Chapter X

HAZARDOUS MATERIALS, RAIL-HIGHWAY GRADE= CROSSINGS, OTHER RAILROAD SAFETY PROGRAMS

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HAZARDOUS MATERIALS

One dimension of the rail safety problem relates to the shipment of hazardous materials. Generally "hazardous materials" are those substances or materials in a quantity and form which may pose an unreasonable risk to health and safety or property when transported in commerce.[1] According to AAR, some 1.04 million carloads of materials, classified as hazardous, are shipped annually. Other sources indicate the figure is about *2.5* million and that 7.5 percent of the hazardous materials shipped by any carrier are shipped by rail. ' It is conceivable that the 1980's will see other increases in the shipments of hazardous materials, Increasing the volumes of hazardous materials shipped by rail could have an effect on the rate of accidents—injuries, fatalities, and property damage. This concern about the level of safety associated with the shipment of hazardous materials is based on an analysis of past accident data and information.

- Between 1971 and 1974, there was an average of 113 railroad accidents reported to be associated with tank cars each year. Associated with those accidents were 320 injuries, *3* deaths, 12,217 evacuations, and property damage of $10 million.[3]
- During 1974, approximately 8,500 hazardous materials incident reports wet-e filed with DOT's Materials Transportation Board for 550 carriers (all modes). Approximately 7 percent of those were filed by the rail carriers. Two hundred forty-eight reports included 32 fatalities and 900 injuries. Eleven of the fatalities involved gasoline as tank truck (or tank trailer) cargo in 10 different incidents. Seven fatalities and 349 injuries involved one liquid propane gas (LPG) tank car incident at Decatur, Ill. Sixty-nine people were injured at Wenatchee, Wash., in the explosion of a tank car containin$_g$ monomethalamine ammonium nitrate solution. Fifty-four people were injured at Oneonta, N. Y., in an accident involving the derailment of an LPG tank car. Roughly 65 percent of railroad cases involving the unintentional release of hazardous materials involved tank cars loaded with LPG, sulfuric acid, anhydrous ammonia, and liquid caustic soda. ~

'In the first quarter of 1977, among the top 25 hazardous materials shipped by rai1 were: ammonia, caustic soda, liquid propane gas (LPG), sulfuric acid, chlorine, propane, ammonium nitrate, gax~line, phosphoric acid, crude oil, methanol, petroleum distillate, vinyl chloride, butane, motor fuel ant i-knock c{}mpound, bu tad iene, and petr{w leum naphtha. (The measure: carloads: the ~(>urce [>f in-f{~rmat ion: AAR.)

'1'MM & Co,, Task I\'.

[3]1975 FRA Annual Report.

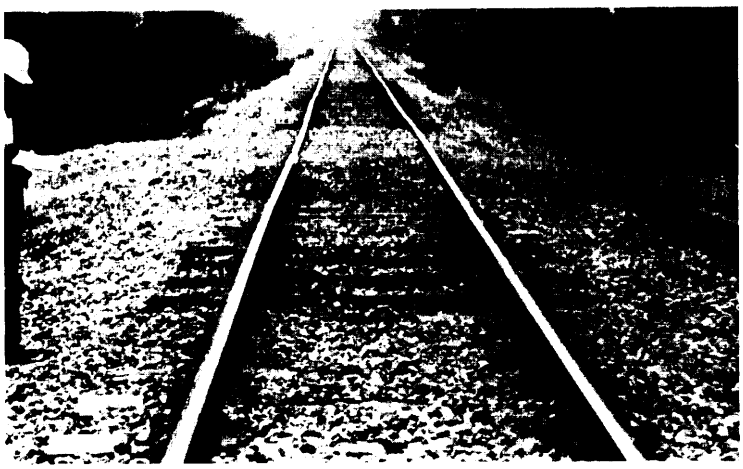
'Ffazardo~E *Matcrzals l)~ci~ic)~t RcpL~rts,* Department of Transportation, hfar. 7, 1975.

Photo Courtesy of the Association of American Railroads

Arrow points to insulated pressure tank car head shield—designed to avert puncture of tank by coupler after accident has occurred.

Photo Courtesy of Federal Railroad Administration

Tank car torching test— testing ability of insulating material to withstand torching environment.



Amtrak tracks; Meets FRA track standards—Class 4.

Frankfort, Ky.; Tank car derailment; Carrying Hydrocyanic acid; Broken rail; December 1977.

Tank car punctured by coupler at the **Frankfort derailment** shown **above.**

Photos Courtesy of National Transportation Safety Board

RESPONSES TO THE PROBLEMS ASSOCIATED WITH THE SHIPMENT OF HAZARDOUS MATERIALS

Federal Government

Statutory and regulatory responses. The need for a hazardous materials safety program was recognized with the passage of the Transportation of Explosives and Combustibles Act of 1908 (18 U.S. Code, $ 831 to 835). That Act prescribed the conditions under which certain explosives were to be shipped in vehicles and vessels engaged in interstate and foreign commerce. The next major piece of legislation was the Transportation of Explosives and Other Dangerous Articles Act of 1960 (P.L. 86-710), which covered radioactive materials and etiologic agents and extended coverage to the transportation of the denominated materials by private and contract carriers. Chapter VII covers a detailed discussion of the provisions of the controlling legislation. Suffice it to say that what controls now is the broadened authority given to the Department of Transportation under the Transportation Safety Act of 1974. Among other things, that Act provided the authority for: the designation of materials as hazardous materials and issuing regulations for their safe transportation; establishing a program of registration of shippers, and container and packaging manufacturing; and establishing criteria for handling hazardous materials. A Materials Transportation Bureau was established in July 1975 and given the responsibility for coordinating the issuance of regulations and exemptions concerning the shipment of hazardous materials solely by rail; designating materials as hazardous; prescribing recordkeeping requirements; imposing sanctions for violations; and collecting and compiling data.

The Federal Railroad Administration has the responsibility for working with MTB in the development of standards, data collection, inspections, and general administration of the rules.

The regulations covering hazardous materials are discussed in chapter VII. See table 40 for actions required of various parties.

