardous materials cars and the parts of trains occupied by humans is intuitively correct.
  - The same is not true between cars carrying hazardous materials:
    - The risk of incompatible chemicals mixing in a derailment is small.
    - Stringent car placement rules would require extra switching, a dangerous activity in itself, and place crews at greater risk.
- Balanced train makeup requires placing cars so that they reduce uneven forces within the train.
- Terrain, curvature, the different properties of empty and loaded cars, and the effects of cars of different length all must be considered.

- FRA has a research contract in place to review of these practices, and plans to launch regulatory action in 1996, after completion of the studies and a review of the data.

(4) An assessment of regulations, rules, orders, or standards that address rail operations procedures associated with carrying hazardous materials on rights-of-way having significant grades or high degrees of curvature.

- Track-caused derailments have declined steadily over the last decade, from a 1983 total of 1,569 to 849 in 1992, a reduction of 46 percent.

- Several key factors played a powerful role in this reduction:

  - The railroads' success in developing and applying new procedures for operating trains and maintaining track in mountainous country.

  - The Railroad Revitalization and Regulatory Reform Act of 1976 and the Staggers Rail Act of 1980 boosted the financial health of the railroads and increased their ability to invest in improved, safer rights of way.

- FRA is exploring revisions to track safety standards through its current rulemaking proceeding.

  - Operations over steep grades and sharp curves are included in the study.

  - FRA received informed comments in response to the November 1992 Advance Notice of Proposed Rulemaking.

- Workshops held with industry and labor representatives in Newark, Atlanta, Denver, and Washington have yielded additional material for consideration.

(5) An assessment of the effectiveness and associated costs of requiring deployment of wayside bearing failure detectors for trains carrying hazardous materials.

- Railroads have greatly reduced the number of accidents caused by hot boxes to only 2 percent of all accidents caused by mechanical failure.

- The reduction in hot box accidents follows improved roller bearing technology and the installation of hot box detectors, about every 20-30 miles along mainline track.

- Hot box detectors work well, but they are expensive to install (nearly $90,000 each) and to maintain ($11,000 to $20,000 per unit per year).

- A requirement that hot box detectors be installed on all routes carrying hazardous materials would not be cost effective; the safety decisions made by the railroads in this area are valid.

(6) An assessment of rail tank car rules, regulations, orders, or standards affecting hazardous materials transportation.

- Tank cars are controlled by rules imposed by the Federal Government and by industry.

    - FRA's freight car and power brake rules govern operating and safety features.

    - Federal hazardous materials regulations govern tank car-specific safety features and construction materials.

    - The Association of American Railroads' (AAR) Interchange Rules control the operation and repair of tank cars, whether owned by other railroads, shippers, or car lessors.

- FRA and RSPA have been working to improve the tank car fleet since the 1970s.

    - Early efforts concentrated on the cars carrying the most volatile products.

    - The success of earlier programs has spread and now the role of the DOT class 111 tank car--the most basic nonpressure car--is being perceptibly reduced in hazardous materials transport.

    - Final rule revisions are being developed to improve the crashworthiness of tank cars and to modernize tank car inspection methods; they are scheduled for publication before the end of 1995.

(7) The status of all planned or pending regulatory activities of the Secretary (including the status of all regulations required by statute) that seek to address the safe transportation of hazardous materials by rail, and the status of rail hazardous materials enforcement activities.

- Two final FRA/RSPA rules, now under development, will regulate the transportation of hazardous materials in railroad tank cars.

    - Docket HM-175A, will improve the crashworthiness of tank cars by requiring proven design features, such as head protection systems, on classes of tank cars where they are not now required.

- Docket HM-201, will replace obsolete low-pressure hydrostatic testing of tank cars with modern nondestructive testing methods.

- FRA enforces compliance with the hazardous materials regulations and the enforcement effort is working.

  - Inspectors report that subsequent visits to a company's facility ofen find conditions much improved.

  - The decrease in hazardous materials releases in derailments is additional evidence of an effective enforcement program.

(8) Such other information as the Secretary determines relevant to the safe transportation of hazardous materials by rail.

- Federal railroad safety laws emphasize national uniformity; states and their political subdivisions, however, have a vital role in caring for local needs and in regulating local safety hazards.

  - The Federal/state partnership for railroad safety is a dynamic, expanding enterprise with proven results.

  - As an example of state efforts in hazardous materials safety, an Appendix to this Report, presents a description of two California Public Utilities Commission railroad regulatory proceedings, one aimed at site specific hazards and the other at hazardous materials transportation methodology.

ONGOING ACTIONS

FRA's Systemic Approach. FRA has reoriented its safety programs to concentrate on systemic safety problems rather than merely reacting, incident by incident, to problems as they emerge.

The Grade Crossing Action Plan sets out initiatives to prevent accidents caused by cars and trucks blocking crossings. Working with the Federal Highway Administration, the National Highway Traffic Safety Administration, and the Federal Transit Administration, the FRA will

- Begin major efforts to educate the public on grade crossing safety,
- Enhance the enforcement of traffic laws at grade crossings,
- Promote systematic corridor reviews of grade crossings,
- Increase safety at private crossings,
- Improve data collection and analysis, and
- Promote research on new safety technologies.

The Railroad Communication and Train Control Action Plan will improve radio communications and institute Positive Train Control, a computer/communication system to prevent collisions, overspeed derailments, and roadway worker injuries. One of the first steps will be to determine which corridors may warrant PTC application, and hazardous materials traffic will be a criterion for that review.

Final Rules issued include rules governing:

- Locomotive Event Recorders, to be required by May 5, 1995, in the lead locomotive of all trains going faster than 30 miles per hour. These will monitor crew performance and provide an unbiased, accurate record of the operations of a train prior to a derailment.

- Alcohol and drug regulations, to prevent the operation of trains by crews under the influence of controlled substances.

- Remedial action reporting, to require a follow-up report to FRA of the actions taken to correct a violation of railroad safety standards discovered by an inspector.

