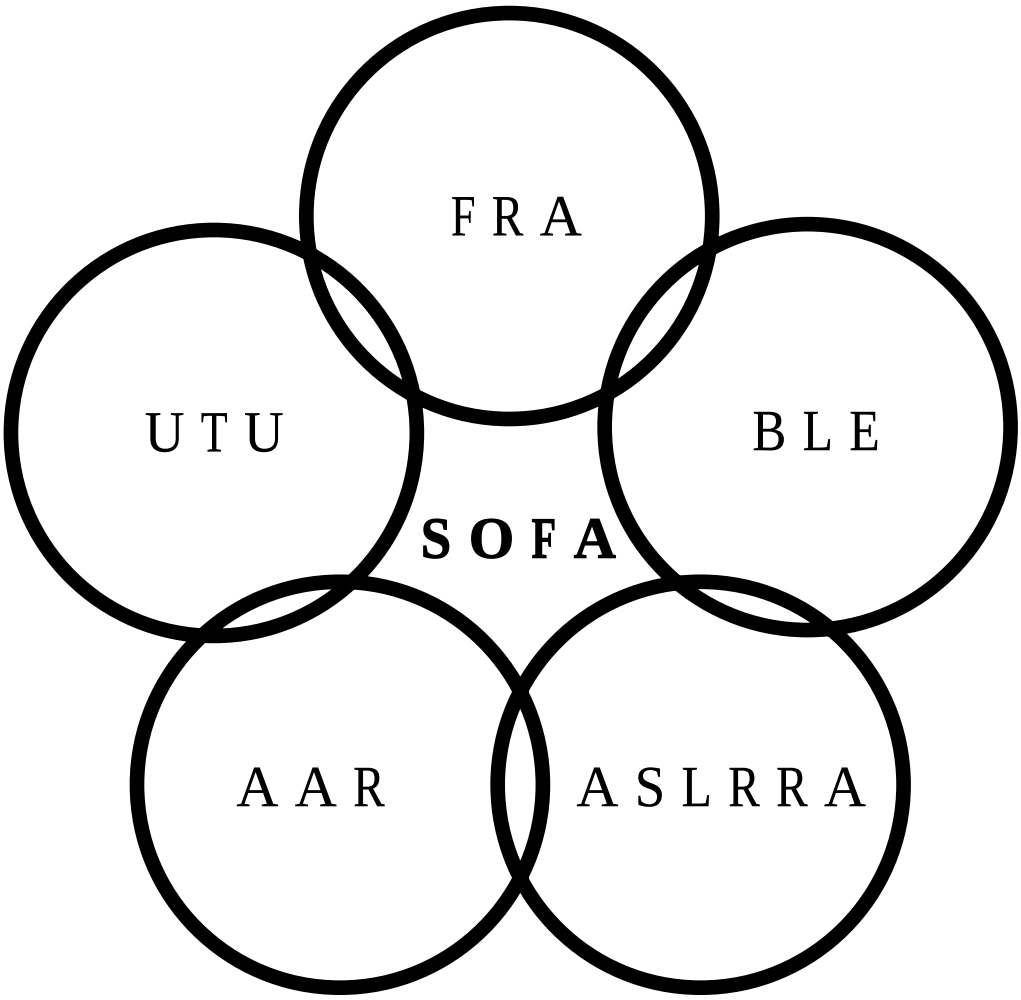
Switching **O**perations **F**atality **A**nalysis



Findings and Recommendations
of the SOFA Working Group

DOT-VNTSC-FRA-00-08
DOT/FRA/ORD-00/04

This report may also be found on the FRA website at http://www.fra.dot.gov

October 1999

NOTICE

The SOFA Working Group was supported by the Federal Railroad Administration's, Office of Research and Development and Office of Safety. The final recommendations and findings printed in this report are consensus recommendations and findings established by the SOFA Working Group. The Federal Railroad Administration report number DOT/FRA/ORD-00/04, referenced on the cover of this document, is published for the convenience of those wishing to obtain copies and for general information purposes. This report also may be found on the FRA web site at http://www.fra.dot.gov.

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SOFA Executive Summary

Introduction

On February 1998, a Switching Operations Fatalities Analysis (SOFA) Working Group, with representatives from the Federal Railroad Administration (FRA), Association of American Railroads, United Transportation Union, Brotherhood of Locomotive Engineers, American Short Line and Regional Railroad Association, was formed at the request of the FRA to review recent fatal incidents and develop recommendations for reducing fatalities in switching operations. Initial efforts of this Working Group have been sponsored by the Office of Safety at the FRA and supported by human factors expertise from the FRA Office of Research and Development, and the John A. Volpe National Transportation Systems Center. Working Group membership and affiliations are given in Appendix B.

The Working Group developed a codified database of standardized information, referred to as the "SOFA Matrix" from the wide range of information in the 76 FRA fatal accident case files between January 1992 and July of 1998. In addition the group reviewed very limited data obtained from FRA files concerning FEs (employee fatalities) from 1975 to 1991 and participated in a series of systematic exercises designed to tap the extensive expertise acquired by the Working Group during their review and analysis of the FEs. This database and the expertise capturing exercises were then used to generate trends or patterns in the data for a more comprehensive understanding of the fatalities they were investigating, and became the foundation for the analysis and recommendations in the report provided here. The small number of FEs and diversity of their circumstances precluded formal statistical analysis. However, based on the objective evidence of likely contributing factors a number of findings and a series of recommendations were developed. These recommendations include actions to improve both the safety of railroad switching operations and the quality of data collected on fatalities in switching operations.

General Findings

1. The occurrence of fatalities in switching yards has not decreased over the period under investigation. They remain a serious problem today.
2. Fatalities are not often the result of a single precipitating cause. Almost always they are the result of multiple possible contributing factors (PCFs). For six of the FEs studied four or more PCFs were identified. For an additional 26 FEs, three PCFs were judged to be contributors.
3. Although data were reviewed concerning time of day, day of the week, geographic location, number of crew members on duty at the time, seniority and years experience in particular jobs, and several other variables of this kind, none of them could be interpreted reliably because there were not sufficient exposure data. Better exposure data are needed to understand the frequency of occurrence of these conditions in the absence of a fatality. Such data would correct the fatality data for the possibility that the differences observed just reflected differences in activity levels, and not real differences in the occurrence of fatalities under equivalent conditions. There is a critical need to develop more detailed data about general levels of activity in switching yards as a function of basic criteria that can be used to

normalize the fatality data so that it might be examined more realistically to diagnose critical issues leading to FEs.

4. Despite the voluminous amount of detail available and the quality of each technical summary, there were still information gaps in the fatality reports that had originally been collected by the FRA. The existing FE files could be greatly improved by including a much broader range of information that can support the interpretation of the possible contributing factors associated with FEs.

The Working group generated two sets of specific recommendations based on their work. First, based on the objective data they reviewed, they made a series of recommendations designed to improve the safety of switching operations. Second, they developed recommendations for the improvement of FE reporting methodologies used by the FRA and by the industry.

Findings and Recommendations for Safety of Switching Operations

Major Finding 1

Eleven of the seventy-six FEs occurred while the employee was adjusting knuckles, adjusting drawbars, or installing an end-of-train device.

Recommendation 1

Any crew member intending to foul track or equipment must notify the locomotive engineer before such action can take place. The locomotive engineer must then apply locomotive or train brakes, have the reverser centered, and then confirm this action with the individual on the ground. Additionally, any crew member that intends to adjust knuckles/drawbars, or apply or remove EOT device, must insure that the cut of cars to be coupled into is separated by no less than 50 feet. Also, the person on the ground must physically inspect the cut of cars not attached to the locomotive to insure that they are completely stopped and, if necessary, a sufficient number of hand brakes must be applied to insure the cut of cars will not move.

Discussion 1

This recommendation emphasizes the importance of securing the equipment. A thorough understanding by all crew members that the area between cars is a hazardous location, whether equipment is moving or standing, is imperative.

Major Finding 2

Twenty of seventy-six FEs were struck by equipment other than their own. Of those twenty FEs, nine occurred in yard or industry tracks.

Recommendation 2

When two or more train crews are simultaneously performing work in the same yard or industry tracks, extra precautions must be taken:

SAME TRACK

- **Two or more crews are prohibited from switching into the same track at the same time, without establishing direct communication with all crew members involved.**

ADJACENT TRACK

- **Protection must be afforded when there is the possibility of movement on adjacent track(s). Each crew will arrange positive protection for (an) adjacent track(s) through positive communication with yardmaster and/or other crew members.**

Discussion 2

FE-06-94 and FE-31-94 both involved standing equipment left by another crew. In both cases, it can be argued that there was no possibility of either piece of equipment being moved. However, the fact that both pieces of equipment contributed to the fatalities and in both cases the respective crews had no knowledge that the equipment had been moved into the work area and that the physical layout expected by each fatality had changed contributed to the incident. Compliance with and an understanding of this recommendation would have prevented the other seven fatalities.

Major Finding 3

A lack of, or inadequate job safety briefings contributed to at least eight FEs.

Recommendation 3

At the beginning of each tour of duty, all crew members will meet and discuss all safety matters and work to be accomplished. Additional briefings will be held any time work changes are made and when necessary to protect their safety during their performance of service.

Discussion 3

Safe switching operations require teamwork and accountability among all crew members. Each crew member takes responsibility for their own and their fellow crew member's safety. Team work begins with a detailed, effective job briefing, but includes continued updates to all crew members describing the current state of each move as it is executed.

Major Finding 4

Ten of the 76 fatalities occurred because of a combination of radio/hand communication, or initial and/or ongoing movement of equipment without specific distances given.

Recommendation 4

When using radio communication, locomotive engineers must not begin any shove move without a specified distance from the person controlling the move. Strict compliance with "distance to go" communication must be maintained.

When controlling train or engine movements, all crew members must communicate by hand signals or radio signals. A combination of hand and radio signals is prohibited. All crew members must confirm when the mode of communication changes.

Discussion 4

The SOFA group believes that the key to radio use when backing, shoving or pushing a train or cut of cars is the communication between the locomotive engineer and the train crew. The crew must develop the discipline to remain stopped until specific car counts are given by the ground person, rather than to begin moving and then expect to receive the count. If this is done, fatalities related to improper radio communication can be substantially reduced. Additionally, mixing radio and hand signals causes confusion, reduces the chance that other members of the crew would hear of a change in the switching operations, thereby greatly increasing misunderstandings, and, has directly led to fatalities studied by the SOFA Group.

Major Finding 5

Eleven of the 76 FEs were shown to have experience of one year or less and/or deficiencies in training. One additional FE had less than 1.5 years and is included below. Of these 12 FEs, all but one occurred in yard or industry tracks.

Recommendation 5

Crew members with less than one year of service must have special attention paid to safety awareness, service qualifications, on-the-job training, physical plant familiarity, and overall ability to perform service safely and efficiently. Programs such as peer review, mentoring, and supervisory observation must be utilized to insure employees are able to perform service in a safe manner.

Discussion 5

While class room training time has increased, in general, the SOFA group has focused on experience and on-the-job training. We have found that limited training and experience continues to factor into many switching operation fatalities. Additional on-the-job training and experience, while working with more experienced peers, may help reduce fatalities among crew members with limited service.

Additional Suggested Actions

The recommendations above address those issues for which the Working Group felt they could respond with confidence based on their expertise and the objective data. In this section we consider other actions that the Working Group recommends taking, based on their expertise to continue to improve the safety of switching operations.

Safety Training Concerning the Implications of Unexpected Train Movement

Finding: Compelling evidence suggests many fatalities resulted from unexpected train movement, particularly at very low speeds.

Action: The railroad industry should consider their existing switching operations training programs to assure that no opportunities are being overlooked to heighten safety awareness and to focus it on the serious implications of unexpected train movement, and on the importance of continual mutual awareness of the location and activities of all crew members.

Rationale: Such FEs are preventable if the crew members have proper understanding of all planned movements, take care to be sure that no individuals are exposed to potential hazards at the time movements are initiated and to assure that detached equipment has been properly protected, i.e., locomotive reverser centered or hand brakes applied, to prevent unplanned movement. Safety awareness training can encourage a strong focus on these issues.

Train Crew Resource Management

Finding: The Working Group has also concluded that an important contributing factor to many of the FEs reviewed was incomplete or inadequate communication among crew members. Sometimes this was a failure of, or improper use of communications equipment, but more often it was a failure or reluctance of the crew member to elevate the importance of communications impacting on safety to the level needed to assure successful, safe operations.

Action: The industry (labor, management, FRA) should consider programs that address improving crew coordination and communication such as Crew Resource Management (CRM) which has been used effectively in the aviation industry.

Rationale: The goal of these training procedures in all industries is to promote safe operations through improved crew member proficiency, situational awareness, effective communication and teamwork, and by providing strategies for appropriately challenging and questioning authority where safety could be jeopardized. Training in the importance of and procedures for effective intra-crew communication has the potential to make a major contribution to the safety of switching operations.

Follow-on SOFA Analysis : Review of Incidents Involving Severe Injury

Finding: The SOFA Working Group has been an effective task force for accomplishing goals that span the interests of labor, management and the FRA in switching operations. Although the review of switching fatalities has been very useful, the body of data is relatively small. Incidents in which serious injury has resulted, such as loss of a limb or requiring that the employee be placed on extended disability are likely to be very similar in kind to FEs. They are likely to

reflect the same safety implications in the sense that the only difference is in the degree of severity of the injury.

Action: The SOFA Working Group or its successor should extend the scope of its investigations by undertaking the review of available FEs where severe injuries have resulted.

Rationale: The data collection procedures for examining railroad injuries has recently been improved so that more complete and useful data for understanding the safety implications are available. In 1998 there were more than 8,000 non-fatal railroad incidents, not including grade crossing incidents. While we do not know the number of these that would be classified as serious and the number that involved switching operations, it is likely to be a significant proportion of this total and therefore would substantially augment the statistical reliability of the aggregate database and the ability to make objective recommendations based on it.

Recommendations for Incident Investigation

Establish and Maintain Database of Objective FE Data

Finding: FRA's existing FE files could be greatly improved by including a much broader range of information that can support the interpretation of the possible contributing factors associated with FEs.

Recommendation: When investigating FEs, the FRA should establish a comprehensive historical database summarizing the objective data and interpretation of FEs occurring in switching operations that will be updated regularly to accumulate reliable and consistent information about the occurrence of switching operations fatalities.

The Working Group, taking advantage of the insights resulting from its extensive analysis of existing data, is providing its recommendations for ensuring that specific data are collected by the FRA during its investigation of FEs.

Discussion: The generated database will provide more reliable clues to the factors contributing to switching operations FEs and support the justification of safety improvements in terms of the number of lives potentially saved. Additionally, the newly generated database will substantially reduce the time and cost of subsequent analyses and recommendations.

Recommendation for Providing Computer Support to the Data Collection Process

Finding: Current data collection procedures involve use of printed forms, notes, diagrams and photographs that do not provide a thorough or uniform data collection to perform accurate statistical analyses.

Recommendation: The FRA should consider creating software to facilitate data entry at the source and at the time the investigation is taking place. This software could operate on portable laptop computers already available to investigators or on off-the-shelf personal data units (PDUs) that are especially suited to the data collection application. The SOFA Working Group offers its assistance in a project to revise the data collection protocol and to develop software to support the fatality investigation and data codification process.

Discussion: The efficiency, accuracy, and thoroughness of the existing data collection in each investigation would be improved. Computer support could reduce the time and cost associated with the complete data collection and consistent codification process.

Recommendation for Continued Review and Monitoring of Fatal Accident Data

Finding: The SOFA Working Group has accumulated the most knowledge of the potential causes of switching operation FEs in the industry.

Recommendation: The SOFA Working Group, or its successor, should undertake a periodic review of the FE switching operations data as it accumulates to seek new lessons learned, to review the integrity of the data, to monitor its usefulness and recommend improvements to the data being collected where appropriate.

Discussion: Their review of the data will (1) provide the best checks that the data being requested are useful, (2) put them in a position to recommend improvements to data collection and (3) put them in a position to recommend potential safety improvements to reduce the incidence of death and injury.

Modification of FRA's Data Collection Process to Include a Team Concept

Finding: No one has all the expertise required to undertake a comprehensive review and revision of FE investigation procedures.

Recommendation: The Working Group believes it is important that FRA's investigation process be consistent, and that a team concept be implemented to insure complete data collection.

Rationale: The SOFA Working Group recognizes that some inspectors collect and produce reports better than others, while other inspectors are more versed in analyzing the FE data. A team (to include all affected disciplines) concept in data collection and analysis will insure a more consistent FE investigation.

1. INTRODUCTION

1.1 Background of SOFA

In February 1998, a Switching Operations Fatalities Analysis (SOFA) Working Group, with representatives from the Federal Railroad Administration (FRA), labor and management, was formed at the request of the FRA to review recent employee fatalities (FEs) and develop recommendations for reducing fatalities in switching operations. The charge to the Working Group was contained in a letter (see Appendix A) from George Gavalla, Associate Administrator for Safety of the FRA to the following four organizations: Association of American Railroads (AAR), American Short Line and Regional Railroad Association (ASLRRA), Brotherhood of Locomotive Engineers (BLE), and the United Transportation Union (UTU). It proposed that the group, "Conduct a detailed fact-finding review and analysis of these incidents to determine whether trends or patterns can be found, identify best practices, and, if possible, formulate recommendations for the entire industry based on its findings."

This small group of senior railroad experts in switching operations met almost monthly for the past 20 months, and reviewed the individual case histories of FEs that occurred in switching operations since 1992. Initial efforts of this Working Group have been sponsored by the Office of Safety and supported by the Office of Research and Development at the FRA. Working Group membership and affiliation are given in Appendix B.

The group began its work by reviewing the FEs summaries available from the FRA. However, they soon realized that to better understand the underlying causal factors of these fatalities, they would need to look in more detail at the entire FE files, including photographs of the site and statements of eyewitnesses. From experience, the SOFA Working Group recognized they could not objectively evaluate the underlying causal factors common across these fatalities by reviewing individual case files.

Consequently, it was determined that a database of selected information in the case files was needed for aggregating data and conducting expert analysis. After several months of dedicated effort pouring over dozens of case files, and with considerable give-and-take from the different parties represented, the SOFA Working Group generated a codified database of standardized information, referred to as the "SOFA Matrix." This codified database was then used to help generate trends or patterns in the data for a more comprehensive understanding of the fatalities they were investigating, and became the foundation for the analysis and recommendations in this report. These recommendations include short- and long-term actions to improve the safety of railroad switching operations and the quality of data collected on fatalities in switching operations.

While the FE reports generally tried to establish a single probable cause of each switching FE, it appeared, to the SOFA Working Group, that fatalities more often resulted from the coming together of a complex set of factors. Had any one of these factors not been present, the fatality would have been less likely to occur.

Shortly after beginning their evaluation process, the SOFA Working Group accepted Human Factors support offered from the Office of Research and Development at the FRA, which then requested additional Human Factors support from the Volpe Center. The Human Factors team brought additional perspectives to the SOFA Working Group while supporting their premise that most FEs have multiple contributing factors. They also helped the SOFA Working Group to

refine the SOFA Matrix, and suggested methods to analyze the database to help answer some of the many questions that arose.

In the course of these lengthy investigations, the Working Group became a highly experienced team in understanding the variety of circumstances that can lead to FEs in switching operations. Periodically, the Human Factors Team would lead one of the meetings, devoting specific attention to such things as elaborating and systematizing the possible contributing factors to fatalities, and establishing the relative importance of these possible contributing factors for each of the FEs they had studied. Results of these meetings form the basis for this report.

1.2 Description of the SOFA Data

In March 1999, the Working Group completed a comprehensive database of objective and interpretive data associated with the 76 railroad operations switching fatalities that occurred from January 1, 1992 to July 1, 1998 as shown in Figure 1-1. The database contains nearly two hundred attributes for each of the 76 switching-related, employee fatalities herein referred to as *FEs*. Previously, no single database of comprehensive information related to railroad switching fatalities was available for electronic analysis. After codifying the database, it then became possible to analyze these FEs, look for common factors and trends, and make appropriate, preventive recommendations.

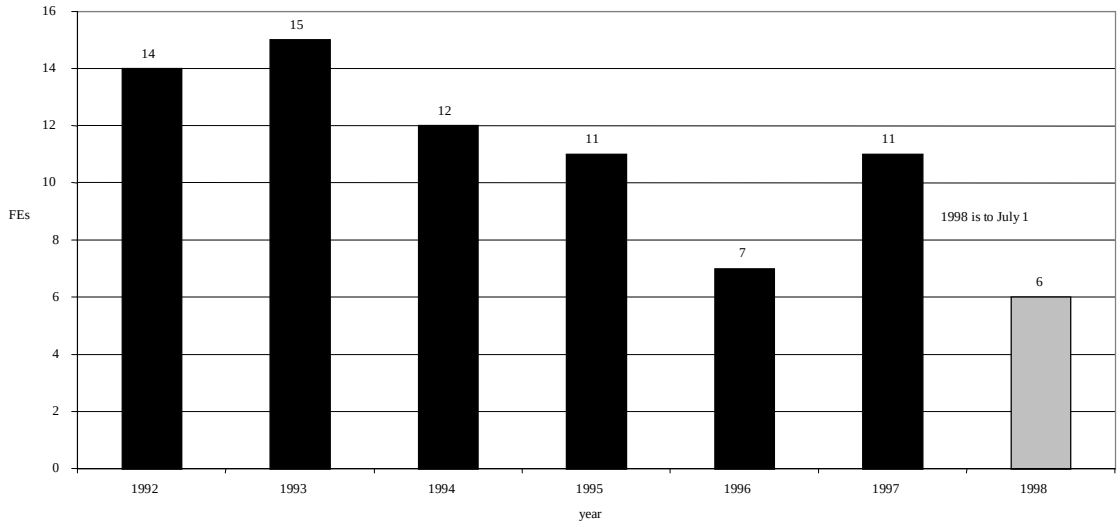


Figure 1-1. Fatalities of Employees (FEs) engaged in switching operations, January 1, 1992 to July 1, 1998.

Additionally, the Working Group supplemented the data in the SOFA Matrix with seventeen mores years of switching FEs which were coded back to 1975 for just eight descriptive attributes. These attributes are listed in section 2.3. This time-series is shown in Figure 1-2. Finally, the Working Group identified important measures of adjusting the data for exposure, such as FEs per million switching miles, to provide a more valid interpretation of any apparent trends in the data.

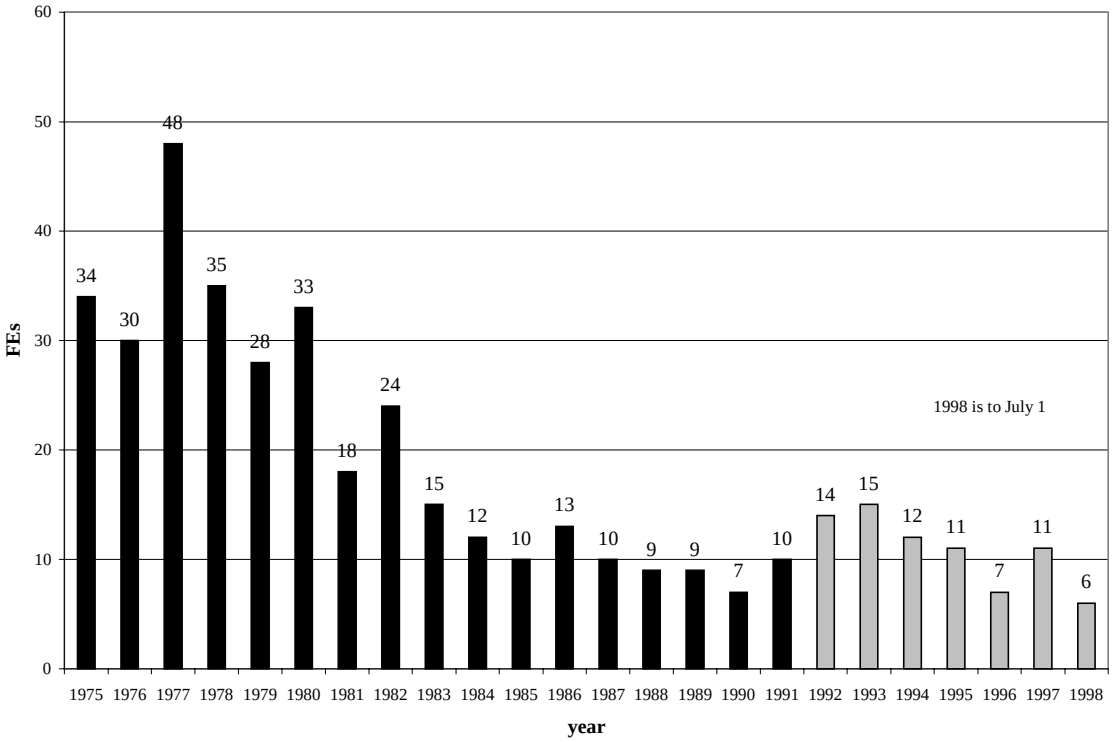


Figure1-2. Fatalities of Employees (FEs) engaged in switching operations, January 1, 1975 to July 1, 1998.