The impact of Federal regulatory action relative to hazardous materials: One activity of the Materials Transportation Bureau is that of requiring all shippers and carriers to file Hazardous Materials Incident Reports citing any and all unintentional release of hazardous materials. The industry response to this requirement indicates that more and more the Department of Transportation is being assisted in developing early warning systems and inspection strategies designed to meet the problem of hazardous materials shipped by rail. During 1971-76, there was an increase in the number of rail carriers reporting incidents. Tables 41 and *42* show the number of reporting carriers and the number of Hazardous Materials Incidents Reports submitted between *1971* and 1976. As can be seen for rail carriers, there **was a** rapid increase in the number of reporting carriers and the number of reports submitted. The increase between 1971 and *1976* of reporting rail carriers was 80 percent. The MTB believes that the increased reporting results from increased awareness of the reporting requirements.

Pressure tank cars have been involved in accidents since *1918.* Since 1969, there has been a growing concern expressed about the involvement of uninsulated pressure tank cars in serious railroad accidents. These concerns led to the issuance of regulations, effective October 19, 1977, calling for cars built after December 31, 1977, to comply; further, the regulations required retrofitting of existing tank cars. In dealing with the tank-car-safety problem, the Department of Transportation first sponsored research and development to provide the necessary analysis of the problem of puncture and rupture of pressure tank cars involved in an accident environment.

The Department of Transportation has issued

Table 40.—Actions Required To Ensure Safe Rail Shipment of Hazardous Materials*

Actions	Container manufacturer	Shipper	Rail carrier	Consignee	Federal inspectors
Packaging *and* ***Loading***					
Assure that the material is properly formulated ($173.22)**		x			
properly classified (173.22)		x			
properly packaged (5173.22)		x			
Assure that the shipping papers correctly describe the materials (s173.427)		x			
Assure proper placement and loading of packaged goods and bulk goods ($1 73.31), (§174.525)		x			
Assure the proper packaging of intermodal shipments such as portable tank and highway trailers; and assure proper loading of the same ($173.32)		x			
Assure proper placarding of the rail cars ($174.548)		x			
Train officers, agents, and employees as to shipping requirements		x			
Inspection					
Ensure compliance with the railroad equipment and safety standards			x		
Ensure compliance with the DOT hazardous materials regulations			x		
Ensure receipt of properly executed shipping papers ($174.510)			x		
Understanding FRA and MTB regulations requiring the proper handling of rail cars			x		
Training personnel in FRA and MTB regulations			x		
Audit shipper rail carrier operations to ensure compliance					x
Incjdent/Accjdent Handling					
Supply information on how to control the problem	x				
Supply notice of certain hazardous materials incidents (~171 .15 and 171 .16)			x		
Unloading					
Safely and completely unloading materials and in the case of tank cars securing valves ($174.560)				x	
Removing placards ($174.562)				x	

● SOURCES: 49 CFR 173ff. Black, W. F. *Transporting, Load/rig and Unloading Hazardous Materials Using Railroad Transportation* Technical Paper No, MS 75-660, Society of Manufacturing Engineers, 1975, p. 2,

●● The citations provided are applicable sections of 49 CFR.

Table 41 .— Number of Carriers Reporting to MTB

Mode	Reporting Carriers 1971	1972	1973	1974	1975	1976*	Total	Percent of total
Air carriers	3	11	15		31	40	50	
Hwy carriers (for-hire)	233	323	353	3%	392	600	700	6 :
Hwy carriers (private)	54	58	73	82	116	200		22
Rail carriers	28	35	35	40	44	43	75	7
Water carriers.	10	8	7	17	23	40	50	4
Total	328	435	483	551	606	930	1,125'	* See note

•Estimated.
••● Total number of different reporting carriers during the 6-year period—not the addition of numbers for each year. (For example–carrier XYZ submitted reports in each year but as the "total" reporting carriers, XYZ is only one reporting carrier— not six.)
SOURCE: Materials Transportation Bureau, from PMM & Co., Task IV.

Table 42.—Number of Reports Submitted to MTB

Mode	Reports Submitted 1971	1972	1973	1974	1975	1976*	Total	Percent of total
Air carriers	5	32		155	152	150'	550	41/4
Hwy carriers (for-hire)	1,633	3,613	5 , 6 :	7,254	8,988	9,900'	36,550	83
Hwy carriers (private)	258	352	450	361	903	950'	3,300	71/4
Rail carriers	346	337	412	617	617	981 '	3,400	71/'
Water carriers.	13	10	12	26	32	50"	150	I/~
Total	2,255	4,344	6,016	8,413	4,750	11,898	44,000	See note**

•Estimated.
••● See note in table 41.
SOURCE: Materials Transportation Bureau, from PMM & Co., Task IV.

a series of regulations covering hazardous materials. Specific topics covered are: general handling and loading, handling of placards, explosives, gases, flammable liquids, flammable solids, oxidizers, poisonous materials, radioactive materials, and corrosive materials. The National Transportation Safety Board has had some concerns about the effectiveness of the regulatory activity, specifically:

- NTSB recommended that the Secretary of Transportation reassess the regulations applicable to the packaging, loading, storing, and transportation of military munitions. (Report issued April 2, 1975.)
- NTSB recommended that the Secretary of Transportation publish guidelines describing methods available for conducting safety analyses that would facilitate the discovery of detonation risks and standards to be met. (Report of March 3, 1976.)
- NTSB recommended that the Secretary of Transportation establish regulations for quality specifications and quality control procedures in the manufacturing, packaging, and loading of detonable hazardous materials.

Accident data and trends were important in initiating regulatory activity which led to the tank-car standard. Accident data should always be one tool of the regulatory process. But that alone is not satisfactory. It is critical to effective safety regulation to ensure that the exposure of people and property to hazardous materials be determined, and this is not being done systematically. The impact of the inspection efforts is discussed in chapter VIII. See table 43 for accidents involving hazardous materials.