- Locomotive conspicuity, to make locomotives more visible and thus reduce grade crossing accidents and head-on collisions.

Hazardous Materials Guidance Documents published include:

- *Field Product Removal from Tank cars*, an updated research report on the field transfer of hazardous materials from tank cars damaged in derailments. (DOT/FRA/ORD 92-27, February, 1993.)

- *Hazardous Materials Emergency Response Plan Guidance Document for Railroads*, providing assistance in the development and review of emergency response plans. (DOT/FRA/ORD 93-09, March 1993.)

FUTURE ACTIONS

FRA will take the following actions to improve further the safety of railroad operations and hazardous materials transportation:

Operation Respond Assessment. FRA will use the lessons learned from the ongoing Operation Respond program in the Houston area to improve the DOT's *Emergency Response Guidebook* and to provide a model for hazardous materials emergency response partnerships for communities throughout the United States.

Train Placement Analysis and Rulemaking. Upon completion of research on optimum train makeup criteria, FRA will analyze the costs and benefits of amending the current regulations and, as appropriate, institute regulatory proceedings to implement the research findings.

Stub Sill Inspection Program. FRA will conclude the stub sill inspection program started under Emergency Order 17, with all cars inspected and repaired as necessary. Nonjacketed cars will be completed by September 1997, and jacketed cars, 2 years later.

Tank Car Crashworthiness. FRA will complete action on the tank car crashworthiness proceeding (HM-175A) within congressionally specified deadlines.

Nondestructive Testing. FRA will complete action on the rule that will establish modern nondestructive testing methods (NDT) to ensure that tank cars are safe to continue in service (HM-201), within congressionally specified deadlines.

Tank Car Unloading. FRA will complete action on the proposed rules regarding human attendance at tank car unloading sites.

Issue Proposed Rules, including:

- Revisions to the power brake regulations.
- Revised operating regulations for maintenance of way equipment.
- Improved track standards.

CONCLUSION

FRA's safety actions, and the safety actions of its intermodal partners throughout the Department of Transportation, will continue to help America's railroads set world standards in safety and efficiency. The ultimate keys to transportation safety, however, are in the hands of people: Whether they work for any of transportation's intermodal carriers, shippers, and suppliers; whether they are transportation's customers; or whether they just share transportation's paths, people make the difference between safety and danger. Given safe hardware and guided by proper procedures, the decisions of transportation people will ensure that the Nation's railroads "Tie America Together" safely.

ACKNOWLEDGEMENTS

Within the Department, FRA was primarily responsible for marshalling the resources to produce this report. To that end, FRA thanks RSPA and its people for their cooperation and assistance. A special acknowledgement is due the Association of American Railroads for making available hazardous materials movement data and for sharing the nonaccident release data maintained by its Bureau of Explosives. Detailed information on the size and composition of the tank car fleet was forthcoming from AAR's UMLER files and it contributed to the completeness of this report.

Thanks are also due the Railway Progress Institute for helping increase FRA's knowledge of tank cars and tank car technology. The reporting team especially thanks those individuals, whether employed by the Federal Government, a state government, or the private sector, who answered questions and provided information.

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ADDENDUM: 1993 SAFETY STATISTICS

The Rail Safety Enforcement and Review Act of 1993 (RSERA) required the Secretary of Transportation to report on the period between 1989 and 1992. The 1993 safety figures became available after the information for this report was collected. They continue to demonstrate world class accomplishments.

The train accident rate (4.54/million train miles) was the second lowest in history, bettered only by 1992. Of the three major causes of train accidents, track, equipment, and human factors, only track caused accidents showed a significant increase. They were up by 18 percent over 1992 (from 849 to 1,017) and were sharply higher in April and in the period June through September, months during which record rains fell and the Midwest was devastated by floods.

In 1993, as in 1992, train accidents with a release of hazardous materials occurred at about half the 1989 level; there were 29 such accidents in 1993, up from 27 the previous year. The number of cars releasing all or part of their dangerous cargo in train accidents rose from 32 in 1992 to 58. Releases in railroad hazardous materials incidents (a broader category including releases from cars not even in trains) fell slightly during 1993 (from 1129 to 1114) but damages caused by such releases dropped to about one-third of their 1992 level.

There are points of concern about the 1993 safety record. Track caused derailments were far too high and another year with over 1,000 hazardous materials incidental releases is simply unacceptable. Actions summarized in the conclusion to this report will address priority concerns and, where a solution has not yet been discovered, FRA will continue pursuing its goal of zero accidents and zero fatalities.

APPENDIX A: A BRIEF HISTORY OF THE TANK CAR

The history of tank cars is a fascinating example of the increasing sophistication of American engineering and materials science.[130] It is also interesting as an exercise in specifications development in a marketplace environment with little or no effective governmental intervention until relatively recently. While beyond the scope of this report, the decades of Federal laissez-faire have important implications for any study of the interaction of industry and the Government as they work to promulgate the standards for, and ensure the certification of, the vehicle that carries the vast majority of rail borne hazardous materials.[131]

In August 1859, the first successful oil well was brought in at Titusville, Pennsylvania, and, when the petroleum trickle soon became a stream, it was obvious that there had to be a better way to transport crude oil than in 42-gallon, iron-hooped barrels on flat cars.[132] Larger "kegs," of about 1,700 gallons, mounted on flat cars,

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[130] This historical summary is adapted from material in a 1990 report by FRA and RSPA assessing relations with, and the performance of, the AAR Tank Car Committee: *A Report on Tank Cars: Federal Oversight of Design, Construction, and Repair*, Federal Railroad Administration and Research and Special Programs Administration, Department of Transportation, Washington, DC, 1990.

[131] The 1990 FRA/RSPA study of the operations of the AAR Tank Car Committee was the first such overview performed by DOT. Section 21 of HMTUSA requires a study, by a disinterested expert body, of the tank car design process and tank car design criteria. That study is currently in process under a contract between DOT and the Transportation Research Board of the National Academy of Sciences. Completion is predicted by September 1994.