1.3 Perspectives on Human Error

The goal of the SOFA Working Group has been to better understand how switching FEs occur and to make recommendations for safer working conditions, improved training, and other important policy changes to minimize both injuries and deaths in switching operations. Injuries and fatalities can be caused by a number of factors, including poor design, equipment failure, inadequate maintenance, or human error.

There is a strong tendency throughout industry to attribute FEs to human error, especially in railroad switching operations where the work is very directly dependent on the actions of individuals. This is only natural, since for FEs to occur, somehow the individual(s) involved had to be caught in a dangerous situation. However, even when it is appropriate to cite human error, the error may be the result of conditions beyond the control of the individual. For example**,** the individual may be trying to compensate for equipment or operating procedures.

Conversely, not all human error leads to an incident. Sometimes it only results in noticeable reduced efficiency or waste. Sometime it happens in a way or at a time where it has no impact at all.

Incidents are not usually the result of a single failure. In some cases they result from the accumulated effects of several contributing factors. This can be seen in the sequence of events in the following two FEs:

- The first FE occurred when the brakes were not securely applied and the space between the freight cars was inadequate. When the freight cars suddenly rolled toward the locomotive, the worker was pinned between the coupler knuckles.
- The second FE occurred when a cut of cars rolled slowly out from another track while a foreman on the adjacent track was riding the point and using a radio to direct a shove move. The foreman, with ten months experience, was crushed when struck by the rolling cars.

It is easy to think of incidents in terms of the immediate cause. The crew member fell into the path of a moving train or caught clothing on moving equipment and was dragged along the roadbed. However, in order to benefit from incident analysis, one must look beyond the immediate cause to understand the conditions that led up to it. Often the critical event occurs at a prior time or at a distance from the observable result. The terms *unsafe acts, latent conditions* and *organizational factors* address attributes of an incident that may be further removed from the immediate cause (Reason, 1990, 1997).

An *unsafe act* may have been the responsibility of the victim, or it may have been performed by another crew member who put the injured party in jeopardy. For example, was the injured brakeman standing near, or "fouling," the track while the on-track equipment was moving? Or did the locomotive engineer fail to wait for confirmation of a radio transmission before initiating a shoving movement?

Latent conditions are the circumstances that contribute to the incident. They are circumstances that are likely to be present for a long time before they have a negative impact. They are sometimes referred to as "incidents waiting to happen." They can arise from careless operations, bad equipment design, lack of equipment, unworkable operating practices, maintenance failures, and inadequate training.

O*rganizational factors* are policies and/or practices that lead to the latent conditions. Was roadbed maintenance assigned a low priority? Was there a history of inadequate training of the crews? Were job briefings conducted regularly and taken seriously?

Figure 1-3 shows some examples of the ways in which unsafe acts can involve human information processing. In the figure, *unsafe acts* are partitioned into *intended* and *unintended* actions. Then it breaks down each type into further categories. Unintended actions can be *slips* or *lapses*. Slips are typically unintentional failures of attention. A yardman intending to uncouple two cars, but walking right by them without doing it would be an example. Lapses are cases where the failure is derived from mis-remembering a rule or procedure. An example might involve forgetting to throw a critical switch setting up a move. Mistakes are cases where the actions taken were intended, but it was not a good thing to do. Examples include applications of the wrong rule, or one not appropriate to the current conditions, or an inappropriate shortcut to a procedure.

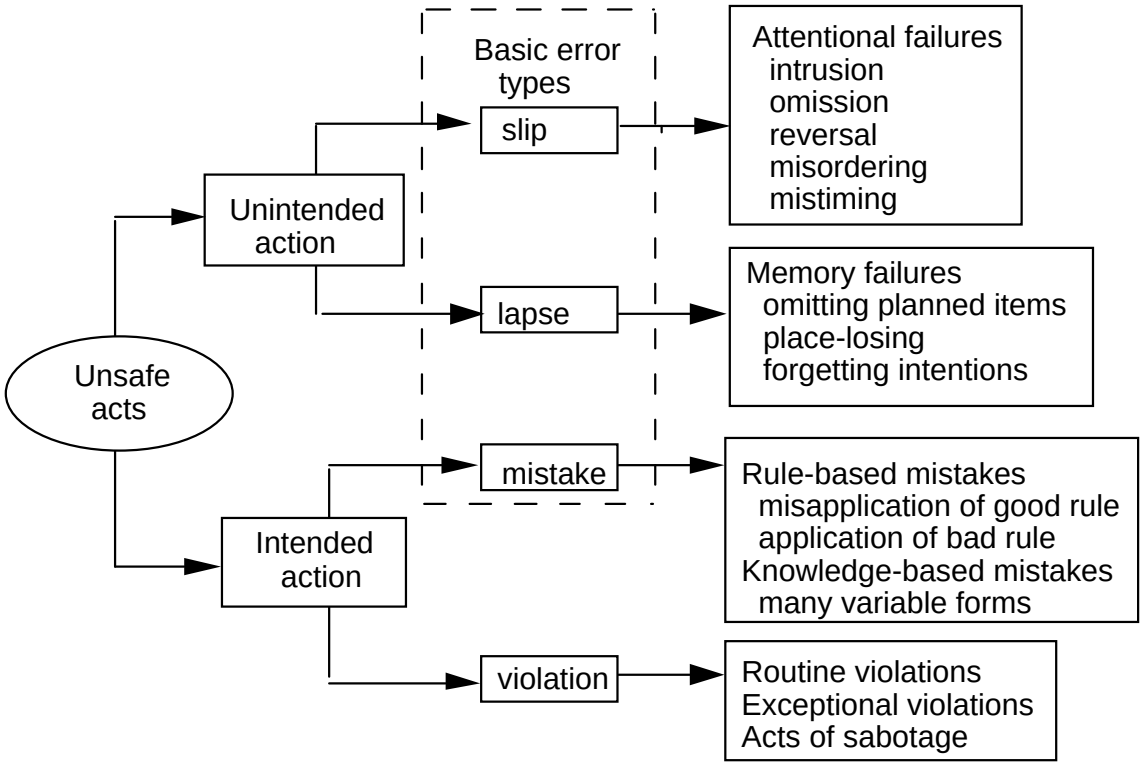


Figure 1-3. Taxonomy of unsafe acts (From Reason, 1997. Reprinted with the permission of Cambridge University Press.)

With respect to violations, it is good to remember that no well-motivated worker intentionally causes an incident unless it is an act of sabotage or terrorism. No such incidents were identified in the cases investigated by the SOFA working group.

The goal of this report is to make recommendations that, when implemented, will reduce the incidence of fatalities and any related injuries in switching operations. Accordingly, the recommendations focus on actions that can be taken by the FRA, and the railroad industry, to improve the safety of switching operations. The Working Group identified five approaches to improving safety that can impact the occurrence of unsafe acts, or latent conditions, that contribute to incidents.

- Improved design of equipment used in yards, rolling stock, worksite and layout.
- Improved training or communication procedures, such as job briefings.
- Revised or re-emphasized rules and procedures.
- Improved track or equipment maintenance.
- Modifications to management policy and workplace culture.

1.4 Using the SOFA Matrix to Examine the Chain of Events

The SOFA Matrix contains a wealth of information – some 200 variables -- about each FE. To discern which factors contributed to each FE, the Working Group looked at the chain of events leading up to the FE. The actual trauma-causing event may have been a derailment, collision, or sudden and unexpected movement of equipment, but other contributing or latent conditions surrounding the event sequence may have been involved as well.

Using the information contained in the SOFA Matrix, the event chains for FEs start with the *general* location of the FE, either on the ground or equipment. Forty-nine FEs (64%) were classified as starting on the ground; 27 FEs (36%) were on railroad equipment as shown in Figure 1-4. From there, the sequence describes a more *specific* location of the FE, then to the physical act the FE was engaged in, the trauma-producing event itself, and the FE crew's next anticipated move. Possible Contributing Factors (PCFs discussed below), and personnel-related information may be provided. Weather, ground conditions, and lighting serve as possible latent conditions.

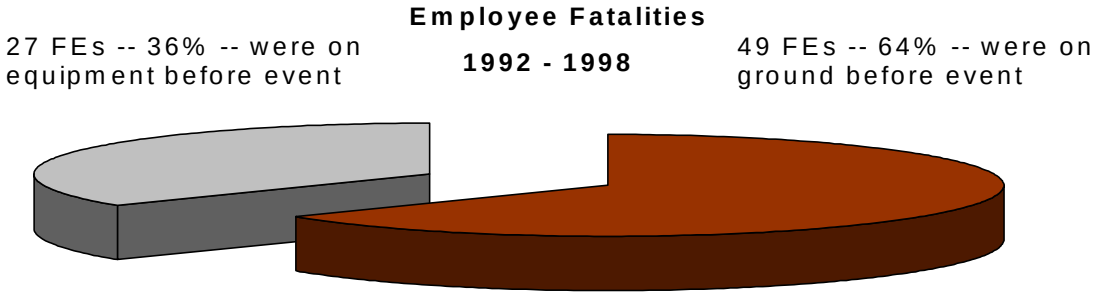


Figure 1-4. Employee location before fatal event.

As an example (FE-29-94): a 57-year-old worker, with 38-years experience, is on the ground (general location) on a flat-yard track (specific location), standing (activity), when struck by his own equipment being shoved at 6 mph. The employee's crew next anticipated move was to "couple." The SOFA Working Group felt that intra-crew communication and failure to comply with shoving requirements were PCFs. The event occurred during daylight hours on a Tuesday with a temperature of 55 degrees Fahrenheit and cloudy atmospheric conditions. The three-person crew was using both hand and radio communication. Evaluating this FE as a chain of sequential events and latent conditions, as shown in Table 1-1, provides a better understanding of the PCFs involved and allows for more specific recommendations to be developed.

Table 1-1. FE Formation as Chain of Events.

General location →	Specific Location →	Physical act →	Anticipated next move
On ground	flat yard track	standing	to "couple"

Possible Contributing factors	Latent Conditions
Intra-crew communication	3-person crew
Failure to comply w/speed	both hand and radio signals used
	55 degrees F

1.5 Summary of Report Content

The remainder of this report is broken into four additional sections. In section 2 we describe the SOFA database, how it was produced and present some summary data that represent findings of the Working Group. In section 3 we describe some additional data collection and analyses that were designed to gain a broader perspective on the knowledge that has been gained by the SOFA Working Group as a result of critical review and analysis of the FE files. In section 4 we present the Working Group's recommendations to the FRA, and to the railroad industry. The report concludes with recommendations for incident investigation in section 5. The Appendix contains the following sections:

- A: Origin of SOFA Working Group
- B: SOFA Working Group Membership and Affiliation
- C: Definitions of Possible Contributing Factors (PCFs): and Activity, Event, and Locations Codes
- D: Frequency of possible Contributing Factors (PCFs) and Pairs of PCFs
- E: Working Version of SOFA Matrix (Full SOFA Matrix appears in Appendix II *)
- F: Recommendation Summary by FE
- G: Data Format for Recommendations for Incident Investigation

* Note: Appendix II, with supporting data, to be issued by December 1999.

2. SOFA TASKS

2.1 Method of Producing Database

The SOFA Working Group began its work by reviewing the FE summaries available from the FRA. However, the Working Group soon realized that to better understand the underlying causal factors of these fatalities, they would need to look in more detail at the entire FE files and develop a codified database of information derived from the files. It also became clear that they would need to use their expert judgment to reach conclusions about how the Possible Contributing Factors (PCFs) for each FE were identified and coded into the database.

First, the Working Group solicited suggestions from each of the following groups: Association of American Railroads (AAR), American Short Line and Regional Railroad Association (ASLRRA), Brotherhood of Locomotive Engineers (BLE), Federal Railroad Administration (FRA), and the United Transportation Union (UTU). These groups established a list of categories to be used for coding the database. As the group gained increasing experience analyzing individual FEs, and as they began to better understand the specific circumstances surrounding each of the FEs, they gradually refined the structure of the database to its present form.

Before any PCFs were assigned to an individual FE, the entire case file for that FE was thoroughly reviewed and extensively discussed by the SOFA members present at that meeting. They reviewed all related summary documentation of the FE, including the FRA summary report, on-site interviews, diagrams and drawings, pictures, autopsy reports, and any other information available. A detailed diagram of the scene was then reconstructed. This visual representation of the FE served as a focal point for discussing and assigning the PCFs to that FE. Ensuing discussions often lasted several hours or more. When questions about the FE arose that could not be answered at that meeting, but which the information was known to be available, one of the SOFA members was assigned the task of finding the answer and reporting back to the group at the next meeting. Only after these extensive discussions and follow-up discussions would the group decide which PCFs to assign to that FE for coding into the database. Furthermore, all members had to agree that the identified factor was indeed a PCF to the FE before it was coded into the SOFA Matrix.

The Working Group represented a wide range of perspectives and interests. Much confidential discussion preceded many of the decisions about how to code individual entries in the database. The process of creating and codifying the SOFA database required approximately eighteen months of regular monthly meetings. The resulting database and findings are described below.

2.2 Description of Data in SOFA Matrix

By March 1999, the Working Group completed a comprehensive database of objective and interpretive data associated with railroad operations switching fatalities covering the period from January 1, 1992 to July 1, 1998, totaling 76 FEs. For the six full years of the SOFA period, FEs averaged 11.3 per year with a range of 7 to 15 FEs a year.

The SOFA Matrix has provision to code some 200 attributes or variables for each FE. Conceptually, it is a matrix with 76 rows representing the FEs and some 200 columns representing the attributes for each of those fatalities. However, not all variables of the matrix apply to each FE. Additionally, some variables were missing because the information was not available. The reasons why this information was not available varied, but were usually because of the time lapse between occurrence and coding, the need for additional investigation, or lack of record keeping. The pattern of missing information across FEs was inconsistent, which makes some analyses impossible or inconclusive.

Although a total of 76 cases, with up to 200 attributes for each case, were included in the database, the small number of cases, combined with the limited number of potential variables, made it insufficient to establish statistical significance in any of the findings. Even after the addition of 95 FEs, with eight attributes coded for each and covering a pre-SOFA period from 1983-1991, statistical significance could still not be established. When the matrix was partitioned into meaningful categories, the number of cases contributing to a particular inference was just too small. There were too few occurrences per year; and too many different causal mechanisms that could have played a role. For example, there were six FEs in which derailment was the trauma-producing event. Yet the last derailment event in the SOFA period occurred in September 1994.

However, that does not mean that the SOFA findings should be taken lightly. When multiple FEs can be marshaled to show that a particular contributing factor was involved repeatedly, and a fatality resulted from each of them, it is hard to argue that safety would not be improved by reducing or eliminating the likelihood of that contributing factor. In fact, when it can be asserted that a policy, procedure, or training change could eliminate the potential occurrence of even one death, then that change is certainly a meaningful candidate for evaluation.

The SOFA Working Group experience, grounded in the objective data they have so carefully analyzed and interpreted, remains the best source of findings and recommendations available.

2.2.1 Conceptually Grouping SOFA Variables

The variables of the SOFA Matrix can be conceptually partitioned into groups. Grouping is helpful in selecting variables to understand the backward event chain and latent conditions involved in FE formation. Table 2-1 lists thirteen groups that were defined and each of the some 200 variables can be thought of as belonging to just one group. The groups, with some examples of variables contained, were:

Table 2-1. SOFA Categories for Grouping Variables.

	Group Name	Example
1.	Background Information	report number, date, and railroad
2.	Weather/Visibility	temperature, wind speed, and visibility
3.	FE Personal Data	date of birth, length of service, and time in occupation
4.	Work/Rest/Fatigue	time work began

Table 2-1. SOFA Categories for Grouping Variables. (cont.)

5.	Personal Issues	result of drug/alcohol testing
6.	Personal Protective Equipment	What clothing/footwear/personal equipment was involved?
7.	FEs Crew Information	Engine crew composition, number of crew members on ground
8.	Data on Other Involved Crews	If any: Was another crew involved?
9.	FE Activity at Time of Incident	FE physical act, FE event, FE location
10.	Site Information	Track type, if yard, hump or flat yard?
11.	Communications Issues	Type of signaling in use, were employees on the lookout for signals?
12.	Emergency Response Issues	Were railroad emergency response procedures followed?
13.	Possible Contributing Factors (PCFs)	Characteristics of worksheet, equipment failure

The full list of variable definitions and complete SOFA Matrix appears in the Appendix, Vol. II.

2.2.2 Coding Types for Variables of SOFA Matrix

Three types of coding were used by the Working Group to represent information in the SOFA Matrix. First, numeric values were coded for variables like *age*, *years of service*, and those representing time since the last safety and rules examination as well as *time*, *date*, *temperature*, and *equipment speed*. Geographic *location* was spelled out.

Second, discrete values, usually *Yes* or *No*, were used for interrogatives like "*Were hand signals being used?*" Many of these variables are blank because either the information did not apply to an FE; or, for reasons mentioned above, the information was not available. A few discrete values have multiple levels. Examples are *visibility* (cloudy, rain, fog, etc.), and *ground footing condition* (wet, frozen, snow, etc.).

A third type of coding, *Cause Codes*, pre-defined information for insertion in FRA-required, railroad incident forms. These Cause Codes were taken *verbatim* from the FRA Guide for Preparing Accident/Incident Reports (1997) and were used for Possible Contributing Factors (PCFs). The SOFA Group also created nine new cause codes specific to switching FEs. To note unusual circumstances, short verbal explanations and narrative comments about events, event sequencing, and latent conditions were occasionally used.

2.2.3 Possible Contributing Factors (PCFs)

For each FE case, the Working Group discussed whether to assign one or more *Cause Codes* to an FE. The cause codes assigned to each case represent the consensus of the group. The Working Group created nine new Cause Codes to capture specifics thought important in switching-related FEs. Examples of new codes are ones representing fouling track, intra-crew communication, close clearance, not providing adequate space between equipment, and insufficient training.

Seventy-one percent of the time, multiple Cause Codes were assigned to an FE. However, there was no implied ranking or importance by the order which these codes were assigned. In fact, to

avoid the implication that one cause code was more important than another, the Working Group replaced the term *Cause Code* with the term *Possible Contributing Factors*, or "PCFs". Thinking in terms of PCFs was an important step in gaining consensus. A full list of PCFs, both new and existing and the frequency of use, appears in the Appendix C.

2.3 Selectively Coding FEs before SOFA Period, 1975 through 1991

The Working Group identified additional information resources to help interpret the information in the SOFA Matrix. These resources include additional years of consistently defined switching FEs coded back to 1975 for eight selected variables. The eight variables were ones that did not require discussion by the SOFA Working Group, (*railroad*, *city*, *state*, *date*, *day-of-week*, *time-of-day*, *age*, and *length-of-service)*. Thus, for a question such as, "How has the number and monthly distribution of switching FEs changed over time?" it is possible to consider seventeen more years of data and 345 additional FEs. The extended time-series add support to some issues addressed in the six-and-one-half year period of the SOFA Matrix.

The SOFA Working Group established, by examining this historical data, that the 1983 to 1991 period was most like that of the January 1, 1992 to July 1, 1998 SOFA period. This can be seen in Figure 2-1 and is discussed further below. The pre-1983 period had higher yearly FE counts as shown in Figure 1-2. Forty-eight FEs occurred in 1977, the largest number of FEs for which data exists. Other years, 1975 to 1982, the count ranged from 35 FEs in 1976 to a low of 18 in 1981. It should be recognized that this data cannot be interpreted without adjustment for exposure.

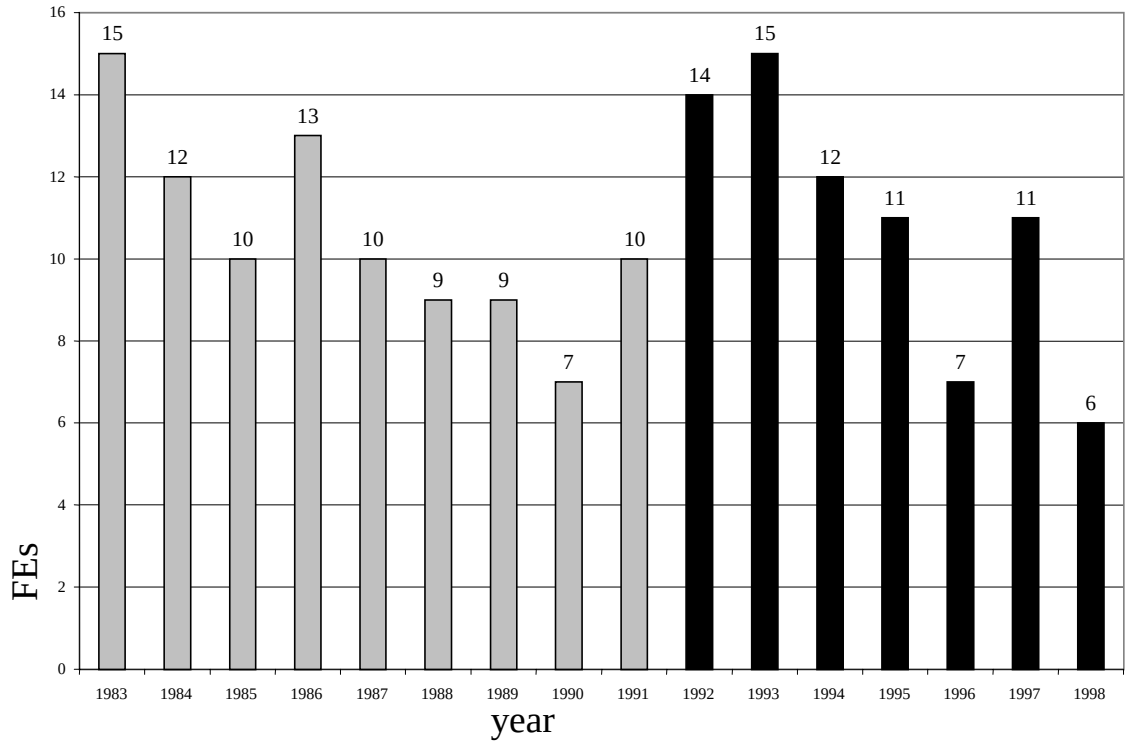


Figure 2-1. 1983 to 1992, Pre-SOFA Period; 1992 to July 1, 1998 SOFA Period.

2.4 Adjustment for Exposure

To make a realistic interpretation of the patterns in the data, appropriate measures of fatality exposure are needed. Fatality exposure is basically defined as measures of railroad activity such as distances moved, number of workers, and number of operations like switching. An increase in FEs from one period to another could simply reflect the fact that there were more people working in the yards in one period than in the other. Similarly, a decrease in the number of FEs from one period to the next could reflect a reduced number of total switching personnel employed during the second period. Consequently before we can state that safety in switching operations is improving because the total number of fatalities are down, we must be certain that the rate of fatalities are also decreasing. The rate can be determined by dividing the number of fatalities in a given period by the total number of switchmen employed during the same period. We refer to this normalization as correcting for exposure. One needs to be sure that what looks like meaningful variations are not simply the result of some baseline variation in activity level. The fatality measures should consistently represent the exposed risk to those railroad workers engaged in switching operations. Caution is advised in using unadjusted measures.

Normalizing the fatality data with the right measure can clarify our understanding of the potential risk of fatalities, while the wrong measure can distort our understanding of the risk of fatalities. The reality is that any exposure data can only approximately control for risk. However, it is important to find the best data available. The Working Group continues to seek better measures of exposure for each category of data. Below, the issue of exposure data is discussed further in regard to specific issues that the Working Group was interested in, where new measures have been identified, or where better measures would be helpful for interpretation are given.

2.5 Analyzing SOFA Matrix

2.5.1 Introductory Comments

For purposes of analyzing the data, the Working Group dealt with information in the SOFA Matrix at three levels of information completeness. That is, safety issues could or could not be addressed based on whether certain types information were or were not available. These three states were:

1. SOFA data was missing or incomplete because it was not available to the SOFA Group.

2. SOFA data was complete but supporting information, such as a specific exposure measure, was not available.

3. Finally, enough information existed so the SOFA Group could make a safety recommendation if it was appropriate to do so.

Some important issues related to the first two levels of data completeness are discussed next. Recommendations made from the third level of data completeness are presented in section 4.

2.5.2 SOFA Matrix Information Was Missing or Incomplete

Three issues – fatigue, communication, and crew size -- could not be fully considered because adequate information to code pertinent variables of the SOFA Matrix were unavailable.

The only data available to investigate the fatigue issue for the majority of the 76 FEs is the variable *time on duty before event* shown in Figure 2-2. Other fatigue-related variables exist in the SOFA Matrix: *time off before shift*, *FEs last tour*, *work/rest*, and *duty/30 days*. Unfortunately, this information was for the most part unavailable.