Training efforts. Both the MTB and FRA have ongoing training programs in the area of transporting hazardous materials. Workshops

Table 43.—Accidents Involving Hazardous Materials, Spills, or Explosions, All Accidents

Cause	1966	1967	1968	1969	1970	1971	1972	1972	1973	1974	Total
Negligence of employees			1	3	5	3	3	3	3		21
Defects/failures of equipment			1	4	4	4	4	5	3		25
Defects in track or structures				1	4	1	1	3	2		12
Miscellaneous causes			18	24	41	28	28	37	32		208
Total			20	32	55	36	36	48	*40*		*267*

*Miscellaneous causes include: Improper loadlng, negligence of nonemployees, malicious acts of nonemployees, forces of nature, rail-highway grade-crossing accidents, coupling or uncoupling locomotives or cars, stumbling, slipping, falling, caught. etc.

" Not available.

SOURCE: FRA Accident Data Base from PM M & Co., Task IV.

and seminars have been conducted to educate shippers, carriers, and local authorities. These sessions focus on increasing the "general awareness" level of those involved in shipping hazardous materials and most are offered at no cost to the industry. The Transportation Safety Institute offers an in-depth, multimodal training program for shippers and carriers and emergenc}' service personnel. It is generally recognized as a very strong hazardous materials program.

The Railroad Industry

Today the railroad industry is involved in inspection, data collection, and training. Up until 1967, the AAR had responsibility (as an agent of the Federal Government) for furnishing technical input for regulations, furnishing laboratory service, and monitoring container development. [5]

Some of the industry's inspection activities are through the AAR's Bureau of Explosives, which has inspectors on railroad property and at shipper facilities inspecting for compliance with the hazardous materials regulations. As far as data collection is concerned, in 1975 the AAR developed a system which identifies hazardous shipments by rail. AAR believes the system is accurate within 1 percent of the total volume shipped (49 series STCC).

The railroad industry—individual railroads and the AAR—is very much involved in training programs. [6] One type of program is designed to ensure that employees understand Federal laws, rules, and regulations pertaining to the proper handling and inspection of hazardous materials. Railroad personnel interviewed as part of the assessment indicated that their training programs were monitored by the safety departments of the railroads. They also indicated that they coordinated their hazardous materials training programs with FRA, MTB, and AAR. The latter two organizations provide much OF the training literature. In addition, AAR's Bureau of Explosives offers training to rail and shipper employees on the handling of hazardous materials.

'Since the passage of the Transportation of Explosives Act in 1908, the Federal Government has depended on the Bureau of Explosives, AAR, to furnish technical input, and so forth, for the Government. Over 200 delegations of authority were issued to carry out those functions. In 1967, the general counsel of the Department of Transportation ruled the delegations of authority illegal.

'Another type of activity is that of providin~ information in any transportation emergency involving chemicals. The CHEMTREC service Provided by the manufacturing chemists association is an example.

RAIL-HIGHWAY GRADE-CROSSINGS

The Problem

As of December 31, 1975, there were over 219,000 locations where public roads crossed railroad tracks. In 1975, there were over 11,000 vehicle-train collisions at the public grade-crossings, resulting in over 9700 deaths and 4,100 injuries. In each of the years between 1965 and 1975 over 1,100 people were killed and some 3,200 injured at grade-crossings.

Grade-crossing accidents continue to be the major cause of fatalities in railroad operations, accounting for approximately 65 percent of the fatalities resulting from all types of railroad accidents during 1965-74.

Federal Government Responses to the Grade= Crossing Safety Problems

The Federal Government has been involved in providing financial support for projects to eliminate hazards at railroad/highway intersections since the establishment of the Federal-Aid Highway Program in 1916. Prior to the passage of the Federal Highway Safety Act of 1973, a U.S. Department of Transportation Report to Congress (August 1972) observed that the total number of grade-crossings warranting improvement indicated that at least 3,000 protection installations should be made annually for the next 10 years at an expenditure of about $75 million a year. It was anticipated that completion of those improvements would eliminate nearly 4,000 motor-vehicle train collisions annually and save some 500 lives per year. [7]

The Federal Highway Safety Act of **1973** had as one of its goals the elimination of hazards at highway-railroad grade-crossings. Section 203 of that Act requires each State to maintain a survey of all railroad-highway crossings and to identify those that may require separation, relocation, or protective devices. The Act provides 90 percent Federal-aid funding for safety improvements to railroad-highway crossings on any Federal-aid highway system, except interstate, and requires at least half of the funds to be available for protective devices. At a minimum, each State must provide signs for all railroad-highway crossings. (See table 44 for indication of eligible activities.)

The Highway Safety Act of 1976 amended Section 203 by authorizing specific funding for grade-crossing improvements in the Federal-aid highway system.

The rail-highway safety programs are complicated by divided jurisdictions and responsibilities, which include:

- The Federal Highway Administration apportions funds to the States by a statutory formula, reserving the right of the Federal Government through local offices to disapprove certain State funding strategies. States may use these funds for a variety of safety activities concerning grade crossings.
- Jurisdiction over railroad-highway intersections resides exclusively in the States, where responsibility can be divided between several agencies.
- Railroad companies have the responsibility for the design, instal1ation and maintenance of train-activated warning devices to be installed only by railroad employees or by private contractors employing members of the railroad union authorized to make such an installation.
- The existence of differing responsibilities, vis a vis the installation of warning devices, between the States and the railroad companies results in the necessity for State/railroad contracts to be executed prior to the installation of the devices.

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[7] U.S. Department of Transportation, Report to Congress, *Railroad-Highway Safety, 1972.*

Table 44.—Grade-Crossing Safety Programs

Program	Items funded*				
	Engineering ••				
	Protection	Elimination	Surface	Education	Other
Federal					
Federal Highway Safety Act of 1973					
&203	X	X	X		
$230 (repealed)	•	•	•		
Federal-Aid Highway Program					
23 U.S.C. 130	X	X	X		
23U.S.C. 163		X	X		
23U.S.C. 219		•	•		
23U.S.C. 322	X•	X•			
23U.S.C. 402	X•	X•	X•		X• training
State***					
Total funding of safety program	•	•	•	•	
Matching Federal funds***	X	X	X	X	
Support of Operation Lifesaver (education and enforcement)				X•	X • enforcement
Maintenance	•	X	X		
Industry					
Installation	X	X•	X•		
Maintenance and operation	X	X•	X•		
Construction		X•			
Support of Operation Lifesaver				X•	
Training of public officials					X supplier seminars
Unions					
Support of Operation Lifesaver				X	

'Items funded for on system indicated with an "X"; for off Federal-aid system with an"-".

