Chapter I

RAILROAD SAFETY FINDINGS

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INDUSTRY OVERVIEW

The railroad safety problem at the turn of the century was characterized primarily by injuries and fatalities; today property loss and damage are also important.

The railroad predominance in intercity passenger and freight transportation at the turn of the century has been substantially eroded over the decades by changes in transportation technology and in the economy, and by Government policy toward various transportation modes. The impacts upon the rail industry have been several. First, they have caused a substantial reduction in the railroads' share of intercity passenger common carrier traffic from 77 percent in 1929 to 6 percent in 1977. Second, while the railroads' total freight traffic (freight revenue ton-miles) increased by 257 percent from 1929 to 1975, rail share of the intercity freight market dropped from 75 percent in 1929 to 37 percent in 1975. Finally, railroad employment dropped by 71 percent from 1929 to 1975. Thus, with fewer passengers and fewer employees but more freight, the rail safety problem has changed its dimensions from being primarily a casualty problem to being both a casualty and a property loss and damage problem.

The decline in the financial condition of the rail industry has resulted in less money being available for maintaining and improving fixed plant in recent decades.

The rate of return after taxes on railroad investment declined from **5.3** percent in **1929** to 1.2 percent in 1975. Railroads have been greatly impaired in obtaining or generating necessary capital as a result of this extremely low rate of return. Moreover, the rail industry has suffered such low earnings from rail operations that it has been unable to generate internally the funds necessary to maintain and improve its track and fixed facilities. Estimates of industry-deferred maintenance have been approximated at $6.6 billion.[1] The combination of these two factors, low rate of return and low level of internally generated resources, has resulted in the industry's estimated need for $14.5 billion[2] (exclusive of Conrail) as the total amount needed to normalize the industry track maintenance level, and to make necessary capital and track improvement over the next 10 years.

Railroad safety laws at the turn of the century were directed at specific safety problems; recent railroad safety laws have provided broad grants of authority to Federal agencies.

In the early 1900's, the railroad safety laws enacted by Congress were designed to address specific safety problems or to implement certain proven safety technologies or practices. Examples of the early legislation include the Locomotive Inspection Act, the Hours of Service Act, and the Safety Appliances Act. The more recent safety laws, such as the Federal Railroad Safety Act of 1970 and the Hazardous Materials Transportation Act have provided the Department of Transporation (DOT) broad regulatory and administrative powers for dealing with "all areas of railroad safety."

[1] Richard J. Barber, Assoc., The *Railroads, Coal and the National Energy Plan: An Assessment of the issues,* 1977, p. 52.
[2] ICC Ex Parte 271, September 1977.

ACCIDENT AND COST DATA

The safety of the railroad industry as shown by available accident data* may be viewed from two perspectives: the safety of people and the safety of property.

- **The safety of people is measured by the number of casualties (injuries and fatalities) and the cost of resulting claims.**
- **The safety of property is measured by the loss of and damage to railroad equipment, track, and roadbed (estimated), and the lading (actual). This loss and damage occurs primarily in collisions, derailments, and other train accidents.**

Safety of People

There was a general decline of casualties during 1966-74’ * of 29 percent for total fatalities and 19 percent for total injuries, as shown in table 1, although some fluctuation did occur during these 9 years. Generally, the casualty trends decreased from the initial year to a low point in either 1972 or 1973 and then increased in 1974.

—During the 9 years, injuries to employees constituted the largest percentage of total injuries (74 percent) while fatalities to persons other than employees, passengers, and trespassers constituted the largest percentage of total fatalities (65 percent). This latter group was made up primarily of persons killed in grade-crossing accidents.

After adjustments in employee casualties by man-hours of employment, fatalities remained the same during 1966-74 and injuries increased slightly.

* Unless otherwise specified, the data used in this study were obtained from the Federal Railroad Administration’s accident data file.

** Public Law 94-348 requested accident data for the 10 years preceding July 1976. The data for 1975 have not been used in this report for purposes of comparison with the data of preceding years because of the substantial changes in the FRA reporting requirements in 1975, which make direct comparison infeasible.

Table 1 .—Casualties Resulting From Class I and II Railroad Accidents (Unnormalized)

Year	Employees		Passengers		Trespassers		Other*		Total	
	Fatalities	Injuries	Fatalities	Injuries	Fatalities	Injuries	Fatalities	Injuries	Fatalities	Injuries
1966	168	18,651	23	1,244	678	702	1,815	4,955	2,684	25,552
1967	176	18,055	12	1,054	646	696	1,649	4,718	2,483	24,523
1968	150	18,116	11	1,329	628	663	1,570	4,500	2,359	24,608
1969	190	17,255	6	862	627	674	1,476	4,565	2,299	23,356
1970	172	16,285	8	489	593	646	1,452	3,907	2,225	21,327
1971	123	14,191	16	536	551	607	1,320	3,638	2,010	18,972
1972	133	12,973	47	680	537		1,228	3,691	1,945	17,930
1973	161	13,511	6	503	578	614	1,171	3,577	1,916	18,245
1974	144	16,002	7	574	565	674	1,192	3.568	1,908	20.818
Total	1,417	145,079	136	7,271	5,403	5,862	12,873	37,119	19,829	195,331
Percent total	7.1	74.3	0.7	3.7	27.3	3.0	64.9	19.0	100.0	100.0

● Other includes all persons not included as employees, passengers or trespassers. (This group was made up primarily of casualties resulting from grade-crossing accidents.)