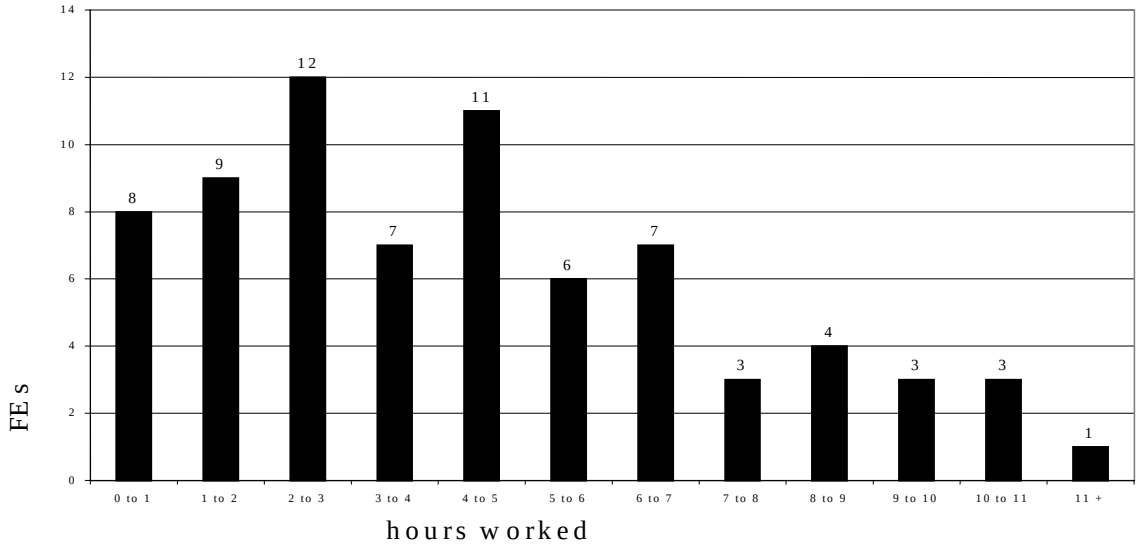


Figure 2-2. Distribution of time-on-duty before fatal event.

The Working Group recognizes more work/rest information is needed, perhaps as much as 30 days prior to the FE, and encourages incident investigators to capture more of this information.

The SOFA Working Group felt that communication, particularly intra-crew, was an important factor in many FEs. Although some 40 variables were created to define aspects of hand and radio communication and signaling among crews, the Working Group was able to code only two of those variables with any sense of completeness.

Figure 2-3 presents the data on crew size. Fifty-six (74%) of the 76 FEs had a crew size of three. Some members of the Working Group speculated that the reduction in crew size during the 1980s might have contributed to an increased FE rate. However, without baseline data on the distribution of crew sizes during the period for which these data are presented, it is not possible to draw a conclusion about the importance of crew size as a contributor to fatalities.

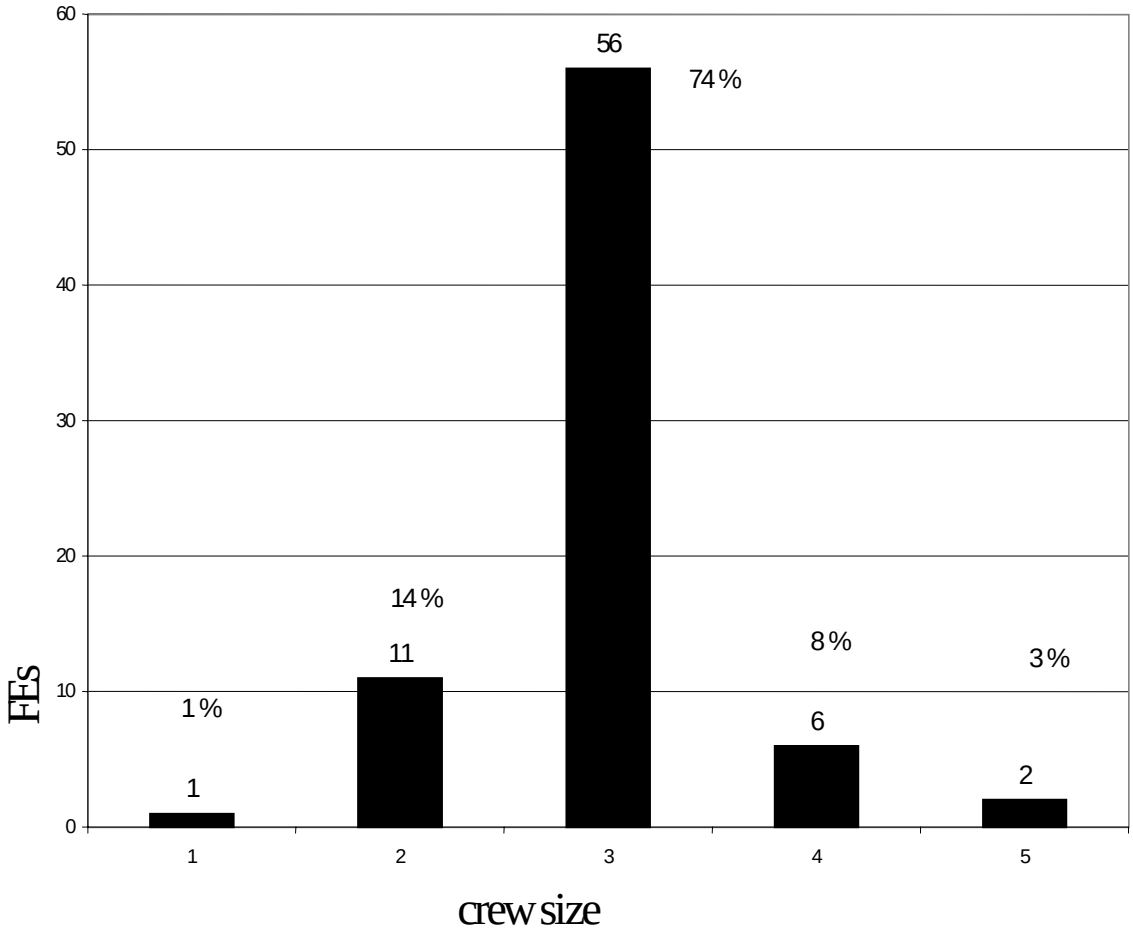


Figure 2-3. Distribution of crew size involved in 76 employee fatalities.

2.5.3 SOFA Matrix Information Was Complete, but Exposure Data was Unavailable

For some issues the SOFA Matrix contains relevant information, but without exposure data indicating the frequency of the activities, it is not possible to determine whether the variations shown reflect contributing factors to FEs or just variation in the underlying frequencies of these activities. There is a need for development of exposure measures to help with interpretation of the information contained throughout the SOFA Matrix.

(Note that for some of the issues in this section the FEs from the pre-SOFA period, defined as 1983 to 1991, are cited. For other issues, reference is made to FEs back to 1975. Depending on availability and relevance, varies time periods of SOFA FEs are presented.)

The following distribution exists for 76 FEs by State: 11, Texas; 6, California and Illinois; 5, Indiana and Kentucky; 4, Georgia and Nebraska; 3, Ohio; 10 states have 2 FEs; and 12 states have 1 FE as shown in Figure 2-4. Because exposure data was not available to properly normalize, the Working Group did not reach any conclusion about the geographic distribution of fatalities.

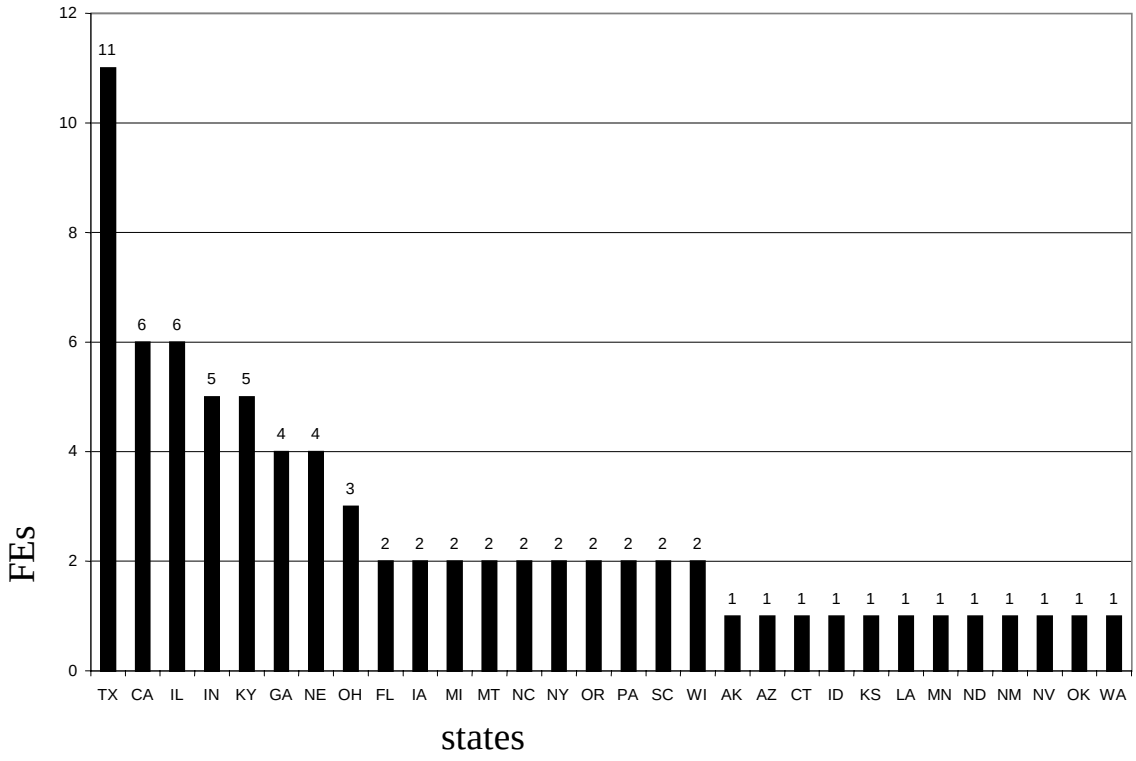


Figure 2-4. Employee fatalities by state not normalized by exposure.

Some exposure data (miles of road, number of railroad employees) for evaluating these differences were identified. However, it was too general to allow for comparisons among states.

Between 1992 and 1998, the average age of FEs ranged between a low of 38.1 and a high of 49.8. Variation exists over the years. For the SOFA, historically, the highest average age was 51.2 in 1981; and the low, 35.3 in 1979. There appears to be no discernible age-related trend among the workers killed in switching operations.

An important question that is difficult to answer is what the effect of exposure is on the age of the employees who died? Is the age of FEs significantly different from that of railroad workers equally exposed to switching operation risk? Baseline data for switching operations are needed. As might be expected, the distribution of length of service follows that of age. It is worth mentioning, however, that of the 76 FEs, 10 FEs (13%) had one year or less of service. Another FE had ten years of service prior to returning for less than a year. As well, one FE had 1.5 years of experience. (See Recommendation 5.) However, in the pre-SOFA period, 1983-91, there is no such cluster of FEs with one year or less of experience.

A number of time-related patterns appear in FE series and are discussed below. Probably the most important such pattern is the yearly incidence of FEs.

Viewed over a 15-year period of switching operations, FEs ranged from a low of 7 to a high of 15 a year, with no discernable trend in absolute values as shown in Figure 2-1. However, for the period from 1975 to 1982, yearly FE counts were higher, from a low of 18 to a high of 48.

The SOFA Working Group considered yard switching miles, staff-hours, and the number of switching-involved employees as candidate exposure measures. In the case of yard switching miles, it was found helpful in distinguishing the period of the mid-1970s from that of the more recent past. Switching miles has gone from over 200 million miles a year down to under 90 million miles between those two periods as shown in Table 2-2. However, changes in yard switching miles are too gross a measure to completely explain changes in FEs within a period such as from 1983 to 1997 where the yearly changes are small and at times in the opposite direction of changes in switching miles. And in that period, the pattern of change in switching miles in relation to the pattern of change in fatalities does not suggest that it is activity level alone that would account for the observed variation in number of fatalities.

Two more promising exposure measures have been identified by the SOFA Working Group. The average number of employees per month that are classified as "Transportation (Train & Engine)," and referred to as the '600 series' shows how this workforce has shrunk since the early 1980's. The Office of Economics, Environmental Analysis, and Administration of the Surface Transportation Board (STB) also makes available on a monthly basis the number of hours worked by these employees. Total hours can be calculated as straight plus overtime. Total hours would seem conceptually a better measure of exposure than the average number of employees. One drawback to these data is that it is only for the Class I railroads. About 70 percent of the total 76 FEs of the SOFA Period occurred, after accounting for mergers, on roads that are presently classified as Class I, as shown in Table 2-3.

Note: Only those railroads with over 400,000 man-hours worked per year are required to report man-hours. All railroads are required to report FEs.

Table 2-2. Employee fatalities and fatality rate by million yard switching miles, 1975 to 1997.

Year		FEs	yard switching miles	rate per million yard switching miles
		(1)	(2)	(1)/(2)
1998	(up to 7/1/98)	6		
1997		11	84,873,799	0.13
1996		7	87,823,254	0.08
1995		11	89,891,866	0.12
1994		12	89,776,044	0.13
1993		15	87,121,756	0.17
1992		14	84,429,603	0.17
1991		10	88,519,350	0.11
1990		7	98,151,387	0.07
1989		9	104,330,103	0.09
1988		9	105,325,469	0.09
1987		10	101,954,793	0.10
1986		13	108,257,858	0.12
1985		10	117,059,027	0.09
1984		12	126,465,254	0.09
1983		15	122,233,983	0.12
1982		24	133,423,632	0.18
1981		18	164,754,470	0.11
1980		33	182,340,123	0.18
1979		28	207,848,728	0.13
1978		35	214,497,878	0.16
1977		48	218,543,852	0.22
1976		30	217,363,453	0.14
1975		34	220,175,000	0.15
total		421	average	0.14

Table 2-3. Employment and Service Hours for Class I Railroads.

Year	Average Number of Employees during Year	Service Hours Paid	FEs
1994	62,473	190,031,440	12
1995	63,831	193,519,210	11
1996	63,230	187,689,409	7
1997	63,422	189,325,391	9
1998	65,988	202,204,015	6*

(* 1998 FEs through July 1. Employees and hours worked are for the full year.)

The monthly distribution of FEs over the SOFA Period is shown in Figure 2-5. Twelve FEs occurred during June and with 10 each for December and January. Low months were February, April, and August with four each; May and September each had three FEs. Exposure measures such as switching miles show only small monthly variations. The fact that this monthly distribution shows cyclical peaks in December-January and June-July suggests that there are critical periods during the winter and summer when FEs are more likely to happen.

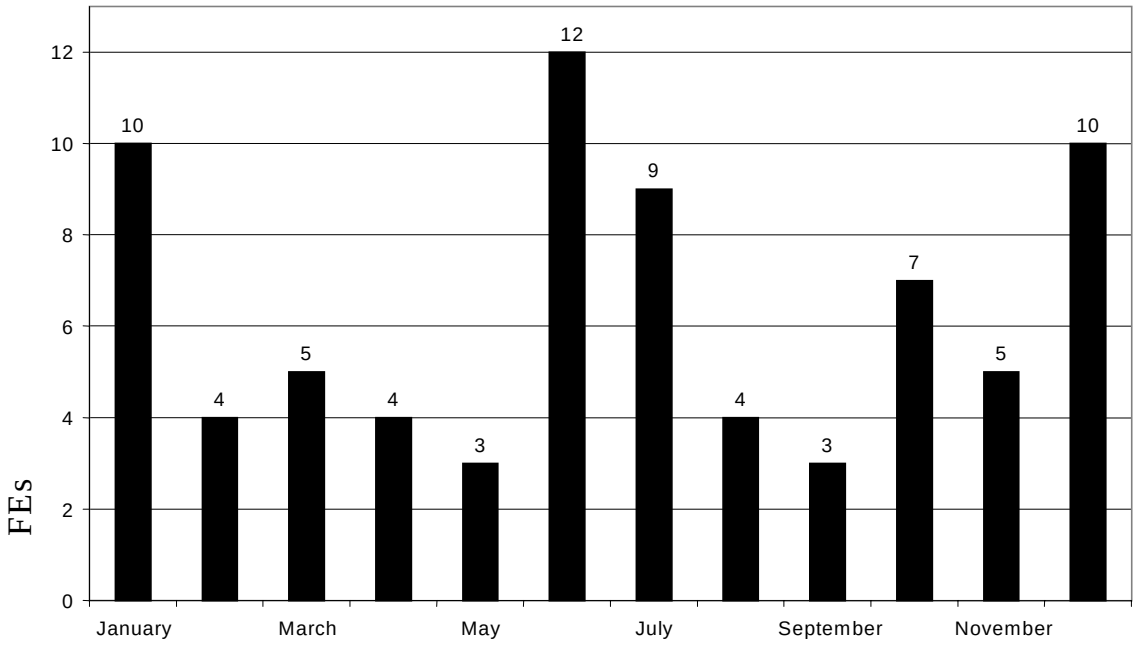


Figure 2-5. Distribution of FEs by month.

There is a distinct day-of-week pattern for the 76 FEs. Eighteen percent (24 FEs), occurred on Tuesday while only four FEs, (1.3) percent, occurred on Sundays. The day-of-week distribution is shown in Figure 2-6. The Working Group would like to be able to control for exposure in analyzing this daily pattern, but switching miles or number of personnel on duty are not maintained in a database in sufficient detail to reflect daily variation.

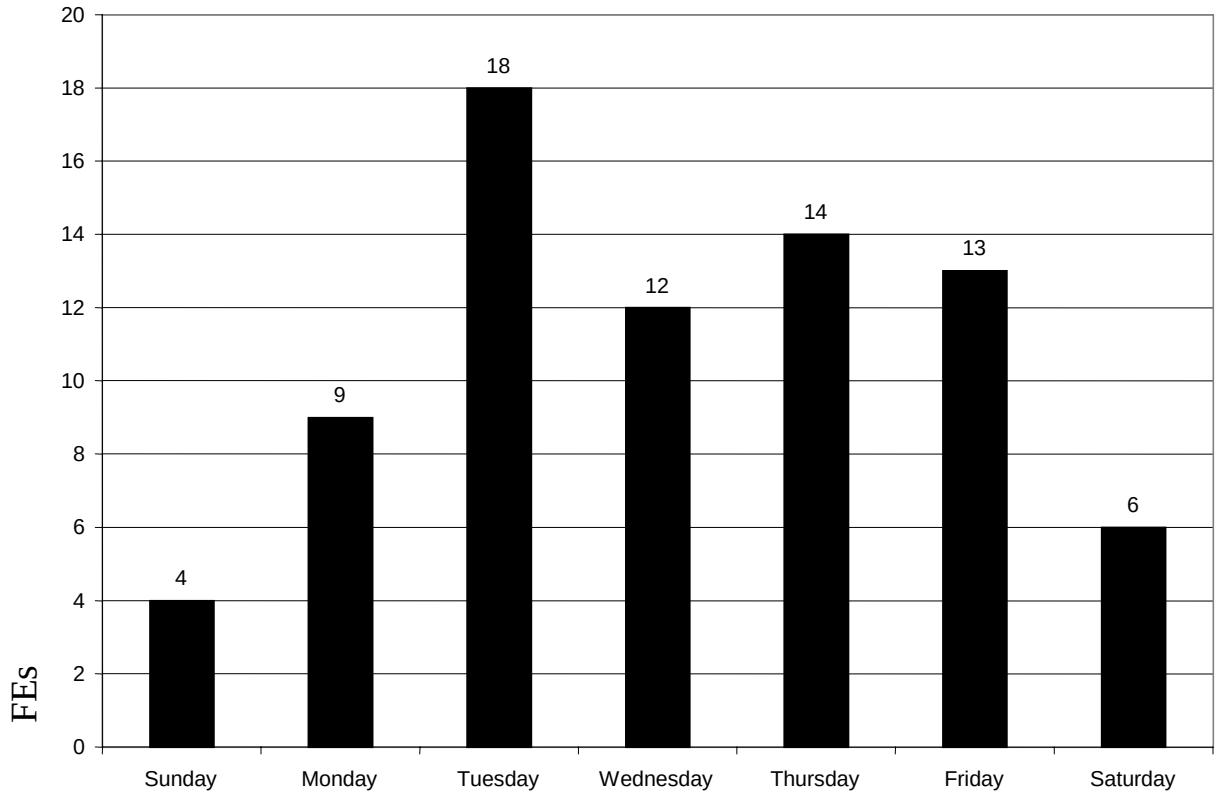
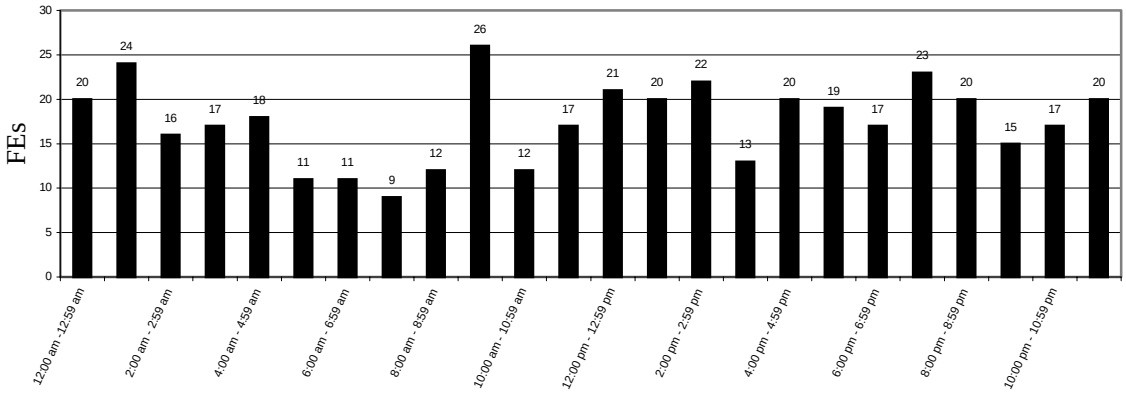


Figure 2-6. Distribution of FEs by day of week.

The distribution of FEs by time-of-day in hourly increments, January 1, 1975 to July 1,1998, is shown in Figure 2-7. Several hourly spikes during the day are shown here.

Perhaps of greater interest is the distribution by shift period. The SOFA Group looked at the number of FEs occurring during each of three work shifts as shown in Figure 2-8. Twenty-eight of the 76 FEs occurred during the first shift, from 8 a.m. to 4 p.m. The second shift, 4 p.m. to 12 a.m., also had 28 FEs. Third shift, 12 a.m. to 8 a.m. had the fewest FEs, 16.[1] Again, without exposure data to use as a control, we must be careful when interpreting these results since there may have been less switching activity during late night and early morning parts of shifts.

[1] Note: This distribution was found to be essentially unchanged back to 1975.



Note: Exposure is not necessarily equal by hour of day.

Figure 2-7. Distribution of FEs by time of day, January 1, 1975 to July 1, 1998.

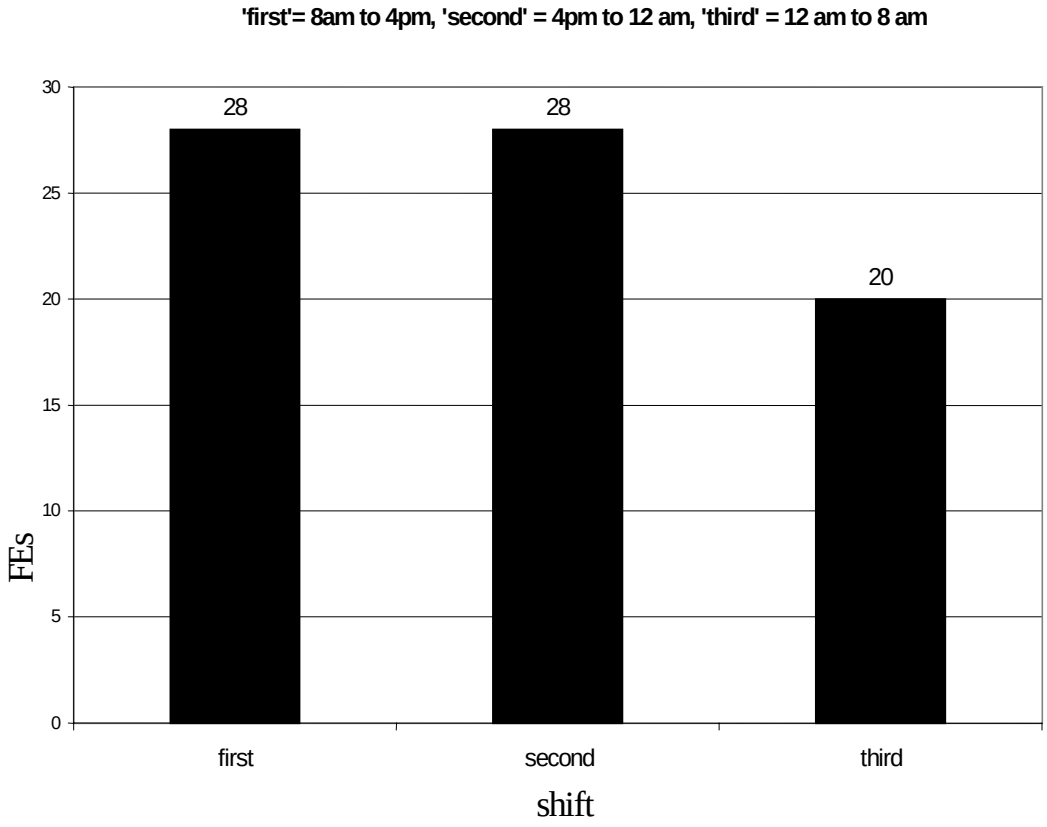


Figure 2-8. Distribution of employee fatalities by work shift.