● *"Protection" Includes installation of automatic devices; elimination includes grade separation; and 'surface" means surface improvements.

● **Some of the programs (where States match Federal funds) service off Federal-aid system crossings. Further, only some of the States, not all, have these programs.

The divided jurisdiction becomes a barrier to effective treatment of the rail-highway grade-crossing problem because:

—It is used to explain why measures of effectiveness of specific actions necessary to properly direct future resources have not been developed, Federal Highway Administration officials have not sufficiently analyzed the contribution Federal dollars have made to the reduction of collision injuries and deaths.

—It allows confusion on the issue of who should provide and pay for the protection or other improvements.

The impact of Section *203 programs* (problems and successes). As of the end of FY 1977, Federal-aid funds totalling *$86* million had been obligated for projects on the Federal-aid system. Funding of the "off-system" program began in FY 1977, and as of September *30, 1977, $17* million had been obligated.

The direct contribution the Federal dollars have made to the reduction of collision *injuries* and deaths is unknown. Federal Highway Administration officials contend that such an analysis would be most difficult—almost impossible—to make, given the divided jurisdiction and responsibilities between the Federal

Government/State government and the railroads. In other words, FHWA officials have not been able (and believe it to be impossible) to determine the extent to which the goals of the 1972 report will be met after the 10-year period has elapsed. What is known is as follows: a) The current number of projects funded each year is estimated to be between 1,200 and l,500; b) the greatest reduction in fatalities within the 1965-75 period was 242 between 1974 and 1975 (see table 45). These numbers seem low if the goal of **30,000 installations and 5,000** less deaths is to be met by *1983.* A number of problems and barriers to an effective program have been suggested above.

Table 45.— Fatalities for All Grade-Crossings

Calendar year	Killed
1965	1,534
1966	1,780
1967	1,632
1968	1,546
1969	1,490
1970	1,440
1971	1,356
1972	1,260
1973	1,185
1974	1,220
1975	978
1976	1,168

SOURCE: Rail-Highway Grade-Crossing Accidents (*Incidents Bulletin,* FRA.)

One additional problem with the program couldbe the manner in which the funds are apportioned to the States. The formula does not take into account the number of grade-crossings in a State or the number of fatalities per grade-crossing, hence producing in some instances results which are not optimal. However, Federal Highway Administration officials note existing strategies and controls which direct the Federal dollars to the priority problem areas. This is so, they contend, because each State is required to have a method of prioritizing all crossings which must be based on a hazard index, onsite inspections, and accident history.

One other possible problem with the pace of the program could be that the railroads are reluctant to install automatic systems because of the potential liability where the systems may not be fail-safe.

Table 46 describes additional federalIyfunded programs and states what is known about their impact.

State Government Programs Designed To Meet the Grade-Crossing Safety Problems. Jurisdiction over grade-crossing improvementis basically at the State government level. State governments fund safety projects primaril, through the use of Federal funds, although some States have special funds for: a) railroad-highway intersection improvement projects; and/orb) the maintenance and operation of the protection. Often, the State officials having responsibility for grade-crossing activities initiate safety projects without specific regard to the funding source. This is not necessarily a positive feature, because the State officials have varying authorities under the different funding mechanisms, and their present strategy may not be the most cost-effective. The *1972* report to Congress noted the following:

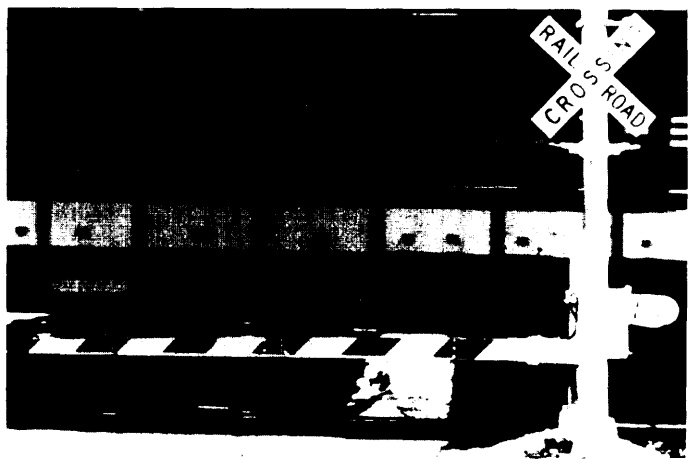
> The net effect of the current division of responsibility and authority among the private and public interests involved at the State and local level results in a fragmented approach to grade-crossing safety. Where there is divided public responsibility, frequently none of the involved public agencies have either legal authority or sufficient resources to make more than token progress in dealing effectively with the problem. The need for national coordination of an issue that affects the Nation's railroad and highway systems is apparent.

The States were expected to participate in the National Railroad-Highway Crossing Inventory and Numbering Project. State officials interviewed noted that the Federal data collection system was not as effective in assisting them in planning for safety, because there was no provision for sending accident statistics to the States on a timely and regular basis.

The States' priority-setting activities are the key to solving the highway-grade-crossing safety problem. The U.S. Department of Transpor-

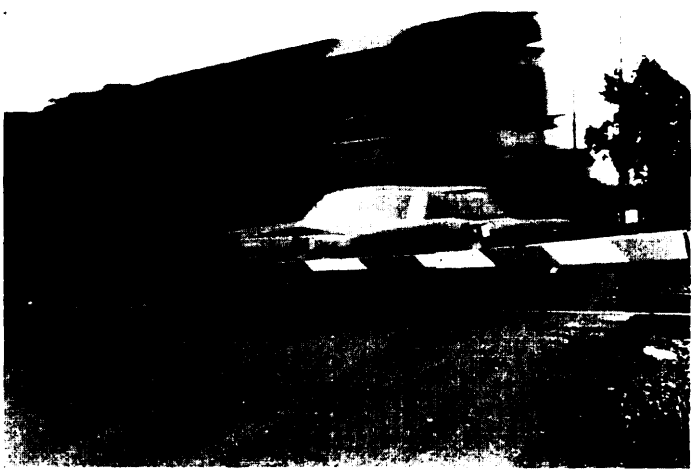
Table 46.— Federal Government Grade-Crossing Programs

