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The Impact of Participatory Safety Rules Revision on Incident Rates, Liability Claims, and Safety Culture in the U.S. Railroad Industry

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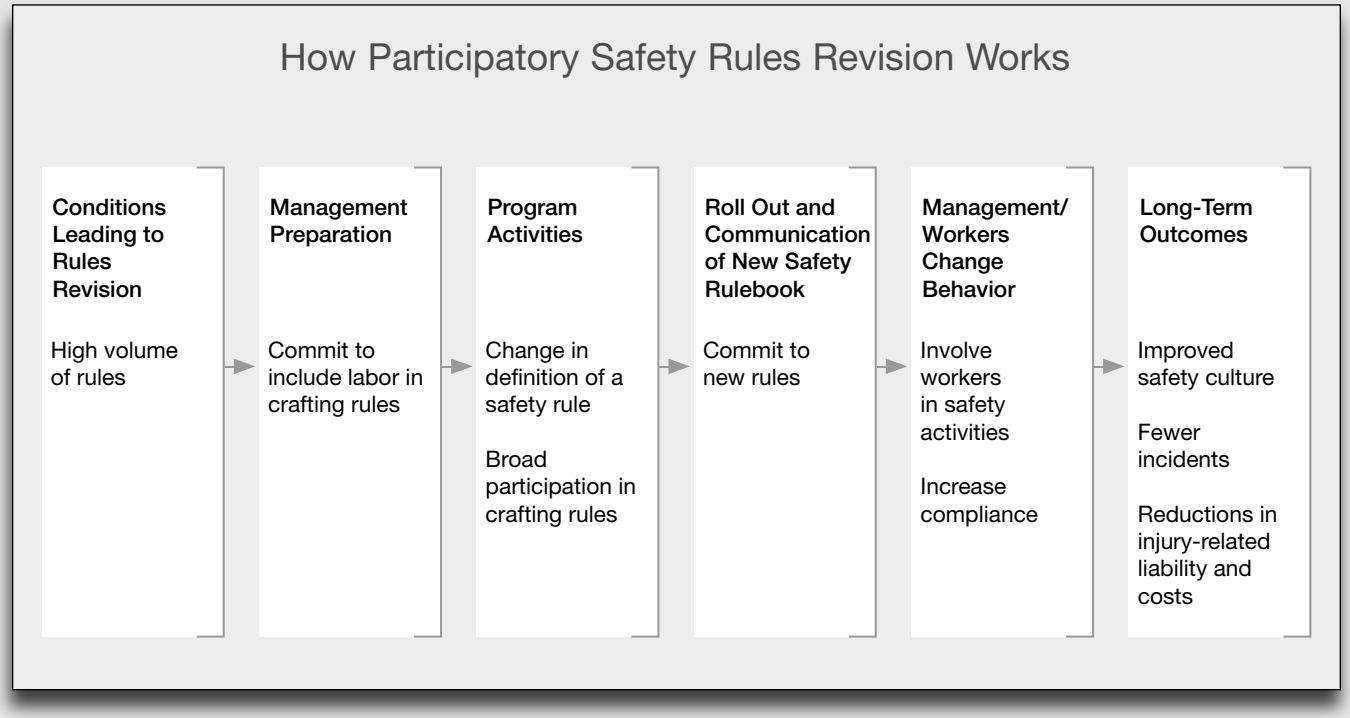

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13. ABSTRACT (Maximum 200 words)
The Federal Railroad Administration Human Factors Research and Development Program sponsored a lessons learned study to examine the impact of safety rules revision on safety culture, incident rates, and liability claims in the railroad industry. Safety rules revision identifies key rules that are universally enforceable and eliminates unnecessary and conflicting rules. The process also seeks to promote improvements in safety culture through labor-management collaboration by including a shift in primary responsibility for rules creation from management to front-line workers.

In this study, the evaluation team reviewed relevant literature, interviewed key participants (management and labor) from transportation carriers that had undertaken safety rules revision, and analyzed relevant incident and injury data. Although outcome data were statistically inconclusive, a number of other indicators in this study suggested a positive benefit on carriers that used the process. Interviewees reported more enforceable safety rules, increased compliance, and overall improvements in several aspects of safety culture, such as labor-management relations. Moreover, some carriers reported significant reductions in the number of claims related to the Federal Employer's Liability Act and the cost per claim. This report examines other potential benefits, challenges, and successful implementation strategies, as well as future directions and activities.

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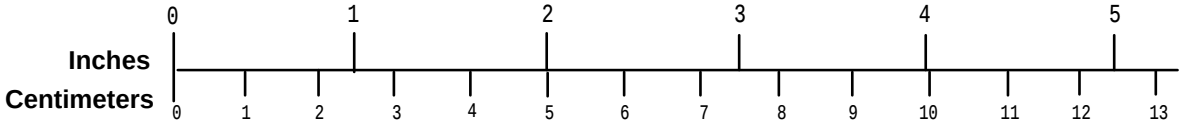

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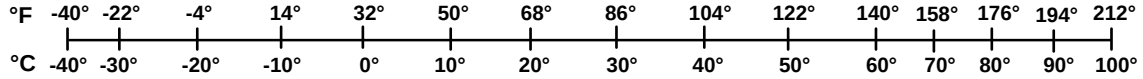

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Table of Contents

List of Figures

List of Tables

Preface

This report summarizes the lessons learned from the implementation of a new safety rules revision intervention in transportation carriers. The purpose of the study, sponsored by the Federal Railroad Administration (FRA) Human Factors Research and Development (R&D) Program, was to examine the impact of safety rules revision on safety culture, incident rates, and liability claims in the rail industry. To examine the impact and identify future activities in the safety rules revision area, the study examined lessons learned from transportation carriers that had undertaken safety rules revision. The study approach used data collected during interviews with management and labor employees in three railroads and one inland barge line. The data were content-analyzed to assess the impact on union-management relations, safety culture, liability claims, and other outcomes. The research team also examined injury rates at the carriers to judge the impact of the programs on safety. Given the preliminary and exploratory nature of this report, the data are used to suggest possible explanations and future activities.

The work has been performed under an interagency agreement between the FRA's Human Factors R&D Program and the Volpe National Transportation Systems Center's Operator Performance and Safety Analysis Division.

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Michael Coplen of the Federal Railroad Administration (FRA) Office of Research and Development (RDV) provided valuable, ongoing guidance. Thomas Raslear, FRA RDV, provided additional insights. The work was performed as part of an interagency agreement between the Volpe Center and FRA.

The authors express their gratitude to the safety and unionized operating employees of CSX Transportation (CSXT), Kansas City Southern (KCS), Canadian National/Illinois Central (CN/IC), and American Commercial Barge Lines (ACBL) who were interviewed in this study. The authors would like to thank Jessie Sampson, Teamsters, ACBL; Bob Keane, General Director Risk Management, CN/IC; Sandy Hall, Manager Operating Practices, and Paul Hillyard, Brotherhood of Railway Carmen, CSXT; and Thomas Leopold, General Director of Safety and Rules, and Fletcher Christian, United Transportation Union, KCS. Glenn Hotz, who led efforts as a senior safety executive at both ACBL and CSXT, provided perspective from experience with leading rules revisions at two companies. The authors would also like to acknowledge the insights gained from the Hile Group and Julie Hile regarding the technical principles underlying rules revision. Julie Hile also helped obtain access to the carriers that were involved in the study.

Last, but not least, the authors wish to acknowledge E. Donald Sussman and Jordan Multer of the Volpe Center for their valuable contributions.

Executive Summary

The purpose of this study, sponsored by the Federal Railroad Administration (FRA) Human Factors Research and Development Program, was to examine the impact of safety rules revision on safety culture, incident rates, and liability claims in the rail industry. To accomplish this and to identify future activities in the area, the authors examined lessons learned from transportation carriers that had undertaken safety rules revision. This report seeks to answer the following questions through a review of relevant literature, interviews with key participants (management and labor) in rules revisions at several freight carriers, and an analysis of incident data from the same organizations.

- How did freight carriers implement the safety rules revision process? What were some of the challenges these companies faced, and how did they address them?
- What are the impacts of safety rules revisions on safety culture, liability, injury rates, and other related outcomes?
- What enhancements to the current research methods would help the industry learn more about the costs and benefits of this intervention?
- What areas concerning safety rules revision should be explored in the future?

Research suggests that safety culture is a significant contributing factor to variations in workplace safety outcomes. Accordingly, organizations in a number of industries have undertaken a variety of reforms aimed to improve the safety culture with the goal of reducing occupational injuries and deaths. In the railroad industry, more carriers are using the safety rules revision process to improve safety culture and obtain greater participation of front-line workers in the prevention of injuries. During safety rules revision (or rules consolidation), the primary responsibility for rules creation shifts from the management to teams of front-line workers, with management in a supporting role. To avoid some of the pitfalls of the old rulebooks, such as duplicative and conflicting safety rules and confusion about which rules applied to everyone versus which ones applied only to a given craft, the rules revision process uses a strict definition of a rule. It must be possible to comply with a rule 100 percent of the time, and a rule must describe the ONLY proper way to perform a work activity.[1] To minimize confusion, rules that are applicable for all employees are defined as core rules, whereas those that are appropriate for only members of a certain craft are craft-specific rules. Thus, rulemakers can identify key rules that are universally enforceable and eliminate unnecessary and conflicting rules. The rulebook format is also modified, so that the rules are easier to locate than in the older rulebooks, which often contained operating rules, training materials, and job aids throughout. Books created using the rules revision process are easier to understand and comply with because of the strict definition of a rule, increased clarity in the rulebook format, and the significant reduction in the number of rules. Rules revisions seek not only to reduce confusion due to poorly written rulebooks, but also to promote compliance and workforce participation in the rules and improve safety culture through the process of carrier-wide negotiation and collaboration on the development of the safety rules.

[1] In addition to rules, recommended work practices also exist, which are suggested guidelines that do not have to be followed in every situation.

Several pressures in the railroad industry prompted companies to create voluminous safety rulebooks. First, when employee behavior not governed by an existing rule led to an injury, management often wrote a new rule to prevent similar injuries. Second, railroad mergers during the 1980s and 1990s resulted in the combination of hundreds of overlapping, and sometimes conflicting, safety rules. Third, the Federal Employer's Liability Act (FELA), which governs the handling of railroad worker injury compensation, requires plaintiffs to show employer fault to receive compensation.[2] In response, railroad management developed increasingly specific and numerous safety rules, which some members of the workforce contend led to confusion, the use of rulebooks as punitive tools for management, and rules proliferation to limit carrier liability.

Railroad management, labor, and FRA have expressed interest in safety rules revision to improve safety culture, prevent injuries, and reduce FELA-related losses in the industry. Rules revision builds trust between labor and management through broad workforce participation in the writing of rules and improves compliance because more ownership of the new rules exists. Carrier liability is reduced because the resulting rules are easier to understand and follow than the rules in use before the revision. Combining these benefits could lead to a reduction in injury-related costs, which could lead to a significant boost to the industry, as injury-related costs are considerable.[3]

Lessons Learned

Analyses of incident rate data and interviews with key participants in safety rules revision efforts suggested a number of lessons learned. These lessons learned were placed in one of four categories: bottom-line benefits, other benefits, implementation strategies, and challenges.

Bottom-Line Benefits

Incident rate improvements. A preliminary analysis of incident data at three carriers suggested that safety rules revision (combined with other senior management activities to increase workforce participation in safety) had a positive impact on incident rates at one rail carrier (Kansas City Southern [KCS]), where a statistically significant ($p < 0.01$) improvement occurred in incident rates beginning in 1999.[4] The management activities, which began before the actual rules revision effort, included a more developmental approach to rule violations and the hiring of a rules revision consultant to identify issues and build trust. Incident rate declines at the other two carriers could not be attributed with complete confidence to the process due to other changes that occurred at the same time, but available data did not fully rule out a positive impact on incident rates. During this study, it was not possible to assess the extent to which

[2] When an incident occurs, blame is assigned to either workers or management. Employees may lose their jobs if it is determined they violated a rule, and the carrier may have to pay damages (in addition to medical costs) to an injured worker for the rest of the worker's life if it is determined that management was acting in a neglectful manner. An unfortunate byproduct of the FELA insurance system is that rules have become central to the relationship between labor and management.

[3] In its 2000 quarterly report to shareholders, Burlington Northern Santa Fe Corporation (BNSF) estimated that its personal-injury-related events were $207 million (BNSF, 2001).

[4] Incident rates were calculated by taking the number of FRA reportable incidents (injuries, illnesses, deaths) per number of full-time equivalent workers per year.

implementation effectiveness varied between different departments within the carriers, or whether a reduction existed in the specific types of incidents related to the rules in the new rulebook. In addition, given the data available, it was impossible to assess whether rules revision was more important than the management preparatory work or vice versa, since the evaluation team could not distinguish their relative effects. In this analysis, their combined effect was investigated, since the management of preparatory work and rules revision were both concerned with changing safety-related values, attitudes, and patterns of behavior.

Reduced liability and injury costs. Safety executives at two carriers reported that the number of FELA claims and the cost per claim dropped significantly as a result of the effort. One executive suggested that FELA-related costs in his company decreased due to the increased clarity of the rulebooks and the decrease in the number of rules.

Spillover effects in non-safety areas. One executive added that rules revision collaborations can sometimes create positive spillovers into productivity-related areas by creating important organizational precedents for collaborative decision processes. One respondent noted greater worker involvement in activities he/she previously considered management work (reengineering, cost-cutting activities).

Other Benefits

- *Changes in values, attitudes, and patterns of behavior related to safety rules.* The rules revision process shifted the primary responsibility for defining safety rules from management to the workforce. Respondents reported that the revised rules focused on significant safety issues and could be complied with 100 percent of the time. Compliance was often not possible with the previous rules.
- *Changes in the usability and number of safety rules.* As expected, the rules revisions dramatically reduced the number of safety rules at the three carriers through a filtering process. The new book was important because it was a visible symbol that reached all employees and demonstrated a commitment to safety. The increased clarity also made the rules easier to follow, improved utilization, and better protected the workers.
- *Improvements in union-management relations.* Most respondents reported improvements in union-management relationships. These workers reported increased trust in management commitment to making the workplace safer. One respondent reported no change, and another reported improvement in management relations with rank-and-file workers but deterioration in management relations with union leadership.
- *Perceived changes in compliance.* Most respondents indicated that the rules revision process had brought greater compliance and greater safety consciousness.