2.5.4 Classifying FEs by Train movement, Equipment Struck by, etc.

The 76 FEs contained in the SOFA Matrix were analyzed by a number of variables thought important in understanding the FE causation as indicated in Figure 2-9. These variables include train movement, FE location (on ground or on equipment before trauma producing event), whether striking equipment belonged to FE's crew or another crew, and the direction of movement as being pulled, shoved or free moving or combinations thereof. In two cases, direction of movement was not coded.

- Seventy FEs, 92 percent, involved train movement; thus, 6 FEs did not.
- Of those 70 FEs, 38 FEs, or 54 percent, were on the ground before the harmful event; 32 FEs, or 46 percent, were riding on equipment.
- Of those on the ground before trauma-causing event, 26 FEs, or 68 percent, were hit by their own equipment; 12 FEs, 32 percent, were hit by another crew's equipment.
- Of those riding on equipment before trauma-causing event, 25 FEs, or 78 percent, were hit by their own equipment; 7 FEs were struck by another crew's equipment.

Figure 2-9 shows the direction of movement for the third level of decomposition of the total 76 FEs. Note that shoving alone occurs in 33, or 47 percent, of the 70 FEs involving train movement. Free movement alone occurs in 14 FEs, or 20 percent, of the 70 FEs involving train movement. Three FEs involve some combination of shoving and free movement. Thus, together shoving and free movement is the direction of movement in 50 FEs, some 71 percent.

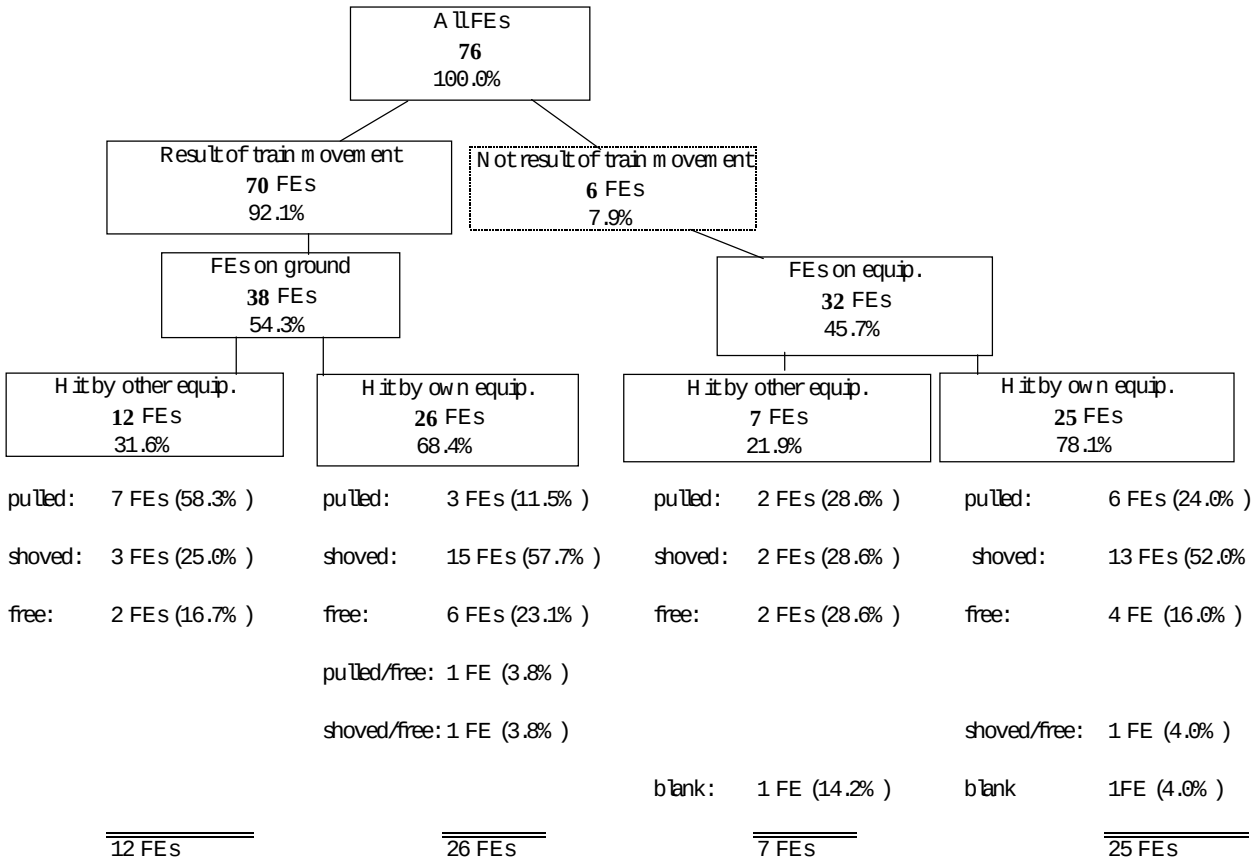


Figure 2-9. Decomposition of Employee Fatalities: train movement, location, hit by own equipment or not, and direction of movement.

2.6 Discussion

Difficult as it may be to adjust the yearly FEs by the proper exposure measure, it appears that even if such were possible yearly FEs still would be shown not to be going down. From 1983 to 1997, yearly FEs have varied between 7 and 15, a 15-year average slightly above 11 per year. Without implementing more effective safety procedures that strike at the heart of FE causation, it is unlikely that this average will change much in of itself.

In the following section, methods are presented by which the SOFA Working Group rigorously went about discovering FE causation.

3. HUMAN FACTORS TASKS

3.1 Human Factor Tasks

The human factors team had the SOFA Group perform a number of tasks in order to take advantage of their expertise and detailed knowledge developed from investigation of the 68 FEs. (Note the original SOFA Matrix contained 68 FEs. Eight more were added after these tasks were completed.)

The purpose of these tasks was to help them step back from the details of the SOFA Matrix and explore incident causation from the perspective of potential actions that could be taken by the railroad community to prevent such incidents in the future and to improve the incidents analysis and reporting methodology. The tasks consisted of the following:

- reaching consensus as a group on ten general categories of incident causation that might provide insight into potential safety improvements together with detailed definitions of the categories;
- rating the importance of each of the causation categories as a contributor to each incident;
- sorting each incident into categories chosen by the individual sorter and assigning a description to the resulting categories; and
- rating the similarity among all possible pairs of the causation categories in order to evaluate the potential relatedness of the categories.

In this section we describe these tasks in detail and the results.

3.2 Category Definition Task

3.2.1 Method

Starting from information about possible contributing factors derived from the SOFA Matrix, the group reached a consensus on a set of ten broad PCFs of FEs in switching operations though extensive discussion, leading to drafting and redrafting of the definitions for these categories. The group was encouraged to consider categories for which recommendations for actions that could be taken to improve the safety of switching operations might result. The discussion process took about 3 hours. Then, a preliminary draft was prepared. Each definition was then reviewed and modified to produce a version that was deemed acceptable to the Working Group. For this activity, eight SOFA Working Group members participated.

3.2.2 Results

The resulting categories and their definitions are given in Table 3-1.

Table 3-1. Railroad Switching Operations Cause Categories.

1) Physical Characteristics of Rolling Stock

a) Definition: Configuration of physical characteristics of engine, rolling stock, or other on-track equipment.

b) examples: flat car (mounting or dismounting), offset grab irons

c) cause codes:

2) Work Site Configuration

a) Definition: Physical characteristics, layout, or configuration of any location at which a train or engine crew is expected to perform switching operations.

b) Examples: yard tracks, sidings, main tracks, industry track work.

c) Cause codes: M102, M404, M411.

3) Operating or Safety Rule Integral to Incident

a) Definition: Possible operating rules or safety infractions that could contribute to an incident.

b) examples: Person absent from leading car, speed violations, individual fouling track or equipment.

c) cause codes: H990

4) Crew Utilization

a) Definition: Assigned crew members that did not or could not fulfill roles required for safe operations.

b) examples: inexperienced crew members not properly supervised

c) cause codes: H316, H305

5) Inter-crew Communication

a) Definition: Absence or improper exchange of information between crews whose work needed to be coordinated.

b) Examples: Two crews working on same track with no communications.

c) Cause codes: H399

6) Intra-crew Communication

a) Definition: Failure of proper operation which could be due to absence of, or improper exchange of information among crew members by face-to-face, radio, or hand signals.

b) Examples: lack of, or no job briefing; changing work activities without informing other crew members.

c) Cause codes:

7) Fitness for Duty

a) Definition: Personal factors related to train and switching operations such as drugs, alcohol or employee physical or mental condition.

b) Examples: impairment of efficiency or judgement because of drugs or alcohol (H101); employee physical condition, other (H199); other personal factors or limitations relating to physical or mental impairment

c) Cause codes: H199, H101

Table 3-1. Railroad Switching Operations Cause Categories. (cont.)

8) Sudden or Unexpected Movement of On-track Equipment

a) Definition: Unexpected movement of on-track engine, rolling stock, or other off-track equipment that affects safety of a crew member.

b) examples: free rolling cars, dropping cars on track being coupled, getting struck by truck.

c) cause codes:

9) Training

a) Definition: Failure of proper operations attributed to inadequate classroom, on-the-job general skills, or site-specific training or knowledge.

b) Examples: inadequate classroom training; inexperience in on-the-job skills; inexperience in physical characteristics of track or work site.

c) cause codes:

10) Track or Equipment Maintenance

a) Definition: Physical condition of track or equipment was below established practices.

b) Examples: sharp/worn flanges, worn switch points, crossover platforms bent, etc.

c) Cause codes: E02C, E09C

3.3 Rating Task

3.3.1 Method

SOFA Team members were asked to rate the relative importance of each of the ten categories described in Table 3-1 as contributors to each of the FEs they had reviewed. The rating was accomplished on a five-point scale from extremely important to not relevant. The full rating scale is illustrated below.

Extremely Important	Very Important	Moderately Important	Applicable, but neither important nor unimportant	Not Relevant
1	2	3	4	5

They were encouraged to refer to the incident summaries if they could not remember the circumstances of a particular incident. Seven SOFA team members participated in this activity.

3.3.2 Results

The results of this task are presented in three ways. First we present Figure 3-1, in which a bar shows the rating, averaged over all seven team members who completed the task, assigned to each of the ten categories. Each bar reflects the number of FEs for whom the mean rating was extremely, very or moderately important. The columns are ordered from "Operating or Safety Rule Integral to Incident," which was rated important most often to "Physical Characteristics of the Rolling Stock," which was rated important least often.

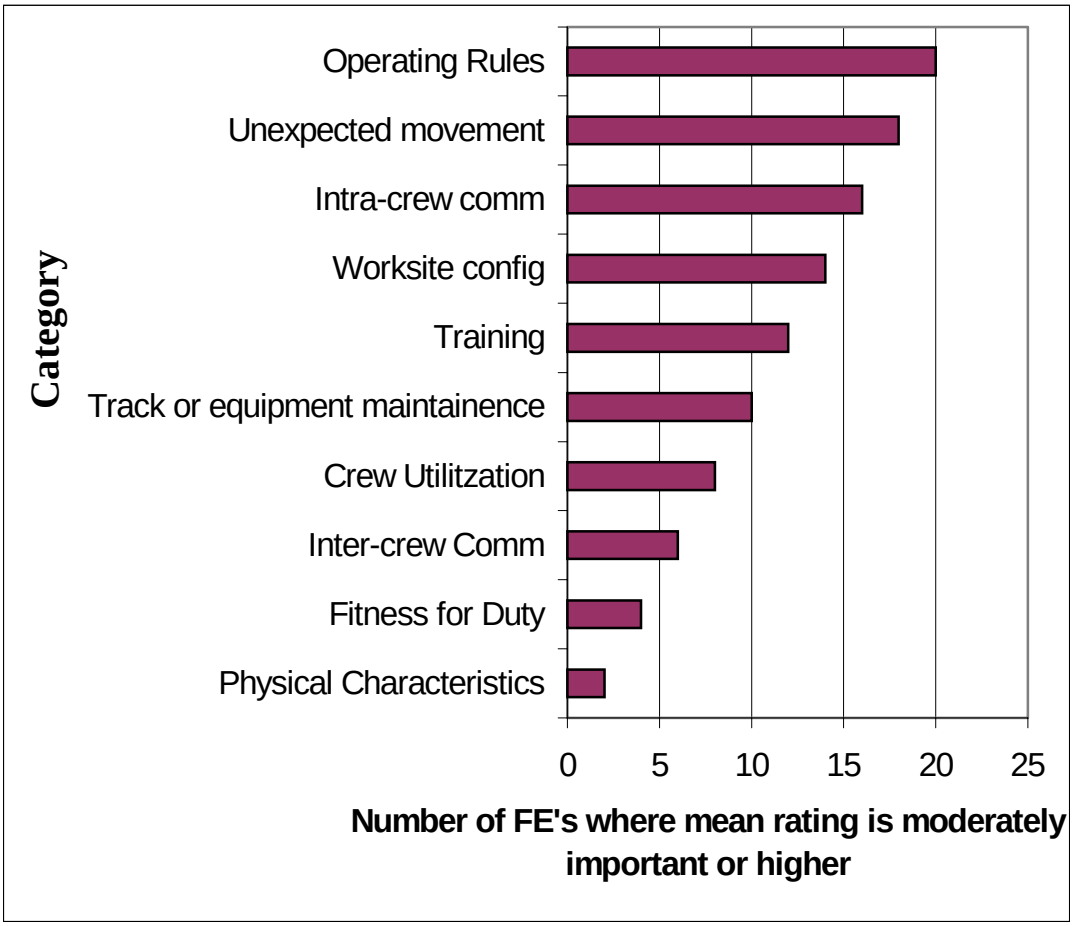


Figure 3-1. The summary ratings of eight SOFA Members of the number of fatalities (FEs) for whom each contributing cause category was rated as extremely, very or moderately important.

Tables 3-2, 3-3, and 3-4 present the same data in a different way. In these tables each row represents a specific employee fatality and each column again represents one of the ten categories. There is a 1 in the column if that category was rated 3 or below for that specific employee fatality and is blank if it was rated above 3, meaning Moderately Important. Thus, there are 1's everywhere that a particular category was rated Moderately Important, Very Important or Extremely Important for any employee fatality.

The rows have been sorted to show how many categories were rated as important for each particular employee fatality according to this definition. Table 3-2 presents the employee fatality for which four or more categories were considered important. There is one for which there were five categories and five employee fatality for which four categories were rated as important. Table 3-3 shows the 24 cases for which three categories were deemed important. Table 3-4 presents the same results for the cases where two categories were rated important.

Table 3.2. FEs having 4 or more categories rated as important. A one (1) in the column indicates a rating of 3 or lower – moderately important.

	Rule	Unexp Mvmt	Train	Intra crew	Inter Crew	Crew Util	Roll Stock	Work Site	Fitness	Maint	# > 3
FE-28-94	1		1	1		1		1			5
FE-30-92	1	1			1	1					4
FE-31-93	1	1	1		1						4
FE-31-94	1		1	1		1					4
FE-35-93	1	1	1	1							4
FE-09-96	1	1	1			1					4

Table 3-3. FEs having 3 cause categories rated as important. A one (1) in column indicates a rating of 3 or lower – moderately important.

	Rule	Unexp Mvmt	Train	Intra crew	Inter Crew	Crew Util	Roll Stock	Work Site	Fitness	Maint	# = 3
FE-12-95	1	1		1							3
FE-23-93	1	1		1							3
FE-2693	1	1		1							3
FE-26-94	1	1		1							3
FE-02-94	1	1		1							3
FE-29-94	1	1		1							3
FE-03-92	1	1		1							3
FE-45-97	1	1		1							3
FE-47-93	1	1		1							3
FE-11-95	1	1			1						3
FE-22-92	1	1						1			3
FE-24-96	1	1								1	3
FE-02-97	1	1	1								3
FE-29-95	1	1	1								3
FE-31-96	1	1								1	3
FE-46-93	1	1							1		3
FE-05-97	1	1			1						3
FE-16-97	1			1						1	3
FE-04-92	1		1	1							3

Table 3.3. FEs having 3 cause categories rated as important. A one (1) in column indicates a rating of 3 or lower – moderately important. (cont.)

FE-22-96	1		1							1	3
FE-32-97	1		1							1	3
FE-40-93	1		1			1					3
FE-49-93	1				1			1			3
FE-53-93	1							1		1	3

Table 3-4. FEs having 2 cause categories rated as important. A one (1) in the column indicates a rating of 3 or lower – moderately important.

	Rule	Unexp Mvmt	Train	Intra crew	Inter Crew	Crew Util	Roll Stock	Work Site	Fitness	Maint	# = 2
FE-20-93		1						1			2
FE-13-93	1	1									2
FE-15-92	1	1									2
FE-16-92	1	1									2
FE-16-95	1	1									2
FE-18-92	1	1									2
FE-18-95	1	1									2
FE-20-92	1	1									2
FE-22-97	1	1									2
FE-32-94	1	1									2
FE-36-97	1	1									2
FE-04-94	1	1									2
FE-12-94	1							1			2
FE-12-96	1							1			2
FE-33-95	1							1			2
FE-34-95	1							1			2
FE-39-92	1							1			2
FE-06-94	1							1			2
FE-27-93								1		1	2
FE-08-92								1		1	2
FE-11-93	1			1							2
FE-14-92	1			1							2
FE-30-93	1			1							2

Table 3-4. FEs having 2 cause categories rated as important. A one (1) in the column indicates a rating of 3 or lower – moderately important. (cont.)											
FE-04-97	1			1							2
FE-09-95	1			1							2
FE-16-94	1					1					2
FE-17-95	1								1		2
FE-17-96	1								1		2
FE-02-95	1									1	2
FE-34-92	1					1					2
FE-22-93							1			1	2
FE-03-94							1			1	2

3.3.3 Conclusions

Most incidents do not happen because of a single cause. They are the result of the convergence of a series of contributing factors. The absence of any one of which might have prevented it. Tables 3-2, 3-3, 3-4 show how incident causes happen to cluster in contributing to these fatalities. Operating Rules were most frequently cited in connection with other categories. Training, Crew Communication and Crew Utilization were also frequently cited together. Training and Maintenance also occurred together frequently, as did intra-crew communication and unexpected movement. This latter pair makes sense because expectations are created by communication and an unexpected movement is likely to result from a failure of that communication.

3.4 Sorting Task

3.4.1 Method

Eight members of the SOFA Team were each given a stack of cards having the code numbers and a brief description of the circumstances of each fatality that had been evaluated. They were asked to sort the fatalities into approximately ten piles, placing fatalities that they thought had similar contributing causes in the same pile. The instructions were: “In thinking about what piles to put them in, be thinking about the pattern of circumstances and actions that together might be associated with the reason that they happened. We are interested in causes that go deeper than simply that an FE fell off the car or lost his balance.” They could put as many or as few cases in each pile as they wished. They were encouraged to refer to the fatality summaries to refresh their memories if they were uncertain about what happened in particular cases. They were encouraged to include one pile that was for cases that were unique or so unusual that they would not be likely to be associated with any other case and they were told to put cases that they had not personally participated in the review in a separate pile. After they had sorted the cards, they were asked to provide a name and a brief definition of each category and to provide one example incident that was especially representative of that category. Finally they were asked for causation codes used in the Matrix that would be associated with that category.

3.4.2 Results

The results of the sorting are shown in Table 3-5 where the rows correspond to the FEs. The first column lists the number of the FE by Code Number. Each of the remaining columns present the names of the categories into which each of the eight team members sorted each incident. All the category names in a given column were provided by a single member of the SOFA team. The rows have been sorted to bring together FEs that were judged to be placed into similar categories by three or more team members.

Only those cases for which there was a consensus among the sorters about how to classify a particular incident are included. There are five such groups. The first puts the cases for which there was agreement about communications failures together. The second grouping is for cases for which there was reasonable consensus that the problem was inattentiveness or lack of situation awareness. There were two FEs for which there was reasonable consensus that the issue was “unsecured equipment.” Finally, there was one FE (40-93) for which there was reasonable agreement that lack of understanding of the situation or lack of experience was the issue and one FE (16-92) for which fouling track was judged to be the major issue.

Table 3-5. Factors Contributing to Switching Fatalities Grouped by Primary Causal Factor as Identified by SOFA Group. (cont.)

	Team Member							
FE #	1	2	3	4	5	6	7	8
	Communication Breakdown							
04-97	Inattentiveness	Communications breakdown	Communication	Fouling equipment	Human factors - Communication	'radio rules not obeyed'	Communication	Moving equipment
11-95	Communication failure	Communications breakdown	Communication	Multiple jobs working	Human factors - Communication	'fouling track'	Communication	Moving equipment
14-92	Communication failure	Communications breakdown	Communication	#N/A	Human factors - Communication	'radio rules not obeyed'	#N/A	On/off equipment
16-97	Inattentiveness	Communications breakdown	Communication	Fouling equipment	Human factors - Communication	'radio rules not obeyed'	Communication	External events
29-94	Communication failure	Communications breakdown	Communication	Fouling equipment	Not applicable	'clearance'	#N/A	Unsecured cars
45-97	Communication failure	Communications breakdown	Communication	Fouling equipment	Human factors - Fouling track	'radio rules not obeyed'	Clear moving equip.	Operating practice
47-93	'Confusion…'	Communications breakdown	Communication	Fouling equipment	Not applicable	'fouling track'	Communication	Unsecured cars
	Inattention or Lack of Situation Awareness							
13-93	Inattentiveness	Not paying attention to other trains	Hit by passing train	Situational awareness	Human factors - Fouling track	“Hot Rail”	Clear moving equip.	Clear mainline
17-96	Inattentiveness	Not paying attention to other trains	Hit by passing train	Situational awareness	Human factors - Fouling track	“Hot Rail”	Clear moving equip.	Clear mainline
22-97	Inattentiveness	Not paying attention to other trains	Hit by passing train	Fouling equipment	Human factors - Fouling track	Distraction/ inattention	Clear moving equip.	Clear mainline

Table 3-5. Factors Contributing to Switching Fatalities Grouped by Primary Causal Factor as Identified by SOFA Group. (cont.)

	Team Member							
FE #	1	2	3	4	5	6	7	8
31-97	Inattentiveness	Not paying attention to other trains	Hit by passing train	Situational awareness	Human factors - Communication	"Fouling track"	Clear moving equip.	Clear mainline
20-92	Inattentiveness	Not paying attention to other trains	Unsafe area or time for rail operations	Situational awareness	Human factors - Fouling track	"Hot Rail"	Clear moving equip.	Clear mainline
	Unsecured Equipment							
18-92	Unsafe action	Bad practices	Failure to secure	Fouling equipment	Human factors - Fouling track	"Clearance"	Equipment not secured	Unsecured cars
22-96	Gross misjudgment	Bad practices	Failure to secure	Fouling equipment	Human factors - Misc.	"Poor switching"	Equipment not secured	Unsecured cars
	Understanding or Experience							
40-93	Lack of experience	Too little understanding	Experience	Fouling equipment	Human factors - Misc.	"Inattentiveness"	Derailment	On/off equipment
	Fouled Track							
16-92	Communication failure	Bad practices	Failure to secure	Fouling equipment	Human factors - Fouling track	"Fouling track"	Clear moving equip.	Moving equipment

3.4.3 Conclusions

Different team members interpreted incident causes at different levels of abstraction. Some thought of them most often at the level of "fouling track" or "clearance" problems. Others stepped away from that level and thought about why they were fouling the track or failed to provide enough clearance. However there was a strong consensus that for seven of the FEs, communications breakdowns played an important role in the occurrence of the fatality. For another five of the FEs there was consensus that inattentiveness or a failure of situation awareness was a key contributing cause. There were two FEs (18-92, 22-96) for which "unsecured equipment" appeared to be a major contributing cause. Finally, there was one FE (40-93) for which there was reasonable agreement that lack of understanding of the situation or lack of experience was the major cause and one FE (16-92) for which fouling track was judged to be the major contributing cause.

3.5 Paired Comparison Task

3.5.1 Method

Eight participants were presented with a list of all possible pairs of the ten categories as defined in Table 3-1. For example, Physical Characteristics of the Rolling Stock was paired with Worksite Configuration and then separately with each of the other categories. There are 45 such pairs made up from the original ten categories. For each pair a similarity rating scale was provided with ratings from 1 = Not At All Similar to 5 = Very Similar. The participants were asked to rate the extent to which each pair of categories were similar to each other or associated with each other in the sense that they might both be considered important for the same FE. They were to rate the pair with a 1 if they thought they were not at all similar and with a 5 if they thought they were very similar.

3.5.2 Results

The pair comparison averages are not of great interest in and of themselves, but they were subjected to a multidimensional scaling (MDS) analysis to see if dimensions would be uncovered that would provide a perspective on the ways in which the various categories were interrelated. Multidimensional scaling is a statistical technique that tries to fit all the pair ratings into a coherent dimensional structure. Sometimes the dimensions that are derived in this way will help the investigators to gain insight into the underlying mechanisms associated with the comparisons under study. It should be emphasized that there is no right versus wrong implied by this kind of analysis. It simply reflects the distillation of the collective opinions of the Working Group participants about cause category interrelationships.