SOURCE: Compiled by OTA from Federal Railroad Administration data.

—During the 9-year period, the major causes of employee injuries were

Major cause	Percent of total employee injuries
Getting on or off trains.	16.6
Construction and maintenance of cars and locomotives	12.2
Construction and maintenance of track, ties, and rail	8.9
Stumbling, slipping, and falling (not on train)	7.9
Coupling and uncoupling.	5.6
Flying or falling objects, burns, etc. .	4.8

—During the 9-year period, the major causes of employee fatalities were:

Major cause	Percent of total employee fatalities
Struck or runover at places other than public rail-highway crossing*	26.7
Various causes of collisions, derailments, and other train accidents	17.9
Coupling and uncoupling.	7.0
Stumbling, slipping, and falling (while on train).	5.8
Getting on or off trains.	5.2
Construction and maintenance of cars . . . . , .	3.7

•Includes those employees killed while walking or working along track.

Of all the employee categories, the transportation group (trainmen and enginemen) accounted for 55 percent of employee injuries and 54 percent of employee fatalities. The yard brakemen and yard helpers, a subset of trainmen and enginemen, have by far the largest problem as measured by the combination of frequency and severity of injuries.

Safety of Property

There was a general increase in train accidents'and a corresponding increase in their costs over the period 1966-74, as shown in table 2.

Table 2.—Train Accidents and Associated Costs (Unnormalized)

Year	Train accidents	Loss and damage to track roadbed, equipment, and lading (million$-current$)
1966.....	6,793	117.6
1967.....	7,294	118.0
1968.....	8,028	140.3
1969.....	8,543	161.7
1970.. •..	8,095	158.4
1971.....	7,304	144.8
1972.....	7,532	140.3
1973.....	9,698	188.4
1974.....	10,694	243.2

SOURCE: Compiled by OTA from Federal Railroad Administration and Association of American Railroads data.

When train accidents are adjusted for the monetary threshold** and normalized for changes in ton-mileage, the increase in train accidents is 16 percent over the 9 years.

When the loss and damage to track, roadbed, equipment, and lading is adjusted to constant 1975 dollars, the increase is **25** percent.

While train accidents in each of the four contributing-cause categories* * * all increased between 1966-74, the largest and most rapidly increasing contributing cause was track. (Table 3.)

Table 3.—Train Accidents by Contributing Cause (Unnormalized)

Cause	Train accidents 1966	1974
Human factors	1,999	2,236
Equipment	1,843	2,175
Track	1,428	4,264
Miscellaneous	1,523	2.017
Total	6,793	10,694

SOURCE: Compiled by OTA from Federal Railroad Administration data.

* A train accident is defined as an accident arising out of the movement or operation of trains and resulting in more than $750 estimated damage to equipment, track, *or road*bed, regardless whether a reportable death or injury occurred.

“ The $750 monetary threshold must be adjusted for inflation to properly analyze train accidents.

*** Cause categories as defined by FRA.

—When train accidents are adjusted for the monetary threshold and normalized by changes in ton-mileage, the increase in track-caused accidents was 106 percent during 1966-74, whereas there was no change in miscellaneous-caused accidents and approximately a 15-percent decrease in both equipment- and human-factor caused accidents.

The most significant area of loss and damage to property resulted from track-caused train accidents on mainline track rather than on branch-Iine or yard track.

—The two most significant causes of track-caused train accidents, based on accident frequency and severity, were mainline rails (broken railend, split **heard,** split web) and mainline line and surface (improper super-elevation, improper alinement, improper surface of track, soft track).

Two factors that appear to be related to increased track-caused accidents are increased axle loadings and the level of deferred maintenance.

—There has been an increase in axle loadings over the last several years. Part of this has resulted from the introduction of higher capacity cars, specifically the 100-ton freight cars. This factor would logically have a negative impact on safety due to increased wear and tear on the roadbed unless the roadbed, is maintained to allow for these changes.

—It has been estimated that approximately $6.6 billion of maintenance was deferred through 1975. The practice of deferring maintenance will logically have a negative impact on safety at existing or increasing levels of use of the track and roadbed. Thus, a substantial improvement in railroad safety is largely dependent on the industry's financial ability to maintain its track, roadbed, and equipment.

The largest and most rapidly increasing class of train accidents over the period *1966-74* was derailments. (See table 4.)