[132] Frank J. Heller, "Evolution of Tank Car Design Through Engineering," privately published monograph of talk before 1970 ASME Petroleum Conference, Denver, CO, p. 1. Much of this historical review is drawn from Frank Heller's work whether or not each statement is specifically footnoted. Mr. Heller was a long-time member of the Tank Car Committee and served a term as its chairman. Another well written history of the tank car, concentrating on the early

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were tried as were horizontally mounted, glued wooden barrels approximately 3,500 gallons in size. One of the problems with this method of moving petroleum was the rain; it dissolved the glue that kept oil inside the kegs! Finally, by the end of oil's first decade, in 1869, the Empire Transportation Company had developed a car with a riveted iron tank mounted to a double-beamed wood freight car frame that at least looked very much like present tank cars.

The post Civil War era saw iron tanks replaced by steel as the Bessemer process yielded improvements. This early rapid evolution in tank designs and materials lead to a development that, in the minds of many, had a profound effect on the future of tank cars. The railroads sought ways to avoid investing in new tank car equipment and they

> argued that it was impractical and economically unsound for each railroad to maintain a fleet of tank cars . . . when a large portion of that fleet might lie idle during slack periods. In 1888 the Interstate Commerce Commission agreed with the railroads and thus, the securing of tank car equipment became a shipper's worry. The result was that private tank car companies were born whereby shippers or builders invested their capital in the acquisition and maintenance of tank cars for their own use or lease.[133]

The ICC's historic, 19th century decision created a class of cars with a unique pattern of ownership. Today, 99 percent of the tank cars in the American fleet are owned by car leasing companies and shippers. The next largest nonrailroad owned fleet are the covered

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[132](...continued)
domination of the petroleum industry by Standard Oil, is Albert Z. Carr's book, *John D. Rockefeller's Secret Weapon*, © 1962, McGraw-Hill Book Company, Inc., New York.

[133] Heller, p. 4.

hoppers, with less than half of them owned by shippers or car companies. In third place are flat cars, about a third of which are held in "private" ownership.[134]

The Interstate Commerce Act played an important role in shaping the way in which railroads dealt with revenue equipment. Under that act, "common carriers" bear a duty to furnish transportation services "upon reasonable request therefore ...."[135] The Act further imposed a requirement for the interchange of both traffic and equipment.[136]

While the Commission established charges for using equipment not owned by the hauling railroad[137], the implications were far greater than just monetary compensation. Rail equipment, in order to move freely from one carrier to any other in the country, had to meet a set of common standards for such basic attributes as wheel gauge and coupler height. It soon became obvious that interchanging equipment meant repairing the damage from ordinary wear and tear. This, in turn, expanded the need to build cars to a common standard.

The problem with tank cars[138] was that, because the railroads did not own them, carrier mechanical officers were not as familiar with them as they were with box cars or gondolas. That ICC decision in 1888 absolving railroads from the responsibility to furnish tank

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[134] Railroad Facts, published annually by the Economics and Finance Department of the Association of American Railroads, Washington, DC.

[135] Interstate Commerce Act, § 1(4). The provisions of this and other sections noted here were re-enacted as Subtitle IV, Title 49, U.S.C. upon repeal of the IC Act. See, in this case, 49 U.S.C. § 11101(a).

[136] IC Act, §§ 3(4) and 1(10). See, generally, 49 U.S.C. § 11121.

[137] IC Act, § 1(14), now 49 U.S.C. 11122.

[138] As early as 1900 there were already 10,000 tank cars in service.

cars made it virtually certain that nonrailroaders would be an essential part of the decisions made about the cars used for chemicals and petroleum products. This dichotomy has shaped both tank car development and the Federal government's relationship to it.

From the first cars at Titusville until just after the turn of the century, tank cars were designed and built by agreement between the builder and the shipper. Railroad "acceptance" dealt with those features necessary for transportation: dimensional compatibility and normal materials of construction. The need to solve these and other problems led to the formation of organizations like the Master Car Builders Association (MCBA). In 1903, the Master Car Builders Association Tank Car Committee (railroad mechanical officers and a representative of Union Tank Line) developed a set of recommended practices for the construction and repair of tank cars. The recommended practices were advanced to industry standards in 1910 when they were accepted by the car builders.

Tank cars made significant progress following the adoption of the first industry standards. Pressure cars were introduced, welded construction was approved, and the shippers, builders and railroads began applying the principles of metallurgy to tank steels. In 1918, a new specification insulated car, known as a Class IV, was developed to haul volatile flammable products. A new Class V car was created especially for products dangerous to life in the event of leakage or rupture (chlorine and sulphur dioxide, for example). These 1918 specifications mark the first time that MCBA preconstruction approval of designs was required.[139]

[139] To complete the early roster of tank cars: Class I cars were those built before 1903, Class II's were built from then until 1917 when a new general purpose specification, the Class III, was required for cars built after May 1, 1917.

On the legislative front, in 1908 Congress passed the Explosives and Combustibles Act, a law that governed hazardous materials transportation for six decades.[140] This legislation authorized the ICC to issue regulations covering the packaging, marking, loading and handling of explosives and other dangerous commodities in transit; it also prescribed criminal penalties for shippers or carriers who violated the ICC regulations.

The regulations adopted three years later by the ICC to implement the Explosives Act were based on rail safety standards developed by the Bureau for the Safe Transportation of Explosives and Other Dangerous Articles (The Bureau of Explosives or BOE).[141] Bolstered by the specific reference to the BOE in the law, the ICC delegated responsibilities to it. Over the next several decades, until the formation of the Department of Transportation, the relationship between the ICC and the BOE continued to grow, as rules that were originally designed for the railroads were applied to other modes of transportation.[142]

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[140] 18 U.S.C. §§ 831-837. Later called the Explosives and Other Dangerous Articles Act, or EODA. (Federal Law of May 30, 1908, modified by the Act of March 4, 1909, §§ 232-236.) Federal hazardous materials transportation safety law is now found at 49 U.S.C. § 5101 *et seq.*

[141] 18 U.S.C. § 834(e) authorized, by name, the "utilization" of the Bureau of Explosives.