The analysis identified three dimensions, which are presented in Figures 3-2, 3-3, and 3-4. In Figure 3-2 we find that categories that are mostly associated with people tend to be grouped on the left while maintenance, rolling stock and to a lesser extent worksite are on the right end of the scale. This suggests that one dimension—the incident cause categories—might distinguish between people-related categories from equipment-related categories. In Figure 3-2 the distinctions are not as clear, but the categories that are grouped near the right end tend to be group activities like Inter-crew Communication and Crew Utilization, while Duty Fitness, clearly an individual issue is at the extreme other end. Thus, a second dimension of the incident cause

categories might distinguish individual from group activities. Finally, in Figure 3-4, Unexpected Moves and Rolling Stock are at one end and Worksite is the most extreme in the opposite direction. Maintenance is also near the right end of the scale. We are suggesting that this dimension might reflect a dimension of cause categories involving movement versus those that are static.

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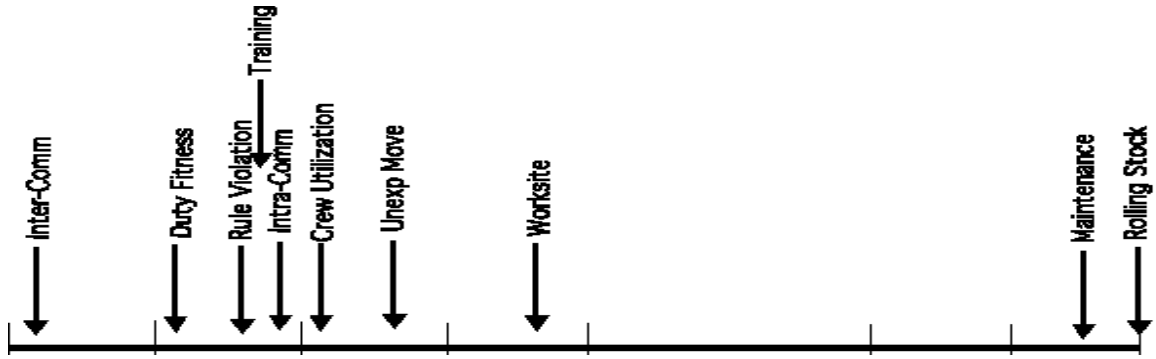


Figure 3-2. MDS Scale illustrating the dimension: People vs. Equipment.

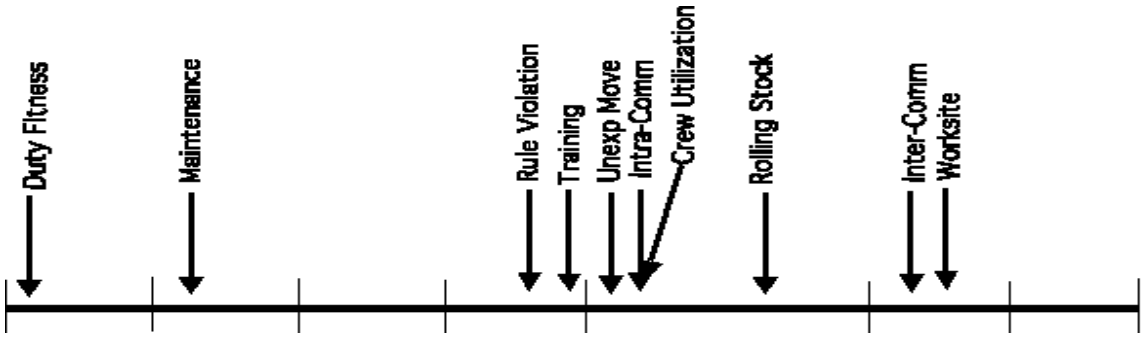


Figure 3-3. MDS Scale illustrating the dimension: Individual vs. Group.

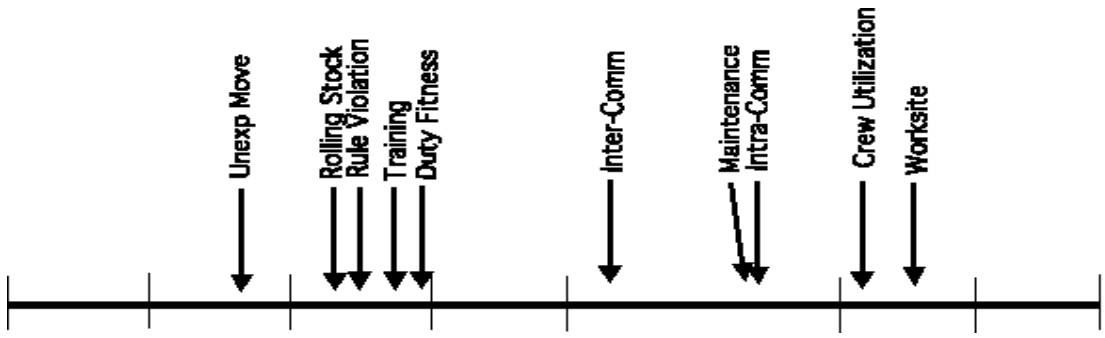


Figure 3-4. MDS Scale illustrating the dimension: Movement vs. Static.

3.5.3 Conclusions

This analysis cannot explain the position of every category on every scale, and while not to be taken too literally, suggests that there might be three very general dimensions that can be used to classify the types of FEs that occur. When taken together with the results of the SOFA Matrix analysis when looking for ways to improve safety, the industry might consider alternatives that focus on equipment movement where group-related issues such as crew communication and utilization have the potential to create incident-provocative situations.

3.6 General Discussion

The goal of the human factors tasks was to seek consensus among the members of the SOFA Working Group concerning the major issues that need to be addressed in order to reduce the frequency of FEs in switching operations. That goal was approached from several different perspectives. First the Working Group defined major causal contributors to FEs and rated their relative importance. An operating rule was judged to be integral to the incident in all but eight cases. Next, most important was Unexpected Movement and then Intra-crew Communication. In ten of the FEs, Unexpected Movement and Intra-crew Communication were identified as both being important.

When the Task Force members were asked to sort the FEs into meaningful categories, seven of the FEs were uniformly sorted into a category that involved communications breakdowns. There was agreement for another five that they predominately involved not paying attention.

Recall that 92 percent of FEs involved movement. It is not surprising, then, that unexpected movement and not paying attention were so important. If the movement had been expected it would not usually result in a fatality. Some of these were the result of derailments or other situations that could not have been anticipated, but many were not. Similarly, it is predictable that many of the unexpected movement cases also involve communication issues, because the best way to prevent a movement from being unexpected is to make sure that all crew members positions are well known and at a safe distance from potential hazards before a movement is initiated. Accomplishing these goals requires effective and timely communication.

The similarity analyses resulted in three scales that were labeled people vs. equipment' individual vs. group and movement vs. static. While far from definitive by themselves, these results lend further support to the association of equipment movement with the need for improved crew communication and utilization.

Intra-crew Communication does not only apply to the situation awareness of crew status, but also to effective job safety briefings that contribute to the teamwork that produces well-coordinated crews who understand the moves to be made. In subsequent reviews, six FEs were identified for which job safety briefings were called into question. Four of these FEs were the same ones that were identified as involving both intra-crew communication issues and unexpected movement.

4. RECOMMENDATIONS

4.1 Recommendations to Improve Safety

In this section we present the recommendations of the SOFA Working Group to improve safety in switching operations. We introduce each recommendation with a finding that indicates the conclusions of the Working Group concerning a specific set of fatalities and with a list of the specific FEs to which this finding applies. Then we present the specific recommendation and this is followed by a brief discussion of the context and rationale for the recommendation.

Each recommendation addresses what the Working Group believes is a specific contributing factor or class of contributing factors that played a role in the FEs listed. However, it should be emphasized that the Working Group does not believe that this was necessarily the only factor in each of these FEs. In fact, thirteen of the FEs are cited in more than one of the five recommendations. It has been widely observed that FEs leading to death or injury in any venue rarely are the result of a single contributing factor. More often FEs occur because of the coming together of a series of circumstances and contexts. The avoidance of any one such contributor might have prevented the incident from happening or from causing injury, death or property loss.

Note: The following recommendations are not presented in any order of priority.

Major Finding and Recommendation 1

4.1.1 Major Finding 1

Eleven of the seventy-six FEs occurred while the employee was adjusting knuckles, adjusting drawbars, or installing an end-of-train device. Table 4-1 summarizes those eleven fatalities.

Table 4-1. FEs for Adjusting Knuckles, Drawbars, or Installing EOT Device.

FE #	DATE	RAILROAD	LOCATION
18-92	06/20/92	CNW	Northlake, IL
26-94	10/17/94	UP	Donaldsville, LA
32-94	12/13/94	UP	Thorton, CA
11-95	02/24/95	ATSF	Amarillo, TX
12-95	03/02/95	NS	Aiken, SC
29-95	10/04/95	CSXT	Riverdale, IL
09-96	03/20/96	BRC	Bedford, IL
24-96	10/07/96	UP	Eagle Pass, TX
25-97	08/15/97	UP	Elko, NV
15-98	05/26/98	BRC	Bedford Park, IL
17-98	06/05/98	NS	Hapeville, GA

4.1.2 Description of FEs for Major Finding 1

FE-18-92: Crew was in the process of coupling cars together in a class track. Standing equipment was not properly secured before conductor fouled the track to adjust couplers and the equipment rolled back in and coupled him up.

FE-26-94: Crew switching in class yard, brakeman attempted to cross between equipment separated by an insufficient distance, and engineer moved locomotive in the wrong direction, coupling him up.

FE-32-94: Crew coupling up cars in an industry track, brakeman attempted to couple air between cars when unexpected movement of railcars occurred resulting in his fatal injury.

FE-11-95: Two crews working in the same yard from opposite ends, one crew dropped ten free rolling cars in on top of the cut where the other crew's foreman was installing the

E.O.T. at the opposite end. Cars impacted with sufficient force to knock down and run over the foreman.

FE-12-95: Switch crew was pulling a cut of cars out of an industry. Brakeman stepped in track gauge to open knuckle on the rear car at the same time crew shoved back to kick two cars which ran over the brakeman.

FE-29-95: Crew performing switching in class yard. Switch foreman placed himself between the rails to adjust a mis-aligned couple on the fifteenth car after the cut was stretched. Switch foreman was facing the coupler with his back to a cut of seven cars which rolled in on top of him and coupled him up.

FE-09-96: Three-person crew was switching in class yard, coupling between sixth and seventh car failed to couple. Conductor stopped locomotive and went between the cars to straighten the drawbar, and twenty-three cars rolled in behind him and coupled him up.

FE-24-96: Three-person crew was switching in class yard, locomotive failed to couple to cut of seven standing cars. Yard foreman used hand signals to separate the locomotive by twenty feet. While adjusting the locomotive drawbar, the seven cars rolled in and coupled him up.

FE-25-97: Crew was switching in class yard, helper was attempting to adjust the drawbar in order to couple to three cars about forty feet away that had not coupled the first time. While adjusting the drawbar, the helper did not notice the three free-rolling cars coming back in on him and the cars coupled him up.

FE-15-98: Crew was working in one track in class yard with helper controlling engine moves, conductor was adjusting coupler when three free rolling cars struck him from behind and coupled him up.

FE-17-98: Three-person crew was performing industrial switching using a runaround track, the yard foreman was attempting to couple up two super-cushion box cars in a curve with power attached in a shove movement. Drawbars bypassed and yard foreman was crushed between the ends of the two cars.

4.1.3 Recommendation 1

Any crew member intending to foul track or equipment must notify the locomotive engineer before such action can take place. The locomotive engineer must then apply locomotive or train brakes, have the reverser centered, and then confirm this action with the individual on the ground. Additionally, any crew member that intends to adjust knuckles/drawbars, or apply or remove EOT device, must insure that the cut of cars to be coupled into is separated by no less than 50 feet. Also, the person on the ground must physically inspect the cut of cars not attached to the locomotive to insure that they are completely stopped and, if necessary, a sufficient number of hand brakes must be applied to insure the cut of cars will not move.

4.1.4 Discussion

This recommendation emphasizes the importance of securing the equipment. A thorough understanding by all crew members that the area between cars is a hazardous location, whether equipment is moving or standing, is imperative.

Major Finding and Recommendation 2

4.1.5 Major Finding 2

Twenty of seventy-six FEs were struck by equipment other than their own. Of those twenty FEs, nine occurred in yard or industry tracks. Table 4-2 summarizes those nine fatalities.

Table 4-2. FEs Struck by Other Than Own Equipment.

FE #	DATE	RAILROAD	LOCATION
30-92	09/24/92	GBW	Wisconsin Rapids, WI
31-93	08/12/93	ATSF	Evadale, TX
06-94	01/20/94	UP	Falls City, NE
31-94	12/06/94	CR	Campbell Hall, NY
11-95	02/24/95	ATSF	Amarillo, TX
18-95	05/03/95	CSX	Evansville, IN
05-97	02/02/97	CR	Burns Harbor, IN
05-98	02/04/98	BRC	Bedford Park, IL
16-98	06/01/98	BNSF	Lubbock, TX

4.1.6 Description of FEs for Major Finding 2

FE-30-92: The road job's brakeman was trying to help the switch crew make up his train. The brakeman was in between cars on an active track being used by the switch crew and was killed when the cars he was between moved upon being struck by a cut of free rolling cars.

FE-31-93: Upon detraining, brakeman was struck and killed by another railroad's yard job working in the same small yard. Members of both crews saw each other but the brakeman apparently did not see the short line crews shove move.

FE-06-94: Conductor riding side of two cars to be kicked, he moves to the opposite side of car to work hand brake and is immediately struck by locomotives standing on adjacent track creating a no-clearance condition. Conductor was not aware that the locomotives had arrived at that location since he had last been there.

FE-31-94: First local had left the immediate location of the work area to be used by the second local without notifying the second local of the position of the switches, derails or returning the switches to a non-conflicting position. Second local shoving three cars

and a caboose with a two-month trainee directing the move, struck standing equipment after traversing switches that were unexpectedly lined for the equipment.

FE-11-95: Foreman of one job was installing the rear end marker on a cut of cars when the foreman of another job sent ten free rolling cars into the same track. The resulting impact caused all the cars to roll enough to knock down and kill the foreman who had been installing the marker.

FE-18-95: Conductor was struck and killed by a shove move on the track adjacent to where he was working. Communication about the move on that adjacent track had been conveyed to the conductor via the "bleeder," a utility type employee.

FE-05-97: Two yard jobs working on adjacent tracks. The conductor of one is studying his switch list as the other job is shoving into the adjacent track. Conductor is struck and killed by the lead car of the adjacent track shove move.

FE-05-98: Conductor and switchman making hoses on track 12, last transmission by conductor is "I think I got all the hoses after that next one…." Conductor is later found to have been struck and killed by a free rolling car on the adjacent track.

FE-16-98: Two yard engines working on adjacent tracks. One left a car fouling a clear track being used by the other engine. The foreman directing the shove move of the lite locomotives was crushed when his engine consist cornered the car fouling the adjacent track.

4.1.7 Recommendation 2

When two or more train crews are simultaneously performing work in the same yard or industry tracks, extra precautions must be taken:

SAME TRACK

- **Two or more crews are prohibited from switching <u>into the same track</u> at the same time, without establishing direct communication with all crew members involved.**

ADJACENT TRACK

- **Protection must be afforded when there is the possibility of movement <u>on adjacent track(s)</u>. Each crew will arrange positive protection for (an) adjacent track(s) through positive communication with yardmaster and/or other crew members.**

4.1.8 Discussion

FE-06-94 and FE-31-94 both involved standing equipment left by another crew. In both cases, it can be argued that there was no possibility of either piece of equipment being moved. However, the fact that both pieces of equipment contributed to the fatalities and in both cases the respective

crews had no knowledge that the equipment had been moved into the work area and that the physical layout expected by each fatality had changed contributed to the incident. Compliance with and an understanding of this recommendation would have prevented the other seven fatalities.

Major Finding and Recommendation 3

4.1.9 Major Finding 3

A lack of, or inadequate job safety briefings contributed to at least eight FEs. Table 4-3 summarizes those eight fatalities.

Table 4-3. FEs for Job Safety Briefings.

FE #	DATE	RAILROAD	LOCATION
30-92	09/24/92	GBW	Wisconsin Rapids, WI
23-93	06/07/93	IC	Fulton, KT
30-93	08/11/93	SP	Tracy, CA
47-93	11/13/93	GC	Macon, GA
49-93	12/05/93	SOU	Atlanta, GA
29-94	11/15/94	CR	Painted Post, NY
09-95	02/17/95	CR	St. James, OH
12-95	03/02/95	NS	Aiken, SC

4.1.10 Description of FEs for Major Finding 3

FE-30-92:Crew performing switching in class yard while road brakeman from another crew was coupling air hoses in a track without proper precautions and protection. Yard crew switched into the track and equipment ran over the road brakeman.

FE-23-93:Crew performing switching duties in class yard failed to have a clear understanding of movements being made. Results were that the rear brakeman was run over by moving equipment. There were no witnesses, but a hand brake was applied. It was thought that the brakeman had gone between the equipment on the ground to release the low hand brake.

FE-30-93:Crew performing industry switching. Brakeman attempted to couple air hoses while conductor gave engineer instructions to shove the movement. Resulting movement was unexpected to brakeman who was fatally injured.

FE-47-93:Trainmaster became involved with crew performing switching in class yard without knowledge of the conductor who was coupling air hoses on a cut of cars. Cars were

shoved without his knowledge while he was in the foul of the movement. Movement ran over conductor and killed him.

FE-49-93:Change in operating procedure between two crews swapping equipment resulted in conductor being struck by unexpected movement while he was in the foul of the track.

FE-29-94:Crew switching in class yard failed to establish and maintain effective communications. Subsequent changes in switching line-up by the conductor resulted in trainman who was in the foul of Track 7 being struck by unexpected movement of equipment.

FE-09-95:Arbitrary change in switching operations by conductor resulted in him being unexpectedly struck and fatally injured by approaching cars while he was fouling the track.

FE-12-95:Switching crew was pulling cut of cars out of an industry. No clear understanding of moves to be done by crew members resulted in brakeman being run over when he stepped in track gauge to open knuckle on the rear car of a cut and the locomotive engineer shoved that cut back over him.

4.1.11 Recommendation 3

At the beginning of each tour of duty, all crew members will meet and discuss all safety matters and work to be accomplished. Additional briefings will be held any time work changes are made and when necessary to protect their safety during their performance of service.

4.1.12 Discussion

Safe switching operations require teamwork and accountability among all crew members. Each crew member takes responsibility for their own and their fellow crew member's safety. Team work begins with a detailed, effective job briefing, but includes continued updates to all crew members describing the current state of each move as it is executed.

Major Finding and Recommendation 4

4.1.13 Major Finding 4

Ten of the 76 fatalities occurred because of a combination of radio/hand communication, or initial and/or ongoing movement of equipment without specific distances given. Table 4-4 summarizes those ten FEs.

Table 4-4. FEs for Improper Communication.

FE #	DATE	RAILROAD	LOCATION
08-92	3/11/92	FEC	Fort Pierce, FL
14-92	6/1/92	ATSF	Escondido, CA
26-93	7/15/93	CR	Anderson, IN
30-93	8/11/93	SP	Tracy, CA
29-94	11/15/94	CR	Painted Post, NY
31-94	12/6/94	CR	Campbell Hall, NY
09-95	2/17/95	CR	St. James, OH
04-97	1/29/97	UP	Mason City, IA
16-97	6/6/97	CMGN	Bay City, MI
45-97	12/26/97	UP	Boise, ID

4.1.14 Description of FEs for Major Finding 4

FE-08-92: This case involved the conductor riding a car into Track 8. The car derailed at the spiked switch and the conductor was subsequently killed. The conductors last radio transmission was "…we're lined in eight rail, three or four cars to a joint." Movement stopped after car had derailed and side swiped adjacent car.

FE-14-92: Brakeman had control of the move and told the engineer, by radio, to back up six cars to a coupling. The brakeman assumed that the conductor would "pick-up" the move when it came into his (the conductor's) view. The movement continued until it struck sitting cars on the track which, when moved, killed the conductor who was in between them.

FE-26-93: After the brakeman had tied the locomotives onto a cut of cars in the yard, the engineer received an instruction, via radio, from the brakeman to "shove to hold more cars." The engineer began to shove and didn't stop until he was on the other end of the

track. The brakeman was run over by the shove move. There was no evidence of any other radio transmissions concerning the shove move.

FE-30-93: Conductor was at the switch using hand signals to stop and back up the locomotives and the brakeman was in the plant using the radio to spot once the cut came into view. When the move had been put back together and the yard job was ready to shove back toward the yard, there was a hand motion by the brakeman interpreted by the conductor as a back up and subsequently relayed to the co-engineer. The brakeman was run over by the two engines and five cars as the move proceeded toward the crossing without further hand signals or radio signals.

FE-29-94: Trainman and conductor working together with two locomotives and involved in switching a few cars, between three different tracks, using a mixture of hand and radio signals. Conductor tells the trainman his instructions by radio and instructs the engineer by hand signals. The engineer moves on a hand signal to back up, the conductor boards the locomotives and the movement continues without further instruction until it runs into a cut of cars that the trainman was apparently fouling, killing the trainman. Engineer thought he would hear, by radio, from the trainman.

FE-31-94: The brakeman trainee was on the caboose to direct the shove move of the three engines, three cars and a caboose toward Track 1 in the yard. The shove move continued although the only radio transmission after getting the move started was “the derail is off.” The movement, which reached approximately 19 mph, struck standing equipment after diverging through two misalign switches and killed the brakeman trainee.

FE-09-95: Conductor instructs engineer, by radio, to “come ahead” (position of controlling locomotive causes this instruction to result in a shove move) with the same cars that he had just come out of the track with. There are no other radio transmissions from the conductor and eventually, the trainman, standing at the other two cars on the same track that was just pulled, directs the move to re-couple figuring that the conductor changed his mind. The movement traveled approximately eleven car lengths prior to coupling.

FE-04-97: Conductor and engineer were moving toward engine house area with lite engines and using hand signals. The conductor stopped the movement to line a switch. The engineer while waiting, heard and acted upon an unidentified radio transmission “come ahead 21.” The engineer initiated the shove movement and eventually, the conductor was struck from behind and killed.

FE-16-97: Conductor began a move using radio communication to shove a cut of cars approximately twenty-five car lengths to a coupling. After the move had begun the engineer didn’t hear another radio transmission from his conductor. The shove move eventually collided with the cars that were to be coupled to. The conductor was crushed in the collision and it was later determined that the portable radio being used by the conductor may have lost enough of it’s charge to effect the transmission.

FE-45-97: Conductor riding equipment while setting hand brakes. Move being shoved; improper radio communication.

4.1.15 Recommendation 4

When using radio communication, locomotive engineers must not begin any shove move without a specified distance from the person controlling the move. Strict compliance with "distance to go" communication must be maintained.

When controlling train or engine movements, all crew members must communicate by hand signals or radio signals. A combination of hand and radio signals is prohibited. All crew members must confirm when the mode of communication changes.

4.1.16 Discussion

The SOFA group believes that the key to radio use when backing, shoving or pushing a train or cut of cars is the communication between the locomotive engineer and the train crew. The crew must develop the discipline to remain stopped until specific car counts are given by the ground person, rather than to begin moving and then expect to receive the count. If this is done, fatalities related to improper radio communication can be substantially reduced. Additionally, mixing radio and hand signals causes confusion, reduces the chance that other members of the crew would hear of a change in the switching operations thereby greatly increasing misunderstandings, and, has directly led to fatalities studied by the SOFA Group.

Major Finding and Recommendation 5

4.1.17 Major Finding 5

Eleven of the 76 FEs were shown to have experience of one year or less and/or deficiencies in training. One additional FE had less than 1.5 years and is included below. Of these 12 FEs, all but one occurred in yard or industry tracks. Table 4-5 summarizes those twelve FEs.

Table 4-5. FEs for Experience and Training.

FE #	DATE	RAILROAD	LOCATION
04-92	1/30/92	AGC	Polk County, FL
47-93	11/13/93	GC	Macon, GA
28-94	11/10/94	PTRA	Houston, TX
31-94	12/6/94	CR	Campbell Hall, NY
29-95	10/4/95	CSXT	Riverdale, IL
09-96	3/20/96	BRC	Bedford Park, IL
12-96	6/15/96	CSX	Charlotte, NC
17-96	7/7/96	NS	Sidney, IN
22-96	9/3/96	DGNO	Dallas, TX
24-96	10/7/96	UP	Eagle Pass, TX
32-97	10/16/97	MRL	Laurel, MT
16-98	6/1/98	BNSF	Lubbock, TX

4.1.18 Description of FEs for Major Finding 5

FE-04-92: Industry switch crew, engineer and two flagmen, both flagmen rode the lower steps of the leading end of the lead locomotive. FE (flagman) on left side, the other flagman on right side. After 2000 feet into this light engine movement the surviving flagman noticed the FE stopped talking and he crossed over to the FE's side and saw FE lying next to the track behind movement. Investigation showed FE either slipped off the fireman's side or tripped while dismounting or attempting to remount from the fireman's side. FE had six months experience.