—When the numbers in the table are adjusted for the monetary threshold and normalized for changes in ton-mileage, derailments increased over *40* percent during the 9 years, while collisions decreased by approximately *15* percent.

Defects in track were the largest and most rapidly increasing single cause of derailments during 1966-74. (See table 5.)

Table 4.—Train Accidents by Class (Unnormalized)

Year	Derailments	Collisions	Other	Total train accidents
1966	4,447	1,552	794	6,793
1967	4,960	1,522	812	7,294
1968	5,487	1,727	814	8,028
1969	5,960	1,810	773	8,543
1970 ..,....	5,602	1,756	737	8,095
1971	5,131	1,529	644	7,304
1972	5,509	1,348	675	7,532
1973	7,389	1,657	652	9,698
1974	8,513	1,551	630	10,694

SOURCE: Federal Railroad Administration.

Table 5.— Derailments by Contributing Cause (Unnormalized)

Year	Track	Equipment	Human factors	Misc.	Total
1966	1,388	1,550	647	862	**4,447**
1967	1,800	1,611	668	881	**4,960**
1968	2,062	1,745	743	937	**5,487**
1969.	2,400	1,863	816	881	**5,960**
1970.	2,393	1,602	765	842	**5,602**
1971	2,194	1,389	721	827	**5,131**
1972.	2,481	1,344	792	892	**5,509**
1973.	3,477	1,755	1,017	1,140	**7,389**
1974.	4,196	1,967	1,043	1,307	**8,513**

SOURCE: Federal Railroad Administration.

Safety of Both Peopleand Property

While train accidents have contributed to virtually all of the loss and damage to property, as reported to the Federal Railroad Administration (FRA) they resulted in only l,569 fatalities (7.9 percent of the total fatalities) and 7,887 injuries (4.0 percent of the total injuries) during 1966-74.

Tank-car accidents must also be viewed as both a safety of people and a safetyof property problem.

—During 1969-75, there were 44,432 derailments reported. Of these derailments, more than 500 involved uninsulated pressure-tank cars, of which more than *170* lost some or all of their lading. Of these occurrences, several accidents resulted in **20** deaths, **855** injuries, and **45** major evacuations of approximately **40,000** persons.[3] Although specific costs are not available, it has been estimated that accidents involving these tank cars have resulted in approximately **10** percent annually of all damage to railroad property, but damage to third-party property and loss of lading could not be isolated for this study.

Cost Analysis

Total costs resulting from railroad accidents rose *38* percent (using the Consumer Price Index to adjust costs to constant 1975 dollars) and increased from **2.4** percent of operating revenues to *3.5* percent during *1966-75. (See* table *6.)*

—The costs resulting from casualties to persons and total property loss and damage each represented 40 to 50 percent of the total industry railroad accident costs over the lo-year period.

—While the number of casualties generaI1y decreased, the dollar value of claims resulting from casualties increased, and at a greater rate than that of the increase in costs resulting from total loss and damage to property.

—The increase in the aggregate costs of casualty claims reflects the fact that the cost per claim has increased at a rate which is greater than the rate of decrease in the number of casualties. Further research is needed to determine the reasons for the increase in cost per claim.

The total cost of railroad safety programs cannot be identified.

—The uniform system of accounts does not isolate such costs.

—Although some railroads have internal accounting systems that identify such costs, these systems are not comparable from railroad to railroad.

—Because a large portion of the safety prevention costs are common costs, they

[3] 42 Fed. Reg. 46312 (Sept. 15, 1977).

Table 6.—Railroad Accident Costs
(Dollars in millions)

Accident cost category	Accident cost: 1968 Current $	1968 1975$	1975 1975$	Percent change
Casualty claim a	$108.5	$179.9	$282.2	+ 45.8
Total loss and damage of property	119.2	197.6	240.0	+ 21.4
Damage to railroad property b	(99.0)	(164.1)	(177.4)	+ 8.1
Damage to livestock%	(1.5)	(2.5)	(1.9)	-26.8
Freight ioss and damage a	(18.7)	(31.0)	(60.7)	+ 95.9
Clearing wrecks a	23.0	38.1	73.2	+ 92.1
Grand total	$250.7	$415.6	$575.4	+36.4
Operating revenues	$10,654.7		$16,401.9	

a *Interstate Commerce* Commission, *Transport Statistics in the United States, Railroad Companies, 1966-75.*
b Federal Rai l road Administrate ion, *Accident Bulletin Summary and Analysis of Accidents on Railroads in the United States, 1966-75.*

SOURCE: Compiled by OTA from Federal Railroad and Interstate Commerce Commission data.

cannot be identified, even if an appropriate accounting system were available, without arbitrarily allocating such costs among safety and other operating purposes.

Data Base

Analysis of the FRA data base by the Association of American Railroads (AAR) has provided some useful insights into the safety problem.