Implementation Strategies

- *Senior management preparation activities*. Safety executives from three of the companies stated that senior management activities to increase the participation of the workforce in safety preceded the rules revisions.[5] The rules revisions occurred

[5] The topic of senior management preparation was not discussed with Canadian National/Illinois Central (CN/IC).

after senior management began to actively involve labor to make the safety culture more participative.

- *Participation.* Buy-in and participation at all levels of the company, from front-line worker to senior management, was deemed critical to successful implementation. Front-line worker involvement was central to the writing of the rules, and front-line supervisor commitment was especially important once the new rules were implemented.
- *External help.* An external consultant's project facilitation was helpful. Since long-time workers and managers were entrenched in the status quo, an external, objective perspective was valuable and helped keep the process on track.
- *Involvement of unions.* All respondents noted the importance of having rank-and-file union members involved in the process. They differed in their opinions about the extent to which involvement of union officials was desirable/necessary.

Challenges

- *Resistance to change among some groups*. Several respondents noted pockets of resistance to the rules revisions, citing managers who feared that the process would amount to "giving the keys to the inmates" and labor members who suspected that the new rulebook would be used to hammer people, just like the old one. Most respondents said that companies must allow time to work out differences in opinion. Some suggested that individuals could facilitate the process by leading by example (e.g., embracing and following the new rules).
- *Turnover on committees.* Since committees included a mix of labor and management, it took time to develop trust. Working through difficult issues also took time and often required multiple meetings to resolve. When a high degree of turnover existed on committees, the process was especially slow.
- *Resource requirements*. The process was time consuming and resource intensive. In addition to the costs of the employee time involved, most felt the need for an objective outside consultant. These costs could make the process prohibitive for the short lines and railroads with scarce resources. Railroads should not undertake this program unless they plan to see it through and sustain it long term.

In short, these findings are encouraging but not conclusive. Ultimately, a final evaluation of the rules revision process will depend upon how stakeholders weigh each of the various outcomes.

Future Direction and Activities

- *Reduction in injury-related liability and costs*. Safety executives from two carriers reported reductions in the number and cost of FELA claims as a result of rules revision. This could not be substantiated due to the lack of data from the carriers, but it is worth pursuing in the future given the significant costs associated with FELA claims in the industry (Section 2). The impact of safety rules revision on other injury-related costs should be studied more closely as well.
- *Senior management involvement.* Safety executives from three carriers discussed senior management preparatory work that included labor to make the safety culture

more participative. In this study, it was not clear whether rules revision was more important than the management preparatory work or vice versa, since the evaluation team could not distinguish their relative effects. Since positive results were found, especially at KCS, while analyzing their combined effect, future work will look more closely at the role of senior management in supporting rules revision and other safety interventions. In addition, management involvement after the preparatory activities should be considered to address rules revision sustainability. For instance, how were senior managers kept involved when a change at the top occurred? Several studies indicated the importance of senior management to safety, as well as the bottom line. The United Kingdom's Railway Safety organization developed a strategic safety management orientation program for senior managers to address issues raised about the role of senior management in the aftermath of the Clapham accident (Nelson, 2002). Analyzing other ways management can engage with labor to improve safety could prove beneficial.

- *Role of union officials.* Respondents from one carrier noted that union officials resisted rules revision. Future activity will explore the role of union officials in rules revisions, the source of their reservations, and their relations with rank-and-file workers and management; both of whom tended to be uniformly enthusiastic about rules revision.
- *Injury data impact assessment at different levels.* Core safety rules apply across the carrier, and craft-specific safety rules apply within a particular craft. Although the impact assessment provided in this report took the carrier as the unit of analysis, the extent and quality of implementation may vary by department. Thus, future research activities should look for variations in implementation across departments or crafts to test whether the safety outcome trends differ. Further, it is possible that a reduction occurred only in the types of incidents that specifically relate to the rules in the new rulebooks, rather than a generalized incident rate impact. Future activities should examine injuries related to the new rules and test for variations in safety outcomes. The department management or representing unions could use information about differences across crafts and types of rules in their efforts to improve safety.
- *Measure of compliance.* The interview data obtained in this study stated that compliance with safety rules improved as a result of the process. In the future, it will be helpful to obtain company records of safety rule violations, as a proxy for compliance, to confirm the interview data. The analysis could determine whether rule violations decreased for all rules, or only for the core rules. A general decrease in rule violations could be related to improvements in safety culture.
- *Sustainability.* At least one of the carriers studied has since added a considerable number of rules to its safety rulebook (coincident with the departure of the senior executive who sponsored the rules revision effort), raising the question of rules revision sustainability. Future activity might track rulebooks and safety practices in carriers that have undertaken rules revisions several years after the end of the process to assess the durability of the reforms. In particular, does the pattern of participation and rule drafting continue? Are core and craft-specific rules still 100 percent enforceable and not in conflict with other rules? Do the crafts still own their own rules? Finally, are subsequent increases in the number and type of rules related to increases in incident rates?

- *Resource intensiveness*. Most respondents mentioned that the process was time consuming and required the use of an external consultant. Future activity should investigate refinements to the process that make it less time intensive and costly while achieving the same level of consensus. For instance, the findings on the importance of leadership suggest that leadership coaching might be a cost-effective way to achieve some safety improvements. Reductions in resource requirements would be particularly essential for the smaller and more resource-constrained railroads. Future research should also study the return on investment for this intervention.

In conclusion, this study finds rules revision worthy of further consideration. Despite the lack of conclusive objective data, the interviewees agreed that safety rules revision had an overall positive benefit. Moreover, the outcome data, while inconclusive, suggests a number of possible benefits worth further exploration. The potential savings associated with a possible reduction in FELA claims alone merit future investigation.

1. Introduction

The proliferation of safety rules at U.S. railroad companies in recent years appears to hinder healthy safety cultures.[1] The sheer volume of these often overlapping rules contributes to poor compliance due to confusion and disagreement about which rules are to be followed. When combined with the existing regime of fault-based injury liability laws that govern the industry,[2] rules often become the focus of worker-management conflict rather than tools for communication about safety hazards and solutions. In response to this problem, several railroad carriers developed and refined a rules revision process that they claimed increased the value and clarity of safety rulebooks and improved the safety culture in which the rules were embedded. Proponents suggested that the improvement of safety culture through this intervention led to decreases in injury rates. This study focuses on this intervention, known as rules revision (or rules consolidation), and includes the following elements: senior management sponsorship, shifting primary responsibility for defining rules from management to the workforce, broad participation in the crafting of the new rulebook, a strict definition of what is and is not a rule, and an easy-to-understand book format. In this report, whenever the term rules revision is included, it refers to the process that includes these elements. Whenever the term rules is used, it refers to safety rules.

Rules revision seeks to change patterns of behavior within the organization. The primary responsibility for determining the worth of rules is transferred from management to the workforce. This shift is thought to increase the workforce's ownership of the rules, how they value the rules, and their willingness to be governed by them. A premise of the intervention is that the shift in ownership, as well as the strict guiding principle for defining rules, and the improved book format lead to increased trust among workers and management, a more usable rulebook, increased compliance, and a resulting decline in injuries.

FRA funded this study to assess the impact of rules revision as an instrument of safety improvement. The Volpe National Transportation Systems Center (Volpe Center), with the assistance of the Western Michigan University Evaluation Center, prepared this report and summarized lessons learned by freight carriers that have undertaken these reforms. In addition to assessing the impact of rules revision on safety outcomes, the report summarized lessons learned about successful implementation. The following key questions drove the research:

- How did freight carriers implement the safety rules revision process? What were some of the challenges these companies faced, and how did they address them?
- What impacts have safety rules revisions had on safety culture, liability, injury rates, and other related outcomes?

[1] The definition of safety culture used for this study is taken from the United Kingdom's Advisory Committee on the Safety of Nuclear Installations (ACSNI) Human Factors Study Group in 1993: "The safety culture of an organization is the product of individual and group values, attitudes, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organization's health and safety programmes."

[2] One study suggests that FELA–the governing liability law in the rail industry–perpetuates an acrimonious environment between management and employees when it comes to safety rules (Reinach, 2001). Moreover, an FRA-sponsored safety culture assessment reported that the current disciplinary process "encourages false reporting and pressure not to report injuries" (Evans Planning Group, 1998). Section 2 provides more details on FELA and its relationship to safety culture.

- What enhancements to current research methods would help the industry learn more about the costs and benefits of this intervention?
- What future directions concerning safety rules revision would be useful?

Data for the study came from a series of interviews with safety executives, workers, and union officials at three railroads and one barge line (see Section 3). Injury rates from three of the four carriers were also examined to assess the impact.

The findings reported herein might help rail carriers to (1) decide whether to undertake rules revision, (2) determine how to most effectively implement such a revision, (3) assess the impact of revision processes on labor-management relations and other facets of organizational culture, and (4) assess the potential effectiveness in reducing injuries and liability claims. In addition, the findings will help FRA to identify concerns that are important to the industry in the area of safety culture. FRA has a long-term goal of sponsoring a workshop where promising safety culture interventions will be shared with the industry. Information from this study will be used to help determine if safety rules revision should be included in that workshop.

The report is organized into five sections. Section 2 reviews the link between safety culture, rules revision, and safety outcomes. It also outlines the process by which rules revision is thought to shift responsibility for the rules from management to the workforce, resulting ultimately in safety outcomes. Section 3 provides an overview of the data collection methods used in this study. Section 4 summarizes key findings from the analysis of interview and incident data. This summary includes the context for the efforts, how rules revision processes were implemented, and a preliminary assessment of whether the rules revision process has succeeded in improving carriers' safety cultures, injury rates, injury-related costs, and other outcomes. Section 5 provides conclusions and recommendations.

Throughout this report, readers should bear in mind that the findings presented herein are based on a small sample size and retrospective recollections of participants who had participated in the rules revision process. Thus, the findings are suggestive and exploratory rather than definitive. Having said that, the findings provide a baseline for discussions about the rules revision process's potential for effectiveness in the rail industry and for future research and evaluation activity on the topic. Section 5 provides suggestions for future research and evaluation.

2. Literature Review and Program Theory of Change

It is reasonable to ask whether an intervention's design addresses key drivers of safety success. Such knowledge can provide useful information in diagnosing reasons for program failure and provide a roadmap for program improvements. Proponents of rules revision believe that the key point of leverage is improvements in safety culture, which will lead to increased compliance with the rules and a reduction in injuries. This section presents a brief review of literature on (1) the relationship between safety culture and safety outcomes, (2) the link between safety rules and safety culture in the rail industry, and (3) precisely how the rules revision process is supposed to leverage these connections into safety improvements (the theory of change).[3]

2.1 Safety Culture and Its Linkage to Safety Outcomes

A growing body of research has shown safety culture to be associated with positive safety outcomes. A study of 50 chemical plants with 6,000 employees demonstrated the relationship between positive safety culture and lower accident rates using a survey (Carder and Ragan, 2003). This study took place over 10 years and included extensive psychometric testing to verify the results. Ostrom, et al. (1993) conducted a study that found that an organization's shared beliefs and attitudes about safety, as measured by a survey, were found to differentially affect safety performance in different departments, according to accident rates. This study, conducted with a Department of Energy contractor, used a second survey based on the indigenous norms and values of the resident organization. Hofmann and Stetzer (1996) conducted a third study and found that safety culture, measured using a survey, and unsafe behaviors, measured by random safety audits, were associated with actual accidents. Data were collected from 21 teams and 22 individuals in a midwestern chemical processing plant. A fourth study, conducted with four railroads, found that the business units with the most positive safety cultures, as measured by a survey, were those units with the best safety performance (Bailey and Petersen, 1989). Yet another study that provides evidence of the relationship between positive safety culture and lower accident rates used case analysis methods. This case study, examining the positive safety culture of an aircraft carrier, found that where loss of life was expected due to the complex, inherently hazardous nature of the work, a minimal number of unsafe events were found (Rochlin, LaPorte, et al., 1987) The study described the patterns of behavior and values that encourage this proactive, vigilant safety culture.

In a random sample of 97 Canadian manufacturing plants, Simard and Marchand (1997) found a positive relationship between safety culture and compliance with safety rules. This study, involving 1,061 workgroups, also found that the supervisor's propensity to engage in participatory management of safety was important, reinforcing the idea that increased ownership relates to compliance.

While the studies previously mentioned are concerned with industrial, transportation, and military organizations, the linkage between safety culture and injury rates receives indirect support from a study conducted in the service industry. Naumann and Bennett (2000) found that, in a study of banks, improvements in one aspect of organizational culture–procedural justice

[3] A more extensive review of safety culture literature appears in the "Baseline Data Collection Summary Report: Amtrak Safety Rules Revision Process" (Ranney, J. and K. Chang, 2001).

culture[4]–were associated with increases in the frequency of helping behaviors. While their study does not focus on safety, it provides evidence that improvements in organizational culture can increase employees' willingness to engage in behaviors that contribute to the achievement of group goals. Examples of safety-related helping behaviors might include participation in safety activities, such as safety committees.

The values and patterns of behavior associated with safety rules can best be understood in an historical context, beginning with a discussion of the labor-management relationship. Railroads, like other transportation modes, derive their organizational structure from a military model and therefore have a strong command and control hierarchy. Aviation, maritime, and railroads all demonstrate this pattern, with aviation being influenced by the U.S. Air Force, maritime by the U.S. Navy, and railroads by the U.S. Army. This military influence encourages an authoritarian management style that permeates the entire enterprise, including this study's specific interest area of safety rules. At the same time, the unions in the transportation industry are also strong and commanding in their own way. Transportation unions are powerful for two reasons:

- First, highly skilled workers, such as pilots, air traffic controllers, captains of ships, and locomotive engineers, take many years to become experienced. If they choose to strike, they are difficult to replace.
- Second, the same unions represent the same job categories across the industry, which means that a locomotive engineer working in any railroad in any part of the country is represented by the same union. As a result, a union issue in one geographical area could be felt throughout the country. Organizational tension is created on safety rules and other issues when management's military style meets labor's highly skilled power style.