FE-47-93: Yard switch crew, engineer, conductor and brakeman, making switching moves into a seven track flat yard that runs up hill from the lead. Crew made pull from originating track, #5 track, FE (conductor) stayed behind after making cut to secure remaining

cars. Brakeman made four moves from lead to other tracks finishing with coupling and shoving #1 track in eleven car lengths. Trainmaster assisted brakeman by watching last car of #1 track. Conductor was found in the middle of #1 track under the cars. Last time he was seen was by the brakeman while he observed the conductor walking between #5 track and #1 track. FE had one year of experience.

FE-28-94: Yard switch crew, engineer, conductor and brakeman, spotting paper mill. FE (brakeman) instructed by conductor to de-train and stay at road crossing while he spotted track. FE found in nearby wood chip auger/conveyer system after mill crew started up the system while crew searched for missing FE. Mill crew was instructed by conductor not to start equipment until FE was located. FE was not familiar with the dangers associated with this mill process. FE had 5 months experience.

FE-31-94: Yard switch crew, engineer, conductor and brakeman, making reverse movement with caboose, three cars and two locomotives. FE (brakeman trainee) controlled the movement from his location in caboose. FE was unsupervised, conductor on engine with engineer. Movement speed was 19 mph at impact. Crew shoved over two switches without hearing radio signs from FE. Last radio transmission from FE was a panicked stop request before colliding with equipment stopped on track ahead of their movement. FE had 10 weeks experience.

FE-29-95: Yard switch crew, engineer, foreman, switchman and utility man, performing switching duty in large bowl yard. FEs first tour of duty as conductor in this yard. FE expressed his concern of working as a conductor in this yard. FE did not feel comfortable in this position due to his lack of experience and unfamiliarity of this yard operation. Original engineer laid off sick after learning the FE would be the conductor rather than work the job with him. FE was by himself coupling a yard track. FE instructed engineer via radio to pull back half a car length. After stopping, engineer continued to see FEs lantern. FE stepped in between the equipment to straighten a draw bar or open a knuckle. While doing this the cars he was trying to couple to rolled down pinning the FE between the equipment. FE had 5 months of experience.

FE-09-96: Yard switch crew, engineer, conductor and switchman, performing switch duty in a hump yard. FE, (conductor) was coupling track in the hump bowl by himself. While adjusting misaligned drawbars the cars he was coupling to unexpectedly moved, pinning FE between equipment. FE had 4 months of experience.

FE-12-96: Yard crew, engineer, conductor and switchman, switching at an industry. While crew was shoving two cars to a spot inside an industry building, FE (switchman) was rolled between lead box car and unloading platform. Platform or building was not marked with any type of ‘no-clearance’ or ‘close clearance’ signage. FE was last seen by conductor on the ground next to movement in a ‘cut-out’ space in the unloading platform. The conductor reported that there is enough room for a man to clear the movement in this ‘cut-out’. After hearing a strange noise the conductor instructed engineer to stop the movement. FE was rolled for 21 feet between box car and platform. FE had one year experience.

FE-17-96: Road crew, engineer and conductor, while stopped on siding track to meet an opposing train, FE (conductor) detrained to perform a roll-by inspection of other train. FE stepped off his train shortly before opposing trains arrival then stood in that trains

track while trying to adjust his portable radio. Opposing train struck FE at this point. FE had one year of experience.

FE-22-96: Yard switch crew, engineer, conductor and brakeman, while switching at an industry on a downhill grade experienced an unwanted run away car. While FE (brakeman) was in position on a car and setting a hand brake, the car started to roll away from the crew. FE continued to try to apply hand brake in an effort to stop the car. When discovering that the car was rolling away, the conductor attempted to slow and stop it by putting wood blocks under the wheels. The car accelerate to 30 to 35 mph. FE did not detrain before car collided with seven other cars at that speed. FE had three weeks experience.

FE-24-96: Yard Switch Crew, engineer, switch foreman, switchman, while attempting to complete a joint between an engine consist of two units and seven cars on an uphill grade, FE (switch foreman) was pinned between the engines and cars when cars unexpectedly rolled back while he went between equipment to adjust coupling. FE had 1 year, 5 months experience.

FE-32-97: Yard switch crew, engineer, switch foreman and switchman, were shoving a cut 41 cars up a grade to a stop. While this was taking place the ground crew boarded the first two cars so they could apply the hand brakes. FE (switchman) fell off the first car while attempting this. This car was found to have a brake platform with a decreasing width. Under the hand brake this platform was found to be 2 inches under the required width over a length of about 30 inches. FE had 10 months experience.

FE-16-98: Yard switch crew, engineer, foreman and brakeman, performing local switching duties struck a car fowling switching lead. The FE (foreman) rode leading end of movement while shoving. While having a discussion on the radio, a cut of cars rolled out slowly from another track striking FE as he rode the point. FE had 10 months experience.

4.1.19 Recommendation 5

Crew members with less than one year of service must have special attention paid to safety awareness, service qualifications, on-the-job training, physical plant familiarity, and overall ability to perform service safely and efficiently. Programs such as peer review, mentoring, and supervisory observation must be utilized to insure employees are able to perform service in a safe manner.

4.1.20 Discussion

While class room training time has increased, in general, the SOFA group has focused on experience and on-the-job training. We have found that limited training and experience continues to factor into many switching operation fatalities. Additional on-the-job training and experience, while working with more experienced peers, may help reduce fatalities among crew members with limited service.

The recommendations above address those issues for which the Working Group felt they could respond with confidence based on their expertise and the objective data. In the following section, we consider other steps that the Working Group recommends taking to continue to improve the safety of switching operations.

4.2 Additional Suggested Actions

The recommendations found in sections 4.1.3, 4.1.7, 4.1.10, 4.1.14, and 4.1.18 address those issues for which the Working Group felt they could respond with confidence based on their expertise and the objective data. In this section, we consider other actions that the Working Group recommends taking, based on their expertise to continue to improve the safety of switching operations.

4.2.1 Safety Training Concerning the Implications of Unexpected Train Movement

Finding: Compelling evidence suggests many FEs involve unexpected train movement, particularly at very low speeds.

Action: The railroad in the industry should review their existing switching operations training programs to assure that no opportunities are being overlooked to heighten safety awareness and to focus it on the serious implications of unexpected train movement, and on the importance of continual mutual awareness of the location and activities of all crew members.

Rationale: Such FEs are preventable if the crew members have proper understanding of all planned movements, take care to be sure that no individuals are exposed to potential hazards at the time movements are initiated and to assure that detached equipment has been properly protected, i.e., locomotive reverser centered or hand brakes applied, to prevent unplanned movement. Safety awareness training can encourage a strong focus on these issues.

4.2.2 Train Crew Resource Management

Finding: The Working Group has also concluded that an important contributing factor to many of the FEs reviewed was incomplete or inadequate communication among crew members. Sometimes this was a failure of, or improper use of communications equipment, but more often it was a failure or reluctance of the crew member to elevate the importance of communications impacting on safety to the level needed to assure successful, safe operations.

Action: The industry (labor, management, FRA) should consider programs that address improving crew coordination and communication such as Crew Resource Management (CRM) which has been used effectively in the aviation industry.

Rationale: The goal of these training procedures in all industries is to promote safe operations through improved crew member proficiency, situational awareness, effective communication and teamwork, and by providing strategies for appropriately challenging and questioning authority where safety could be jeopardized. Training in the importance of and procedures for effective intra-crew communication has the potential to make a major contribution to the safety of switching operations.

4.2.3 Follow-on SOFA Analysis : Review of Incidents Involving Severe Injury

Finding: The SOFA Working Group has been an effective task force for accomplishing goals that span the interests of labor, management and the FRA in switching operations. Although the review of switching fatalities has been very useful, the body of data is relatively small. Incidents in which serious injury has resulted, such as loss of a limb or requiring that the employee be placed on extended disability are likely to be very similar in kind to FEs. They are likely to

reflect the same safety implications in the sense that the only difference is in the degree of severity of the injury.

Action: The SOFA Working Group or its successor should extend the scope of its investigations by undertaking the review of available incidents where severe injuries have resulted.

Rationale: The data collection procedures for examining railroad injuries has recently been improved so that more complete and useful data for understanding the safety implications are available. In 1998 there were more than 8,000 non-fatal railroad incidents, not including grade crossing incidents. While we do not know the number of these that would be classified as serious, and the number that involved switching operations, it is likely to be a significant proportion of this total. This information would substantially augment the statistical reliability of the aggregate database and the ability to make objective recommendations based on it.

5. RECOMMENDATIONS FOR INCIDENT INVESTIGATION

A few months into their evaluation process, the SOFA Working Group found that, despite the voluminous amount of detail available and the quality of each technical summary, there were still information gaps in the fatality reports that had originally been collected. For example, although general weather information (cloudy, cool, etc.) was usually available for each incident, more specific information, such as temperature, was not consistently collected in all cases. The lack of specific information reduces the usefulness of the data for subsequent analysis.

The incident reports generally tried to establish a single probable cause of each switching incident. However, the SOFA Working Group concluded that fatalities more often resulted from the coming together of a complex set of factors. Had any one of these factors not been present, the fatality would have been less likely to occur. The SOFA Working Group also discovered that some of the codes needed to capture all of these possible factors into the SOFA matrix database were not available in the established code lists contained in the Appendices of the *Accident/Incident Reporting Guide*. Consequently, new codes were established to account for these factors, and added to the SOFA matrix. These new codes are shown in Appendix C.

The SOFA Working Group confirmed the importance of developing a more comprehensive database of FEs in switching operations to support a deeper understanding.

With respect to incident investigation and analysis, the SOFA Working Group made four specific recommendations to the FRA.

5.1.1 Establish and Maintain Database of Objective FE Data

Finding: FRA's existing FE files could be greatly improved by including a much broader range of information that can support the interpretation of the possible contributing factors associated with FEs.

Recommendation: When investigating FEs, the FRA should establish a comprehensive historical database summarizing the objective data and interpretation of FEs occurring in switching operations that will be updated regularly to accumulate reliable and consistent information about the occurrence of switching operations fatalities.

The Working Group, taking advantage of the insights resulting from its extensive analysis of existing data, is providing its recommendations for ensuring that specific data are collected by the FRA during its investigation of FEs.

Discussion: The generated database will provide more reliable clues to the factors contributing to switching operations FEs and support the justification of safety improvements in terms of the number of lives potentially saved. Additionally, the newly generated database will substantially reduce the time and cost of subsequent analyses and recommendations.

5.1.2 Recommendation for Providing Computer Support to the Data Collection Process

Finding: Current data collection procedures involve use of printed forms, notes, diagrams and photographs that do not provide a thorough or uniform data collection to perform accurate statistical analyses.

Recommendation: The FRA should consider creating software to facilitate data entry at the source and at the time the investigation is taking place. This software could operate on portable laptop computers already available to investigators or on off-the-shelf personal data units (PDUs) that are especially suited to the data collection application. The SOFA Working Group offers its assistance in a project to revise the data collection protocol and to develop software to support the fatality investigation and data codification process.

Discussion: The efficiency, accuracy, and thoroughness of the existing data collection in each investigation would be improved. Computer support could reduce the time and cost associated with the complete data collection and consistent codification process.

5.1.3 Recommendation for Continued Review and Monitoring of Fatal Accident Data

Finding: The SOFA Working Group has accumulated the most knowledge of the potential causes of switching operation FEs in the industry.

Recommendation: The SOFA Working Group, or its successor, should undertake a periodic review of the FE switching operations data as it accumulates to seek new lessons learned, to review the integrity of the data, to monitor its usefulness and recommend improvements to the data being collected where appropriate.

Discussion: Their review of the data will (1) provide the best checks that the data being requested are useful, (2) put them in a position to recommend improvements to data collection and (3) put them in a position to recommend potential safety improvements to reduce the incidence of death and injury.

5.1.4 Modification of FRA's Data Collection Process to Include a Team Concept

Finding: No one has all the expertise required to undertake a comprehensive review and revision of FE investigation procedures.

Recommendation: The Working Group believes it is important that FRA's investigation process be consistent, and that a team concept be implemented to insure complete data collection.

Rationale: The SOFA Working Group recognizes that some inspectors collect and produce reports better than others, while other inspectors are more versed in analyzing the FE data. A team (to include all affected disciplines) concept in data collection and analysis will insure a more consistent FE investigation.

5.1.5 Fatal Incident Investigation Protocol

The following sections present the data fields that the SOFA Working Group recommends be collected by the FRA in each future fatality incident investigation. The field descriptions are especially adapted to forms that could be implemented in computer software and take advantage of branching structures to present for entry only the data fields that are relevant to each investigation. However, they could also be formatted in paper forms, if required.

The data are organized into sections that address:

- Background information
- Weather/Visibility
- FE personal data
- Work/Rest/Fatigue
- Personal Issues
- Personal Protective Equipment
- FEs Crew Information
- Data on other involved crews, if any
- FE Activity at time of Incident
- Site information
- Communications Issues
- Emergency response Issues
- Possible contributing factors

To accomplish this we have identified seven data types:

- Alphanumeric Entries (abbreviated Alpha): Examples: Railroad; FE Date of Birth

  Example:

Railroad	FE Date of Birth		
	Mo	Day	Year

- Check Box (answer yes no, or unknown): Examples: Was employee protection system in effect?

  Example:

Was employee protection equipment in effect?

Yes ☐ No ☐ Unknown ☐

- Menu Selection from small set of specific possibilities: Examples: Type of movement (Shove, Pull, Free-Running)

  Example:

Type of Movement

☐ Shove ☐ Pull ☐ Free Running

- Coded entries derived from code sheets - some pre-existing, some to be created: Examples: Physical Act Circumstance Codes; FEs crew anticipated next move

Example:

Physical Act	Code

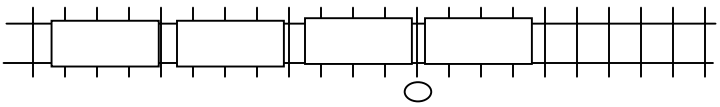
- Calculated Value: These values are derived by calculation from other data obtained. Example: Day of the week may be calculated from Date.

Example:

Tuesday

Graphics: Examples: layout of yard, layout of incident geometry

Example:



FE

- Narrative text

Example

Explanation of Stress or Emotional Problem Employee spouse disappeared from home previous evening.

- Rating Scale

Example

Rating Scale	1= Extremely Important	2 = Very Important	3 = Moderately Important	4 = Applicable but neither important nor unimportant	5 = Not Applicable
	X				

REFERENCES

Reason, J., (1990) Human Error. NY, Cambridge University Press.

Reason, J., (1997) Managing the Risks of Organizational Accidents, Aldershot, England, Ashgate.

APPENDIX

A: Origin of SOFA Working Group

B: SOFA Working Group Membership and Affiliation

C: Definitions of Possible Contributing Factors (PCFs); and
Activity, Event, and Location Codes

D: Frequency of Possible Contributing Factors (PCFs) and Pairs of PCFs

E: Working Version of SOFA Matrix (Full SOFA Matrix appears in Appendix II)*

F: Recommendation Summary by FE

G: Data Format for Recommendation for Incident Investigation

* Note: Appendix II, with supporting data, to be issued by December 1999.

Appendix A:

Origin of SOFA Working Group

Appendix A: Origin of SOFA Working Group

The letter below was sent by George Gavalla, Associate Administrator for Safety, Federal Railroad Administration to Charles E. Dettmann, Association of American Railroads (AAR), William E. Loftus, President, American Short Line and Regional Railroad Association (ASLRRA), Clarence V. Monin, International President, Brotherhood of Locomotive Engineers (BLE), and Charles L Little, International President, United Transportation Union (UTU).

This letter forms the basis for the creation of the Switching Operations Fatality Analysis (SOFA) Working Group.

February 1998

U.S. Department
Of Transportation
Federal Railroad Administration

Dear Sirs:

I would like to bring your attention to a serious concern that I have with respect to train and engine service (T&E) employee fatalities. The Federal Railroad Administration (FRA) recently conducted a preliminary review of all T&E employee fatalities for a six year period beginning in 1992. We found that 66 T&E employees were fatally injured in incidents other than major train collisions. These fatal train incidents typically occurred in yards and terminals when the T&E employee was struck by, fell from, or run over by equipment. Unlike major train collisions, the root cause of these incidents, as well as any appropriate corrective action, is often far more difficult to determine.

As in the past, we need your help if we are going to reduce and eliminate these fatal train incidents. I believe that a task force consisting of representatives from labor, management, and FRA should be formed to find a way to prevent these tragic occurrences. The team will conduct a detailed fact finding and review and analysis of these incidents to determine whether trends or patterns can be found, identify best practices, and, if possible, formulate recommendations for the entire industry based on the findings.

The process is very similar to the highly successful approach utilized by the joint labor and management Roadway Worker Protection Task Force to analyze roadway worker fatalities and injuries prior to the first formal negotiated rulemaking committee meeting. However, unlike that task force, the findings and recommendations from this team are neither intended to be used in a rulemaking process not to otherwise lead to formal action by FRA. Rather, railroads will be able to evaluate the team's findings and recommendations with respect to their individual operating requirements and would, through the Safety Assurance and Compliance program process, be encouraged to implement recommendations that would benefit their safety program.

I would like to invite you or your representatives to a planning meeting to discuss the feasibility of such an effort and to determine the team make-up. I suggest a meeting at FRA Headquarters, 1120 Vermont Avenue, N.W., Room 6046, Washington, D.C., on February 10 at 10 a.m. If this is inconvenient, please contact my office at (202) 632-3310. I will be glad to arrange for an alternate date and time or perhaps set up a conference call at a mutually convenient time.

Sincerely,

George Gavalla
Acting Associate Administrator
for Safety

Appendix B:

SOFA Working Group Membership and Affiliation

APPENDIX B: SOFA WORKING GROUP MEMBERSHIP AND AFFILIATION

Mr. Sam Arrington
Texas State Legislative Director
United Transportation Union

Mr. David Brickey
Michigan State Legislative Director
United Transportation Union

Mr. William M. Browder
Director of Operations
Association of American Railroads

Mr. Michael K. Coplen,
Program Manager, Human Factors
Office of Research and Development
Federal Railroad Administration

Mr. Michael R. Deatherage
Director Safety and Operating Practices
RAILTEX

Mr. Charles E. Dettmann
Executive Vice President
Association of American Railroads

Mr. S. Joseph Gallant
Railroad Safety Specialist, Operating Practices
Office of Safety Assurance and Compliance
Federal Railroad Administration

Mr. Robert A. Harvey
Regulatory Research Coordinator
Brotherhood of Locomotive Engineers

Mr. Raymond Holmes
Texas Legislative Board Chairman
Brotherhood of Locomotive Engineers

Mr. George J. Last
Colorado Legislative Board Chairman
Brotherhood of Locomotive Engineers

Mr. Thomas J. Perkovich
Minnesota Legislative Board Chairman
Brotherhood of Locomotive Engineers

Dr. Richard W. Pew
Principal Scientist
Human Factors Division
BBN Technologies/GTE Corporation

Mr. Matthew B. Reilly, Jr.
Executive Director, Federal and Industry
American Short Line and Regional Railroad Association

Mr. David Skinner
Economist
Human Factors Division
Volpe National Transportation Systems Center

Mr. John P. Smullen
Minnesota State Legislative Director
United Transportation Union

Appendix C:

Definitions of PCFs; and Activity, Event, and Location Codes

Appendix C:
Definitions of Possible Contributing Factors (PCFs); and Activity, Event, and Location Codes

Listed below are the new and existing cause codes used by the SOFA Working Group to describe the 76 FE incidents studied. The new codes were established by the SOFA Group in doing their work. Also listed are the Activity, Event, and Location Codes that were used.

New Cause Codes Created by SOFA Groups

H316 Poor intra-crew communication about work in progress
H317 Failure to communicate unsafe condition
H318 Poor crew utilization
H500 Slack action
H990 Employee on or fouling track

Note: Event Circumstance Code '99' has been used in connection with H990.

Note: Location Code A4 includes fouling tracks when used in connection with H990.

H996 Insufficient training
H997 Failure to provide adequate space between equipment
H998 Employee falling from moving equipment
M411 Close or no clearance

Existing FRA Cause Codes (Note: Full verbal definition not given.) *

E02C Broken brake pipe or connections
E09C Other brake defects (cars)
E24C Center plate disengaged from truck (car of center)
E29C Other body defects (car)
E34C Draft gear/mechanism broken or defective (including yoke)
E39C Other coupler and draft system defects
E39L Other coupler or draft system defects (locomotives)
E67C Damaged flange or tread (build up)
H008 Improper operation of train line air connections (bottling the air)
H018 Failure to properly secure hand brake on car(s) railroad employee
H019 Failure to release hand brakes on car(s) (railroad employee)
H020 Failure to apply sufficient number of hand brakes on car(s) (railroad employee)
H021 Failure to apply handbrakes on car(s) (railroad employee)
H025 Failure to control speed of car using hand brake (railroad employee)
H099 Use of brakes, other
H101 Impairment of efficiency or judgement because of drugs or alcohol

H199 Employee physical condition, other
H207 Hand signal, failure to comply
H210 Radio communication, failure to comply
H211 Radio communication, improper
H212 Radio communication, failure to give/receive
H301 Car(s) shoved out and left out of clear
H303 Derail, failure to apply or remove
H305 Instructions to train/yard crew improper
H306 Shoving movement, absence of a man on or at leading end of movement
H307 Shoving movement, man on or at leading end of movement, failure to control
H310 Failure to couple
H312 Passed couplers
H399 Other general switching rules
H503 Buffing or slack action excessive, train handling
H599 Other causes relating to train handling or makeup
H602 Switching movement, excessive speed
H605 Failure to comply with restricted speed
H699 Speed, other
H702 Switch improperly lined
H999 Other train operation/human factors
M101 Snow, ice, mud, gravel, coal etc. on the track
M199 Other extreme environmental condition
M302 Highway user inattentiveness
M304 Highway user cited for violation of highway-rail grade crossing traffic laws
M305 Highway user unawareness due to environmental factors (angle of sun, etc.)
M307 Malfunction, improper operation of train activated warning devices
M404 Object or equipment on or fouling the tracks (other than above) not vandalism
M501 Interference (other the vandalism) with railroad operations by non-railroad employee
M502 Vandalism of on-track equipment, i e , brakes released
M504 Failure by non-railroad employee...to control speed of car using hand brake
M599 Other miscellaneous causes
S012 Radio communication equipment failure
T099 Other roadbed defects
T222 Worn rail
T319 Switch point gapped (between switch point and stock rail)

Note: H301 and H302 were modified to include locomotive(s)

Location Code A5 includes riding or platform between two cars/locomotives.
Location Code B7 means between/within the gauge of the track.

* Taken from FRA Guide for Preparing Accident/Incident Reports (DOT/FRA/RRS-22)

Event Codes Used by SOFA Group

17-collision, on track equip
18-collision with motor vehicle
20-defective/malfunctionioning equip
21-drailment
34-lost balance
35-missed handhold, grabiron, step, etc.
39-pushed/shoved into/against
42-ran into on-track equip
50-slack action, draft, compressive buff/coupling
58-struck by object
59-struck by on-track equip
61-struck against object
64-sudden/unexpected movement of equip
99-other

Location Codes Used by SOFA Group

A1-near equip
A3-beside track
A4-between tracks
A5-between cars
A6-on/in loc
A7-in car
B6-side of car
B7-on track
B8-end of car
C6-on loc
X9-near pit

Activity Codes Used by SOFA Group

01-adj. coupler
02-adjust drawbar
13-coupling air hose
16-crossing between
22-flagging

24-getting on
25-getting off
39-installing
45-lining switches
50-adj. angle cock
51-operating
58-riding

Appendix D:

Frequency of PCFs; and Pairs of PCFs

Appendix D:
Frequency of Possible Contributing Factors (PCFs) and Pairs of PCFs

* frequency of PCFs that occur three or more in SOFA matrix.

** frequency of pairs of PCFs that occur three or more time in SOFA matrix.

PCFs

	freq *
H990	33
H316	11
H399	10
H997	10
M411	8
H305	7
H306	7
H998	7
H018	6
H211	6
H996	6
M101	5
H021	4
H310	4
H318	4
H605	4
H999	4
E29C	3
H210	3
H307	3
H312	3
H599	3
H702	3
M302	3
T099	3

Pairs of PCFs

		freq **
H990	H211	5
H990	H316	5
H990	H399	5
H990	H997	4
H399	T099	3
H211	H316	3

Appendix E:

Working Version of SOFA Matrix

Note: Full SOFA Matrix appears in Appendix II.