For example, preliminary analyses have been conducted on railroad accidents occurring to both people and property.'[5] Further effort based on this work should be undertaken to understand more fully the railroad safety problems and to identify specifically the reasons why accidents are occurring. Also, individual railroads have conducted safety analyses of their specific operations. The transfer of information from these types of analyses to other railroads could be improved.

The accident data base collected by the FRA provides a large amount of significant information but has limitations for the following reasons:

—A substantial number of accidents, are classified in the undefined category of "other." Therefore, their specific causes cannot be determined. Although the revision in the 1975 cause code attempted to deal with some of this problem, the condition still exists. A revision was again made in 1977, but it is too early to determine the success of these changes.

—Due to the change in cause codes, the data are not comparable before and after 1975 and make analysis of trends encompassing years before and after 1975 impractical.

—The changes in reporting requirements for the 1975 data had the effect of greatly increasing the number of injuries reported to FRA. This occurred because the reporting threshold for injuries, measured in days

4A. E. Shulman and C .E. Taylor, *Analysis of Nine Years of Railroad Accident Data* 1966-1974, Association of American Railroads, April 1976.

5A.E. Shulman, *Analysis of Nine Years of Railroad Personnel Casualty Data 1966-1974,* Association of American Railroads, November 1976.

disabled, increased from "more than one day" to "one or more days." Also, the inelusion of "occupational illness" and "receiving medical attention from a physician" increased the number of reportable accidents.

Notwithstanding the limitations of the accident data base, FRA analysis of the data and its use in guiding regulatory and enforcement activities appear to be inadequate.

—Although FRA does perform sorting and tabulations of accidents by various means which aid in identifying some of the problem areas, more in-depth analyses of data are necessary to assist in determining causes and potential problems.

SAFETY LAWS AND REGULATIONS

The existing Federal safety laws, taken as a whole, provide sufficient statutory authority to deal with the existing hazards of railroad operations.

The early safety laws—aimed at specific railroad hazards—are supplemented by the Federal Railroad Safety Act of 1970, which provides regulatory and administrative powers applicable to "all areas of railroad safety." Likewise, the Hazardous Materials Transportation Act supplements earlier laws dealing with hazardous materials by providing the Secretary of Transportation with broad regulatory and administrative powers to deal with the hazards posed by the transportation of hazardous materials.

Repeal of the early safety laws and enactment of their substantive provisions as regulations would not have a beneficial impact on safety, although certain provisions of those laws appear to impair their execution unnecessarily.

The early safety laws do not, in general, place undue rigidity upon treatment of the particular hazards to which they are addressed. To the extent the laws are obsolete, their existence does not impair safety or cause other substantial harm. Thus, the effort necessary to change the substance of these laws would likely exceed the benefits of such a change and would distract attention from other important safety issues. However, there are two provisions which impair the execution of these laws:

- The definition of time on duty and similar details in the Hours of Service Act have spawned much litigation and might have more appropriately been the subject of a grant of rulemaking authority to the Secretary; and
- The limited enforcement power available under most of the early safety laws hinders action against habitual violators of those laws or the regulations thereunder.

Generally, the response to a particular safety hazard has been to adopt a law or regulation to require or prohibit certain action and thereby eliminate the perceived cause of that hazard. That response has been typically made without adequate consideration of alternative responses such as cooperative programs, collective bargaining and arbitration procedures, and adoption of incentive programs.

The Federal Railroad Safety Authorization Act of 1976 provides two particularly good and not atypical examples of this response—the provisions regarding the location of crew quarters and the requirement for rear-end markers. In each case, a solution to a hazard was mandated by law. The law required further detailed regulation in advance of consideration of alternative courses of action, or a clear understanding of the extent of the hazard and its significance relative to other hazards. In making this response without full consideration of alternative approaches, unnecessary inflexibility and inefficiency are built into the overall safety program and emphasize an adversarial rather than cooperative approach to safety.

The uncertainty as to what authority, if any, the Federal Railroad Administration has with respect to occupational safety and health hazards, combined with persistent but unsuccessful challenges to the authority of the Occupational Safety and Health Administration (OSHA) to regulate such hazards in the rail industry, has resulted in a gap in administration and enforcement of a program to deal with those hazards.

There is no gap in statutory authority to deal with occupational safety and health hazards since OSHA has such authority and can exercise it to the extent FRA does not. However, FRA has failed to exercise any substantive jurisdiction in this area (other than reporting requirements), in part, because its legislative authority to do so has been seriously questioned. In addition, OSHA has been hampered in administering its program on railroad property because of continued litigation as to its authority, although every appellate court that has considered it has sustained OSHA'S power in this regard and now OSHA is able to carry out its program in most jurisdictions. Moreover, OSHA and FRA have never reached agreement as to how responsibility for treatment of occupational safety and health hazards should be divided.