The historical trends in the scientific paradigms that underlie safety analysis affect safety rules. Hale (2000) suggests that the current interest in safety culture is part of a broader paradigm shift in the safety discipline away from a blame the worker, rule-based approach and toward a systems view of the causes of incidents, including organizational explanations. A century ago, he writes, the field was primarily focused on designing-out injuries through technology. This focus led to significant advances with technologies such as "personal protective equipment, no-go areas around dangerous processes and bursting disks and bunds for tanks."[5] According to Hale, the human factor age, characterized by an increasing focus on the individual contribution to accidents, followed the engineering age. Significant improvements were made and continue to be made, related to operator performance. The engineering and human factors ages shared an emphasis on eliminating, as far as possible, the need for unnecessary human intervention through automation. If human intervention could not be eliminated, the approaches sought to reduce harm by restricting individuals' choices by specifying rigid rules. Hale writes:

> Ultimately, we get a rule for everything and safety is seen as something which requires no thinking any longer, but simply good training, a prodigious memory, a large safety manual or computer to refer to, and an iron discipline.[6]

[4] Procedural justice culture involves perceptions about how a group is treated as a whole.
[5] Hale (2000), p. 6.
[6] Ibid., p. 7-8.

These approaches have been succeeded by the belief that safety analysis must look at organizational, not just individual, factors.

2.2 Rules, FELA, and Safety Culture in the Rail Industry

Existing safety practice in the rail industry has traditionally reflected the engineering and human factor ages with the emphasis on reducing discretion through rules (2000). Indeed, it is not uncommon for rail carriers' safety rulebooks to have more than 500 rules.[7] For the most part, the rules are extremely detailed. They are often duplicative and unclear. Reactive rulemaking; mergers and acquisitions; liability and FELA; and rules, safety culture, and safety outcomes contributed to the proliferation of rules in the rail industry.

2.2.1 Reactive Rulemaking

Industry officials noted that safety rules were frequently written in response to particular accidents or near misses. The motivation for writing rules appeared to be connected to a desire that similar accidents never happen again. Supervisors often reported that having an employee killed, injured, or even experienced a near miss could be a life-changing experience–one that supervisors never wanted to live through again.

In short, a primary reason for the proliferation of rules in the rail industry is the desire to prevent accidents. A classic study of bureaucratic organization once observed that compassion spawns red tape (Kaufman, 1977).

2.2.2 Mergers and Acquisitions

The large number of mergers and acquisitions in the railroad industry contributed to the proliferation of safety rules in railroad companies. A review of Coleman's "The Family Tree of North American Railroads" suggested that 170-200 mergers and acquisitions occurred between 1865 and 1995 in the United States (Coleman, 2001). Coleman's analysis was limited to Class I, former Class I, or major regional lines and, therefore, should be taken as a conservative number. Many of the railroads had too many predecessors to track. This food chain-like dynamic produced the Class I railroads. To highlight a few Class I examples between 1996 and the present: Southern Pacific acquired Denver & Rio Grande Western and Saint Louis Southwestern in February 1997. Union Pacific then acquired Southern Pacific in 1997. In 1999, a portion of Conrail merged with CSX Transportation (CSXT), and another portion merged with Norfolk Southern.

The need to combine rulebooks occurred every time as each railroad had a pre-existing set of practices and historical circumstances reflected in their rulebooks. Most companies did relatively little to address the inevitable duplication and inconsistencies that resulted from the merging process.

[7] See Table 1 for an account of the number of rules in the carriers studied both before and after the rules revision process.

2.2.3 Liability and FELA

Existing liability laws for the rail industry provide a clear economic incentive for a proliferation of rules. FELA, which governs worker compensation for injuries, is best understood in contrast to the worker's compensation system that governs most other industries.

Worker's compensation is a no-fault system that bases the cost of premiums on the injury rates of the industry. Both employers and employees pay into the system, and employees receive benefits when a claim is approved. Essentially a contract exists between employers and workers whereby employers lose a number of previously available legal defenses against liability, including contributory negligence on the part of the worker and the claim that workers voluntarily assume risk in taking their jobs. In exchange, the worker's compensation system regularizes employers' exposure to liability by linking compensation to a benefits schedule that increases as a function of the injury's severity. For their part, workers accept ceilings on employer liability in exchange for the avoidance of lengthy litigation and delays in the receipt of benefits (General Accounting Office, 1996).

FELA retains the kernel of a fault-based system in that employees retain the right to sue employers and employers retain access to the defense of contributory negligence on the part of employees. Employee compensation is determined after an apportioning of fault between employer and employee.[8]

The FELA system encourages the proliferation of safety rules because the existence of a safety rule, and evidence that the employee failed to follow the rule, can be an effective employer defense against liability claims. Thus, companies may view the proliferation of rules as a way to minimize exposure to liability in a fault-based system in which such exposure can vary considerably over time. The financial incentives for rulemaking are intensified by the fact that, under FELA, employers must place into escrow the amount equal to the claim an injured employee makes.

2.2.4 Rules, Safety Culture, and Safety Outcomes

The proliferation of rules, combined with the fault-based nature of FELA, tends to foster an adversarial relationship between railroad management and labor, in which each party wants to blame the other. As a result, full and complete investigation of an accident or injury might not occur, due to incentives for both the employee and railroad management to avoid revealing any facts or circumstances that would indicate their responsibility for the accident or injury.

When a reportable safety incident occurs, a worker's immediate concern, other than the extent of his injury, is his job. If the accident investigation team determines that he has broken rules, he

[8] Over the years, the FELA system has adopted a number of administrative procedures that streamline the claims process, rendering it similar to the no-fault worker's compensation system. For most claims, the employee and the railroad's representatives negotiate directly and reach a settlement. Approximately 70 percent of claims are settled this way. Another 10 percent are settled after the employee retains legal counsel but before a suit is filed. The remaining 20 percent of injury cases are litigated in a traditional adversarial process; of these, only 5 percent reach the point of a jury verdict (Reinach and Gertler, 2001).

may be let go.[9] No matter what, the outcome of an injury is typically a negative mark in an employment record. Indeed, some unions are unwilling to participate in investigations since part of the goal is to assign blame and potentially mete out disciplinary action. Thus, this reporting system discourages the airing of important safety-related information, inhibits the creation of a cooperative working relationship between labor and management, and may hinder efforts to improve safety in the workplace.

Previous research supports this view of the rules and FELA in safety culture. For instance, a study conducted by Elling (1991) on worker perceptions found that British railway workers perceived safety rules negatively. In particular, this included the following:

- 80 percent of respondents considered that the rules were mainly concerned with pinning blame.
- 79 percent of respondents thought there were too many rules, 12 percent thought there were too few; only 9 percent had no complaints on this score.
- 77 percent of respondents found them conflicting, 95 percent of respondents thought that work could not be finished on time if the rules were all followed.
- 85 percent of respondents found it hard to find what they wanted in the rulebook.
- 70 percent of respondents found them too complex and hard to read when they had found them.
- 71 percent of respondents thought there was little motivation given to follow rules.

"Not one [of the respondents] could remember ever having referred to the rules in a practical work situation in the last six months." Similarly, a study of railroad yard employees found that employees perceived that management used the safety rules against employees, especially in cases of injury, to protect the financial interests of the railroad (Reinach and Gertler, 2001). The authors of this study suggested that FELA contributed to an adversarial relationship between workers and management.

The FELA adversarial safety culture has economic and safety implications. The search continues for ways to reduce injury costs. In its 2000 quarterly report to shareholders, BNSF estimated its personal injury-related events were $207 million (BNSF, 2001). Though injury costs were lower that year than during the previous 2 years, they were still a significant burden and contributed to annual decreased net income for the railroad. In 1994, the Transportation Research Board estimated that job-related injuries cost Class I railroads more than $1 billion annually (Reinach and Gertler, 2001).

Views of the costs of FELA and its impact on safety are divided. Unionized workers believe the cost of potential FELA awards can be used as leverage to ensure that management eliminates unsafe conditions. Management, believing that the FELA compensation concept is out of date, focuses primarily on the safety costs incurred by damaged equipment (Reinach and Gertler,

[9] Generally, after an accident, the supervisor submits a form to a central reporting office detailing the incident. This form often includes the supervisor's report, the employee's report (including a legal release), and a portion to be filled out by a medical treatment facility. If warranted, a committee, which may include a union representative, is formed to investigate the accident.

2001). In either case, it appears that improving rule compliance would reduce the number of injuries to the satisfaction of labor and lower liability costs to the satisfaction of management.

2.3 The Program Theory of Change Behind Rules Revision

The proliferation of rules, combined with FELA's liability regime, has created disincentives for open communication about safety issues, cooperative efforts to address safety problems, and compliance with rules. Safety rules revision represents one type of intervention designed to address challenges in safety culture and, ultimately, improve bottom-line safety performance. Given the evidence that improvements in safety culture are an important component in the theory linking rules revisions to reductions injury rates, the question becomes: How can rules revisions change safety cultures?

This section describes the rules revision process in greater detail, as well as the mechanisms by which it seeks to change safety culture and safety outcomes.[10] The section begins with a general statement of the mechanisms rules revision uses to leverage changes in safety culture, specifically which values and patterns of behavior it seeks to change.

The revision process that is the focus of this study views formal safety rules as an essential part of a carrier's safety culture. The process includes broad workforce participation in the decision about what rules are worthy of being rules, determination of which rules cover all employees and which ones are craft specific, and what language will be used in the new rules. The conventional approach to safety rules revision has been to have the safety department commission a technical writer to rewrite them with direction from management. This conventional approach results in a new rulebook, but it generally does not include broad participation from the workforce. In contrast, the rules revision process that is the focus of this study sees the rewriting of the rulebook as an occasion for improving the safety culture. The advocates posit that rules will be effective only if "values, attitudes, competencies and patterns of behavior" support them (ACSNI, 1993) that directly change the blame game. Carroll further suggested that other safety process management practices must support to impact outcomes. Carroll noted that that removing the blame game and increasing compliance allowed for more robust safety management practices to function effectively, such as improved root cause analysis and communication between engineers and operators (Carroll, 2000).

The desired result of rules revision is to make the rules more credible and hence worthy of being used by the workforce for governance and standard setting. The process changes the "values, attitude, competencies and patterns of behavior" by shifting the primary responsibility for

[10] The description of the rules revision program theory is based on discussions with the Hile Group, the primary provider of consulting services in the safety rules revision process. The Hile Group has implemented this approach at four railroads (BNSF, CSXT, KCS, and CN/IC) and one inland waterway carrier (American Commercial Barge Lines (ACBL)). Attempts to describe the theory of change behind programs and policies are often called program theories (Chen, 1990; Chen and Rossi, 1992). Program theories can aid in program design, modifications, and evaluations in a number of ways. First, they provide a shared road map for the implementation of an intervention. Such road maps provide useful benchmarks that allow program designers and stakeholders to chart implementation progress. Second, such program road maps help evaluators and stakeholders discern the extent to which any findings of no impact might be the result of implementation failure versus inherent flaws in program design. Finally, program theories aid in program improvement by identifying strong and weak points in the flow of events that link program inputs and processes with policy outcomes. Indeed, one often finds that some parts of an intervention work better than others.

drafting rules from management to workers and by revising or eliminating rules that are not meaningful to the workforce. When rules are conflicting and voluminous, one can easily defend noncompliance to oneself and to one's peers. When only a few rules exist that one's peers have drafted personally, common sense and peer pressure encourage compliance. Rules revision, in short, is a process of "streamlining rules into the culture."[11]

Figure 1 illustrates the linkages.[12] On the far left side of the diagram lie the conditions that lead to a need for rules revision. Next to these conditions are the activities in the safety rules revision process itself. The third box depicts factors related to compliance with the new rules, including sense of ownership, communication, and cooperation among various parts of the organization undergoing rules revision. Finally, on the far right side of the diagram are the program's long-term goals for outcome measures.[13]

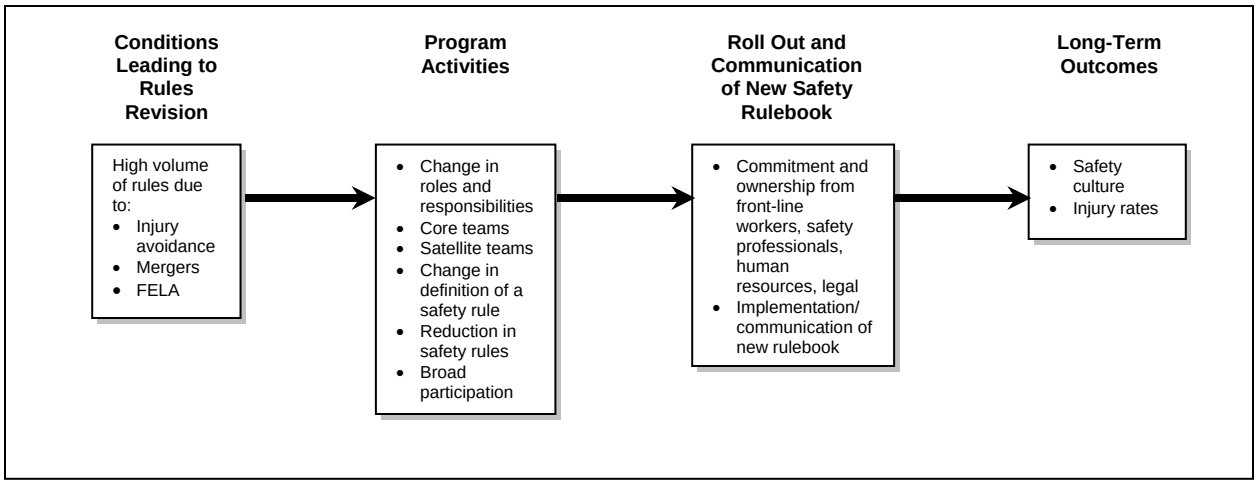

Figure 1. Rules Revision Program Theory

The third box in Figure 1 is important because it emphasizes that stakeholder commitment, ownership, and communication are essential components. The process employed by the Hile Group features the following strategies for developing such commitment, ownership, and open communication:

- Management, employees, and unions are involved in all aspects of the process.
- A Core Team is created to oversee the work of craft-specific Satellite Teams, draft rules and non-rules materials (e.g., recommended work practices), disseminate information, incorporate feedback, and promote the cultural shift.
- Craft-specific Satellite Teams draft craft-specific rules and non-rules materials, disseminate information, incorporate feedback, and promote the cultural shift.

[11] Hile Group interview.

[12] The program theory presented here was revised as a result of what was learned in this study. Section 5 presents the revised program theory.

[13] Like most program theories, this diagram is an oversimplification. Indeed, one could provide a more indepth model of the relationship among these outcomes. For instance, it may be that an interaction exists between safety culture and incidence of at-risk behaviors. Moreover, changes in both safety culture and at-risk behaviors/conditions might cause changes in injury rates.