[142] Formed in 1905 and operational soon thereafter, the Bureau of Explosives developed standards for safe hazardous materials transportation and, through a network of inspectors across the United States and Canada, enforced those standards. Its laboratory tested new dangerous commodities to determine their classification for transportation. The relationship between BOE and the ICC was so close that the Bureau effectively wrote most of the hazardous materials regulations inherited by the Department of Transportation. BOE joined the Association of American Railroads when that organization was formed in 1935. In 1985, after more than 75 years of service, the AAR drastically changed the structure and methods of the Bureau and altered its name to "Hazardous Materials Systems." By then, of course, the Department of Transportation was well along in building its own history and further discussion of the internal affairs

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By 1927, the Commission and the American Railway Association (ARA) Committee on Tank Cars had collaborated on a set of seven tank car specifications and, effective July 1, 1927, they were adopted as ICC regulations. In terms which foretell the current procedures, the ICC regulations required a builder to secure approval of all designs from the ARA Committee on Tank Cars before beginning construction. To illustrate, a proponent seeking a change in the tank car specifications was required to submit the proposal to the ARA (through the Secretary, Mechanical Division) for review by its Committee on Tank Cars. The Committee then transmitted its approval or rejection, with reasons, to the Commission. Review of the proposal and the Committee action on it would pass through the Bureau of Explosives for comments and suggestions prior to final action by the Commission.

Further, an applicant for approval of plans for construction needed to submit complete detailed prints/plans to the mechanical division secretary for a thorough investigation and review. If the application was in full compliance with specifications of the Commission and no increase in hazard was involved, approval would be granted. If the application was in full compliance with specifications of the Commission but a possible increase in hazard was involved, service trials would be necessary before permitting extended use. When, in the opinion of the Committee, the application did not comply with specifications of the Commission, but service trials were considered desirable, the Commission would have to approve the conditions of the service trials. In practice, the ICC relied heavily on the expertise of the Bureau of Explosives and the Committee's expert opinions were given substantial weight by the Commission in determining appropriate final action.

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[142](...continued)
of the AAR is not relevant to this Report.

In 1934, the American Railway Association, the Bureau of Explosives, and the associations for Railway Executives, Railway Accounting Officers, Railway Treasury, and Railway Economics were combined into the existing Association of American Railroads. The final rule, written by the AAR/ICC partnership and issued by the Commission, was published October 19, 1964, and established 49 C.F.R. Section 79.3 (currently Section 179.3), codifying an approval process very much as had been in use since 1930.

In 1967, authority to regulate the transportation of hazardous materials was transferred from the ICC to a new Federal agency, the Department of Transportation. Within DOT, separate modal administrations were retained to preserve organizational continuity; the FRA was charged with responsibility for rail transportation safety matters. A separate entity, the Hazardous Materials Regulations Board, was created by the Secretary to coordinate hazardous materials activities within the DOT.

The change from ICC to DOT added a research capability to the Federal Government's hazardous materials transportation activities and allowed FRA to become involved in the design of tank cars. Indeed, the FRA was considered a "member" of the Tank Car Committee and attended Committee functions from 1968 to 1975. From the passage of the HMTA in 1975 until 1980, a RSPA staff member attended TCC functions, sometimes with an FRA representative. Participation by FRA and RSPA, however, was restricted by the industry to "open" sessions only. Federal staff members acted as observers and did not participate in or vote on any issues pertaining to proposed changes or to tank car applications for new construction, alterations, or repairs.

In 1975, the enactment of the HMTA improved departmental regulatory and enforcement activities by giving the Secretary of Transportation authority to establish regulations to "govern any safety aspect of the transportation of hazardous materials which the

Secretary deems necessary or appropriate ...."[143] Shortly after passage, the Secretary created the Materials Transportation Bureau and named it the lead DOT agency for hazardous materials regulations, but enforcement authority was divided between the MTB and the modal administrations. In 1986, the MTB was abolished and its hazardous materials functions vested in the Office of Hazardous Materials Transportation and the RSPA Administrator.

The pattern of Government staff involvement with the Tank Car Committee has evolved over time. From July 1, 1927, when the ICC specifications first superseded those of the industry, until April 1, 1967, when the DOT came into existence, the ICC took the language of the Explosives and Other Dangerous Articles Act quite literally and turned tank car activity over to the BOE and the Committee on Tank Cars. The ICC had a representative at meetings of the Committee whose primary function was to review proposals for acceptability.

Between 1980 and 1983, cooperation between DOT and the Tank Car Committee dwindled and the Federal representatives were not invited to, or advised of, Committee or subcommittee sessions. Beginning in 1983, FRA again asserted its role and resumed reviewing tank car issues through active participation with the Tank Car Committee.[144]

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[143] 49 U.S.C. § 5103, formerly 49 U.S.C. § 1804(a).

[144] Federal representatives do not participate in deliberations that do not involve delegated authorities, for example, discussions involving the development of the industry's responses to DOT rulemaking proceedings.

APPENDIX B: STATE REGULATION OF HAZARDOUS MATERIALS TRANSPORTATION: THE CALIFORNIA EXAMPLE

SUMMARY: In 1993, California's Public Utilities Commission opened two railroad regulatory proceedings, one aimed at site specific hazards and the other at hazardous materials transportation methodology. FRA is not a party to these proceedings and they are not sufficiently advanced to predict their eventual outcome. While the Federal Railroad Safety Act properly emphasizes uniform and consistent safety rules that benefit the entire nations, state regulatory action can often point the way for national standards.

REPORT: On July 14, 1991, at Dunsmuir, California, excessive lateral in-train forces led to the derailment of one locomotive and 7 (of 97) cars. One of the cars was a tank car of metam sodium, an agricultural pesticide; it fell from a bridge, landed in the Sacramento River, was punctured and lost most of its contents. Fourteen days later, at Seacliff, California, a failed roller bearing journal caused a derailment of 14 (of 39) cars and the loss into the atmosphere of about 440 gallons of hydrazine, aqueous solution, from ruptured drums in an intermodal container.