In exercising its rulemaking power, FRA does not articulate adequately the relationship between its regulatory objective and the requirements of the rule, nor does it establish measures for later determining the effectiveness of its rule.

A reading of the preambles and the docket to FRA's rules generally indicates the nature of the hazard to which the rule is addressed. However, there is usually no indication as to why the requirements of the rule were established as the best means for dealing with the hazard in question. While in some instances this relationship between the hazard and the rule is self-evident, particularly where performance standards are used, often there is no indication in the preambles or the docket as to why a particular standard or requirement will best eliminate or reduce the hazard. Moreover, neither the rules nor their preambles or other related information provide any measure that can be used to determine the effectiveness of the rules in dealing with the hazards to which they are addressed.

Analysis of five significant rulemaking proceedings* involving FRA over the last 7 years indicates the following:

—FRA has worked closely with the industry in formulating and amending its rules, but it has maintained a degree of independence and balance in resolving major issues that is consistent with its role as a regulator;

—The public record (meaning the agency docket) generally does not indicate the specific reasons for FRA's resolution of the issues raised in the proceeding;

—In most cases, the public record contains only superficial cost-benefit analysis of the rules;

—The public record in most proceedings does not show any use of pertinent accident data in formulating the rulemaking objective and selecting the appropriate means for obtaining that objective (e.g., there is no analysis to show that a Federal blue signal (flag) protection rule would meet a particular safety hazard of significance or that the particular requirements of that rule will have any impact on safety);

*Track safety standards, State participation rules, power brake rules, blue signal protection rules, and tank car specifications.

—Most of these rulemaking proceedings took a considerable period of time (over 5 years in one case from advance notice of proposed rulemaking to final action), but FRA was not usually the sole or even main cause of this delay. The time each proceeding took was the result of a variety of factors including the complexity of the problem addressed, the degree to which data with respect to the problem and the solution were available, the degree of controversy among special interest groups, the level of congressional and other public involvement, and the growth and maturity of FRA as a rulemaking agency. Recent legislation has limited FRA to 1 year for completing any regulatory act.

The likelihood that the tools for enforcement of Federal safety laws and regulations will be effective in inducing compliance is hampered by (a) the excessive time taken to collect monetary penalties, (b) the failure to make effective use of the emergency order power or any use of the power to issue compliance orders, and (c) the favorable treatment accorded bankrupt or financially weak carriers.

The time between occurrence of a violation and enforcement of a penalty, usually a fine, averages approximately 16 months, with many taking 2 years or more. This clearly reduces the impact of the penalty as a deterrent to violation of safety requirements. Moreover, FRA has issued only seven emergency orders since 1970 and has never issued an order directing compliance. These powers, particularly the latter, could be far more effective in correcting habitual violations than collection of civil fines. Bankrupt or financially weak carriers were treated more leniently in enforcement of civil fines, a policy consistent with the need of those carriers to conserve funds. This reduces the incentive of those carriers to apply limited resources to correct conditions that are violative of Federal safety requirements.

INSPECTION ACTIVITIES

The accident rate does not appear to have been affected by the increased inspection activity.

In assigning a significant portion of its safety resources to its inspection programs, the FRA appears to be operating on the assumption that Federal inspection programs can help to reduce the accident rate. However, the relationship of the inspection programs to accident prevention/reduction is difficult to define—given the number of variables that must be considered and the fact that adequate measures of effectiveness do not appear to exist. While it would not be expected that accident reduction would be the sole measure of the effectiveness of inspection programs, lacking other measures, it provides one relevant benchmark for assessing the effectiveness of the inspection efforts. Increased and/or continuing accident rates that coexist with increased inspection personnel may indicate that Federal inspection does not provide a significant incentive to comply with railroad safety standards.

The allocation of inspection funds/personnel does not appear to coincide with the accident pattern.

From the information available to this study, it is not apparent what basis the FRA has used for assigning levels of effort in the five inspection program areas that have been established. Although track accidents account for the largest number of train accidents and the largest amount of property damage, the resources allocated to this inspection effort at the Federal level are only half those allocated to the motive power and equipment inspection program. On the other hand, while a significant number of fatalities to employees appears to occur as a result of human factors, the inspection effort for operating practices is allocated approximately one-tenth the funding and half the personnel allocated the motive power and equipment inspection program. Human factors are not sufficiently understood, so that increased inspection of those operating practices may not necessarily be an improvement. There appears to be some shifts in resource allocation, with motive power and equipment decreasing and the other programs increasing; nonetheless, the basis for the shifts, their magnitude, and their timing are not clearly related to the accident pattern.

There does not appear to be a way, at present, of determining the effectiveness and the continued desirability of the State Participation Inspection Program.