- All crafts, functions, constituencies, and possible attitudes regarding the process are represented on the Core and Satellite Teams.
- Consultants are involved in project design, facilitation, provision of safety performance expertise, and writing support.
- An explicit implementation/communication phase is included after the new rulebook is written to communicate the new rules to all employees (the consultant supports but does not provide it).

The use of Core and Satellite Teams increases the ownership and accountability for the rules by the workforce and specific unions. Core Teams write core rules, which are defined as practices across all crafts that can be complied with 100 percent of the time and that represent the only way to perform a work activity. Satellite Teams, comprised of union representatives from the major crafts (Operations, Mechanical, Track Engineering, Clerical), write craft-specific rules that should be complied with 100 percent of the time for a specific craft. The Core and Satellite Teams clearly distinguished rules from recommended work practices. Recommended work practices, as the name implies, are to be followed at the worker's discretion, making allowances for the particular circumstances in which workers find themselves. Given the crisis-and-response origin of many safety rules generated under the FELA regime, many of the rules in the older safety rulebooks do not apply to all workers in all situations. Therefore, reclassifying the rules as recommended work practices increases the focus on the real rules.

Proponents of rules revision note that another important change is the language and tone of the rules. When management writes the rules, they are written from a "thou shalt" perspective. When the workforce writes the rules that govern themselves, they are written from a more introspective "we will" perspective. Changing from "thou shalt" to "we will" reflects a change in values and attitudes from the traditional top-down approach for rules and safety activities to one that is participatory instead. Proponents contend that this change in language was one reason why compliance was easier to obtain.

Below is an example of an old rule exemplifying the "thou shalt" attitude and how it was changed to a rule with more of a "we will" attitude on the part of the worker.

- Old Rule for Welding-Fire Protection:

  Use only a friction lighter, stationary pilot light, or some other source of suitable ignition to light torch. Do not light torch with matches, cigarette, or cigarette lighter (Illinois Central Railroad System, 1998).

- New Rule for Welding-Fire Protection:

  Use only approved flint strikers to light welding torch (CN/IC, 2002).

Previous research provides some validation of the linkage between participatory decisionmaking by the workforce and rule compliance. Several studies have found that safety compliance is higher when workgroups have some power and influence over the decisions that affect their safety. Grote and Kunzler (1996) and Grote et al. (1997) found in their study of chemical and transportation companies that the integration of safety in day-to-day operations was easier in organizations whose primary task was defined in terms of the quantity, quality, and safety of

production, as opposed to organizations whose primary task was only defined in terms of quantity and quality. Rules revision gave significant control to workgroups over safety in their work environment because it allowed them to rewrite the safety rules used on a day-to-day basis.

Other studies point to the critical role that first-line supervisors play in safety rule compliance.[14] In their research on workgroup propensity to comply with safety rules, Simard and Marchand (1997) found that micro-organization factors at the front line are the primary determinants of compliance. Research was conducted using 1,061 workgroups from a random sample of 97 manufacturing plants. Results from this study suggest that a cooperative workgroup-supervisor relationship is the most important variable, but the supervisor's propensity to engage in participatory management of safety was also important. Other findings suggested that the front-line supervisor may act like a safety culture engineer by motivating workers to conform to safety rules rather than imposing rules on them. Simard and Marchand (1997) found that compliance was higher when supervisors had some control over the safety of their people. Naumann and Bennett (2000) found, in their study of 220 employees at 40 different locations of 2 banks, that safe behavior and perceptions of safety are largely dependent on supervisors. This study found that workgroups whose supervisors applied the same policies and procedures to all employees perceived more fairness than workgroups whose supervisors applied policies and procedures less systematically.

Finally, other studies point to the importance of senior management in fostering compliance. In a study on compliance with operating rules in the rail industry, Coplen (1999) found that senior management unintentionally encouraged middle management to value productivity over protection by offering productivity bonuses and other incentives. Findings by Ranney (1996) linked senior management leadership in managing team-based organizations to bottom-line results.

In sum, proponents believe that rules revision only improves safety culture and outcomes when all the groups in an organization work together effectively to encourage the change in the pattern of behaviors and values in which safety rules are embedded. The combination of players, decisions, dialogue, and new rulebook are necessary to change the system in which the safety rules are embedded.

[14] These studies are interesting because supervisor activity is not directly emphasized in the Hile Group's approach.

3. Methods

Two sources of data were collected from carriers that completed rules revisions: interviews and incident data. Incident data allowed the evaluation team to examine the impact of rules revision on bottom-line safety outcomes. The interview data, by contrast, allowed the team to examine the reasons for undertaking rules revisions, key implementation issues, and a range of possible outcomes of the intervention.

3.1 Interview Data

Eleven people were interviewed from three railroads and one in-land barge carrier. Respondents included five senior safety officials and six workers/union members. A barge carrier was included because it was transportation-related, previously had a large number of safety rules, and used a similar rules revision process. One of the railroads (CN/IC) was in the process of conducting its rules revision process when the interviews occurred, so the data collected from CN/IC primarily detailed the reasons it initiated rules revision and the way it had structured its effort.

During the first phase of data collection in fall 2001, the evaluation team interviewed safety executives at the four companies. For the second phase of data collection in winter 2002, the evaluation team interviewed five union workers at these same companies. The team conducted followup interviews with safety executives at the companies during the spring and summer of 2002 to confirm interpretations of the data and explore issues that arose during the initial data analysis. At that time, the Hile Group provided an analysis of the number of rules at each carrier before and after rules revision.

The evaluation team obtained the names of the freight carriers' safety executives from the consultant who facilitated the processes in these carriers.[15] The team sent each executive a letter explaining the research project and requesting an interview to generate lessons learned from revision of railroad safety rules.[16] The questions asked during the interviews reflected the following differences: CN/IC was beginning its rules revision process, CSXT and KCS had completed its interventions, and ACBL was the barge line. The evaluation team asked safety executives from the carriers that had completed rules revision the following types of questions:

- What were your reasons for undertaking the rules revision project?
- To what extent was the project successful?
- What factors helped/hindered the drafting and implementation of the new rulebook?
- How were the unions involved, and what were the strengths and weaknesses of their involvement?
- What was the role of the rules revision consultant with your project?
- What advice do you have for other companies seeking to do a rules revision?
- What quantitative impacts did you see as a result of rules revision?
- What unanticipated benefits or liabilities did you experience as a result of the effort?

[15] The Hile Group was the only consulting firm providing services in the area of participative rules revisions at that time.

[16] The safety executive at a fifth carrier could not be contacted by the evaluation team and, therefore, was not included in the sample.

The interview with the CN/IC executive was limited to why the company was engaging in rules revision and how it was structuring the effort.

The evaluation team asked the safety executives to provide names and contact information for 1 to 5 individuals who could provide a union perspective on rules revision (12 were identified, 6 were interviewed). Most of these individuals were union workers; some were local union representatives.[17] All interviewees were intimately involved in the rules revision process. Interview questions with the workers who had completed rules revision included the following types of questions:

- What job do you hold in your carrier and union?
- From your point of view, what aspects of rules revision were successful/not successful?
- What factors helped/hindered the rules revision process?
- How would you describe the impact of rules revision on the relationships between management and labor?
- What advice do you have for other companies seeking to conduct a rules revision?

The interview with the CN/IC employee focused mostly on aspects of the project startup that were working successfully from the worker's point of view.

All interviews were conducted over the phone and lasted approximately 1 hour. Typically, there were two interviewers (a lead interviewer and a note taker); the conversations were not recorded. Written notes from the interview were transcribed by the note-taker and reviewed by three members of the evaluation team.

In order to ensure the validity of the conclusions drawn from the interview data, followup interviews with safety executives were conducted to verify interpretations generated by the initial round of qualitative data analysis. In addition, where possible, the evaluation team asked the same question of more than one respondent from each firm to triangulate interpretations. Finally, four members of the evaluation team checked the interpretations of the qualitative data to ensure reliability.

The small sample size in this study limits the generalizability of the findings. As noted above, respondents were chosen to target individuals who had either led or participated in projects as members of Core and/or Satellite Teams. This gives the evaluation team a reasonable degree of confidence in the external validity of the findings. Practical constraints limited the evaluation team's ability to obtain nominations for interviewees from union representatives.

3.2 Injury Data

While injury data alone were not obtainable, railroad incident data, consisting of FRA reportable injuries, illnesses, and fatalities to employees on duty (EOD), were available. Incident rates were calculated by multiplying yearly FRA reportable incidents (injuries, illnesses, deaths) by 200,000 and dividing the product by actual employee hours worked. Incident and employee hours worked data (which includes all employees in all departments) were taken from *Railroad Safety*

[17] In one case, the name of the safety director at a unionized facility was given to the team. During an interview, this director provided the name of a front-line union worker, whom the team interviewed later.

Statistics (FRA, 1997-2002) and *Accident/Incident Bulletin* (FRA, 1983-1996). Glenn Hotz, Vice President for Safety and Health at ACBL at the time the study was initiated, provided ACBL incident data.

For all companies, incident rate trends were compared with comparable industry-level data. For the rail firms these data came from the sources noted above. ACBL data were two-digit standard industrial code time series data, downloaded from the Bureau of Labor Statistics Web site.[18]

[18] http://www.bls.gov.

4. Lessons from Rules Revision Efforts

After setting out the context of the safety rules revision process and exploring the ways in which it is supposed to operate, this report now turns to a review of the interview and outcome data, including incident rates.

4.1 Context and Implementation

The information presented in this section is based on interviews with stakeholders of U.S. rail and barge carriers that had undertaken rules revisions. The section begins with a brief discussion of the context for the efforts, including the reasons these carriers undertook rules revisions. Next, the carriers' experiences with drafting new rulebooks and putting them into effect are examined. The section concludes with a special focus on the role of unions in the process and other observations about the implementation of rules revisions.

4.1.1 Reasons for Undertaking a Safety Rules Revision

Safety professionals from each of the carriers independently decided to initiate the rules revision process and sought assistance from the Hile Group. CSXT was the first carrier to try the intervention, so the CSXT safety professionals were instrumental in creating the process with the Hile Group. Safety professional respondents from all of the carriers stated that informal sharing occurred between carriers to determine how to make safety rules more effective.

When respondents were asked to identify their company's principal reasons for undertaking a rules revision, the reasons given were generally congruent with those of advocates of the rules revision process. These reasons centered on the complexity of high-volume rulebooks, uncertainty about which rules applied where, low compliance levels, and lack of communication and trust.

Nearly all respondents noted that the old rulebooks simply had too many rules. "The men were getting more books than they could carry," observed one conductor. The number of rules appeared to impede the integration of the rules into the day-to-day practices of line workers. If too many rules existed, workers could not remember them all. More importantly, the old rulebooks did not allow workers and the managers who enforced the rules to distinguish between the most and least important rules. In addition, many rules were not applicable to all workers. A former union local chairman described the state of the rules:

> There was a rule that said, 'Don't pull broken glass from a window.' Does that really need to be a rule? Those types of rules disappeared right away. There's not very many core rules, but they are ones that everyone needs to adhere to; they're not craft-specific. People started to realize there was lots of redundancy, lots of rules that didn't need to be in there. The new rules are more precise, more straightforward.

The rules revision process, according to one safety executive, provided the company with a way to distinguish rules, which must be followed under all circumstances, from work procedures, which are only advisory in nature: "If it is a rule, it has to contain a 'must' or 'must not.' Otherwise, it is a work procedure, but is not the *only* safe way to do something. A rule is the *only* safe way."

Interview responses also reflected changes in the process of rulemaking. Indeed, many spoke—often without prompting—of the organizational processes that generated the old rulebooks. The old rules, according to these respondents, grew out of a reactive, and seemingly unreflective, process by which rules were formulated in response to specific, isolated events. A former front-line worker spoke of a rule requiring that cans be opened with can openers. The rule, on this worker's account, arose after an employee had cut himself trying to open a can of food with a pocketknife. As one worker observed: "The old rules—we called them CYA [cover your ass] rules—were typically made in reaction to incidents. If someone got injured, they made up a rule about it."

While stories about can-opener rules are humorous, many of the respondents indicated that even seemingly arcane rules could be used as instruments of punishment rather than tools for pursuing safety improvements. Another part of the ACSNI definition for safety culture introduced earlier states, "Organizations with a positive safety culture are characterized by communications founded on mutual trust" (1993). Rules, as described by these respondents, are not founded on mutual trust. In a similar vein, a safety executive noted: "Our company's culture was that the safety rulebook was used as a 'gotcha tool.' If you do something wrong and get hurt, I'm going to find a rule to nail you with—rather than using the rulebook as a safety tool to prevent people from getting hurt."

These responses to questions about the reasons for undertaking rules revisions generated three observations. First, the interview data appeared to support the claim that the blame game fostered by FELA was related to problems in carriers' safety cultures. Indeed, respondents reported that the rulebooks, prior to rules revisions, were used primarily to assign or avoid blame, not as part of an ongoing attempt to work together to improve safety. Second, the interview data appeared to support the claim, embedded in the rules revision program theory, that a link existed between the content and pattern of use of safety rulebooks and organizational safety culture. This, in turn, supported the notion that improvements in safety culture may be facilitated by changes in the content and pattern of use of safety rulebooks. Third, the terms and concepts the rules revision consultant used were remarkably consistent to those used by respondents during the interviews. This suggested a considerable level of understanding and acceptance of the intervention by the employees, an important indicator of the degree and quality of implementation.

Throughout, one must remember that all respondents came from carriers that had previously decided to undertake rules revisions. Thus, the evaluation team can make no claim that this diagnosis of safety problems resonates industry-wide. In addition, it is important to note that the interviewers did not ask respondents directly about the connection between FELA provisions and their carrier's safety rulebooks and cultures.

4.1.2 The Startup Phase

If poor safety culture is an important cause of poor safety performance, the process of reform must try to leverage culture change. The rules revision process, as discussed in Section 3, seeks to improve the culture through a participatory process. How did this work? Who participated? What factors helped and hindered this process?

Most respondents emphasized the inherent difficulty of rules revisions. Some indicated that the suspicion, distrust, and conflict generated by the existing safety culture and rulebook structure could continue to cast a shadow over the rules revision process. Representatives of crafts, according to one safety executive, were concerned that revising and repealing rules might lead to more injuries, while management representatives expressed the fear that the process amounted to "giving the keys to the inmates." A respondent indicated that worker representatives had a hard time getting past the suspicion that the new rules would be used to hammer people, just like the old ones. At least one respondent noted resistance from company attorneys, who continued to view the rulebook as a way to indemnify the company against liability for accidents. One worker involved in a rules revision process was succinct: "This is not an easy thing to do."