Neutralization procedures and cleanup efforts at each of the sites required considerable time, involved scores of workers, necessitated specially trained personnel and specialized equipment, and cost millions of dollars. The California General Assembly found that the damage to the environment and to wildlife, the costs of evacuating people from their homes, and the inconvenience caused by road closings was inestimable. The legislature required the Public Utilities Commission to report on hazardous railroad sites, to identify track sections that pose local safety hazards, and to propose regulations and procedures to abate or mitigate any hazards.

In an Order Instituting Rulemaking R.93-10-002,[145] the PUC has proposed 33 rail segments and, for each, regulations tailored to the counter measures deemed necessary at each site. The railroads affected include Southern Pacific, Union Pacific, Santa Fe, San Diego Northern, Metrolink, and the North Coast Railroad. At the same time, the PUC decided to embark on a second proceeding, this one addressing the transportation of hazardous materials generally. The Commission wanted to keep regulations dealing with site safety separate from those aimed at transportation methodology. On the latter topic, the PUC Order Instituting Rulemaking is number R.93-12-008.[146]

This report is neither a forum for determining issues of Federal/state preemption[147] nor comment by FRA about any aspect of the California Commission's proceeding. As Congress intended in RSERA 1992, this is a report "regarding issues presented by the transportation by rail of hazardous materials." Consideration of the possible outcome of the PUC proceeding would be mere speculation now; besides, FRA is not a participant in the Commission's rulemaking and nothing said here is should be used either as evidence of FRA's opinions about that proceeding or in any attempt to influence the deliberations of the PUC.

<u>Site Safety Regulatory Proposals</u>:

PUC has proposed that the following regulatory measures be applied to one or more of the sites designated as local safety hazards:

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[145] Filed at the Commission's San Francisco office October 6, 1993.

[146] Filed at the Commission's San Francisco office December 17, 1993.

[147] See 49 U.S.C. § 20106, formerly 45 U.S.C. § 434. The standard is that laws relating to railroad safety shall be nationally uniform to the extent practical. The term "Federal railroad safety laws" also includes the Hazardous Materials Transportation Act. 49 U.S.C. § 20109(e)(1), formerly 45 U.S.C. § 441(e).

Track Train Dynamics: The railroads would be required to follow the "rules" developed by the International Government-Industry Research Program on Track Train Dynamics. "TTD principles take into account the locomotive tractive effort, trailing tonnage, drawbar force, and grade and curvature of the track. The end result is the ability to avoid derailment ...."[148] This aspect of the California Commission's proposals is discussed in more detail in the section of this report dealing with the in-train placement of hazardous materials cars.

Dynamic Brake Regulation: This proposal would require each train operated over an applicable site to have operative dynamic brakes for use on descending grades. "Operative" would be functionally defined as dynamic brakes that are working and that have sufficient braking capacity to operate over the site without the use of retainer brakes. Trains with insufficient dynamic brakes would be required to add helpers or to "lighten" the train.

End-of-Train Telemetry Systems Regulation: This proposal would require trains operating over an applicable site to have two-way end-of-train telemetry systems. Trains carrying cabooses meeting certain requirements of the PUC, and placed at the end of the train, and occupied by a member of the train crew would not be required to have two-way telemetry. As defined by the Commission, two-way end-of-train telemetry means a radio transmitter and receiver system with one such device on the last car of the train and a second device in the control compartment of the controlling locomotive, visible to the engineer. These devices must be capable of communicating with each other and, as to the last car of the train, indicating brake pipe pressure in increments of one pound per square inch; rear car movement; operation (or nonoperation) of the rear marker light; remaining battery life; interruption of the communication link between the two units; and the total distance in

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[148] *Track Train Dynamics*, p. 3-1.

feet travelled by the locomotive carrying the forward device. In addition, the telemetry system shall permit a crew member in the controlling locomotive to remotely activate an emergency brake application starting at the rear device.

Training Regulation: The proposed regulations would require that train and yard service employees be provided classroom training about the unique operating characteristic of the applicable site; that locomotive engineers receive specialized instruction in track train dynamics, dynamic braking, ascending grade, descending grade, helper service, and track curvature considerations. Employees responsible for train make-up would be required to have training in track train dynamics, including the origins and consequences of steady and transient high lateral forces, the reasons for each of the track train dynamics rules, and the special characteristics of the applicable site.

Service over Site - Requalification Regulation: The proposed regulations would require locomotive engineers and conductors to be accompanied by a supervisor if they had not performed service over the applicable site within the preceding 180 days.

Accident Notification Regulation: The proposal would require accidents to be reported to the Safety Division of the PUC whether or not they met Federal reporting criteria.

Securement of Trains and Cars Set-Out: The proposed regulation would require that cars left on a main track, or placed on a spur from a main track have a sufficient number of hand brakes set to prevent movement. In addition, derail protection would be required unless the cars are placed beyond a facing point switch aligned against movement or on a track with an ascending grade between the cars and the main track, populated area, or environmentally sensitive area.

Track Regulation: The proposed regulation would mandate extraordinary track design and maintenance measures on sites where there is a special potential for disaster due to the extreme forces applied to the track structure. As examples, antiroll blocks would be required at least every eighth tie, curve wear on the gage side exceeding 1/2 inch would be prohibited, double shoulder tie plates would be required on curves exceeding 8 degrees, conventional spiked tie plates would require at least 5 spikes per plate, rail anchors in a box pattern on every other tie would be required, as would larger dimension ties, and grade compensation in specific curves would have to match a stated specification.

Transportation Methodology Regulatory Proposals:

The PUC staff has proposed the following regulatory measures to improve transportation methodology:

Information on Train Consist: In addition to the Federal requirements, the Commission proposes that trains carrying hazardous materials shall carry a packet of shipping papers "in the engine occupied by the conductor." The packet must be kept in a container marked "Secondary Emergency Response Materials." As proposed, the packet would contain:

- A physical description of the type of car.
- Information to identify the particular car, such as the identification number and the position of the car in the train.
- The size and carrying capacity of the car in pounds for solids, gallons for liquids, or cubic feet for gaseous materials.