The State Participation Inspection Program has been controversial from its inception, with the States and the FRA differing in several respects as to how it should be implemented and what the respective roles/responsibilities of the States and the FRA should be. Several additional factors have complicated participation from the point of view of individual States; these factors include lack of an entity having appropriate jurisdiction, lack of funding, lack of sufficient railroad mileage to warrant and/or qualify for participation, lack of qualified inspectors, and reluctance to be tied to Federal funding. Although these factors have played a part in the development of this program, it is not possible to say to what extent they have affected its implementation. As with other inspection efforts, adequate measures of effectiveness for the State Participation Inspection Program do not exist; however several observations are pertinent:

—Rate of entry of States into the program was not as rapid as was originally anticipated.

—Current State participation regulations promulgated by the FRA permit State participation inspection efforts against only two standards: track and equipment.

—States have, by statute, virtually no enforcement power of their own.

—Participation of States is uneven, i.e., not all States are participating and some are participating in one program and not the other.

The adequacy of the FRA inspection strategy, the adequacy of the present standards upon which inspections are based, and the possibility of approaches other than inspection having greater leverage in promoting safety in certain areas presently covered by the standards, have not been appropriately addressed in the administration of the FRA safety program.

A significant component of the FRA safety program relies on the concept of inspection. An inspection program proceeds on the assumption that the standards against which it inspects are correctly conceived and that compliance with them will enhance safety. It also proceeds upon the assumption that the inspection program's ability to detect noncompliance and to cause the assessment of penalties is sufficient to make noncompliance with the standards unattractive. However, some noncompliance exists and indications are that selective noncompliance with railroad safety standards occurs for three general reasons:

1. A number of the standards lack credibility due to the perception that: a) their sometimes cumbersome requirements are not always related directly to safety; b) their tendency not to differentiate between potentially serious defects and other defects; and c) in some cases, enforcement of the standard is not always feasible.

2. It sometimes costs the railroads less to pay

a PenaltY when a violation has been detected or to risk having to pay a penalty than to stop service.

3. Some railroads are not financially able to comply across-the-board with all the requirements of all the safety standards.

RESEARCH AND DEVELOPMENT

Railroad safety-related research and development activity (Government* and industry) has placed more emphasis on reducing the causes of property damage than reducing the causes of human casualties.

The major research and development efforts during 1973-76 were directed at track structures and rolling stock which, except for tank-car design research, can be expected to have a greater impact upon the safety of property than on the safety of people. Those efforts received a far greater amount of funding applied to research and development activity than those directed at major causes of human casualties.

Of the research and development activity directed at casualties, greater attention has been focused on grade-crossing accidents and hazardous materials problems, with less attention being directed toward employee casualties.

Most of the research and development activity directed at casualties has been focused on tank-car design because of its potential for a catastrophe and on grade-crossing accidents because of the high number of fatalities and severe injuries associated with these accidents. Relatively less attention has been given to railroad employee casualties.

Moreover, very little research has been done to identify the chief contributing factors to employee casualties. For example, even though there seems to be some recognition that alcohol or drug abuse may be factors in railroad accidents, as evidenced by the growing number of industry programs dealing with such abuse, there has been little research effort to determine the extent to which alcohol and drug abuse are safety problems.

Railroad safety research and development appears to have been most successful in terms of its adoption and utilization by the affected parties when all interested parties are involved in the formulation and implementation of the research and development effort.

The research on tank-car design, glazing of locomotives and cabooses (not completed), and locomotive cab interiors has been conducted with the involvement of all interested parties and has been, or is expected to be, very successful in terms of the use of the benefits of this research by those parties. Conversely, past efforts at standardizing operating rules (only in part a research effort), establishing railway employee medical standards, and analyzing the tasks of certain railroad employees were characterized by a lack of cooperation among interested parties and in general have not been successful.

*Does not include funds spent by the Federal Highway Administration (FHWA) on demonstration projects.

HAZARDOUS MATERIALS

The Department of Transportation and the railroad industry have taken major steps to deal with one of the most serious problems associated with hazardous materials by issuing the October 17, 1977, tank-car regulations.

In 1974, roughly 65 percent of tank cars loaded with liquefied petroleum gas, sulfuric acid, anhydrous ammonia, and liquid caustic soda were involved in the accidental release of hazardous materials. The Department of Transportation and the industry acted on data indicating the serious nature of the problem by conducting research and development and then proposing and making final regulations covering specifications for tank cars such as shelf couplers, thermal protection, and tank head shields. The effective date of the regulation was October 17, 1977, calling for cars built after December 31, **197'7,** to comply. Further, under that regulation, retrofitting of existing tank cars would be completed by January 1, **1982.**

This action should reduce the problem associated with hazardous materials significantly, provided that there is effective monitoring to ensure compliance with the regulation. However, FRA should ensure the effectiveness of the regulatory action in reducing accidents.

Additional analysis of the risk and exposure associated with the transportation of hazardous materials should be conducted to anticipate future problems.

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 regulation, to ensure safety, that the exposure of people and property to hazardous materials be determined.