Another finding that emerged from the interview data is the importance of management commitment (including resources) to the process. In all four cases, the revision process took a minimum of 6 months. Most said that the time was required to allow the necessary consensus building among management and the numerous crafts.

Several safety professionals explained that before the start of the rules revision, management activities existed to help prepare for the effort, such as discussions addressing issues of distrust and suspicion on the part of labor and management. Two of the carriers' senior management became active sponsors of the project, and in another carrier, they were committed but less visible.[19] Senior management from one of the carriers where visible management were committed wrote a value statement that embraced a more participative management style in all areas of the company, not just safety. This company held employee meetings and distributed videotapes and written materials to communicate the message. Rather than the traditional punitive approach, responses to rules violations became more developmental; employees were trained and coached, rather than disciplined. This company also had safety committees visit other stations to conduct risk assessments designed to improve their ability to assess risk, raise their personal awareness of safety, and give the assessed stations feedback on hazards. These efforts paved the way for the rules revision, and the new safety rulebook was a highly visible way to demonstrate the commitment to participatory culture on the part of management. Another carrier had the rules revision consultant work with all of the safety committees before the rules revision initiative started to help till the soil by raising and addressing concerns.

4.1.3 The Drafting Process

Because the process allowed the carriers to identify issues and open up communication channels, most respondents pointed to a number of strategies that allowed the carriers to address, and sometimes even overcome, the issues identified. Most agreed that buy-in at all levels of the company is a successful outcome of the rules revision process. In particular, respondents noted the importance of getting front-line workers involved in the process. As one worker observed, "There are a lot of crafts [at the worksite]. We tried to get someone from each area to be involved." Worker involvement appeared to be especially helpful in distinguishing core, company-wide safety rules from craft-specific rules and work practices. The worker previously quoted went on to observe that, "It's a lot better for someone who actually performs the work to analyze a task and work up a procedure to make employees safe." Having workers create and

[19] CN/IC data were insufficient for commenting on this topic.

review the rules helped to ensure that the new rules were reasonable and practicable. One worker explained:

> There was a rule that you had to wear leggings that covered your leg from your knee to your shoe, in certain hot-work areas. Some welders and fitters pointed out that if something fell into the top of the legging, it would burn you even worse than if you didn't have the leggings. So that got changed... It benefits the company to listen to the employees. A lot of these guys have a great deal of sense about them.

This example illustrates how the rules revision process, by opening up channels of communication, tapped into hitherto unused (or perhaps underused) knowledge about safety embedded with the workforce.

Most respondents underscored the importance of commitment and buy-in from top company management. According to one worker, such a commitment can help keep the process on track even in the face of resistance from detractors. One respondent, however, said he wished his company had provided even stronger leadership.

Respondents emphasized that leadership in the process could not be purely top-down in nature. Along with seeking buy-in from front-line workers, reformers should include a steering committee that represents a wide variety of interests. As one safety executive noted:

> We established a high-level steering committee—broad-based in membership. We identified possible barriers—law, medical, risk management, senior level managers from all crafts, union leaders—and included them on the steering committee. Then it became easy to cascade the efforts down to the ranks and ask for involvement.

Bringing management and workers together on teams, however, can present its own problems. Meetings can often become venues for airing old grievances and giving voice to long-standing sources of conflict. One worker stated that carriers must be willing to allow a certain amount of venting during such meetings if the process is to succeed: "One guy threw a book through a wall; others threw chairs." Most respondents indicated that such conflicts could be tempered by continuing dialogue and the development of a (sometimes new) language for discussing these issues. One safety executive said that his company was able to get around this problem by casting their discussion of new rules in moral terms, which centered on an emerging consensus that all members of the company had a responsibility to see that workers did not get hurt. Another safety executive surmised that it is important to let workers and managers vent at first but then emphasized that these problems are in the past and that it is time to move forward and fix them.

At least one worker cautioned that sending replacements when a regular member could not attend committees and working groups would further slow the process.

> People would come to several meetings, then they couldn't make one, so they'd send a replacement. It takes time for those new people to understand—they'd want to bring up the same points that the group had already gone over.

This worker also saw some potential advantages in sending replacements.

> After awhile, I realized it [sending replacements] broadens the base of commitment, gives you new ideas. You want them to be quick, but there are months between meetings and you need to get everyone on the same page first. [It is okay to send replacements, but] replacements have to be brought up to speed, and you have to allow time to bring them back around.

Finally, several respondents highlighted the importance of having outside leadership and assistance from the consultant. According to one safety executive, the consultant provided not only writing, organizational, and technical skills, but also a totally unbiased voice. This person continued:

> We're all a product of where we were programmed. It's very hard to be neutral. I was very slanted on some things and not on others. Railroads are so entrenched that they need someone from the outside to be neutral.

4.1.4 The Roll-Out Phase

Conventionally, one would expect the managers to roll out finished rulebooks to the entire company with much fanfare. In this case, the marketing process actually began during drafting, since the rules revision process was participative. Workforce involvement in rules rewriting and employee familiarity with new rulebooks greatly facilitated the formal rulebook roll-out phase. The fact that interviewees had considerably less to say about the roll-out phase than the drafting phase suggests that the roll-out process was less problematic, since broad participation was achieved during the drafting phase.

Several respondents noted that, even after the consensus building during the drafting phase, significant pockets of resistance to the new safety rulebooks still remained. Some respondents noted that resisters always exist in any change in policy and programs. One worker attributed this to long-standing personal relationships that leave some managers unwilling to confront workers they have supervised for decades. Some workers viewed safety measures as an inconvenience and, he added, would retaliate against new rules by slowing work processes. Another worker expressed a similar sentiment:

> Some people still have jaded perspectives about safety. You'll find a lot of people who have been employed here for 20-30 years have a different outlook on safety and management. They've been around for a long time, when things were managed more poorly and safety wasn't as important. They say, 'Why do I have to wear a respirator? I didn't wear one for the first 28 years, why now?'

One safety executive added that, "The further away from headquarters, the less consistency there is. You've got to communicate the content *and* intent."

The importance of communication was echoed by a number of respondents. Among the communication techniques they reported using were feedback sessions with workers, brochures mailed to employees' homes, and reviews of rules at safety meetings. One safety executive said

that his company reviewed a rule at each of its weekly safety meetings; when they ran out of rules, they started over again. At least one respondent noted that the consultant played an important role by helping to draft company communiqués about the new safety rulebook.

Leadership by example provided another vehicle for communication of new rules across work sites. One conductor gave the following account of a rule that met resistance from workers.

> There was one major change with the new rules—implementation of a red zone for employee protection when moving between railroad equipment. That was a major change. The members participated—it was up to us to set an example and use it [the new rule] and it caught on. I was concerned because it was a completely different—a new signal. I didn't like the idea of replacing an existing signal. I felt we should use the old signal. I didn't like it. But a different signal is not going to make or break this rulebook.

This comment illustrates the importance of having a core group of employees who are champions of the new rulebook and are willing to put it into practice even though they may disagree with certain parts of it.

4.1.5 The Role of Union Officials

Given the importance of unions discussed earlier, respondents were asked to describe and assess the involvement of rank-and-file, as well as officials, in the rules revision processes. Union rank-and-file held the majority of positions on the Core and Satellite Teams at each of the carriers examined. At one company, general chairmen from the unions were asked to nominate people to be involved in the process. Management selected members of the teams from the list of nominations.

Some disagreement existed among respondents about the desirability or necessity of involving union officials in the process. A worker at one company—a union rank-and-file employee—said that union officials had resisted the rules revision and had sought to derail it. When asked what advice he would give to other railroads, he noted that a union official "can really put a stinker in the middle of this thing" and create a number of ancillary issues that Core and Satellite Teams must address. He added that the official's message had little resonance with the rank-and-file. Indeed, the safety executive of another company noted that the fact that rank-and-file members were a part of the drafting process neutralized objections from union leaders. "It's hard to argue with recommendations from your own people," he observed.

4.2 Outcomes and Impacts

As discussed in Section 2, the intended outcome of the rules revision process was to increase compliance and reduce injury rates. The theory of change and literature review suggested a number of intermediate outcomes underlying the rules revision process that were thought to pave the way for reductions in injury rates. This section examines seven outcomes:

- Changes in values, attitudes, and patterns of behavior related to safety rules
- Changes in the usability and number of safety rules
- Changes in union-management relations

- Perceived changes in compliance
- Changes in incident rates
- Changes in injury-related liability and costs
- Spillover effects in non-safety areas

4.2.1 Changes in Values, Attitudes, and Patterns of Behavior Related to Safety Rules

The interview data suggested that the rules revision process generated a significant change in the values, attitudes, competencies, and patterns of behavior related to safety rules–as envisioned by the program theory discussed above. This fundamental change in how rules were valued and used was shown in the following quote from a safety professional:

> A main barrier at [our] carrier was defining the definition of a safety rule. All rules had been created by management and dictated to the workforce. Usually they had been created at the time of a catastrophe. The workforce was asked to comply with rules that didn't make sense. Some were 80 years old when we had different equipment.

Most respondents described similar changes, including a shift from a solely management-driven rulemaking process to one that emphasized the role of the workforce in deciding what rules were worthy of being real rules and each craft's responsibility for their own rulebook. The fact that the process encouraged consensus meant that extensive concurrence existed about every rule in the book, which greatly increased the book's credibility. Another change mentioned was a move from confusing criteria about what went into a rulebook to a strict definition of a rule and what could be included in a rulebook.

A worker described the core rules versus suggested work practices:

> (Core) Rules applies to all departments; they're safety-related, critical to safety, enforceable, compliable. If they're less than that, they might be 'departmental procedures,' which are departmental specific and also safety related. There are also 'suggested work procedures' which are not enforceable.

Another pattern that changed was the type of language used in the rules. The language changed from a "thou shalt" to a "we will" style of writing. Below is an example, shared earlier in this report, of an old rule exemplifying the "thou shalt" attitude and how it was changed to a rule that assumed more of a "we will" attitude on the part of the worker.

- Old Rule for Welding-Fire Protection:

  Use only a friction lighter, stationary pilot light, or some other source of suitable ignition to light torch. Do not light torch with matches, cigarette, or cigarette lighter (Illinois Central Railroad System, 1998).

- New Rule for Welding-Fire Protection:

  Use only approved flint strikers to light welding torch (Canadian National/Illinois Central Railroad, 2002).

The new rule sounds more like a rule that coworkers would write for themselves. It is succinct and focuses on what should be done to perform the job safely.[20]

In this next example, the new rule was written with a "we will" attitude, is explicit about what is prohibited, and was written to cover a wide range of equipment.

- Old Rule for Tool Use:

  Employee will use handle, which is standard for the type of jack being operated. Use of a bar or handle which does not fit is prohibited. Use of jack handles that have been welded is prohibited (Illinois Central Railroad System, 1998).

- New Rule for Tool Use:

  Use approved tools, equipment, and materials for the purpose(s) intended. Unauthorized modifications, overrides to safety devices, and removal of safety guards are prohibited (CN/IC, 2002).

This final example contrasts an old rule that is overly prescriptive with the new rule that is simpler to follow.

- Old Rule for Fork Lift Use:

  Employees are prohibited from:
  - Riding on any machine except when specifically designed for that purpose.
  - Riding on coupling devices or tongues between tractors or trucks.
  - Riding up or down, standing or working from a platform on a forklift truck or similar device unless the platform is suitably designed, properly secured, and protected by handrails (Illinois Central Railroad System, 1998).

- New Rule for Fork Lift Use (partial list):

  When operating forklifts:
  - Face the direction of movement with loads. Back loaded forklift down ramps/inclines or if view is obstructed.
  - Keep body inside moving vehicle.

[20] A question could be raised about whether the rule in this example is written in a way that can easily accommodate changes in technology. Rules should empower the workforce, but also be flexible enough to accommodate technological advances. How would a shift in technology to electric starters be handled? Would the entire consensus process need to be repeated to accommodate this technological improvement?

- Do not transport passengers.
- Space forks so that load is fully supported and so that the forks are fully under the load (CN/IC, 2002).

4.2.2 Changes in the Usability and Number of Safety Rules

One of the most noticeable improvements was the increased understandability of the rulebooks due to the reduction in the number and complexity of the safety rules. The collaborative process and new definition of a rule helped streamline the books. This also led to increased concurrence about the worthiness of the rules that were included and increased the focus on what was important. Additionally, the front-line employees benefited from having fewer rules to remember. Although having fewer rules is not a success measure in and of itself, when combined with the improvements in understandability and concurrence, it provides some insight into the program's effectiveness.

Table 1 illustrates the reduction in the complexity and number of safety rules for three carriers for which data were available during this study. It was difficult to precisely compare the number of rules before and after because the old rulebooks had duplicative and conflicting safety rules and confusion about which rules applied to everyone and which ones applied only to a given craft. In addition, operating rules, training material, and job aids were interspersed throughout the rulebooks. To obtain a relatively consistent picture, the evaluation team asked the Hile Group to hand count the rules in the original versus new rulebooks for all the carriers. In each case, the safety rules before the revision process numbered in the hundreds and were reduced to less than 30 core rules. The number of rules should be taken here as an imprecise measure of the improved readability, and usability, of the rulebooks, but not as a direct measure of safety.

Table 1. Reduction in the Complexity and Number of Safety Rules [21]

Company	Before Revision	After Revision
ACBL	400 safety and operating rules, job aids, training information (confusion about which rules applied to all employees versus a specific craft)	24 core safety rules (applied to everyone) and 101 craft-specific rules and recommended work practices
CSXT	900 safety and operating rules, job aids, training information (confusion about which rules applied to all employees versus a specific craft)	17 core safety rules (applied to everyone) and craft-specific rules for transportation (19), mechanical (88), track engineering (number not available, but estimated to be similar to mechanical), and clerical (number not available)
KCS	742 safety and operating rules, job aids, training information (confusion about which rules applied to all employees versus a specific craft)	17 core rules (applied to everyone) and craft-specific rules for transportation (93), mechanical (242), track engineering (227), and clerical (98)

A respondent from CSXT stated that the company has since added 300-400 new rules, following a change in senior management in 1995. Interestingly, the ownership for the rules at CSXT has not shifted back to management, "The amount of craft participation has been upheld. There is strong involvement in the Core Safety Committee."