- For vehicles carrying nonbulk packages of hazardous materials, a description of the weight and volume of the packages.

- A list of each hazardous material in each car.

- The general chemical name for each hazardous material.

- The common trade name for each hazardous material.

- If the hazardous material is a solution or mixture, the major constituents, listed in descending volume order.

- A name and 24-hour telephone number for the hazardous materials manufacturer for each hazardous material.

- A name and 24-hour telephone number for each shipper of a hazardous material.

- The United Nations (UN) or North American (NA) number for each hazardous material.

- The Standard Transportation Commodity Code (STCC) number for each hazardous material.

- The DOT hazard class for each hazardous material.

In addition to the information on a normal train consist, the proposal would require a description of all rail cars carrying hazardous materials in bulk. Further, both the hazardous materials information and the non-hazardous materials information would be required to be maintained by the railroad: in a manner that allows emergency responders to gain access to it by voice, modem, or facsimile on request of the incident commander at the scene. Finally, the railroad would be required to maintain a 24-hour telephone number to "facilitate" access to the information.

Inspection Requirements: A rolling inspection would be required before a train carrying hazardous materials crosses into California.

Operation Requirements: The Commission proposes a rule requiring a walking inspection of a train following an emergency application of the brakes while moving or severe slack action incidental to stopping. The inspection is to make certain that the track and equipment is in proper condition and that all wheels are on the track. If part of the train is on a bridge or other location where a physical inspection is impossible, the crew would be required to inspect as much of the train as possible and then to move the train at a speed not to exceed 4 miles per hour no further than necessary to complete the walking inspection.

Under the proposal, if a "train defect detector" is actuated and an overheated journal is indicated, but inspection reveals a false activation, the train must be operated not to exceed 30 miles per hour past the next operative hot box detector and, if the same car again activates the detector, the car must be set out. If cars are set out, the railroad would be required to set sufficient hand brakes and derail protection unless the main track is protected by a facing point switch lined against movement and locked or there is an ascending grade between the cars and the main track.

Training Requirements: The PUC proposes that employees handling hazardous materials shipments be given job specific training to perform the following:

- Comply with the hazardous materials shipping paper requirements.

- Recognize markings and placards.
- Conduct a walk-around inspection to determine the external condition of placarded hazardous materials shipments.
- Switch placarded hazardous materials shipments in accordance with applicable regulations.
- Execute proper train placement of hazardous materials cars.

In addition, employees who handle hazardous materials would have to receive training to perform enumerated tasks in the event of a hazardous materials incident:

- Identify hazardous materials, make appropriate notifications, provide appropriate material to emergency responders.
- Take the proper action to protect self and others at the scene.
- Provide assistance to local emergency response forces by giving them the proper information on hazardous materials and by helping them interpret information on the consist.

The proposal would also require the keeping of the necessary records to demonstrate compliance.

Recommendations to the Department of Transportation:

In 1991, the California General Assembly amended the Public Utilities Code to require the Commission to request appropriate Federal agencies to make several changes in regulations covering the shipment of hazardous materials by railroad. On July 19, 1992, PUC President William Fessler wrote then Secretary of Transportation Andrew Card, transmitting 10 recommendations. The subject matter of California's recommendations involves the regulatory jurisdiction of both FRA and RSPA. Both agencies are considering them; in fact, both agencies have active, ongoing rulemaking proceedings encompassing many of the individual recommendations; in the case of at least one -- the addition of marine pollutants to the Hazardous Materials Table -- the action has been completed.

The exposition of the Commission's recommendations here is just that, and not a comment on where or whether they might fit into a Federal regulatory program. To the same effect, mention of or comment on the recommendations is not to be taken as a statement of departmental policy on any pending rulemaking proceeding.

Classification of Chemical Compounds: The California Environmental Protection Agency's Office of Environmental Health Hazard Assessment recommended that a list of marine pollutants, including metam sodium, be added to the Hazardous Materials Table.

Safer Rail Cars for Hazardous Materials: The PUC recommended that DOT identify the most harmful hazardous materials now moving and require that they move in "stronger" cars with head shields and thermal jackets; if a phased implementation is necessary, DOT should do it by protecting the most harmful substances first.

Better Information on Train Manifests: The PUC recommends a revision of the requirements for displaying hazardous materials information on movement documents, with the goal of making the information and warnings understandable to emergency response personnel. Recommended improvements include:

- Including information on environmental effects in the manifest.
- Enhancing the description of the rail car by including a physical description, e.g., tank car, intermodal container car ....
- Include a piece count of non-bulk packaging on or within a container or freight car, and include the weight and volume of each such piece.
- Show the size and capacity of the rail car, with the information stated in pounds for solids, gallons for liquids, and cubic feet for gaseous materials.
- List each hazardous material in or on each rail car.
- List all the chemical constituents of solutions in descending order of the concentrations by volume.
- Furnish train crews with an accurate listing of the cars in the train, including contents and weight.

Dynamic Brake Standards: PUC recommended that DOT develop dynamic brake standards and regulations to ensure that each train actually has adequate dynamic braking.

Trackside Detectors: CPUC recommended that DOT develop and establish safety standards and regulations governing the uniform application and use of hot wheel bearing and dragging equipment trackside detectors. This is especially important, in the Commission's view, with cabooseless trains.

End-of-Train Braking Devices: The use of two-way end-of-train braking devices is recommended whenever trains are operated in mountain grade territory. As advanced by PUC, such a dual capacity is crucial where activation of the brakes from the front of the train is prevented, whether through inadequate maintenance or the action of vandals in closing train line shut-off valves.

Car Weighing and Shipper Loading Certification: The Commission recommended that DOT establish freight car weight and shipper loading certification because of continuing problems associated with the failure of shippers to determine and communicate the accurate "trailing weight" of a train to train crew members. PUC has found at least one instance where the train was 50 percent heavier than was stated in the documents provided to the engineer.