Appendix E:
Working Version of SOFA Matrix

Event Code 21 -- derailments -- 6 of 76 FEs (about 8%)

number of FE type	report #	event code	location	FE between equip	activity	line of road	date	day	light	years of service	result of train move	movement type	struck by own equip	crew size	struck by other crew	striking equip within rules	hand signs	radio	both hand and radio
1	FE-03-94	21	A4-between tracks	no	62-standing	yard	01/14/94	fri	day	36	yes	pulled	no	3	yes	yes		yes	
2	FE-20-94	21	A7-in car	no	60-sitting	line	09/20/94	tues	day	20	yes	shoved	no	3	no	----		----	
3	FE-27-93	21	B8-end of car	no	58-riding	other	08/04/93	wed	day	18	yes	shoved	yes	3	no	yes		yes	
4	FE-40-93	21	B6-side of car	no	58-riding-lead	siding	10/19/93	tues	night	2	yes	shoved	yes	3	no	----		yes	
5	FE-53-93	21	B6-side of car	no	58-riding-lead	industrial	12/30/93	thurs	day	38	yes	shoved	yes	3	no	----		yes	
6	FE-08-92	21	A1-near equip	no	58-riding-lead	yard	03/11/92	wed	night	16	yes	shoved	yes	2	no	yes		yes	

Appendix E:
Working Version of SOFA Matrix

Event Code 21 -- derailments -- 6 of 76 FEs (about 8%), Jan. 1, 1999 to July 1, 1998

number of FE type	report #	PCF	other crew cause code	external circumstance	PCF
1	FE-03-94		E39C-coupler/draft defects		
2	FE-20-94	M302-highway user inattentiveness M304-highway user violations		M305-highway user unawareness due to environmental factors	Sun in eyes
3	FE-27-93	T222-worn rail M411-close/no clearance H998-fell from moving equip			
4	FE-40-93	H303-derailer H996-insufficient training H318-poor crew utilization			
5	FE-53-93	T099-roadbed defect M101-snow, ice, etc., on track H602-switching movement		Others Assisted Crew	
6	FE-08-92	T319-switch point gapped E67C-worn tread		Track Conditions	

Event Code 17 -- collisions between on track equip -- 7of 76 FEs (about 9%)

number of FE type	report #	event	location	FE between equip	activity	line of road	date	day	light	years of service	result of train move	movement type	struck by own equip	crew size	struck by other crew	striking equip within rules	hand signs	radio	both hand and radio
1	FE-16-97	17	B8-end of car	yes	58-riding	yard	06/06/97	fri	night	7	yes	shoved	yes	2	no	no			
2	FE-16-95	17	B8-end of car	yes	58-riding	line	04/06/95	thurs	night	7	yes	shoved	yes	2	no	no		yes	
3	FE-15-92	17	B8-end of car		58-riding	yard	06/01/92	mon	day	22	yes	free	yes	4					
4	FE-34-92	17	A4-between tracks	yes	62-standing	yard	10/23/92	fri	day	28	yes	shoved	yes	3	no	no		yes	
5	FE-39-92	17	A5-between cars	yes	62-standing	line	11/16/92	mon	night	13	yes	shoved	yes	2	no	yes		yes	
6	FE-16-98	17	C6-on loc	no	58-riding-lead	yard	06/01/98	mon	night	0.83			no	3		no	yes	yes	
7	FE-17-98	17	A4-between tracks	yes	2-adjust drawbar	yard/industrial	06/05/98	fri	day	27	yes	shoved	yes	3		yes	no	yes	

Event Code 17 -- collisions between on track equip -- 7of 76 FEs (about 9%)

number of FE type	report #	PCF	other crew cause code	external circumstance	PCF
1	FE-16-97	H210-radio-failed to comply SO12-radio equipment failure		Radio Failure	Clear x-ing
2	FE-16-95	H018-securing brakes H008-improper bottling the air H605-failure to comply with speed			H020-insufficient number of hand brakes
3	FE-15-92	H018-securing brakes H317-comm unsafe condition		H399-switching rules	
4	FE-34-92	H997-adequate space between equip		Unsafe commonly accepted operational practice	
5	FE-39-92	H990-fouling track		Jammed Knuckle pin	Track curve/broken knuckle
6	FE-16-98	H307-shove-failure to control H302-cars left foul H996-insufficient training	H021-apply brakes		History of track roll outs
7	FE-17-98	H990-fouling track H312-passed couplers H310-failure to couple		No Devise to asst. aligning drawbar	2 Super cusioned cars

Event Code 64 -- sudden/unexpected movement of on track equip -- 11of 76 FEs (about 15.5%)

number of FE type	report #	event	location	FE between equip	activity	line of road	date	day	light	years of service	result of train move	movement type	struck by own equip	crew size	struck by other crew	striking equip within rule	hand signs	radio	both hand and radio
1	FE-02-94	64	A5-between cars	yes	72-walking	yard	01/04/94	tues	night	20	yes	pulled/free	yes	3	no			yes	
2	FE-04-94	64	B8-end of car	no	58-riding	industrial	01/18/94	tues	day	25	yes	shoved	yes	3	no	yes		yes	
3	FE-26-94	64	A5-between cars	yes	16-crossing between	yard	10/17/94	mon	day	16	yes	shoved	yes	3	no	no		yes	
4	FE-32-94	64	A5-between cars	yes	2-adjust drawbar	industrial	12/13/94	tues	night	26	yes	pulled	yes	4	no	yes		yes	N
5	FE-23-93	64	B7-on track	no	62-standing	yard	06/07/93	mon	day	20	yes	free	yes	4	no	yes		yes	N
6	FE-14-92	64	A5-between cars	yes	9-climbing	industrial	06/01/92	mon	day	29	yes	free	yes	3	no	no		yes	
7	FE-45-97	64	B7-on track	yes	50-adj. Angle cock	line/industrial	12/26/97	fri	night	32	yes	shoved	yes	3	no	no		yes	
8	FE-25-97	64	A5-between cars	yes	2-adjust drawbar	yard	08/15/97	fri	night	28	no	free	yes	3	no		no	yes	
9	FE-05-98	64	A4-between tracks	no	62-standing	yard	02/04/98	wed	day	23	no	free	no	3	no	yes	no	yes	
#	FE-15-98	64	B7-on track	yes	2-adjust drawbar	yard	05/26/98	tues	day	36	no	free	yes	3	no	yes	no	yes	
#	FE-24-96	64	A5-between cars	yes	01-adj. coupler	other	10/07/96	mon	night	10.08	yes	free	yes	3	no	no			

Event Code 64 -- sudden/unexpected movement of on track equip -- 11of 76 FEs (about 15.5%)

number of FE type	report #	PCF	other crew cause code	external circumstance	PCF
1	FE-02-94	H990-fouling track H310-failure to couple			H997-adequate space between equipment
2	FE-04-94	H998-fell from moving equip H500-			
3	FE-26-94	H997-adequate space between equip H210-radio-failed to comply		H599-train handling	
4	FE-32-94	H997-adequate space between equip		H990-fouling track	
5	FE-23-93	H990-fouling track H316-intra-crew communication		X-car-/llist chng	H305-improper instruction
6	FE-14-92	H210-radio-failed to comply H306-shove-no man on front H316-intra-crew communication			
7	FE-45-97	H990-fouling track H316-intra-crew communication H211-radio-improper		Grade x-ing placement	
8	FE-25-97	H021-apply brakes H990-fouling track		Yard Track Grade	
9	FE-05-98	H990-fouling track M411-close /no clearance		Track Centerline at 13 feet	
10	FE-15-98	H990-fouling track H305-improper instruction H021-apply brakes H997-adequate space between equip			
11	FE-24-96	H018-securing brakes E39C-coupler/draft defects E39L-other coupler or draft defect, loc H997-adequate space between equip			

Event Code 59 -- struck by on track equipment -- 32 of 76 FEs (about 42%)

number of FE type	report #	event	location	FE between equip	activity	line of road	date	day	light	years of service	result of train move	movement type	struck by own equip	crew size	struck by other crew	striking equip within rules	hand signs	radio	both radio and hand
1	FE-17-96	59	B7-on track		62-standing	line	07/07/96	sun	night	1	yes	pulled	no	2	yes	yes			
2	FE-09-96	59	A5-between cars	yes	01-adj. coupler		03/20/96	wed	night	0.3	yes	free	yes	3	no	yes			
3	FE-04-97	59	B7-on track	no	72-walking	yard	01/29/97	wed	day	28	yes	shoved	yes	2	no	no	yes	yes	Y
4	FE-05-97	59	A3-beside track	no	62-standing	yard	02/02/97	sun	night	27	yes	shoved	no	3	yes	no			
5	FE-19-97	59	B7-on track	no	72-walking	siding	06/24/97	tues	night	2.5	yes	shoved	yes	2	no	yes			N
6	FE-22-97	59	B7-on track	no	22-flagging	line	07/18/97	fri	night	7.6	yes	pulled	no	1	yes	yes			
7	FE-02-95	59	B6-side of car	no	58-riding	industrial	01/11/95	wed	night	30	yes	shoved	yes	3	no	yes		yes	
8	FE-09-95	59	A1-near equip	no	72-walking	industrial	02/17/95	fri	day	29	yes	shoved	yes	3	no	no		yes	
9	FE-11-95	59	B7-on track	yes	39-installing	yard	02/24/95	fri	day	19	yes	free	no	4	yes	yes			
10	FE-12-95	59	B7-on track	yes	1-adj. coupler	line	03/02/95	thurs	day	22	yes	shoved	yes	3	no	yes		yes	
11	FE-17-95	59	B7-on track	no	72-walking	industrial	03/21/95	fri	day	24	yes	shoved	yes	3	no	yes		yes	
12	FE-18-95	59	A4-between track	no	62-standing	yard	05/03/95	wed	day	32	yes	shoved	no	3	yes			yes	
13	FE-29-95	59	A5-between cars	yes	2-adjust drawbar	yard	10/04/95	wed	day	0.5	yes	free	yes	4	no	no	yes	yes	
14	FE-29-94	59	B7-on track	yes	62-standing	yard	11/15/94	tues	day	38	yes	shoved	yes	3	no	no	yes	yes	Y
15	FE-13-93	59	B7-on track	no	72-walking	line	04/13/93	tues	day	16	yes	pulled	no	3	yes	yes		yes	

Event Code 59 -- struck by on track equipment -- 32 of 76 FEs (about 42%)

number of FE type	report #	PCF	other crew cause code	external circumstance	PCF
1	FE-17-96	H990-fouling track H199-other physical condition			
2	FE-09-96	H990-fouling track H021-apply brakes		Crew experiance	
3	FE-04-97	H211-radio-improper H990-fouling track			Moved on wrong trnmsn.
4	FE-05-97	H306-shove-no man on front	H306-shove no man on front		Reading ist
5	FE-19-97	H702-switch improperly lined			
6	FE-22-97	H990-fouling track			
7	FE-02-95	H998-fell from moving equip E29C-car defects			
8	FE-09-95	H702-switch improperly lined H990-fouling track H211-radio-improper			
9	FE-11-95	H305-improper instruction		Yardmaster	H305-improper instruction
10	FE-12-95	H997-adequate space between equip H316-intra-crew communication			
11	FE-17-95	H990-fouling track		H199-other physical condition	
12	FE-18-95	H990-fouling track	H306-shove no man on front	Two Radio Chanels Used	
13	FE-29-95	H997-adequate space between equip H996-insufficient training		H999-not operation/human factors	Green Ground Crew
14	FE-29-94	H316-intra-crew communication H605-failure to comply with speed			
15	FE-13-93	H990-fouling track		EC 24-center plate disengaged from truck (car off cen	M307-shove-failure to control

Working Version of SOFA Matrix

number of FE type	report #	event	location	FE between equip	activity	line of road	date	day	light	years of service	result of train move	movement type	struck by own equip	crew size	struck by other crew	striking equip within rules	hand signs	radio	both radio and hand
16	FE-26-93	59	B7-on track	yes	13-coupling air ho:	yard	07/15/93	thurs	day	25	yes	shoved	yes	3	no	no		yes	
17	FE-30-93	59	B8-end of car		24-getting on	industrial	08/11/93	wed	day	29	yes	shoved	yes	5	no	no	yes	yes	Y
18	FE-31-93	59	B7-on track	no	62-standing	siding/industrial	#######	thurs	day	31	yes	shoved	no	3	yes	no			
19	FE-35-93	59	B7-on track	yes	16-crossing betwe	yard	#######	thurs	day	24	yes	shoved	yes	5	no	yes		yes	
20	FE-46-93	59	B6-side of car	no	58-riding-lead	line/industrial	#######	fri	night	21	yes	shoved	yes	3	no	no	yes	yes	Y
21	FE-47-93	59	B7-on track			yard	#######	sat	day	1	yes		yes	3	no			yes	
22	FE-49-93	59	A4-between track	no	25-getting off	line/siding	#######	sun	night	29	yes	pulled	no	2	yes	yes		yes	
23	FE-03-92	59	B7-on track	no	72-walking	yard	#######	tues	night	22	yes	hoved/free	yes	3	no	yes	yes	yes	Y
24	FE-09-92	59	A1-near equip	no	50-adj. angle cock-lea	line	#######	thurs	day	13	yes	free	yes	3	no	no	yes	yes	N
25	FE-16-92	59	B7-on track	no	59-running	industrial	#######	tues	day	23	yes	free	yes	2	no				
26	FE-20-92	59	A4-between track	no	72-walking	line/siding	#######	tues	day	12	yes	pulled	no	2	yes	yes			
27	FE-22-92	59	A4-between track	no	72-walking	yard	#######	sat	day	28	yes	shoved	yes	3		no		yes	
28	FE-30-92	59	B7-on track	yes	13-coupling air ho:	yard	#######	thurs	night	13	yes	free	no	3	yes	yes		yes	
29	FE-36-97	59	A4-between track	no	62-standing	line/yard	#######	tues	night	30	yes	pulled	no	3	yes	yes		yes	
30	FE-18-97	59	A1-near equip	yes	72-walking	yard	#######	tues	night	28	yes	pulled	yes	3	no	yes	no	yes	
31	FE-31-96	59	B8-end of car	yes	58-riding		#######	wed	day	26	yes	hoved/free	yes	3	no				
32	FE-30-96	59	A5-between cars	yes	58-riding		#######	mon	night	21	yes	pulled	yes	3	no	yes			

number of FE type	report #	PCF	other crew cause code	external circumstance	PCF
16	FE-26-93	H990-fouling track H998-fell from moving equip H316-intra-crew communication H211-radio-improper			
17	FE-30-93	H316-intra-crew communication H207-hand signal, failure to comply E29C-other body defects, car		H318-poor crew utilization	M199-other extreme environmental conditions
18	FE-31-93	H990-fouling track	H306-shove no man on front	H317-comm unsafe condition	H399-switching rules
19	FE-35-93	H990-fouling track H997-adequate space between equip H312-passed couplers		H999-not operation/human factors	
20	FE-46-93	H021-apply brakes H310-failure to couple		H101-impairment…because of drugs or alcohol	
21	FE-47-93	H316-intra-crew communication H990-fouling track		TM Assisted Crew	H399-switching rules
22	FE-49-93	H990-fouling track H399-switching rules	H399-other general switching rul	T099-other roadbed defects	
23	FE-03-92	H990-fouling track H399-switching rules		Heavy Clothing, Hood(s)	Radio Conversation w/2nd crew
24	FE-09-92	H602-switching movement, excessive speed		T099-other roadbed defects	H399-switching rules
25	FE-16-92	H018-securing brakes H990-fouling track			
26	FE-20-92	H990-fouling track	None	Noise from FE's Locos	M404-object/equip fouling track
27	FE-22-92	H990-fouling track		Engineer didn't change ends	Hand Switch Confusion
28	FE-30-92	H990-fouling track M599-other misc. causes	H305-improper instruction	Improper mingeling of crews members	No on-going job briefing
29	FE-36-97	H990-fouling track	None		
30	FE-18-97	H019-failure to release hand brakes H990-fouling track			
31	FE-31-96	H018-securing brakes H307-shove, failure to control E02C-broken brake pipe or connections			Cold Temp
32	FE-30-96	H998-fell from moving equip H101-drugs, alcohol			

Misc. Event Codes -- other types of FEs -- 20 of 76 FEs (about 26%)

number of FE type	report #	event	location	FE between equip	activity	line of road	date	day	light	years of service	result of train move	movement type	struck by own equip	crew size	struck by other crew	striking equip within rules	hand signs	radio	both hand and radio
1	FE-12-96	39-pushed/shoved into/again	A1-near equip	no	62-standing		06/15/96	wed	day	1	yes	shoved	yes	3	no	no			
1	FE-22-96	42-ran into on-track equip	B8-end of car	no	62-standing		09/03/96	tues	day	0.1	yes	free	no	3	no	no			
2	FE-31-94	42-ran into on-track equip	A7-in car	no	58-riding	yard	12/06/94	tues	night	0.2	yes	shoved	no	3	no	no		yes	N

Misc. Event Codes -- other types of FEs -- 20 code

number of FE type	report #	PCF	other crew cause code	external circumstance	PCF
1	FE-12-96	H599-train handling M411-close/no clearance			
1	FE-22-96	H018-securing brakes E09C-other brake defect, cars H996-insufficient training			Failure to test HB
2	FE-31-94	H318-poor crew utilization H211-radio improper H307-shoved-failure to control H605-failure to comply with speed H212-radio, failure to give/receive H303-derailer H699-speed, other			

number of FE type	report #	event	location	FE between equip	activity	line of road	date	day	light	years of service	result of train move	movement type	struck by own equip	crew size	struck by other crew	striking equip within rules	hand signs	radio	both hand and radio
1	FE-34-95	61-struck against object	B6-side of car	no	58-riding	yard	12/14/95	thurs	night	33	yes	shoved	yes	3	no	yes		yes	
2	FE-12-94	61-struck against object	B6-side of car	no	58-riding-trailing		04/12/94	tues	day	37	yes	pulled	yes	3	no	yes	yes	yes	
1	FE-11-93	58-struck by object	B8-end of car	no	58-riding	yard	03/27/93	sat	day	19	yes	pulled	yes	4	no	no		yes	
2	FE-02-98	58-struck by object	A3-beside track	no	45-lining switch	yard	01/24/98	sat	day	26	yes	pulled	no	3	no			yes	
1	FE-23-95	99-other (describe in narrativ	A5-between car	yes	58-riding	industrial	07/21/95	fri	day	40	yes	pulled	yes	3	no	yes		yes	
2	FE-33-95	99-other (describe in narrativ	A1-near equip	no	62-standing	industrial	12/11/95	mon	night	32	yes	pulled	yes	3	no	yes		yes	
3	FE-06-94	99-other (describe in narrativ	B6-side of car	no	58-riding-trailing	yard	01/20/94	thurs	night	16	yes	free	no	3	no			yes	
4	FE-16-94	99-other (describe in narrativ	A5-between car	yes	51-operating	industrial	07/05/94	tues	day	35	yes	free	yes	3	no	no	yes	yes	Y
5	FE-19-98	99-other (describe in narrativ	B6-side of car	no	58-riding	industrial	07/01/98	wed	night	30	yes	pulled		3	no			yes	

number of FE type	report #	PCF	other crew cause code	external circumstance	PCF
1	FE-34-95	M502-improper placement of cars			
		M404-object/equip fouling track			
2	FE-12-94	M411-close/no clearance			
1	FE-11-93	H990-fouling track		M101-snow, ice, etc., on tra	H019-failure to release hand brakes
2	FE-02-98	H605-failure to comply with speed	H399-switching rules		H305-improper instruction
		H399-switching rules			
		H702-switch improperly lined			
		H101-drugs, alcohol			
1	FE-23-95	H998-fell from moving equip			ECC 34-
2	FE-33-95	M101-snow, ice, etc., on track			
		H990-fouling track			
		M411-close/no clearance			
3	FE-06-94	M411-close/no clearance	H301-car shoved out and left…		
		H318-poor crew utilization			
4	FE-16-94	H025-failure to control speed		H099-roadbed defect	
		H599-other causes, train makeup or handling			
5	FE-19-98	H316-intra-crew communication		Illegal Handrail	
		M411-close/no clearance			

number of FE type	report #	event	location	FE between equip	activity	line of road	date	day	light	years of service	result of train move	movement type	struck by own equip	crew size	struck by other crew	striking equip within rules	hand signs	radio	both hand and radio
1	FE-32-97	34-lost balance	A5-between car	yes	58-riding	yard	10/16/97	thurs	night	0.8	yes	shoved	yes	3	no	yes			
2	FE-22-93	34-lost balance	A6-on/in loc	no	62-standing	line	06/04/93	fri	night	6	yes	pulled	no	2	no				
1	FE-04-92	35-missed handhold, grabiron, step	C6-on loc	no	24-getting on-trailin	yard/industrial	01/30/92	thurs	day	0.5	yes	pulled	yes	3	no	yes			
1	FE-02-97	50-slack action, draft, compressive	B6-side of car	no	58-riding-lead	siding	01/12/97	sun	night	35	yes	shoved	yes	3	no	no			
1	FE-18-92	20-defective/malfunctionioning ew	B7-on track	yes	2-adjust drawbar		06/20/92	sat	day	15	yes	free	yes	3	no	yes		yes	
1	FE-20-93	18-collision with motor vehi	A1-near equip	no	62-standing		05/22/93	sat	day	27	no		no	3	yes			yes	
1	FE-28-94	9-compressed	X9-fell in pit		99-other	industrial	11/10/94	thurs	night	0.5				3				yes	
2	FE-33-92	9-compressed	X9	no	99-other	industrial	10/15/92	thurs	night	14	no		no	3	no			yes	

number of FE type	report #	PCF	other crew cause code	external circumstance	PCF
1	FE-32-97	E29C-car defects H998-fell from moving equip		Moving Equipment	
2	FE-22-93	H599-other causes, train makeup or handling			
1	FE-04-92	H316-intra-crew communication		Board/disbaord wrong side	H996-insufficient training
1	FE-02-97	H503-slack action excessive		Unfam w/territory	
1	FE-18-92	H997-adequate space between equip H310-failure to couple H312-passed couplers		M411-close/no clearance	Use of wood chalks & decending grade of yard
1	FE-20-93	M302-highway user M501-interference with rr operations			
1	FE-28-94	H996-insufficient training H999-other train/human factors	M504-failure non rr employee		
2	FE-33-92	M999- M101-snow, ice, etc., on track			

Appendix F:

Recommendation Summary by FE

Appendix F: Recommendation Summary by FE

#	Report #	Date	RR	State	Recommendation #: 1	2	3	4	5
1	FE-03-92	01/28/92	BN	MN					
2	FE-04-92	01/30/92	AGC	FL					X
3	FE-08-92	03/11/92	FEC	FL				X	
4	FE-09-92	04/09/92	ATSF	AZ					
5	FE-14-92	06/01/92	ATSF	CA				X	
6	FE-15-92	06/01/92	BN	WA					
7	FE-16-92	06/02/92	IHRC	KY					
8	FE-18-92	06/20/92	CNW	IL	X				
9	FE-20-92	07/07/92	SSW	TX					
10	FE-22-92	07/25/92	UP	OR					
11	FE-30-92	07/24/92	GBW	WI		X	X		
12	FE-33-92	10/15/92	BN	NE					
13	FE-34-92	10/23/92	GTW	MI					
14	FE-39-92	11/16/92	TTIS	KY					
15	FE-11-93	03/27/93	SP	CA					
16	FE-13-93	04/13/93	CSX	KY					
17	FE-20-93	05/22/93	ATSF	TX					
18	FE-22-93	06/04/93	SEPTA	PA					
19	FE-23-93	06/07/93	IC	KY			X		
20	FE-26-93	07/15/93	CR	IN				X	
21	FE-27-93	08/04/93	UP	OK					
22	FE-30-93	08/11/93	SP	CA			X	X	
23	FE-31-93	08/12/93	ATSF	TX		X			
24	FE-35-93	09/02/93	ATSF	NM					
25	FE-40-93	10/19/93	SOO	ND					
26	FE-46-93	11/12/93	ATSF	TX					
27	FE-47-93	11/13/93	GC	GA			X		X
28	FE-49-93	12/05/93	SOU	GA			X		
29	FE-53-93	12/30/93	CR	OH					

#	Report #	Date	RR	State	Recommendation #: 1	2	3	4	5
30	FE-02-94	01/04/94	BN	NE					
31	FE-03-94	01/14/94	BN	TX					
32	FE-04-94	01/18/94	CSXT	GA					
33	FE-06-94	01/20/94	UP	NE		X			
34	FE-12-94	04/12/94	SP	TX					
35	FE-16-94	07/05/94	BN	MT					
36	FE-20-94	09/20/94	ARR	AK					
37	FE-26-94	10/17/94	UP	LA	X				
38	FE-28-94	11/10/94	PTRA	TX					X
39	FE-29-94	11/15/94	CR	NY			X	X	
40	FE-31-94	12/06/94	CR	NY		X		X	X
41	FE-32-94	12/13/94	UP	CA	X				

1994

#	Report #	Date	RR	State	Recommendation #: 1	2	3	4	5
42	FE-02-95	01/11/95	CR	IN					
43	FE-09-95	02/17/95	CR	OH			X	X	
44	FE-11-95	02/24/95	ATSF	TX	X	X			
45	FE-12-95	03/02/95	NS	SC	X		X		
46	FE-16-95	04/06/95	WC	WI					
47	FE-17-95	03/21/95	SP	CA					
48	FE-18-95	05/03/95	CSXT	IN		X			
49	FE-23-95	07/21/95	CR	PA					
50	FE-29-95	10/04/95	CSXT	IL	X				X
51	FE-33-95	12/11/95	NS	OH					
52	FE-34-95	12/14/95	CSXT	NC					

1995

					Recommendation #:	1	2	3	4	5
#	Report #	Date	RR	State						
53	FE-09-96	03/20/96	BRC	IL		X				X
54	FE-12-96	06/15/96	CSX	NC						X
55	FE-17-96	07/07/96	NS	IN						X
56	FE-22-96	09/03/96	DGNO	TX						X
57	FE-24-96	10/07/96	UP	TX		X				X
58	FE-30-96	12/16/96	UP	IA						
59	FE-31-96	12/18/96	IC	IL						
60	FE-02-97	01/12/97	UP	CA						
61	FE-04-97	01/29/97	UP	IA					X	
62	FE-05-97	02/02/97	CR	IN			X			
63	FE-16-97	06/06/97	CMRC	MI					X	
64	FE-18-97	06/24/97	UP	OR						
65	FE-19-97	06/24/97	NS	SC						
66	FE-22-97	07/18/97	MNCW	CT						
67	FE-25-97	08/15/97	UP	NV		X				
68	FE-32-97	10/16/97	MRL	MT						X
69	FE-36-97	12/02/97	BNSF	KS						
70	FE-45-97	12/26/97	UP	ID					X	
71	FE-02-98	01/24/98	BNSF	NE						
72	FE-05-98	02/04/98	BRC	IL			X			
73	FE-15-98	05/26/98	BRC	IL		X				
74	FE-16-98	06/01/98	BNSF	TX			X			X
75	FE-17-98	06/05/98	NS	GA		X				
76	FE-19-98	07/01/98	NS	KY						
					Recommendation #:	1	2	3	4	5
					TOTALS	**11**	**9**	**8**	**10**	**12**

50 FEs cited. Because of multiple referencing **37**, or **49%**, of FEs have a Recommendation applying.

Appendix G:

Data Format for Recommendation for Incident Investigation

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Appendix G: Data Format for Recommendations for Incident Investigation

In the body of this report we have presented recommendations for new data collection items that are recommended to be included in future versions of the fatal accident collection protocol. We have also recommended that data collection should be computer supported, reducing the labor associated with data entry and improving accuracy by entering the data in the data base directly at the source where it is collected. The following data field descriptors are provided in a format that is suitable for computer implementation, but they could also be used in equivalent paper forms. Sample formats in which data items would be presented are shown in Section 5.2.5.