4.2.3 Changes in Union-Management Relations

Most respondents reported improvements in union-management relations. Worker respondents were asked to rank union-management relations on a scale of 1 to 5 (with 1–very hostile and 5–very cooperative) both before and after the rules revision. Of the six who provided ratings,[22] four reported ratings that were higher after the rules revision (they indicated improvements of 1,

[21] As mentioned earlier, CN/IC was initiating rules revision when the initial interviews were conducted and therefore were not included in the impact analysis. In fall 2002 when the Hile Group provided the before and after comparison of the number of rules, CN/IC had completed its rulebook. CN/IC initially had "1,360 safety and operating rules, job aids, training information (some craft-specific and some for general use)" before and "18 core safety rules (applied to everyone), and craft-specific rules for transportation (62), mechanical (259), track engineering (216), and clerical (133)" after.

[22] Only six respondents provided ratings because this question was added to the interview protocol in the middle of the interview process.

2, 3, and 4 points). A fifth respondent reported no change in union-management relations (a rating of 3 both before and after). A sixth said that, while relations between management and rank-and-file union members had improved from a 2 to a 4, relations between management and union officials had deteriorated from a 2 to a 1.

One worker who reported an improvement in union-management relations observed that the rules revision process "helped the relationship between management and the union. It showed employees that management was willing to listen." A worker from another company suggested that the rules revision process also helped to draw the unions into a more constructive dialogue on safety:

> There is a lot more safety involvement by the unions. Local reps work with management on safety at the local level. Local unions didn't participate before—maybe they'd show up for [the] meeting and that was it. There was like a fence you didn't cross. The book process served to draw both sides in. Now you have more involvement.

Another worker observed that management and workers appeared to have placed greater emphasis on worker safety since the rules revision. They reported:

> Five years ago, safety wasn't a big deal. We've accomplished a lot. These people [management] are genuinely interested in safety. Rules weren't their main priority, but that has changed… I see that men at the superintendent level care about safety. For example, we have a lot of switches that are notoriously hard to throw. There is a regular program to oil and maintain those switches. If there is a lot of rain or a flood, they are out there working on it. It will be fixed. Before, if something needed fixing, it might not get fixed at all if they didn't consider it bad enough. Now if I turn something in [report something that might be unsafe], it gets fixed right away.
>
> It's been a complete turnaround… There had been safety committees going on for several years. Not much was being accomplished. Only a few men were participating, now there's more participation and more is getting accomplished. [Now] everything is leading toward our #1 goal, which is to be the safest railroad in the industry.

Reports that management and employees were more likely, after the rules revision process, to engage in open communication about safety was more directly relevant to the issue of management and labor relationships. One safety executive observed that: "The consolidation was an outstanding success. It helped develop trust. Craft employees know they have had a hand in putting together the rules."

Another safety executive took the point further:

> With the new culture, it is easier to confront people engaged in unsafe behavior, since interveners can cite rules in which line workers' peers had a part in creating. Before people were doing crazy things like jumping off elevated surfaces, wearing short sleeve shirts. After, 90 percent of people

> were complying with rules; they were wearing [personal protective equipment (PPE)]; supervisors were more educated. They weren't 100 percent safe, but much improved.

4.2.4 Changes in Compliance

Respondents were asked to comment on the extent to which the rules revision process led to changes in compliance with rules, the degree to which there was a focus on safety, and other factors related to safety culture.

Generally, agreement existed among respondents that the rules revision process had been associated with improvements in rules compliance. Safety executives reported that they observed fewer at-risk behaviors among employees. As one worker noted:

> It seems like more people are abiding by the rules. For example, with PPE: there is a chart in the book about PPE. You don't see people without their hardhats, glasses, safety shoes. I never see people without it. I see 100 percent participation. If not, you approach them in a friendly manner, and don't be critical.

One executive cautioned against attributing too much causal influence to the rules revision process specifically. This respondent noted that commitment by management to worker participation was a necessary precursor to culture change. Rules revisions can be a useful vehicle for improving safety culture but not without a prior commitment to collaborative decision processes.

While the interview data on rule compliance was encouraging, the evaluation team was not able to confirm the compliance improvement independently. It would have been helpful to have company records related to safety rule violations, as a proxy indicator of compliance, to confirm the interview data. If companies do not keep such data as a part of their FELA records, a secondary analysis of the injury data could be performed to determine if any rules were violated when injuries occurred. The additional data could then be used to examine whether rule violations decreased only for the rules that became core rules or if there was a more generalized effect. It would be helpful to know if safety culture improvements led to a decrease in rule violations across the board.

4.2.5 Changes in Incident Rates

One of the most important indicators of success for any safety intervention is the extent to which it leads to reductions in incidents. While the safety executives interviewed said they undertook the process primarily to improve their rulebooks and obtain more participation from the workforce in safety governance as outlined previously, they did report that incident rates had improved as a result of the rules revision process. In order to assess the rules revisions' impacts on injury rates, the evaluation team gathered data on the incident rates at the carriers who had completed the process: CSXT, KCS, and ACBL. The incident rates, presented in Figures 2, 3, and 4, may be interpreted as the number of employees injured in a year per 100 employees working full-time.

In each case, time series data for the treatment group was compared with similar data for the remainder of the industry, including both Class I and short lines (excluding the treatment firm). This analysis allowed evaluators to assess whether any observed changes in the treatment firms might have happened without the intervention (Shadish, Cook et al., 2002).

CSXT

Figure 2 shows that incident rates at CSXT had been generally improving since the mid-1980s. Thus, the key question is whether the rules revision led to additional safety improvements. Visual inspection of Figure 2 suggests that a sharp drop occurred in injury rates between 1989 and 1990. Given that the formal rules revision process did not begin until 1991, it seems unlikely that the rules revision per se caused the change in incident rates. Indepth interviews with company officials, however, indicated that rules revision was preceded by a preparatory process that included extensive union-management collaboration designed to increase worker involvement in safety and emphasize management commitment to safety (see Section 4.1.1). If the evaluation team takes these preparatory activities as the beginning of the intervention, then evidence exists that rules revision preceded the drop in injury rates. Statistical analysis suggests that this immediate drop was statistically significant (see Table A-2).

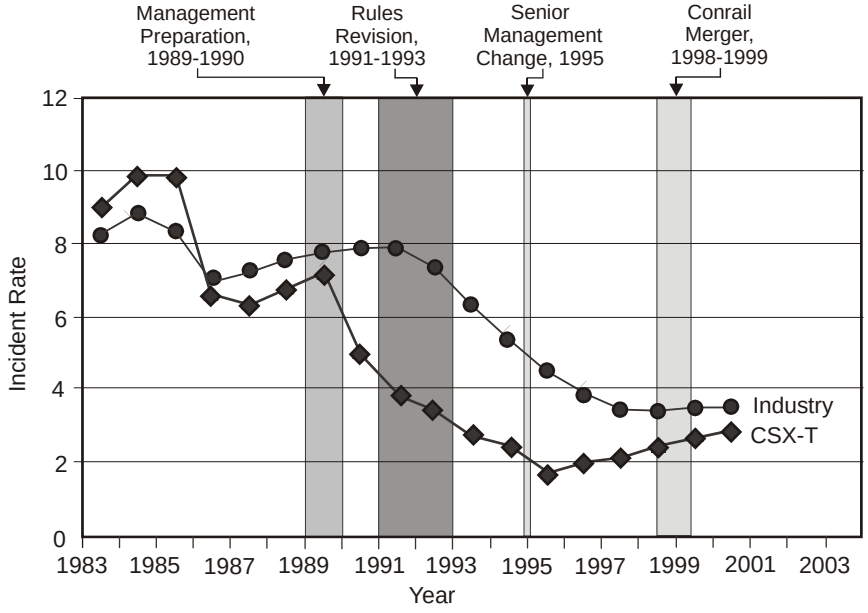

Figure 2. CSXT and Industry Incident Rates Comparison, 1983-2002

Thus, it appeared that rules revision, combined with management preparatory activities, led to additional safety improvements–at least in the short-run. Examination of the industry series suggested, however, that while improvements at CSXT preceded similar improvements in the industry, they were not unique. Indeed, statistical analysis suggested that the pre-/post-difference at CSXT was indistinguishable from that in the industry at large ($p = 0.60$). Thus, while evidence existed of a possible positive impact on incident rates at CSXT, the fact that these improvements were mirrored–if belatedly–by the remainder of the industry raised the possibility that they were caused by something other than rules revision.

The evaluation team noted that the increase in the rate of safety improvement during the early 1990s was followed by a gradual leveling off, with rates on the rise again by the late 1990s. This addressed the question of the sustainability of any rules revision impact. One interpretation of the reversal is that it reflects a general wearing off of the intervention's impact. Alternatively, it might reflect the intervention's lack of resiliency to changes in the organizational and task environments. It could indicate that management thought that safety was under control and became distracted by the leadership change at the company in 1995. As one respondent observed,

> We lost a senior leader in [1995] and it had tremendous impact. With new leadership, the rulebook came under fire. We didn't have time to develop deep roots to the change effort and were in the middle of implementation when leadership changed. The new senior leader said the rulebook looked like a cartoon. There was a reversion back to the pre-[1989] status quo to a certain extent, but not completely.

Industry experts have stated that safety is a constant struggle. After the leadership change, CSXT merged with Conrail in 1999. The addition of Conrail's rules to CSXT safety rulebooks and the reduction in clarity of organizational norms may have fueled an increase in incident rates. Other exogenous factors that might have contributed were technology, reduced employee expertise due to an influx of new hires and training. Finally, the reverse in rates might reflect some sort of floor effect. That is, the effort costs of reducing injuries might be much greater at lower incident rates, creating barriers to further reductions. While available data were not conclusive, it was clear that resiliency of the rules revision intervention is an issue that bears further investigation.

KCS

Similar data were gathered for KCS. Once again, interview data suggested that the intervention began not with the formal rules revision (2000), but with a number of preparatory management activities in 1999. These earlier activities were designed to improve trust between management and workers and featured changes by management to make the rules violation reporting process more developmental and less punitive. In addition, the rules revision consultant was hired to work with all the safety committees to identify issues, build trust, and obtain agreement from labor to rewrite the safety rules in a participatory manner.

As in Figure 3, the preparatory management activities were associated with a statistically significant increase in the rate of improvement ($p < 0.001$). Unlike CSXT, the post-intervention improvements at KCS were not mirrored in the remainder of the industry. Indeed, the difference in pre-/post-incident rate changes between KCS and the remainder of the industry was found to be statistically significant,[23] lending credence to the claim that the rules revision and management preparatory work at KCS (rather than some other factor common to the entire industry) caused the improvements.

[23] Scientific convention generally adopts a significance level of 0.05 as the criterion for deciding if an event is statistically significant. Given the minimal KCS data available, and the exploratory nature of the study, 0.07 was considered worthy of consideration because of the potential benefits a positive result could have for the railroads.

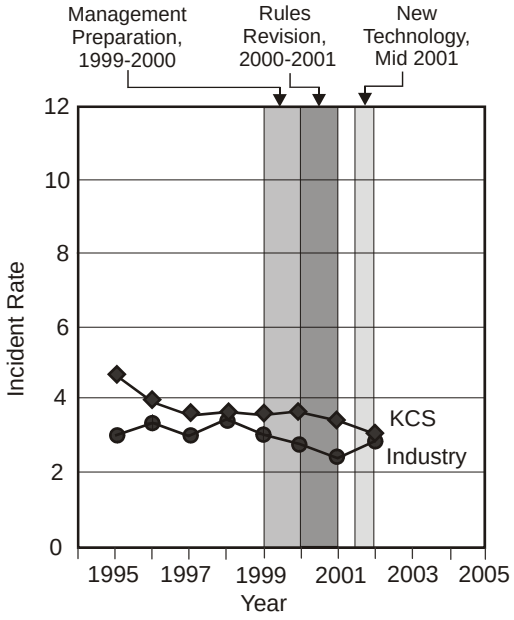

Figure 3. KCS and Industry Incident Rates Comparison, 1995-2002

These positive findings were limited by the fact that relatively few post-intervention observations existed. The challenge was how to sustain safety improvements in the face of various exogenous factors; indeed, an increase occurred in incident rates during 2002. One KCS safety executive explained that this increase might correspond with the introduction of a new car control system that led to delays and fatigue issues, as well as other technological changes. Once again, this raised questions about the resiliency of the intervention to changes in organizational and task environment.

ACBL

ACBL had management preparatory activities in 1994, including collaborative sessions where managers and workers established core values, goals, and objectives. As with CSXT, evidence existed that incident rates were already improving before the rules revision. Unlike CSXT, no statistical evidence existed that the rules revision process, combined with the management preparatory activities, was followed by any additional improvements in safety outcomes (see Figure 4). In fact, a slight, though statistically insignificant, reduction occurred in the rate of safety improvement ($p = 0.13$). A lack of pre-/post-difference might be viewed as positive had an increase in incident rates occurred in the remainder of the industry. While a slight, though statistically insignificant, increase occurred in the industry ($p = 0.36$), the increase at ACBL was larger and statistically different from the industry increase ($p = 0.10$). In short, no evidence existed of any pre-/post-incident rate changes associated with rules revision at ACBL.

The null findings might be due, in part, to confounding of the data as a result of the four mergers and acquisitions between 1996 and 2000. [24] Therefore, when one reviews the ACBL data, it is a combination of ACBL plus four additional companies. While independent pre-merger/

[24] The mergers and acquisitions involved ContiCarriers and Terminals, Inc., in 1996, National Marine, Inc., in 1998, Peavy Barge Line in 2000, and Ultrapetrol in 2000.

acquisition injury data were not available for the other carriers, the safety professional interviewed stated that the strong safety culture that ACBL had achieved, due in part to the rules revision, helped to smooth out the merger process and helped the other companies to lower their injury rates as they joined. For instance, "National Marine had an injury rate of 11 before they joined ACBL and dropped to 4 the year they merged (1998)." The respondent stated that if the mergers and acquisitions had not occurred, the slope change at ACBL might have been steeper. Unfortunately, the data did not allow the evaluation team to test these claims empirically.