Program	Description and Status	Impact (problems and successes)
Railroad-Highway Crossing Demonstration Projects (Section 163, Federal-Aid Highway Act of **1973, amended by the** 1976 Act).	Section 163 authorized demonstration projects in 12 cities for the purpose of protecting or eliminating certain public, ground-level, rail-highway **crossings, relocating railroad lines,** and constructing overpasses **and** underpasses. This 1973 provision contemplated 95/5- or 100-percent Federal funding. The 1976 Act authorized four additional projects and provided for 70/30 matching ratio for the additional cities.	A total of $30.9 million had been appropriated for this program through 1977, of which *$12.8* **million had been obligated** by the end of the transition quarter. Three of the projects are under construction; all other projects are in the preliminary engineering stage.
Federal-Aid Highway	The entire cost of construction of projects for the elimination of hazards, including the separation or protection of grade-crossings and the relocation of highways may be paid, and under certain circumstances, 100-percent Federal funding may be allowed.	
23. U.S.C. 219	The Secretary is authorized to make project grants to States for the construction and improvement of any off-system road for such purposes as the correction of safety hazards, or the elimination of high-hazard locations.	
23 U.S.C. 402	Funds are authorized to carry out State highway safety programs including training programs.	
Federal-Aid Safer Roads Demonstration Program **(Section 430, Highway** Safety Act of 1973) 23. U.S.C. 405	This program required identification of projects for the correction of gated **hazards on all roads** off the Federal-aid system and the systematic correction of the hazards. The law provialed 90 percent Federal-aid funding.	Of the more than $72 million obli- in FY **1976, nearly 40 percent** was spent on railroad projects (correcting hazards at rail-highway grade-crossings).
	Repealed by the Federal-Aid Highway Act of 1976, Sec. 135 (c) of FHWA 1976 (now a part of the section 203 program).	According to the 1977 Highway Safety Improvement Program Report, the program was slow getting started. States were reluctant to place these programs in a priority category and had not identified problem areas to move construction.
Rail Crossings Demonstration Projects 23 U.S.C. 322	Two demonstration projects were authorized: one, to eliminate public, ground-level, rail-highway crossings along the Northeast Corridor, except those of low-hazard potential (which could be protected by warning devices); the other, to consolidate and relocate lines bisecting Greenwood, S.C. Railroads were required to pay 10 percent of the cost of the project.	The Penn Central was not able to **contribute its 10 percent of the cost of the Northeast Corridor Pro ject, which delayed the project. Eventually the States involved agreed to cover the railroad's share. Delay also was caused by meeting the environmental requirements, holding public hearings, and making design changes. The total cost estimate for this program** has more than doubled since 1970 due to design modifications and inflation.



Scenes of typical grade-crossings found through. out the Nation. The photo below depicts a near accident involving a car and train.

Photos Courtesy of fhe Assoc/af/on 01 American Ra//roads



tation has developed a computer model to assist State departments of transportation in determining the optimum allocation of funds and types of equipment based on accident rates, traffic densities, and terrain. The extent to which that model or similar models are being used and whether it is sufficient to make a significant impact on solving the safety problem have *not* been determined.

Industry Programs Designed To Meet the Grade-Crossing Safety Problems. Industry efforts fall into the following five categories: a) data collection and analysis; b) operation and maintenance of warning devices; c) installation of warning devices; d) information and education; and e) participation in joint industry and Government activities such as Operation Lifesaver. There is limited information available on the railroads' expenditures for these types of activities, One railroad interviewed for this study indicated that at one point they collected grade-crossing accident statistics, but when financial difficulties came, they funded only crossing improvements and other operations. Based then on the sample of this study, the railroads' data collection activity is limited. Some of the railroads do participate in a "near-miss" program, in which railroad employees complete a "near-miss" or "failure to stop at grade-crossing" report. FoIlowing the submission of such reports to local authorities, the motor vehicle owner in question is contacted and warned. In general, railroads maintain grade-crossing devices if the device is activated by the train. There are instances where the railroads have participated in funding the installation of the warning devices. An example of industry participation in information and education activities is the rail industry suppliers' grade-crossing program, involving the conduct of seminars "to educate State transportation authorities on the latest available grade-crossing systems."~

Joint Programs and Efforts Designed To Meet the Grade Crossing Safety Problems. One major joint program is Operation Lifesaver, Operation Lifesaver is based on the premise that a successful grade-crossing safety program depends on engineering, education, and enforcement. The Operation Lifesaver program, operating at the State level, consists of public and private agencies' efforts to fund and conduct an integrated effort to "improve, accelerate and continue effective grade-crossing programs. " Participants in the program may on occasion, depending upon the State structure, include State departments of transportation, public utilities, and education; unions; railroads; and civic organizations. The engineering aspect of the program is generally supported by Federal/State funds and consists of some type of protection devices, and their operation and maintenance. Education activities could consist of safety movies used in the schools, on TV, and in commercial movie houses. The enforcement activities are carried on by State and local public officials. One problem with the Operation Lifesaver program is that none of the agencies involved and contacted during the study had published a thorough analysis of the costs and benefits of the program. From the single performance measure, fatalities, the program was a success in the opinion of Illinois Commerce Commission officials. But that same State did not publish an analysis of the accident rates or nonfatality injury rates as they relate to Operation Lifesaver activities, as compared to other grade-crossing projects.

Federal Highway Administration officials note also that Operation Lifesaver is effective only so long as it is in existence. The engineering, education, and enforcement activities must be on a continuing basis; there cannot be a one-time "awareness" campaign which makes lasting impact. Again, the weakness with this conclusion is the lack of evaluative studies to support it.

"Railway Progress Institute.