In the elaboration of data field descriptions below, each data field will be classified according to data type, and where a small set of menu items are requested, the set of alternatives will be proposed. Where necessary, notes will be appended to provide guidance to understand the intent of the field. The references to Code Appendices are taken from FRA Guide for Preparing Incident / Incident Reports, DOT / FRA / RRS-22, January 1997.

Background Data

1. Field: Report Number
Type: Alpha
Comment: In the historical data set the report number has been constructed from the serial number of the incident within a specific year and the year of the incident. For example FE 13-98.

2. Field: Name of the approver of this report
Type: Alpha
Comment: The person who signed off on the report.

3. Field: Date of Sign-off
Type: Alpha

4. Field: Date
Type: Alpha
Comment: Date of the incident.

5. Field: Incident Category
Type: Alpha
Comment: All these incidents will be classified as switching operations incidents, but it needs to be coded for comparison with other FRA data

6. Field: Railroad
Type: Alpha
Comment: Name of the Railroad whose employee was killed

7. Field: city, town, village or other jurisdiction
Type: Alpha
Comment: Nearest city to where the incident happened. If it was not near a city, town, or a village, a township or county should be provided

8. Field: Day of the Week when the incident happened
Type: Calculated value
Comment: Calculated from the date of the incident.

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9. Field: Time
Type: Alpha
Comment: The time at which the incident happened that caused the fatality.

Weather/Visibility/Ground Conditions

10. Field: Weather
Type: Menu: Clear, Overcast, Partly-Cloudy, Raining, Drizzle, Snowing, Freezing Rain, Fog, Dust
Comment:

11. Field: Temperature:
Type: Alpha
Comment: In degrees Fahrenheit at the time of the incident

12. Field: Wind direction
Type: Menu : N, NE, E, SE, S, SW, W, NW
Comment:

13. Field: Wind speed
Type: Alpha
Comment: In miles per hour

14. Field: Humidity
Type: Alpha
Comment: Units to be defined

15. Field: Wind Chill Factor
Type: Calculated
Comment: From Temperature, humidity and wind speed

16. Field: Visibility
Type: Menu: Good, Fair, Poor
Comment: The reason for the visibility condition is contained in the weather reported above.

17. Field: Lighting Conditions
Type: Menu: Daylight, Dawn / Dusk, Night – no artificial lights, Night – artificial lights.
Comment:

18. Field: Ground Conditions
Type: Menu: wet, snow, wet snow, Frost, Ice, Muddy
Comment: This field is to be used together with the footing conditions associated with the site description Item 19

19. Field: Footing Conditions
Type: Menu: Walkway, grass, main-line ballast, walking ballast, Uneven walkway, debris
Comment: Move to Site Section

FE Personal Data

20. Field: Date of birth
Type: Alpha

`

Comment:

21. Field: Gender
Type: Menu: Male, Female
Comment:

22. Field: Length of Service
Type: Alpha
Comment: Time with this particular railroad

23. Field: FE Job Code
Type: Code: see Appendix D of Accident/Incident Report Guide
Comment: Enter the job code for the FE's regular work assignment

24. Field: Job Code of assignment at time of incident
Type: Code: report Same or See Appendix D of Accident/Incident Report Guide
Comment: If the FE was working a different assignment at the time of the incident, enter that job code here.

25. Field: Type of assignment
Type: Menu: Regular, Extraboard
Comment: At the time of the incident was the FE working a regular shift or on Extraboard?

26. Field: Length of time in occupation
Type: Alpha
Comment: Length of time in the Regularly assigned job code above, not necessarily the assignment at the time of the incident.

27. Field: Number of Months since last rules training
Type: Alpha
Comment:

28. Field: Number of months since last formal safety training
Type: Alpha
Comment:

29. Field: Was a safety briefing held on the day of the incident?
Type: Checkbox
Comment:

Work/Rest/Fatigue Issues

30. Field: Time Start Job
Type: Alpha
Comment: Investigator should collect these data from employee records for each of the last 30 days before the incident, including the day of the incident. This information and the next field can be codified into an easy-to-record tabular format. See Appendix B to this document for example.

31. Field: Time End Job
Type: Alpha
Comment: Investigator should collect these data from employee records for each of the last 30 days before the incident

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32. Field: Expected call time
Type: Alpha
Comment: This field is applicable to all employees.
33. Field: Actual call time
Type: Alpha
Comment: This field is applicable to all employees.

34. Field: Hours awake before reporting on day of incident
Type: Alpha
Comment: This information may be available from interviews with spouse or colleagues on the job

Personal Issues

35. Field: Did the fatality display any identifiable stress or emotional problems
Type: Checkbox
Comment: (for example, drugs, alcohol, family) If yes, provide narrative explanation

36. Field: Explanation of stress or emotional problem
Type: Narrative
Comment: Provide if answer is yes to previous question

37. Field: Was the fatality taking prescription medication?
Type: Checkbox
Comment: The time period on or just before the day of the incident is of interest.

38. Field: Result of drug / alcohol testing
Type: Alpha
Comment: Report BAC or Drug test result

Personal Protective Equipment

39. Field: What Personal Protective Equipment was the FE required to wear?
Type: Menu: N / A, Hearing protection, Eye protection, Footwear, Hard hat, Hard hat liner or other hood, Hand Protection, Safety Visibility Vest
Comment: Check all that apply.

40. Field: Was the protection in use?
Type: Menu: N / A, Hearing protection, Eye protection, Footwear, Hard hat, Hard hat liner or other hood, Hand Protection, Safety Visibility Vest
Comment: Check all that apply

41. Field: Was clothing, footwear or personal equipment contributory to the incident?
Type: Checkbox
Comment: If yes, answer the next question

42. Field: What clothing / footwear / personal equipment was involved
Type: Alpha
Comment: Answer only if answer to previous question was yes

`

FE Crew Information

43. Field: Engine Crew Composition
Type: Menu Engineer, Fireman
Comment: Indicate the number of each crew type

44. Field: Engineer yrs. railroad experience
Type: Alpha
Comment: Provide for each engine crew member identified

45. Field: Engineer yrs. craft experience
Type: Alpha
Comment: Provide for each engine crew member identified

46. Field: Train Crew Composition
Type: Menu: Conductor , Switchman, Brakeman, Student
Comment: Indicate the number of each crew type

47. Field: Conductor yrs. railroad experience
Type: Alpha
Comment: Provide for each train crew member identified

48. Field: Conductor yrs. craft experience
Type: Alpha
Comment: Provide for each train crew member identified

49. Field: Brakeman yrs. railroad experience
Type: Alpha
Comment: Provide for each train crew member identified

50. Field: Brakeman yrs. craft experience
Type: Alpha
Comment: Provide for each train crew member identified

51. Field: Switchman yrs. railroad experience
Type: Alpha
Comment: Provide for each train crew member identified

52. Field: Switchman yrs. craft experience
Type: Alpha
Comment: Provide for each train crew member identified

53. Field: Number of crew members on Ground
Type: Alpha
Comment: Provide for each train crew member identified

54. Field: Number of ground crew actually involved in the move
Type: Alpha
Comment:

55. Field: Were crew member drugs or alcohol contributory to the incident?

`

Type: Checkbox
Comment:

FE Activity at Time of Incident

56. Field: FE Physical Act
Type: Code
Comment: Select from Physical Act Circumstance Codes, FRA Guide Appendix F
57. Field: FE Event
Type: Code
Comment: : Select from Event Circumstance Codes, FRA Guide Appendix F

58. Field: FE Location
Type: Code
Comment: Select from Location Circumstance Codes, FRA Guide Appendix F

59. Field: Has FE worked this location in the past?
Type: Checkbox
Comment:

60. Field: Was FE familiar with local rules and procedures?
Type: Checkbox
Comment: Decide from interviews performed.

FE Crew Activity

61. Field: Engineer Physical Act
Type: Code
Comment: Select from Physical Act Circumstance Codes, FRA Guide Appendix F

62. Field: Engineer Event
Type: Code
Comment: Select from Event Circumstance Codes, FRA Guide Appendix F

63. Field: Engineer Location
Type: Code
Comment: Select from Location Circumstance Codes, FRA Guide Appendix F

64. Field: Trainman Physical Act
Type: Code
Comment: Select from Physical Act Circumstance Codes, FRA Guide Appendix F

65. Field: Trainman Event
Type: Code
Comment: Select from Event Circumstance Codes, FRA Guide Appendix F

66. Field: Trainman Location
Type: Code
Comment: Select from Location Circumstance Codes, FRA Guide Appendix F Repeat this series of three entries for each member of the FE Crew

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67. Field: FE Crew's anticipated next move
Type: Menu: Spot, Couple, Uncouple, Stop, Shove, Begin movement, Other
Comment: This field is useful to help understand potential sources of attention distraction.

68. Field: External or unusual circumstances
Type: Narrative
Comment: In this field put information that is relevant but does not fit the other categories. For example, Hand-switch confusion, Jammed knuckle, Illegal handrail.

Other Involved Crew

69. Field: Was another crew involved in the incident?
Type: Checkbox
Comment: If answer is yes, then fill in information below about that crew

70. Field: Engine Crew Composition
Type: Menu Engineer, Fireman
Comment: Indicate the number of each crew type

71. Field: Train Crew Composition
Type: Menu: Conductor , Switchman, Brakeman, Student
Comment: Indicate the number of each crew type

72. Field: Number of Crew members on Ground
Type: Alpha
Comment:

73. Field: Number of ground crew actually involved in the move
Type: Alpha
Comment:

Experience of Other Relevant Employees

74. Field: Yardmaster yrs. railroad experience
Type: Alpha
Comment:

75. Field: Yardmaster yrs. craft experience
Type: Alpha
Comment:

76. Field: Dispatcher yrs. railroad experience
Type: Alpha
Comment:

77. Field: Dispatcher yrs. craft experience
Type: Alpha
Comment:

Site Information

78. Field: Track Type

`

Type: Menu: Line of Road, Siding, Hump Yard, Flat Yard, Industrial, Industrial Spot, Stub Track, Storage, Repair, Cleaning, Inspection, Other
Comment: If Hump yard, Flat yard or Industrial Spot, fill in next appropriate field

79. Field: If Hump or Flat Yard, describe type
Type: Menu: Lead , Receiving/Departure , Classification, Repair, Storage, Service, Inspection, Other
Comment:

80. Field: If Industrial spot describe type
Type: Menu: Inside, Outside
Comment:

Equipment Movement Perspectives

81. Field: Was fatality a result of train, rail car or engine movement?
Type: Checkbox
Comment: If answer is yes, then fill in the following items

82. Field: Authority for Movement
Type: Menu: Dispatcher, Yardmaster, Conductor/Engine Foreman, Trainmaster, Other
Comment: Person who authorized or requested making the movement

83. Field: Speed of movement
Type: Alpha
Comment: If movement speed was unknown, enter 1 mph.

84. Field: Was employee struck by own crew' equipment or that of another crew
Type: Menu: Own Crew, Other crew
Comment:

85. Field: What was the nature of the movement?
Type: Menu: Pull, shove, free-running
Comment:

86. Field: Where on the locomotive / equipment was the FE riding?
Type: Menu: Side –leading end, Side-Trailing end, end
Comment:

87. Field: Were there other movements in the immediate area on same track
Type: Checkbox
Comment:

88. Field: Were there other movements in the immediate area on adjacent tracks
Type: Checkbox
Comment:

89. Field: Was locomotive / equipment operating in accordance with rules?
Type: Checkbox
Comment:

`

Communications Issues

90. Field: Type of signaling in use
Type: Menu: Hand signals, radio signals, none
Comment: If either hand signals or radio signals were in use, answer the sections below that apply.

If hand signals used, fill in the following fields

91. Field: Type of Hand Signals
Type: Menu: unaided hands, Fusee, railroad lantern, flashlight or other individual light, unaided hands under lights
Comment:

92. Field: Were employees on the lookout for signals?
Type: Checkbox
Comment:

93. Field: Did employees comply with the intent of the signals?
Type: Checkbox
Comment:

94. Field: Did employees act on any signal that they did not understand or that may have been intended for other trains or engines?
Type: Checkbox
Comment:

95. Field: Was the proper signal (stop, proceed, back up) given?
Type: Checkbox
Comment:

96. Field: Did employees use other hand signals that the entire crew understood?
Type: Checkbox
Comment:

97. Field: Were gestures that resembled a hand signal given that resulted in confusion to those acting on them?
Type: Checkbox
Comment:

98. Field: Were the employees giving signals plainly seen?
Type: Checkbox
Comment:

99. Field: Were signals given clearly so they could be understood?
Type: Checkbox
Comment:

100. Field: Were signals given on the engineer's side of the track when practical?
Type: Checkbox
Comment:

101. Field: Did the movement stop, in accordance with railroad operating rules
Type: Checkbox
Comment:

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102. Field: If a light was being used, under the same circumstances did the movement stop after the disappearance of the light?
Type: Checkbox
Comment:

If Radio signals used, fill in the following fields

103. Field: Type of Radio Used
Type: Menu: Handset, Chestpack, Remote microphone, Waist/belt pack, Locomotive mounted
Comment:

104. Field: Was the radio used when hand signals could have been used instead?
Type: Checkbox
Comment:

105. Field: Did the employees know which moves were to be made by radio comm.?
Type: Checkbox
Comment:

106. Field: Did the employees understand that while using the radio, the engineer will not accept any hand signals, unless it is a Stop signal.
Type: Checkbox
Comment:

107. Field: Were specific instructions given for each movement?
Type: Checkbox
Comment:

108. Field: Did the employees respond to those specific instructions?
Type: Checkbox
Comment:

109. Field: Was there a mixture of hand and radio signals used?
Type: Checkbox
Comment:

110. Field: If the movement involved backing or shoving, did the radio communication specify the direction and distance?
Type: Checkbox
Comment:

111. Field: Was the direction & distance acknowledged if that distance was more than four car lengths?
Type: Checkbox
Comment:

112. Field: Did the employees listen to make sure the channel was not being used?
Type: Checkbox
Comment:

113. Field: Did the employees give the required identification?
Type: Checkbox
Comment:

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114. Field: Did the employee continue to proceed, though acknowledgement was not received?
Type: Checkbox
Comment:

115. Field: Was proper identification a factor in the incident?
Type: Checkbox
Comment:

116. Field: Was the use of or the absence of "over" and "out" an incident factor?
Type: Checkbox
Comment:

117. Field: Did employees act on an incomplete or misunderstood radio comm.?
Type: Checkbox
Comment:
118. Field: Did employees acknowledge radio calls immediately?
Type: Checkbox
Comment:

119. Field: Was the movement stopped within half the distance specified when additional instructions were not received?
Type: Checkbox
Comment:
120. Field: Was the radio tested by crew at some point preceding the incident?
Type: Checkbox
Comment:

121. Field: Did radio malfunction any time b/4 incident and still used in service?
Type: Checkbox
Comment:

122. Field: Were there other radio communications that interfered with transmission?
Type: Checkbox
Comments:

123. Field: Was radio on and tuned to proper channel?
Type: Checkbox
Comment:

124. Field: Were proper radio procedures utilized?
Type: Checkbox
Comment:

125. Field: Was transmission/reception clear ?
Type: Checkbox
Comment:

126. Field: Was radio continuously operable ?
Type: Checkbox
Comment:

Emergency Response

127. Field: Were Railroad emergency response procedures followed?
Type: Checkbox

`

Comment: Each railroad has its own emergency response procedures

128. Field: Time of call to EMS
Type: Alpha
Comment:

129. Field Time of EMS arrival on the scene of the incident
Type: Alpha
Comment:

130. Field: Distance, in miles, EMS traveled to reach the scene
Type Alpha
Comment: This should be the distance traveled from the EMS equipment location at the time of the call to the site location

131. Field: Available reports
Type: Menu: Autopsy, Coroner, Police, Fire, Other
Comment: If other, please specify

Importance of Possible Contributing Factors

After the investigator has collected all the relevant factual information available and has completed the investigative phase of the evaluation, we recommend the following Fields be filled out. The definitions of the Possible Contributing Factors that are to be rated in Fields 132-141 are listed in Table 3-1 in Section 3.

132. Field: Physical Characteristics of the Rolling Stock
Type: Rating Scale

Comment: Please rate the importance of this possible contributing factor to the occurrence this incident using the following scale: 1= Extremely Important, 2 = Very Important, 3 = Moderately Important, 4 = Applicable but neither important nor unimportant, 5 = Not Applicable. The definition of the category is given in Table 3-1 of this document.

133. Field Track or Equipment Maintenance
Type: Rating Scale

Comment: Please rate the importance of this possible contributing factor to the occurrence this incident using the following scale: 1= Extremely Important, 2 = Very Important, 3 = Moderately Important, 4 = Applicable but neither important nor unimportant, 5 = Not Applicable. The definition of the category is given in Table 3-1 of this document.

134. Field: Worksite Configuration
Type: Rating Scale

Comment: Please rate the importance of this possible contributing factor to the occurrence this incident using the following scale: 1= Extremely Important, 2 = Very Important, 3 = Moderately Important, 4 = Applicable but neither important nor unimportant, 5 = Not Applicable. The definition of the category is given in Table 3-1 of this document.

135. Field: Sudden or Unexpected Movement of On-Track Equipment
Type: Rating Scale

`

Comment: Please rate the importance of this possible contributing factor to the occurrence this incident using the following scale: 1= Extremely Important, 2 = Very Important, 3 = Moderately Important, 4 = Applicable but neither important nor unimportant, 5 = Not Applicable. The definition of the category is given in Table 3-1 of this document.

136. Field: Crew Utilization
Type: Rating Scale

Comment: Please rate the importance of this possible contributing factor to the occurrence this incident using the following scale: 1= Extremely Important, 2 = Very Important, 3 = Moderately Important, 4 = Applicable but neither important nor unimportant, 5 = Not Applicable. The definition of the category is given in Table 3-1 of this document.

137. Field: Operating or Safety Rule Integral to Incident
Type: Rating Scale

Comment: Please rate the importance of this possible contributing factor to the occurrence this incident using the following scale: 1= Extremely Important, 2 = Very Important, 3 = Moderately Important, 4 = Applicable but neither important nor unimportant, 5 = Not Applicable. The definition of the category is given in Table 3-1 of this document.

138. Field: Intra-Crew Communication
Type: Rating Scale

Comment: Please rate the importance of this possible contributing factor to the occurrence this incident using the following scale: 1= Extremely Important, 2 = Very Important, 3 = Moderately Important, 4 = Applicable but neither important nor unimportant, 5 = Not Applicable. The definition of the category is given in Table 3-1 of this document.

139. Field: Inter-Crew Communication
Type: Rating Scale

Comment: Please rate the importance of this possible contributing factor to the occurrence this incident using the following scale: 1= Extremely Important, 2 = Very Important, 3 = Moderately Important, 4 = Applicable but neither important nor unimportant, 5 = Not Applicable. The definition of the category is given in Table 3-1 of this document.

140. Field: Fitness for Duty
Type: Rating Scale

Comment: Please rate the importance of this possible contributing factor to the occurrence this incident using the following scale: 1= Extremely Important, 2 = Very Important, 3 = Moderately Important, 4 = Applicable but neither important nor unimportant, 5 = Not Applicable. The definition of the category is given in Table 3-1 of this document.

141. Field: Training
Type: Rating Scale

Comment: Please rate the importance of this possible contributing factor to the occurrence this incident using the following scale: 1= Extremely Important, 2 = Very Important, 3 = Moderately Important, 4 = Applicable but neither important nor unimportant, 5 = Not Applicable. The definition of the category is given in Table 3-1 of this document.

The Figure below presents an example of how the start and end time for each day of the FE's work history for the last 30 days could be drawn graphically in a computer-implemented data entry system.

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The first column shows each day in the format in which D-13 means the 13th day before the fatality occurred. The D is the day that the fatality actually occurred. Begin the arrow with the Start Time and end the arrow with the End Time. See next page for example. In the example only 17 days have been shown.

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Work History and Possible Contributing Factors

Summary of the FE's Work Schedule Start and End Time for Each of Previous 30 Days of Work

DATE	12 M		2 AM	3 AM	4 AM	5 AM	6 AM	7 AM	8 AM	9 AM	10 AM	11 AM	12 N	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM	7 PM	8 PM	9 PM	10 PM
D-17																							
D-16																							
D-15																							
D-14																							
D-13																							
D-12																							
D-11																							
D-10																							
D-9																							
D-8																							
D-7																							
D-6																							
D-5																							
D-4																							
D-3																							
D-2																							
D-1																							
D																							

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The following contains the definitions of the Possible Contributing Factors that are to be rated in Fields 132-141.

RAILROAD SWITCHING OPERATIONS

Possible Contributing Factors

1. **Physical Characteristics of Rolling Stock**

a. Definition: Configuration of physical characteristics of engine, rolling stock, or other on-track equipment.

b. examples: flat car (mounting or dismounting), offset grab irons

c. cause codes: E30C, E19C

2. **Work Site Configuration**

a. Definition: Physical characteristics, layout, or configuration of any location at which a train or engine crew is expected to perform switching operations.

b. Examples: yard tracks, sidings, main tracks, industry track work site, etc.

c. Cause codes: M102, M404, M411.

3. **Operating or Safety Rule Integral to Incident**

a. Definition: Possible operating rules or safety infractions that could contribute to an incident.

b. examples: Person absent from leading car, speed violations, individual fouling track or equipment.

c. cause codes: H990

4. **Crew Utilization**

a. Definition: Assigned crew members that did not or could not fulfill roles required for safe operations.

b. examples: inexperienced crewmembers not properly supervised

c. cause codes: H316, H305

5. **Inter-crew Communication**

a. Definition: Absence or improper exchange of information between crews whose work needed to be coordinated.

b. Examples: Two crews working on same track with no communications.

c. Cause codes: H399

6. **Intra-crew Communication**

a. Definition: Failure of proper operation which could be due to absence of, or improper, exchange of information among crew members by face to face, radio, or hand signals.

b. Examples: lack of, or no, job briefing; changing work activities without informing other crew members.

c. Cause codes: H316

7. **Fitness f or Duty**

a. Definition: Personal factors related to train and switching operations such as drugs, alcohol or employee physical or mental condition.

b. Examples: impairment of efficiency or judgement because of drugs or alcohol (H101); employee physical condition, other (H199); other personal factors or limitations relating to physical or mental impairment

c. Cause codes: H199, H101,

8. **Sudden or Unexpected Movement of On-track Equipment**

a. Definition: Unexpected movement of on-track engine, rolling stock, or other off-track equipment that affects safety of a crewmember.

b. examples: free rolling cars or dropping cars on track being coupled.

c. cause codes:

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9. **Training**
   a. Definition: Failure of proper operations attributed to inadequate classroom, on-the-job general skills, or site-specific training or knowledge.
   b. Examples: inadequate classroom training; inexperience in on-the-job skills; inexperience in physical characteristics of track or work site.
   c. cause codes: H996

10. **Track or Equipment Maintenance**
   a. Definition: Physical condition of track or equipment was below established practices.
   b. Examples: sharp / worn flanges, worn switch points, crossover platforms bent, etc.
   c. Cause codes: E02C, E09C