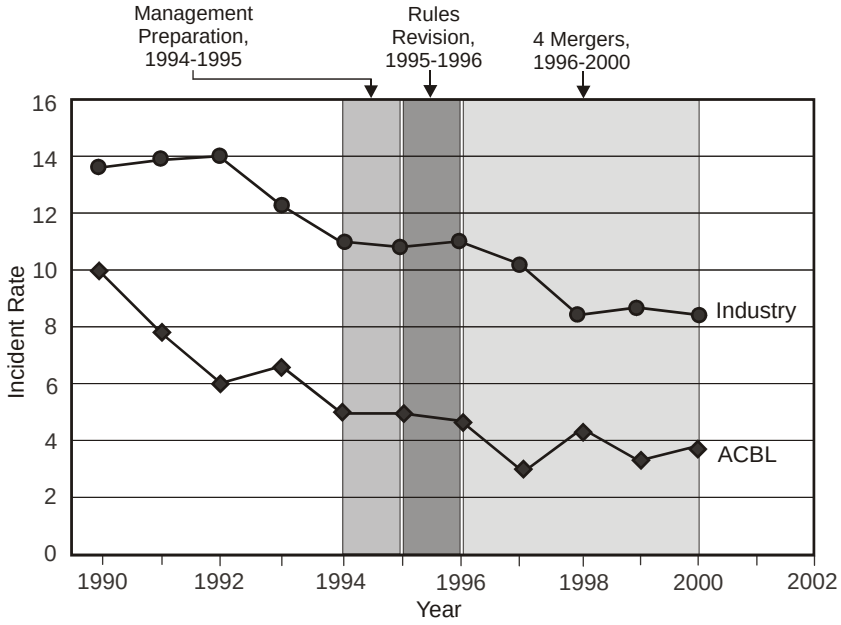

Figure 4. ACBL and Industry Incident Rates Comparison, 1999-2000

Department-Level Rates

It is possible that incident rates measured at the department level could show significant pre-/post-impacts. One rail safety executive mentioned variation in implementation at the department level: "Mechanical had good sharing with one session a week. Not as good as [Track] Engineering. Clerical was okay. Transportation–it was hard to get them to spend time."

When asked about their injury rate, a rail mechanical worker also indicated a potential difference by department. He seemed to track only his department's injury rate. "There was a 40-50 percent reduction in Mechanical. We're at about 1.82 for car maintenance (train yards, repair shops locomotive service not attended to by locomotive operations) and .85 for locomotive operations (located in Georgia, New York)."

Incident Rates and Specific Rules

Due to limitations in the data set, the analysis only tested for a reduction in total incidents. It is possible that the incident decreases observed were primarily due to a reduction in incidents that specifically related to the new core rules. It would be useful to test whether only the injuries related to the new rules went down or whether all injuries were reduced due to a generalized effect of improved safety culture. Section 4.2.4 expressed a similar sentiment, to look more closely at the relationship between the outcome measures and the specific rules.

Summary of Incident Rate Findings

To summarize the results, a preliminary analysis of incident rate data found possible evidence of a positive impact at CSXT and KCS and no evidence of impact at ACBL. The impacts were described as possible at CSXT because of questions about whether the improvements observed could have been caused by factors that helped not only CSXT, but also the entire industry, and at KCS because of the paucity of post-intervention data. In addition, as noted above, the findings for CSXT and KCS were highly sensitive to the assumption that the intervention began with management preparatory activities. The ACBL findings were subject to uncertainty because while rates did not decline, they did not increase in spite of several mergers after the rules revision. Thus, while some evidence existed that rules revision holds promise as a mechanism for reducing incident rates, these findings were subject to considerable uncertainty.

During this study, it was not possible to determine the extent to which departmental implementation effectiveness impacted departmental injury rates or whether rules that were included in the new rulebook impacted rule-related injury rates. Additional data and analysis will be required to distinguish these relative effects. In addition, given the data available, it was impossible to assess whether rules revision was more important than the management preparatory work or vice versa, since the evaluation team could not distinguish their relative effects. In this analysis, their combined effect was investigated, since both were concerned with changing safety-related values, attitudes, and patterns of behavior.

4.2.6 Changes in Injury-Related Liability and Costs

Two carriers noted that rules revision decreased the number of claims and the claims payouts. One of the respondents reported that she was told, “Safety is contributing to the bottom line because of the drop.” Another person mentioned claims decreasing both in payout and number: “We also saw our claims go down significantly... The claims ratio dropped, but also the cost per claim dropped by 45 percent between [1995] and today. Claims data is very closely held so there is no written documentation that can be given out.”

The evaluation team was not able to obtain documentation to substantiate these statements. , Inclusion of the information, however, seemed warranted given the exploratory nature of the study. The third carrier that completed the effort did not mention this outcome. The fourth carrier did not yet have any outcome data.

In addition to the reduction in claims, another FELA-related impact concerns the reduction in the number of rules. One respondent pointed out a legal advantage to having fewer rules.

> … We always included risk management and legal in the Satellite and Core Teams. Didn't want them to feel in the end that the rulebook was not defensible in court. The reason it is considered more defensible is because there are fewer rules. With fewer rules it is possible to do more indepth training. With employees participating there is more agreement on what is important to enforce in all situations on the side of labor and management. In addition the 'preferred work practices' category puts responsibility for determining and using the 'preferred work practices' on the shoulders of both management and labor. If a rule cannot be enforced due to a facility or other reason a set of preferred work practices are identified and anyone can use them.

4.2.7 Spillover Effects in Non-Safety Areas

One executive added that collaboration on rules revisions can sometimes create positive spillovers in non-safety areas by creating important organizational precedents for collaborative decision processes. One respondent stated that after the rules revision project occurred, joint management-labor groups came together to implement improvements in several areas other than safety, such as reengineering and other cost-cutting projects. This respondent cited workforce involvement in efforts to improve such productivity-related issues as traffic flow, turn time, cost reductions, and fuel efficiency as examples of non-safety areas addressed by the same collaborative relationships created for rules revision. Previously, the labor management relationship at this carrier had been strained, and collaborative work on productivity issues did not occur often.

5. Conclusions and Recommendations

More than a mechanism for reducing paperwork burdens and administrative complexity, the rules revision process seeks to develop consensus around core and craft safety rules and, in so doing, improve rules compliance and safety culture, thus reducing injury rates. This section presents a revised version of the program theory, evaluates key program impacts, summarizes and discusses key findings on the implementation of rules revisions, and provides suggestions for further work.

5.1 Revised Program Theory

Revisions to the program theory presented in Section 2 are provided to show a more complete and informative picture of the process. Figure 5 shows the original program theory above the revised one to facilitate comparison. Boxes in the revised program theory that were added or modified have bold outlines.

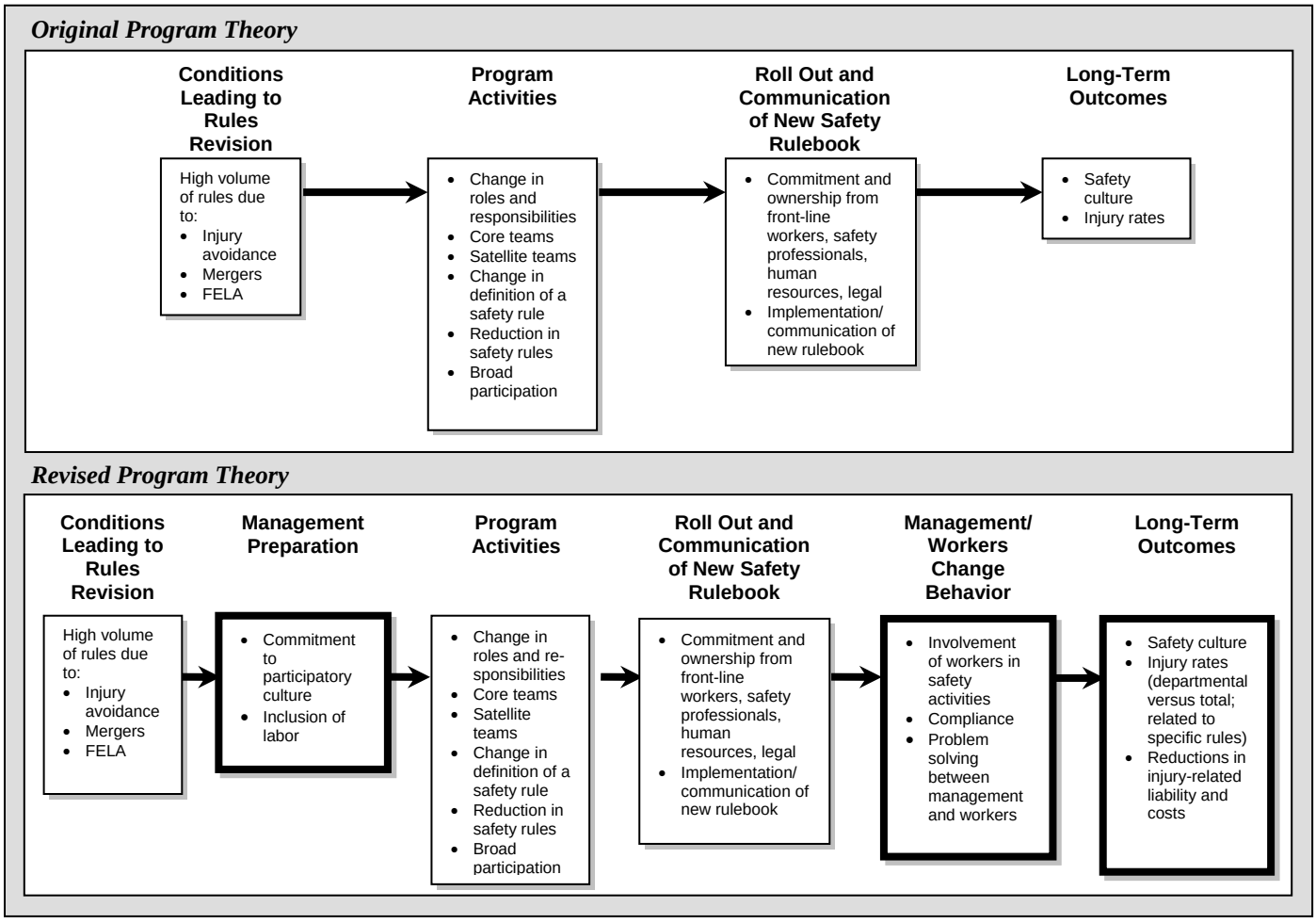

Figure 5. Original and Revised Rules Revision Program Theory

Several safety executives said that senior management became active and visible in their commitment to building a participatory culture before the rules revision process began, and the inclusion of labor was important.[25] Therefore, a step was added to the program theory diagram to account for management preparation.

Another box was added to the program theory to address changes in management and worker behaviors following the roll out of the new safety rulebook. Interview data suggested that the level of increased involvement in safety activities, such as safety committees and peer-to-peer feedback of at-risk behavior, occurred, which may be necessary before changes in injury rates can be observed. Compliance and problem solving between management and workers are other outcomes that were included in this box in the program theory.

Changes were made to the final box in the program theory. The injury rate outcome was revised to allow for the possibility that the injury impact might be observed at the department level and/or that the injury impact might be observed at the specific rule level. Another bullet was added to show that reductions in injury-related liability and costs are perceived to be a long-term outcome of the rules revision process.

5.2 Program Impacts

Data presented in this report suggest a number of benefits associated with rules revision. Evidence on bottom-line outcomes was inconclusive. Evidence on other outcomes, however, was more clearly positive.

5.2.1 Bottom Line Benefits

- *Incident rate improvements.* A preliminary analysis of incident data at three carriers suggested that safety rules revision (combined with other senior management activities to increase workforce participation in safety) had a positive impact on incident rates at one rail carrier (KCS), where a statistically significant ($p < 0.01$) improvement occurred in incident rates beginning in 1999. The management activities, which began before the actual rules revision effort, included a more developmental approach to rule violations and the hiring of a rules revision consultant to identify issues and build trust. Incident rate declines at the other two carriers could not be attributed with complete confidence to the process because other changes occurred at the same time, but available data do not fully rule out a positive impact on incident rates. During this study, it was not possible to assess the extent to which implementation effectiveness varied between different departments within the carriers or whether a reduction existed in the specific types of incidents related to the rules in the new rulebook. In addition, given the data available, it was impossible to assess whether rules revision was more important than the management preparatory work or vice versa, since the evaluation team could not distinguish their relative effects. In this analysis, their combined effect was investigated, since the management preparatory work and rules revision are both concerned with changing safety-related values, attitudes, and patterns of behavior.

[25] This was not discussed with CN/IC.

- *Reduced liability and injury costs.* Safety executives at two carriers reported that the number of FELA claims and the cost per claim dropped significantly as a result of the effort. One executive suggested that FELA-related costs for his company decreased due to the increased clarity of the rulebooks and the decrease in the number of rules.

- *Spillover effects in non-safety areas.* One executive added that collaboration on rules revisions can sometimes create positive spillovers into productivity-related areas by creating important organizational precedents for collaborative decision processes. One respondent noted an increase in worker involvement on activities they previously considered management work (reengineering, cost-cutting activities).

5.2.2 Other Benefits

- *Changes in values, attitudes, and patterns of behavior related to safety rules.* The rules revision process shifted the primary responsibility for defining safety rules from the management to the workforce. Respondents reported that the revised rules focused on significant safety issues and could be complied with 100 percent of the time. Compliance was often not possible with the previous rules.

- *Changes in the usability and number of safety rules.* As expected, rules revisions dramatically reduced the number of safety rules through the filtering process employed by the three carriers studied. The new book was important because it was a visible symbol that reached all employees and demonstrated a commitment to safety. The increased clarity made the rules easier to follow, improved utilization, and better protected the workers.

- *Improvements in union-management relations.* Most respondents reported improvements in union-management relationships. These workers reported increased trust that management was committed to making the workplace safer. One respondent reported no change, and another reported improvement in management relations with rank-and-file workers but deterioration in management relations with union leadership.

- *Perceived changes in compliance.* Most respondents indicated that the rules revision process had brought greater compliance and greater safety consciousness.

5.3 Implementing Safety Rules Revisions

The evaluation found a remarkable degree of consistency in the way that respondents understood and described the process and the reasons for undertaking it. Most noted that their previous safety rulebooks were developed unreflectively and reactively in response to particular safety incidents. The end results were extensive, and cumbersome rulebooks were viewed by employers as insurance against liability for accidents and viewed by workers as hammers used to punish workers. It appears that these rulebooks both reflected and promoted unhealthy safety cultures, which featured poor communication, unclear expectations, and lack of trust. While most respondents did not speak of the legal climate, it seems likely that the FELA provisions described in Section 2 contributed to these complex rulebooks and undesirable safety cultures.

Interviews suggested a number of promising strategies for implementing rules revision.