Wheel Bearing Assembly Problems: The PUC recommended that DOT urgently support continued testing of the relationship between defective cap screw seals and the backing out of Brenco locking bolts from wheel bearing assemblies. If a causal relationship is found between this defect and overheated bearings, it was recommended that DOT require an industry retrofit program.

Accident Reporting Accuracy: Citing a U.S. General Accounting Office report that concluded there was considerable under reporting of accidents, damages, injuries, and days lost because of injuries, PUC recommended that 49 CFR § 225 be amended to require more coordination between the railroad office making accident reports and the railroad's claims and repair departments; to require enhanced record retention; to update data as changes become known, and to update data bases to correct deficiencies.

Hours of Service Act: CPUC recommended the Hours of Service Act be amended "to more adequately account for human capacities and limitations on performance." PUC recommended that hours worked at night be differentiated from hours worked during daylight and that limits be placed on the cumulative hours during a certain period of time.

Response to the Commission's Recommendations:

On September 28, 1993, FRA's Associate Administrator for Safety wrote the Chief of the Railroad Division of the Commission, sending him an updated summary of DOT action pertinent to the recommendations. The reply, included below, has itself been updated to reflect status changes as this report was in the final stages of agency and review.

Classification of Chemical Compounds: The Commission recommended that RSPA add to the DOT list of regulated materials those materials included in Annex III of the 1973 International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) and certain other substances regarded as hazardous by California's Office of Environmental Health and Hazard Assessment (Director's list). On November 5, 1992, RSPA issued a Final Rule to list and regulate, in all modes of transportation, those materials identified as marine pollutants under MARPOL III. Concerning those materials on the Director's list, they are under review by RSPA for consideration of adoption into Federal regulations.

Safer Rail Cars for Hazardous Materials: The Commission recommends that DOT require the implementation of the recommendations set forth by the National Transportation Safety Board's "Safety Study, Transport of Hazardous Materials by Rail." The Board's report compared the accident performance of the DOT 111-A tank car with higher test pressure tank cars equipped with enhanced safety systems.

It is important to consider the Board's recommendation in the appropriate and intended perspective. The Board did not take the position that the DOT 111-A car is unsafe. On July 31, 1991, the Board testified before the House Committee on Government Operations as follows:

> the Safety Board did not take the position in its recent safety study that DOT 111-A tank cars are per se unsafe for hazardous materials. We believe, in fact, they are very safe for many of the materials that are on the list.
>
> What needs to be done in the long term is exactly what we have asked RSPA to do--developing this process to classify the risks associated with all of these materials, everything that is shipped by rail tank car, classify the risks associated with all of them, determine the risks the public is willing to accept, and then determine how to package them so that the risks they pose once they are packaged is at an acceptable level.

In an earlier recommendation, the Board asked the Department to do just that. The FRA completed the first phase of a research project to develop such a methodology. That phase addresses the compatibility of transporting flammable gases and liquids and materials poisonous by inhalation with the tank. Research on additional classes of commodities is ongoing.

Other recommendations issued by the Board are being considered in the departmental rulemaking under RSPA Docket No. HM-175A. FRA and RSPA are considering expanding the types of tank cars that require additional "safety systems." Safety systems include tank head puncture resistant systems (head shields), thermal protection systems (normally a fire retardant material enveloping the tank), coupler vertical restraint systems (shelf couplers), and requirements for roll-over protection. The Notice of Proposed Rulemaking in this matter was published October 8, 1993, a hearing has been held and the comments received thus far have been reviewed.

Please note, as well, that strengthened requirements for transportation of materials poisonous by inhalation, which were issued under RSPA Docket No. HM-181, become effective October 1, 1993. FRA has made a special effort to contact shippers of these commodities to emphasize the need for use of higher pressure tank cars meeting the requirements of the revised regulations.

Better Information on Train Manifests: The Commission recommends that, with respect to hazardous materials, the Department revise the requirements for setting forth information on a train manifest. Present Federal transportation requirements do not mandate the use of a manifest nor its use to communicate the hazards of a hazardous material. The regulations do require the conveyance of a shipping paper that identifies the material, the risk or risks associated with that material, and the material's identification number to cross-reference the material with other literature. Furthermore, immediate emergency response information containing fire-fighting, first-aid, and environmental mitigation procedures and an emergency response telephone number must accompany the shipment. Also, when shipping a material under a general entry, or when the shipping name does not show the component of a systemic poison, the shipping paper must contain the technical name of at least two major components that contribute to the toxicity of the material.

FRA understands that the Commission is reviewing the format in which information is presented on train consists, and in particular the use of a variety of codes to describe attributes of the equipment. The concern is that emergency responders be able to readily decipher the documents provided by the train crew. FRA encourages the Commission to continue its dialogue with railroads operating in California regarding this issue, and FRA would appreciate any further insights that the Commission may develop regarding practical means of addressing this issue.

In a rulemaking RSPA is considering issuing, FRA and RSPA would solicit comments on the costs or benefits of requiring a manifest with detailed hazardous materials information. DOT will consider the Commission's comments in developing any proposed rule. FRA expects to commence this rulemaking not later than September 1994.

RSPA published an ANPRM in Docket No. HM-206 (57 FR 24532; June 9, 1992) to solicit comments on the need to improve the current placarding system for the transportation of hazardous materials. The ANPRM also requested cost or benefit information on the need for a centralized reporting and computerized telecommunications data center and a requirement for carriers to establish a 24-hour emergency response telephone number. RSPA is presently reviewing a report of the National Academy of Sciences on the issue of centralized tracking of hazardous materials shipments and will progress this rulemaking in the future.