RAIL-HIGHWAY GRADE= CROSSINGS

Although accidents and fatalities associated with rail-highway grade-crossings have been decreasing, the problem continues to be a serious safety matter.

Table 7 gives grade-crossing accident data for **1965-75.**

Although the numbers are decreasing, the problem remains serious basically for two reasons:

1. 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.
2. The desirable rate of improvement (i.e. 3,000 yearly protection installations over the next 10 years and an annual reduction of 500 fatalities) in grade-crossing accident problems, which was indicated by the Department of Transportation in its 1972 Report to Congress, has not been met for a variety of reasons, including delays in funding until mid-1974.

The environment for solving the rail-highway safety problem is complicated by divided jurisdictions, which is a barrier to effective treatment of the problem.

The divided jurisdiction and responsibilities result from the following:

Table 7.— Rail-Highway Grade-Crossing Accidents

Year	Number of accidents	Accidents per billion vehicle miles	Killed	Injured	Total casualties	Casualties per accident
1965	**3,820**	4.3	1,534	3,801	5,325	1.39
1966	**4,097**	4.4	1,780	4,043	5,823	1.42
1967	**3,932**	4.1	1,632	3,812	5,444	1.38
1968	**3,816**	3.8	1,546	3,774	5,320	1.39
1969	**3,774**	3.6	1,490	3,669	5,159	1.36
1970	**3,559**	3.2	1,440	3,336	4,776	1.34
1971	**3,392**	2.9	1,356	3,332	4,688	1.38
1972	**3,379**	2.7	1,260	3,285	4,545	1.34
1973	**3,379**	2.6	1,185	3,283	4,468	1.32
1974	**3,268**	2.5	1,220	3,249	4,469	1.36
1975*	N/A	N/A	978	4,168	5,146	N/A

•1975 figures are not comparable to previous years due to changes in reporting requirements. Peat, Marwick, Mitchell & Company, Inc. (Task IV) projected the number of fatalities in 1976 to be 1,124, based on 6-months of data.

SOURCE: Compiled by OTA from Federal Railroad Administration and Association of American Railroads data.

–The Federal Highway Administration apportions funds to 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 is often divided among several State agencies.

—Railroad companies have the responsibility for the design, installation, 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 divided jurisdiction becomes a barrier to effective treatment of the 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.

—It makes the assurance that new technology is transferred to all entities requiring solutions to grade-crossing problems difficult.

Technology and interdisciplinary efforts have provided some solutions to the rail/highway safety problem, but the basic problem is the rate of adoption of the solutions.

Solutions Exist. Among the solutions identified are the automatic warning devices. According to a California study, the automatic warning devices are quite effective in reducing vehicle-train accidents and casualties at public railroad-highway grade-crossings. 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.0

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

Operation Lifesaver, a multidisciplinary approach to grade-crossing safety, operates on the premise that a successful grade-crossing safety program depends on engineering, education, and enforcement. In the opinion of Illinois Cornmerce Commission officials, from the single performance measure—fatalities—the program was a success. [7]

Barriers Exist. The analysis of each grade-crossing in terms of the costs and benefits of various protections, separations, passive controls (motorist awareness activities), or "no action" coupled with the allocation of necessary resources has not been and does not appear to be the strategy the States are following presently.

It may be most difficult to fund all necessary activities, given the costs of the various alternatives. One study showed the installation of flashing lights in 1975 to be $16,250 while cost of the installation of the automatic gates would be $27,290. That same study did not make the comparison between the protection devices and grade separation but other analyses have indicated that grade separations would be 27 times more expensive than the warning devices. [8]

In addition to the complicated jurisdictional problem discussed above, there is a barrier to implementation of the solutions brought about by the legislative authority of the Federal Highway Administration. Under FHWA's authority, the Federal formula for funding does not take into account the number of grade-crossings in a State or the number of fatalities per grade-crossing.

OTHER RAIL-SAFETY PROGRAMS

Activities such as use of safety committees, safety incentive programs, and alcohol and drug abuse programs may be effective in improving rail safety—in addition to Federal standards, inspection, and enforcement. However, little is known about the effectiveness of these programs, because measurable goals and objectives have usually not been established.

A variety of nonregulatory programs conducted by railroads, unions, and Government have the potential of contributing in a substantial way to improving railroad safety. The types of programs are:

—Information and education programs (industry and Government) which include training and public and employee awareness programs;

—Safety committees, some of which are organized by specific railroads to deal with their safety problems, and others which are organized at the national level to deal with safety problems;

—Incentive programs which provide local and national awards to railroad employees and to railroads for good safety practices; and

—Alcohol and drug abuse treatment programs which are designed to provide information and counseling to rail employees.

Even though many of these programs have existed for some time, there are gaps in the understanding of their effectiveness.

—There are differences in the methods and techniques used in railroad training

'Illinois Commerce Commission, Illinois, Railroad Grade Crossing Safety Council, "Operation Lifesaver, " July 1977.