ANALYSIS OF SPECIFIC GRADE-CROSSING SAFETY ACTIVITIES

Relative Effectiveness of Automatic Warning Devices

According to a California study, automatic warning devices are quite effective in reducing vehicle-train accidents and casualties at public railroad-highway grade-crossings in California. ' That study concluded that the installation of automatic crossing gates can be expected, on the average, to result in 70-percent fewer vehicle-train accidents per year and an additional 48-percent fewer casualties per accident. Automatic gates were considered to be superior to other types of warning devices because they have a visual and auditory impact on driver response. The gates help in solving the problem of inadequate sight distance or general inability to see or perceive an approaching train. The gates aid in preventing accidents caused by traffic or rail volumes; accidents caused by trains operating on multiple tracks; and accidents caused by distractions and other road hazards. Automatic devices probably will not prevent vehicle-train accidents caused by complete driver inattention, excessive vehicular speed, violations of the law, or poor driver judgment. A study of activity between 1960 and 1970 indicated the following relative accident frequencies:

	Accident frequency	*Accident deaths*	*Severity injuries*
Crossbucks.	1.00	1.00	1.00
Flashing lights.	.33	.54	.57
Automatic gates	.13	.25	.46

'California Public Utilities Commission, *The Effectiveness of Automatic Protection in Reducing Accident Frequency and Severity at Public Grade Crossings in* California, 1974.

Cost Variations in Grade= Crossing Safety Activities

It was determined that in California (1975) the cost of installing flashing lights was $16,250; $27,290 for automatic gates, and $190 for crossbucks. The maintenance and operation cost for flashing lights is *$500* annually; $1,000 for automatic gates. On an incremental basis, then, in California in *1975* it cost $2,190 **a** year more for flashing lights than crossbucks and $1,670 more for automatic gates.

The Texas Transportation Institute analyzed the relative cost of installing warning devices versus grade-separation. In 1970 figures, the total program would have cost $120 million for installation of the necessary warning devices in Texas and about $4.5 billion for a complete grade-separation program.

Elements Necessary for an Effective Grade-Crossing Safety Program

The report on the California experience concludes that the greater-than-average success in grade-crossing safety resulted from sufficient financial support for the installation and maintenance of the warning devices; the well-managed State government effort to provide the analytical support for crossing-improvement decisions; and strong safety efforts on the part of financially healthy railroads. 10

'°R. G. Kennedy, *A Review of the California Railroad-Highway Grade Crossing Program,* Consad Research Corporation, Pennsylvania, 1974.

Federal Funding of Grade-Crossing Activities

Tables 47 and 48 indicate program costs and results. Although many argue that this is not the proper way of analyzing the effectiveness of the Federal grade-crossing effort, the facts speak for themselves:

In FY 1974 and 1975, $38.2 million was obligated and 717 projects initiated under Section 203. Using the goal 3,000 projects initiated at $75 million, suggested in the *1972* Department of Transportation grade-crossing report, the program would have required a 47-percent increase in activity to meet that goal.

Table 47.—Summary of Program Costs and Results

1. Section 203 costs
   a. Obligated funds
      • FY 74: $4,323,420
      FY 75: $33,928,498
   b. Authorized funds
      FY 76: $48,150,329
      . FY 77 (section 203, 1973 Act): $81,226,152
      FY 77 (section 203, 1976 Act): $17,688,814
2. Section 203 results
   a. FY 74 and 75—717 projects
   b. FY 76: 903 projects authorized
3. Section 230 costs
   a. Obligated funds
      FY 74, 75: $26,180,800
      FY 76: $27,917,750
4. Section 230 results
   FY 74,75: 953 projects
5. Section 322 costs
   a. Obligated funds
      As of January 31, 1977: $12.5 million
6. Section 322 results
   48 public crossings and 3 grade stops
7. Section 163 costs
   As of transition quarter: $12.8 million
8. Section 163 results
   5 projects are under construction
   13 projects are in the engineering phase
9. Section 210 funds
   Obligated FY 74 and FY 75: $65,450
   Obligated FY 76: $1,661,250
10. Section 209 funds
    Obligated FY 74 and FY 75: $731,300
    Obligated FY 76: $449,950

SOURCE: PMM & Co., Task IV Report.

Table 48.—Title 23 Costs

	costs		Results		
Fiscal vear	Federal funds	Total funds	Crossings eliminated	Structures reconstructed	Crossings protected
1965.	$ 85,848,377	$215,096,245	421	35	319
1966.	65,384,470	195,646,396	377	45	250
1967.	40,298,099	162,370,184	398	48	295
1968.	49,157,015	175,690,265	319		276
1969.	48,059,294	178,826,058	282	: 1	221
1970, ... , ...	20,952,022	143,249,929	242	43	167
1971	29,948,764	152,882,583	246	40	178
1972.	157,632,238	189,380,439	233	31	224
1973.	194,174,814	226,695,715	214	36	165
1974.	110,626,804	142,133,552	134	41	275
1975.	179,070,554	204,562,810	112	40	211
1976.	156,801,293	184,366,905	183	91	365
Transition quarter. .	47,146,825	54,089,292	46	18	118

SOURCE: PMM & Co,, Task IV Report,

OTHER RAILROAD SAFETY PROGRAMS

This study of railroad safety is concerned primarily with certain basic activities: data collection and analysis by Federal Government agencies; standards setting; inspection; and enforcement of Federal Government rules and regulations. There are, however, other activities which support railroad safety efforts. Among those activities are training, incentive programs, and employee assistance programs. (See table 49 for list.) The purpose of this chapter is to describe those types of programs and, where possible, to discuss the program's costs and impact.

The first types of programs to be discussed are the railroad Safety Operations Programs. These are voluntary efforts initiated by the railroads which often encompass the establishment of safety operating practices and their enforcement, and some forms of data collection and analysis. Although the safety operations-type programs are initiated and implemented generally by the railroad companies, some unions have initiated similar activities. For example, some unions collect and analyze safety information which comes in the form of employee complaints. As a part of railroad companies' safety operation programs, operating rules are published to establish and avoid conflicts in operating procedures. Some of the railroads participating in the study interviews indicated that, in addition to publishing operating rules, safety rules often are published separately for each department, covering such items as transportation, communication, signal, and mechanical safety.

Violation of the operating rules often covers sanctions imposed by the railroad companies—such as warning notices or possible dismissal. Inasmuch as the railroads require employees to apply the operating rules to their actions, enforcement of those rules exists.