Dynamic Brake Standards: The Commission requests that the Department develop dynamic brake standards and regulations for locomotives. The issue of dynamic brakes is being addressed in a rulemaking on train and locomotive brake systems. FRA published an ANPRM on December 31, 1992, and conducted four days of public workshops this past spring. Participants in the proceeding generally agreed that dynamic brakes should not be relied upon as a primary safety system. However, it was recognized that engineers may rely upon dynamic brakes as a second-order safety system; and the RSERA requires that FRA issue standards for dynamic brakes, applicable where locomotives are equipped with this feature. As this report was written, a Notice of Proposed Rulemaking was in the final stages of review within DOT and publication is expected in the near future.

Track-side Detectors: The Commission recommends that the Department develop and establish safety standards and regulations governing the uniform application and use of hot wheel bearing and dragging equipment detectors. FRA regulates dragging equipment detectors, slide detectors, and other similar protective devices when these devices are interconnected with a signal system. FRA has no other regulations governing the application and use of hot wheel bearing or dragging equipment trackside detectors.

The AAR, however, has published recommended standards for hot wheel bearing detectors on "key routes." A key route is any track with a combination of 10,000 car loads or intermodal portable tank loads of hazardous materials, or a combination of 4,000 car loads of a material that meets the criteria of extremely poisonous by inhalation or classified as a flammable gas, an Explosive A, or an environmentally sensitive chemical, over a period of one year. The AAR recommendation suggests placement of wayside defective bearing detectors 40 miles apart on key routes. Major railroads are implementing programs having objectives that generally exceed this criterion.

FRA will continue to monitor implementation of carrier wayside detector programs and the performance of roller bearing-equipped cars. Roller bearing failures are often preceded by little warning and thus cannot always be prevented through automated detection, regardless of the level of expenditures devoted to this purpose. However, FRA agrees that system analysis of risk factors such as population density and proximity to major waterways is desirable to develop appropriate strategies in this area. This is a technically complex undertaking that FRA will integrate into a larger examination of safety risks on major rail routes. FRA is also continuing to fund research into bearing failure modes and failure detection technology.

End-of-Train Braking Devices: The Commission recommends that the Department require the use of two-way, end-of-train braking devices whenever trains are operating in mountain grade territory. This issue is included in the rulemaking on train and locomotive brakes discussed above.

Car Weighing and Shipper Loading Certification: The Commission recommends that the Department develop and establish freight car weight and shipper loading certification. The frequency of excessive "trailing weight" on freight trains, to the extent that the excessive weight contributed to the unsafe operation of the train, is low. With over 20 years of accident investigation history, FRA has not encountered compelling evidence that would justify a regulation on these topics. The extraordinary circumstances involved in the Cajon, California, accident have not recurred. The carrier introduced corrective measures at the accident site to guard against excessive weight of trains.

It is by no means clear that Federal action addressing this subject matter would be more effective than the market forces already at work between carriers and shippers. When allegations that show excessive weight threatening the safe operation of a train do arise, FRA will investigate the circumstances surrounding the operation and take appropriate action. Should the Commission acquire data that indicates a systemic problem, FRA would welcome the opportunity to review that data.

Wheel Bearing Assembly Problems: The Commission recommends that the Department support continued testing by AAR and FRA of the relationship between defective cap screw seals and the "backing out" of Brenco locking bolts from wheel bearing assemblies.

The technical question regarding cap screw seals is not limited to bearings of a particular manufacturer. AAR discontinued the application of cap screw seals to roller bearings on May 1, 1988. No bearings manufactured or remanufactured since then would have the cap screw seals. Several railroads have undertaken special programs to remove cap seals from existing roller bearing assemblies. FRA has encouraged the Association of American Railroads to examine whether accelerated removal of roller bearing cap seals is warranted. The AAR now has under active consideration a program to accomplish this removal, and we expect a decision within the next few months.

Accident Reporting Accuracy: The Commission recommends the amendment of 49 CFR Part 225 to foster greater accuracy and completeness in accident reporting. In 1990, FRA issued an ANPRM to seek public comment on the need for railroads to put into effect, among other things, internal management controls for reporting accidents and incidents to FRA. FRA is nearing completion of an NPRM that addresses most of the Commission's concerns.

Since issuance of the General Accounting Office's (GAO) report on railroad accident reporting, FRA has taken positive steps to ensure the accuracy of these reports by conducting regular inspections of the carrier's reporting processes and procedures. Furthermore, FRA conducted a follow-up investigation on the seven railroads identified by GAO as under-reporting accidents, damages, injuries, and days lost because of injuries. Each carrier has improved its internal management controls for ensuring the accuracy of the accident and incident reports submitted to FRA. However, structural improvements in the regulatory program continue to be indicated.

Hours of Service Act: The Commission recommends that the Department propose that Congress amend the Hours of Service Act to account more adequately for human capacities and limitations on performance.

In 1991, the Department proposed legislation that would have repealed the Hours of Service Act and required that its provisions be issued as regulations. FRA would then have been empowered to begin development of requirements to address, in a more effective manner, the problems of contemporary work patterns, including irregular starts and the effects of disrupting biological rhythms. This type of statutory latitude is available in other transportation modes, such as aviation and commercial trucking, and it permits the DOT regulatory agencies to respond to changing work patterns and developments in scientific knowledge regarding human performance. Neither rail labor nor rail management supported this proposal, and the 102nd Congress ended without enactment of the legislation.

However, the issue is squarely before the Congress and the industry parties, and there is an increasing recognition that some kind of response is needed. The House Energy and Commerce Committee has requested that GAO study the issue of engine crew schedules, and the GAO has now issued two reports on that issue. The second of the GAO reports credited the railroad crew calling systems with good performance in providing notice of assignments. The report indicated mixed findings on the issue of the relationship between shift variability or time of day and the occurrence of train accidents.

FRA continues to conduct research and investigation regarding this matter through laboratory explorations of engineer performance on the simulator and through review of actual locomotive engineer work and rest patterns. FRA will continue to evaluate the need for greater flexibility to issue responsive regulations. In addition, the Association of American Railroads is working with the major unions representing operating employees to explore further the relationship between irregular or unpredictable hours and degraded performance. FRA will continue to follow the progress of that effort.