'Texas Transportation Institute Study, November 1970, programs- some programs emphasize on-the-job training, others emphasize class-room training. There are no convincing studies as to which, if any, method or methods are more effective than the others.

—The safety committees appear, in concept, to be a good approach to solving the safety problems by the cooperative efforts of some stakeholders. Some studies of the effectiveness of the committees indicate concern about the continuity of the activities and meaningful participation of all in safety-policy decisions. [9]

---Alcohol" abuse programs were found to be cost-efiective in a 1976 Naval Weapons Support Center survey. Similar cost-effective studiea were not apparent in other programs dealing with human problems affecting salety -- such as drug abuse and difficult family situations.

The railroads and unions should be more involved in activities required to solve **safety** problems.

If it is preferable to have less Government involvement in rail-safety matters, which is not the present trend, then the railroads and the unions will have to take on more of the burden in solving the safety problems. A critique of their present efforts indicates the following short corn i ngs:

—The unions have minima] data collection and analysis activities, even though they gather some employee complaint information and review FRA and AAR data. A part of the problem relates to the reluctance of railroad management to share safety information, such as claims data, for fear it will be used against them. Although railroads themselves and the AAR are involved in data collection and analysis, there is some evidence that, for example, in the hazardous materials area, the data are not being used to determine the probability of risks associated with many hazardous materials.

—Except in the research and development activities, there is little evidence that safety committees have a measurable impact on the solution of rail safety problems.

—Neither the railroads nor the unions appear to have developed sufficient programs to meet the safety problems of railroad employees.

SAFETY CONCEPTS

The increased demand for protection against railroad accidents matches the increasing demand for safety in all industries.

Society continues to demand higher levels of safety in all its activities. In the evolution of the concept of safety in the workplace, the first major responses to the safety problems in the 19th century were under common law where the injured worker was protected if the employer was proved to be at fault. The next major phase of activity, after the laws were passed requiring employers to provide safe tools, was the passage of the Workmen's Compensation Laws-which placed a definite responsibility upon the employer. In more recent times, safety in the workplace has evolved to provide other protections under laws such as the Occupational Safety and Health Act. The demand for the level of safety has evolved to a higher level today in all workplaces, including railroads. In addition, this evolutionary process has affected the safety of the public interacting with the railroad system.

'Thomas A, Kochan, Lee Dyer, and David Dipsky, The *Effectiveness of Union Management Safety and Health Committees,* W. E. Upjohn Institute for Employment Research cited in Peat, Marwick and Mitchell study (Task IV).

The bases for all safety questions are trade-offs between the acceptable levels of risk, the benefits, and the costs.

The individual and society as a whole make determinations as to the optimal balance which can and shouId be achieved between the value of different levels of safety and the cost of providing those levels. It is agreed that critical to decisions about safety is a determination about the probability and severity of accidents associated with a product or activity. It is also understood that the acceptable levels of safety are not decided upon in a vacuum but rather there are considerations of their efficacy, and the distribution of hazards, costs, and benefits. In order to understand the hazards involved, a variety of factors may be considered. Among these are:

> the extent to which the action is voluntary or involuntary; whether the effect is immediate or delayed; whether alternatives exist; whether the risk is certain or not known; whether the action is essential or a luxury; whether the action is or is not occupation-related; whether the hazard is common or dread; whether the risk will be to average people or unusually sensitive people; whether the activity will be as intended; and whether the consequences are reversible or irreversible. 10

There is the need to apply methods of analysis (including cost/benefit) of alternative solutions to safety problems.

10 William w. *Lowrance, Of Acceptable Risk (Drawing* from Chauncey Starr and others), William Kaufmann, Inc., Los Altos, Calif., 1976.

Once there is an understanding of safety problems, the next step is the identification of alternative solutions and the selection of the solution which best addresses the problem. The selection that is made among the alternatives must be based on a weighing of their costs and benefits. Thus, it is necessary that methods of conducting cost/benefit analyses be developed and applied specifically for safety-related matters. It is important to note that in developing such cost/benefit analysis methods, the complex issue of the value of human life is raised among others. *

The bases for determining acceptable levels of safety in the future may change.

Decisions about safety in the future will continue to be based in part on risk, efficacy, and the distribution of the hazards, benefits, and costs. But there may be additional considerations—given the effect of such activities as changing patterns of governmental involvement with the railroads, changes in technology, the concern about the environmental impact, and the possibility of new types of hazardous materials.

* Some judgment of the value of life is implicit in every safety decision. The methodology dealing with the value of life and safety improvement in a form amenable to analysis using the conceptual apparatus of economic theory has been treated recently by M.W. Jones-Lee in The Value of *Life.* That methodology may be effective in quantifying the costs of injuries and fatalities and in quantifying the benefits of reduced injuries and fatalities. In any event, methods need to be developed to facilitate the conduct of safety analyses of alternative solution's to safety problems.