Another activity of the railroads is data collection and analysis over and above that required by the Federal Government. As was indicated above, some of the unions collect complaint information, but generally, unions' data collection activities are limited. The interviews conducted in conjunction with the study revealed that the unions do not have internal procedures to collect extensive safety-related data. Although national union leaders receive and review some FRA and AAR data, these are not used other than as general background information by unions for their general advocacy activities. Some railroad management is reluctant to share safety information with the unions for fear the data, such as claims data, will be used against them.

Information and Education Programs are another general category of safety efforts and include: a) training programs, and b) awareness programs, for both the public and employees. Railroads, unions, and Government are all involved in some type of training program. The methods and techniques of railroad training programs vary. Some of the railroad programs emphasize on-the-job training, others emphasize classroom training, while others use combinations of the two. One of the railroads involved in the study interviews described its training program to include:

> At a center built specifically for training, the program includes classroom work as well as actual practice in work functions and safety pertaining to jobs such as switchmen; brakemen; firemen; repairmen; and inspectors of cars, locomotives, and track and signal systems. Prospective locomotive engineers are given practice in train operation in a variety of operating situations through use of a train simulator. Upon satisfactory completion of training at the center, employees are given on-the-job training at their assigned locations by supervisors and other experienced personnel before being assigned to a specific job. Included in the overall program for the prevention of injury is training in the proper execution of such physical tasks as lifting

Table 49.— Railroad Safety Programs

Program sponsor	Program type: Safety operations: Operating practices	Safety operations: Enforcement	Safety operations: Data analysis	Information and education: Training	Information and education: Awareness: Employee	Information and education: Awareness: Public
Railroads	x	x	x	x	x	x
Unions			x*		x	
AAR			x	x	x	
Federal Government			x	x	x	x
Joint				x	x	x

Program sponsor	Safety committees: Specific raiiroad	Safety committees: National	Safety committees: Incentive programs
Railroads	x		
Unions		X	
AFAR			
Federal Government		x	
Other			X.Hairriman Memorial Awards Institute
Joint		x	

Program sponsor	Personnel management and assistance: Recruitment &promotion	Personnel management and assistance: Protective clothing	Personnel management and assistance: Alcohol &drug	Advocacy
Railroads	x	x	x	x
Unions				x
AFAR				x
Federal Government		x		
Joint				.X.-.... ;l:l;:::l:;:ll1 1llll1ll:Jll

heavy objects, throwing track switches, and getting on and off cars and locomotives.11

Another railroad indicated that new employees are given on-the-job training by supervisors and other experienced employees until such time as they are judged by the supervisors to be qualified for aspecific job.

Most of the current training in the railroad industry is achieved under union contract agreements. The unions generally support apprenticeship or other forms of on-the-job training where employees learn and earn at the same time.

Several agencies of the Federal Government recently developed training programs and materials to be used for training both Government and railroad employees. One trainin$_g$ program is that of the Transportation Safety Institute (TSI) established in 1971 to foster and promote the development and improvement of transportation safety by designing and conducting resident and nonresident trainin$_g$ programs responsive to modal and intermodal requirements. One of the goals of TSI is to reduce the number of transportation accidents in the United States. The types of courses offered by TSI are: railroad accident investigations; rail transportation of hazardous materials; locomotive inspection; and railroad track safety standards. The major users of the TSI courses are the Federal Railroad Administration inspec-

11PMM&Co.,TaskIV.

tors and, to some extent, State employees involved in State participation programs.

Federal Railroad Administration inspectors for locomotives, cars, and signal systems also receive formal classroom training in courses related to their particular discipline. These courses are offered by suppliers of railroad equipment. In order to keep pace with technological developments, FRA inspectors attend these courses related to their particular discipline on a 2-year cycle.

A different type of information and education activity can be classified as "awareness" programs. Railroads, unions, and Government have initiated some types of programs for employees as well as the public. One railroad used innovative safety materials from the Japanese National Railroad to stimulate employee safety awareness. Examples of other railroad awareness activities directed at employees are:

- Posters showing employees in unsafe situations as well as descriptions of accidents related to human error or negligence resulting in injuries and/or fatalities.

Specific safety rules selected for review at the direction of supervisors.

In addition to specific railroad activities, the Association of American Railroads publishes posters, the "Safety Talk" bulletin, and various booklets and bibliographies on safety.

The unions also have been involved in "awareness" activities. One union organized a regional safety meeting to include such topics as: identification of safety hazards; establishment of folIow-up safety activities; and collective bargaining on safety matters. The Brotherhood of Locomotive Engineers has sponsored regional conferences attended by FRA representatives to discuss locomotive inspection procedures and hours of service.

The Federal Government has been involved in "awareness" activities through the industrial education program conducted by the Federal Railroad Administration's Office of Safety. Through that program, safety law seminars and conferences are held for personnel in the railroad industry. The purpose of these seminars is to bring to local railroad safety officials an understanding of the existing Federal safety laws, standards, and regulations. In addition to the seminars, which have been held in cooperation with the AAR, the American Short Line Railroad Association, and the Railway Labor Executives Association, the FRA has made available to the railroads a list of movies which describe specific aspects of the FRA safety laws and interpretations of those laws.

The railroads have been involved in such public awareness activities as:

- Lectures given at schools to impress upon children the dangers associated with crossing or standing on tracks when trains are approaching, playing around railroad yards, and placing objects on tracks that might cause derailment.
- Instructions to personnel of customers in the proper handling of freight car parts, such as doors, loading hatches, and outlet gates.
- Informing the public through the media of accidents; particularly those involving hazardous materials.

Safety Committees are used to conduct certain safety activities. Some are organized by specific railroads and cover the safety issues of that railroad. Others, national in scope, concern safety issues more universal in nature. In any event, the safety committees represent different interests. The railroad companies' safety committees are generally composed of employee representatives and supervisory personnel. These committees meet periodically to discuss timely safety issues, allow employee representatives to report existing unsafe conditions, and report on correction of previously reported unsafe conditions. Minutes of meetings are generally required to be sent to supervisors and safety department officials. Further, some railroads have formed safety committees composed of the heads of various departments, such as safety, transportation, maintenance of way, etc. These committees meet periodically to con-

sider and often act upon specific safety problems.

Certain unions are involved in safety issues through participation in various joint committees where representation could be from the Government, railroads and suppliers, railroad and supplier associations, researchers, and the like. An example of such activity is the Locomotive Cab Committee, where the union representing locomotive engineers, AAR, suppliers, and FRA are working together to develop significant safety improvements for locomotive cabs.

Incentive Programs have a role in promoting safety. The railroads design incentive programs to recognize employees who maintain good safety records. Examples of specific incentive efforts are as follows:

- One program provides for a specified number of employees to be named annually from among all employees who have worked that year without an injury. The winners are awarded cash prizes.
- Another program provides an annual safety award-to be made by the president of the company to the personnel supervised by a vice-president having the lowest number of injuries per 100,000 man-hours worked.

A national contest is sponsored by the E. H. Harriman Memorial Awards Institute. The competition provides for line-haul railroads to be grouped according to man-hours worked per year. In each category, awards are made for outstanding safety performance. Separate awards are made to switching and terminal companies.

Personnel Management and Assistance Programs are other types of safety efforts. These programs include: a) recruitment, selection, and promotion activities; b) protective clothing programs; and c) alcohol and drug abuse programs.

First, a discussion of the manner m which the personnel management system is used to promote safety efforts. Certain railroads attempt to predict an employee's future safety record and use that prediction to determine whether to hire or promote the candidate. The prediction is based on: the prospective employee's work experience and education; physical examinations; and in some cases mental aptitude tests.

Another safety effort suggested in connection with personnel management activities is certification of locomotive engineers and the withdrawal of certification in the event an engineer is charged with a specified number of violations, depending upon severity of operating and/or safety rules violated. Railroads generally support certification as a means of eliminating "seniority-tenured" engineers who are not otherwise qualified. Unions are opposed to it because of the potential labor conflicts that it could promote and also the possibility of too much management influence over who is or is not to be certified.

Safety is often ensured through the use of protective clothing. Special clothing and/or devices are required (by regulations in some instances and by the railroads in others) when employees are performing certain work functions or while working in certain areas. Examples of such requirements include the use of goggles, a respirator when spray painting, and hard hats under certain circumstances.

During the past 10 years, many railroads have implemented alcohol and drug abuse programs in recognition of the fact that the abuse of alcohol and drugs does contribute to some railroad accidents. These programs go beyond the railroads' initial response to the problem, which was to issue a rule similar to Rule G of the Association of American Railroads Standard Code of Operating Rules. It stated that "the use of alcoholic beverages or narcotics by employees subject to duty is prohibited. Being under the influence of alcoholic beverage or narcotics while on duty or their use or possession while on duty is prohibited. "

In 1976, a survey conducted by the Naval Weapons Support Center indicated the following about the railroad alcohol and drug abuse programs:

- *Program Policy:* General 1 y the older programs in existence (5 to 10 years) limit treatment to alcoholism problems, while

recent programs address other human ailments (drug abuse, marital counseling, etc.) in addition to alcoholism. A majority of the programs operate with labor involvement in program activities and control.

- *Program Design:* Programs emphasizing treatment for alcoholism tend to-be based on patterns established by Alcoholics Anonymous. Employees often volunteer for the program, although the most likely circumstance would be where an employee is referred by the supervisor. The vast majority of the programs surveyed separate the alcohol/drug abuse program from disciplinary proceedings. However, reinstatements of employees with a problem are more likely if there is successful program treatment.

Advocacy is another way of ensuring the promotion and implementation of safety. The railroads and the unions serve as advocates for safety before Congress, the Government agencies, and each other.

Railroad and Union Safety Organization

Within the railroad companies, safety programs appear to be carried out through a variety of organizational arrangements. Among 21 major railroads which explicitly have a chief safety officer (according to the July-August 1977 issue of *The Official Railway Guide), 15* were situated in the operating department, where employees' risk-exposure is presumably highest, and 5 were situated within the personnel department, where safety had been designated as an independent function.

Every railroad company interviewed as part of the study (and all others on which information is available) has safety officials assigned to its headquarters staff and many have full-time safety supervisors assigned at major operating locations. In addition to the full-time safety staffs, which may have as many as 15 individuals, every line and staff observer also is charged with enforcing and carrying out the safety programs sponsored and funded by management. The industry's official attitude is that every railroad employee or official is responsible for safety awareness and safety enforcement.

Unions also are organizing safety activities. One union contacted as part of the study interview reported the recent creation of a position of Vice-President for Education and Safety to coordinate and direct the union's safety programs.

Findings as to Program's Costs and Impact

Little is known about the extent to which these programs are cost-effective in reducing railroad accidents, because measurable goals and objectives usually have not been established. There are, however, certain findings which should be considered as part of this study. Those findings are discussed below.

Information and Education program50 Assessment interviews indicate that both railroad and union officials are becoming more and more safety conscious. Safety training is so important to one railroad that it offers make-up classes for employees. Those who do not attend the make-up safety classes are removed from service until the classwork is completed. There has been notable participation in some of the awareness programs; for example, joint safety law seminars were attended by 1,100 persons in 1975 and *1,600* in *1976.* As was indicated earlier, there are differences in training methods; there are, however, no convincing studies as to their effectiveness.

Safety Committees. Some union officials have concerns about the effectiveness of union-management safety committees. Union officials in the course of the study indicated that one main reason for the desire of the unions to include safety procedures in contracts with management is the fact that many union-management joint safety processes (committees) are short-lived. A study of this problem cited various steps which can be taken to maintain

the necessary continuity of the joint committees. Among the steps cited were: allow rank-and-file involvement; use the minutes of the committee meetings to develop continuity of action; make monthly joint safety inspections as part of the committee processes; and have union members use the committees, instead of the formal grievance procedure, as a forum for dealing with safety and health problems.

Personnel Assistance Programs (Alcohol and Drug Abuse). The **1976** Naval Weapons Support Center survey of alcohol and drug abuse programs in the railroad industry found that labor involvement in the program results in a higher percentage of individuals volunteering for help. The program costs ranged from $2 to $10 per employee per year in the **20** programs surveyed, with employee treatment costs almost always covered by group health insurance. The study found that the rate of successful intervention averaged *69* percent.

[12]Kochan, Dyer, and Lipsky, *The Effectiveness of Union Management Safety and Health Commission.*