- *Senior management preparation activities.* Safety executives from three of the companies stated that the rules revisions were preceded by senior management activities to increase the participation of the workforce in safety.[26] The rules revisions occurred after senior management had started actively to involve labor in an attempt to make the safety culture more participative.
- *Participation.* Buy-in and participation at all levels of the company, from front-line workers to senior management, was critical to successful implementation. Front-line worker involvement was central to the writing of the rules, and front-line supervisor commitment was especially important once the new rules were implemented.
- *External help.* Project facilitation by the external consultant was found to be helpful. Since long-time workers and managers were entrenched in the status quo, an external, objective perspective was valuable and helped keep the process on track.
- *Involvement of unions.* All respondents noted the importance of having rank-and-file union members involved in the process. They differed in their opinions about the extent to which involvement by union officials was desirable/necessary.

Respondents also identified a number of challenges.

- *Resistance to change among some groups.* Several respondents noted pockets of resistance to the rules revisions. They cited managers who feared that the process would amount to "giving the keys to the inmates" and labor members who suspected that the new rulebook would be used to hammer people, just like the old one. Most respondents said that companies must allow time for differences in opinion to be worked out. Some suggested that individuals could facilitate the process by leading by example (e.g., embracing and following the new rules).
- *Turnover on committees.* Since committees included a mix of labor and management, it took time to develop trust. Working through difficult issues also took time and often occurred over multiple meetings. When a high degree of turnover occurred on committees, the process was especially slow.
- *Resource requirements.* The process was time consuming and resource intensive. In addition to the costs of the employee time involved, most felt the need for an objective outside consultant. These costs could make the process prohibitive for the short lines and railroads with scarce resources. Railroads should not undertake this program unless they plan to see it through and sustain it long term.

5.4 Future Directions

The research and evaluation activities in this study were exploratory but indicate the importance of organizational factors on safety. The following recommendations for further activities build on the findings presented in this report.

- *Reduction in injury-related liability and costs.* Safety executives from two carriers reported reductions in the number and cost of FELA claims as a result of rules revision. This could not be substantiated due to the lack of data from the carriers but is worth pursuing in the future, given the significant costs associated with FELA

[26] The topic of senior management preparation was not discussed with CN/IC.

claims in the industry (Section 2). The impact of safety rules revision on other injury-related costs should be studied more closely as well.

- *Senior management involvement.* Safety executives from three carriers discussed senior management preparatory work that involved including labor to make the safety culture more participative. In this study, it was not clear whether rules revision was more important than the management preparatory work or vice versa, since the evaluation team could not distinguish their relative effects. Since positive results were found, especially at KCS, while analyzing their combined effect, future work should more closely examine the role of senior management in supporting rules revision and other safety interventions. In addition, management involvement after the preparatory activities must be considered to address sustainability. For instance, how do you keep senior managers involved when a change at the very top occurs? Several studies have pointed out the importance of senior management to safety, as well as the bottom line. The United Kingdom's Railway Safety organization developed a strategic safety management orientation program for senior managers to address issues raised about the role of senior management in the aftermath of the Clapham accident (Nelson, 2002). Analyzing other ways management can engage with labor to improve safety could prove to be very beneficial.
- *Role of union officials.* Respondents from one carrier noted that union officials resisted the rules revision. Future activity might explore the role of union officials in rules revisions, the source of their reservations, and their relations with rank-and-file workers and management; both of whom tended to be uniformly enthusiastic about rules revision.
- *Injury data impact assessment at different levels.* Core safety rules apply across the carrier, and craft-specific safety rules apply within a particular craft. Although the impact assessment provided in this report took the carrier as the unit of analysis, the extent and quality of implementation may vary by department. Thus, future research activities should look for variations in implementation across departments or crafts to test whether the safety outcome trends differ. Further, it is possible that a reduction occurred only in the types of incidents that specifically relate to the rules in the new rulebooks, rather than a generalized incident rate impact. Future activities should examine injuries related to the new rules and test for variations in safety outcomes. The department management or representing unions could use this information to improve safety.
- *Measure of compliance.* The interview data obtained in this study stated that compliance with safety rules improved as a result of the process. In the future, it would be helpful to obtain company records of safety rule violations, as a proxy for compliance, to confirm the interview data. The analysis could determine whether rule violations decreased for all rules or only for the core rules. A general decrease in rule violations could be related to improvements in safety culture.
- *Sustainability.* At least one of the carriers studied has since added a considerable number of rules to its safety rulebook (this was coincident with the departure of the senior executive who sponsored the rules revision effort), raising the question of the sustainability of rules revisions. Future activity might track rulebooks and safety practices in carriers that have undertaken rules revisions several years after the end

of the process to assess the durability of the reforms in these carriers. In particular, does the pattern of workforce participation and rule drafting continue? Are core and craft rules still 100 percent able to be complied with and not in conflict with other rules? Do crafts still own their own rules? Finally, are subsequent increases in the number and type of rules related to increases in incident rates? [27]

- *Resource intensiveness*. Most respondents mentioned that the process was time consuming and required the use of an external consultant. Future activity should investigate refinements to the process that make it less time intensive and costly while achieving the same level of consensus. For instance, the findings on the importance of leadership suggest that leadership coaching might be a cost-effective way to achieve some safety improvements. Reductions in resource requirements would be particularly essential for the smaller and more resource-constrained railroads. Future research should also study the return on investment for this intervention.

In conclusion, this study found rules revision worthy of future study. Despite the lack of conclusive quantitative data, the interviewees agreed that safety rules revision had an overall positive benefit. Moreover, the outcome data, while inconclusive, suggested a number of possible benefits worth further exploration. The potential savings associated with a possible reduction in FELA claims alone merit future investigation.

[27] More generally, the renascence of rules proliferation might allow for a removed treatment analysis, in which evaluators test not only whether the advent of the intervention leads to improvements in outcomes, but also whether withdrawal of the intervention leads to deterioration of outcomes. Such designs increase evaluators' ability to establish whether an intervention is both a necessary and a sufficient condition of the observed outcomes (Shadish, 2002).

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Appendix A. Statistical Analysis of Incident Rate Data

Formal statistical analysis, which provided a more precise characterization of the magnitude of the effects, supplemented visual inspection of treatment and comparison group incident rates series (see Section 4.2.5). In keeping with the use of the control series quasi-experimental design, the analysis sought to estimate the difference in pre-/post-differences between the treatment and comparison groups (Shadish, Cook, et al., 2002).

The statistical analysis proceeded in three steps. First, interrupted times series models were estimated against the treatment series only. This provided an assessment of whether rules revision, combined with management preparatory activities, was a sufficient condition of reductions in incident rates. Causal attribution, however, also requires demonstration that rules revision, combined with management preparatory activities, was a necessary condition of pre-/post-differences. Thus, the second stage in the analysis involved estimating the same interrupted time series models against the comparison group series. Finally, a pooled regime-switching regression model was estimated in order to statistically compare the estimated pre-/post-differences in the treatment series with the estimated pre-/post-differences in the comparison series (e.g., Ashenfelter, 1978; Card and Sullivan, 1988). All models were estimated using robust regression (iteratively reweighted least squares), which downweights outlying observations.[28]

A.1 Modeling the Treatment Series

The most important decision in modeling the treatment series was placement of the point of intervention. In three cases (CSXT, KCS, and ACBL), qualitative data suggested that the intervention began not with the formal rules revision process but with various preparatory management activities that preceded the formal rules revision process (see Section 4.1.1). Thus, the point of intervention was the preparatory activities.[29] Since the idea behind interrupted time series analysis is to test the null hypothesis of no difference between pre- and post-intervention series, the remaining features of the model specifications were tailored to each case's data (see McDowall, McCleary et al., 1980).[30]

The models for KCS and ACBL were quite simple given that the paucity of observations precluded more complex models. The distribution of rates in these cases suggested a Gaussian stochastic process. Since inspection of the time series revealed no structural breaks, the pre-/post-differences were modeled as spline regressions (e.g., Kmenta, 1986; Greene, 2000), which include slope shifts but no intercept shifts. Equation 1 gives the formal statistical model for KCS and ACBL:

$$RATE_t = \beta_0 + \beta_1 TIME_t + \beta_2 TPOST_t + \varepsilon_t \qquad (1)$$

[28] The robust regressions were estimated using STATA version 7, with Huber weights and biweights.
[29] In all three cases, placing the point of intervention at the beginning of formal rules revision produced null findings.
[30] Model specification in the KCS model was also limited by the small number observations.

where $TIME_t$ represents the pre-intervention slope, $TPOST_t$ the difference between the pre- and post-intervention slope, and ε_t an independently and identically distributed disturbance term.

Inspection of the CSXT series, by contrast, suggested a nonlinear process both in the pre- and post-intervention series. Moreover, the distribution of the rates suggested a log-normal stochastic process. Thus, the log of incident rates was estimated as a function of the following five parameters: (1) the incident rate immediately preceding the intervention (β_0),[31] (2) the rate of decline and acceleration/reversion before the intervention (β_1 and β_2), (3) the immediate change in rate (intercept shift parameter) just after the intervention (β_3), (4) the immediate change in the rate of decline (slope shift parameters) in incident rate (β_4), and (5) the rate at which incident rates reverted toward the pre-intervention mean (β_5). Equation 2 gives the formal model:[32]

$$\log(RATE_t) = \beta_0 + \beta_1 TIME_t + \beta_2 TIME_t^2 + \beta_3 INTERV_t + \beta_4 TPOST_i + \beta_5 T^2 POST + \varepsilon_t \qquad (2)$$

A.2 Modeling the Comparison Series

Assessing the causal impact of the intervention requires a demonstration that the intervention was a necessary condition of any observed pre-/post-differences. Thus, the second step in the analysis involved estimating the same intervention model against incident rate data from the comparison groups. For each case, the placement of the intervention was the same as in the treatment series. This provided a test of whether any pre-/post-changes in the treatment series might have occurred without the intervention (i.e., whether the treatment was necessary condition of pre-/post-changes).

A.3 Estimating the Differences in Pre-/Post-Differences

In the final step of the analysis, estimates from the treatment and comparison group impact models were compared to assess whether any changes in the treatment group were truly unique. Visual comparison of the coefficient estimates for each group was followed by estimation of a pooled model in a regime-switching regression. Here, the treatment and comparison group series were pooled. The models shown in Equations 1 and 2 were modified to include (1) a dummy variable distinguishing treatment from comparison group data and (2) interactions between the dummy variable and each of the remaining parameters. The coefficients on the dummy-interaction terms represent the difference between the two groups and allow the evaluation team to statistically test the null hypothesis of no difference between the coefficient estimates for each group. Pooling data in switching regressions requires the assumption of homogeneous variance between the regimes (Kmenta, 1986). Fortunately, for each of the three cases, F-tests for the homogeneity of variance provided support for this assumption (see Table A-1).

[31] The time variables were centered at the period immediately preceding the intervention. Thus, the intercept may be interpreted as the predicted level immediately preceding the intervention.

[32] A fully linear model was also estimated. The nature of the time series, however, makes this model less credible than the nonlinear model.

Table A-1. Test of the Homogeneity of Variances in Treatment and Comparison Group Series

Firm	Standard Deviation		Test of Homogeneity of Standard Deviation (p-value)
	Treatment Series	Comparison Series	
CSXT	2.8	2.1	0.22
KCS	0.3	0.5	0.39
ACBL	2.0	2.4	0.99

A.4 Findings

The statistical analysis confirmed findings from visual inspection of the graphs. The following provides key statistical findings for each of the three cases.

CSXT. Table A-2 provides findings for the analysis of CSXT. Values in the first column provide estimates for the CSXT series only, while values in the second column provide estimates for the comparison series. Estimates of the difference-in-difference are provided in the rightmost column. Since incident rates were modeled in logs, the regression coefficients may be interpreted as percentage changes.

The parameters of greatest interest are those for *INTERV* (the immediate drop in rates), *TPOST* (the change in slope after the intervention), and T^2POST (the change in the rate of acceleration/reversion in the rate of change). Visual inspection of columns I and II confirms the finding from the graphical analysis of an immediate drop in rates coincident with management preparatory activities at CSXT, but not in the comparison series. The difference between CSXT and the comparison group barely reaches conventional standards of statistical significance (p = 0.10), as shown in column III; however, it reflects the fact that safety improvements at CSXT preceded those in the comparison group. The coefficient on *TPOST* also confirms the finding that, in spite of an earlier rate decline in CSXT than in the industry, the eventual rates of post-intervention decline in the two groups were nearly identical. Again, the absence of a clear difference is illustrated by the p-value in column III (0.60). Finally, the statistical analysis confirms the finding of a reversion in the CSXT series. Indeed, the coefficient on the T^2POST variable is 0.01 for CSXT and -0.02 for the industry comparison group.[33] In sum, while it is clear that the decline in the CSXT series preceded that in the industry, no clear evidence exists that the decline was unique to CSXT.[34]

KCS. As noted above, both the nature of the time series and the paucity of observations suggested a linear model in the KCS case. Thus, the coefficient of primary interest in this analysis focuses on the *TPOST* variable. The results reported in Table A-3 show that, while KCS

[33] The small magnitude of the coefficients reflects that the variable is in squared units.

[34] High collinearity likely inflated the standard errors on the difference-in-difference estimates on the β_4 and β_5 coefficients, increasing the likelihood of Type II error (improperly failing to reject the null hypothesis).

experienced a statistically significant increase in the rate of safety improvement (β = -0.51, p < 0.001), the industry comparison series showed no change (p = 0.19). The estimate in column III confirms that the difference in pre-/post-differences between the KCS and industry series (β = -0.76) is statistically significant (p = 0.07). In short, while the KCS series showed an increase in the rate of improvement after the intervention, the remainder of the industry did not.

Table A-2. Coefficient Estimates for CSXT and Industry (Logged Rates)[#]

Variable	I CSXT (β) (p-values)	II Industry (β) (p-values)	III β CSXT - β Industry (p-value)
Intercept (β_0)	1.35* (0.09)	0.92 (0.19)	0.43 (0.39)
TIME (β_1)	-0.16 (0.27)	-0.24* (0.10)	0.08 (0.24)
TIME^2 (β_2)	0.01 (0.50)	0.02 (0.14)	-0.01 (0.76)
INTERV (β_3)	-0.05 (0.79)	0.32** (0.02)	-0.37* (0.10)
TPOST (β_4)	-0.29** (0.03)	-0.27*** (0.005)	-0.02 (0.60)
T^{2}POST (β_5)	0.01 (0.67)	-0.02 (0.19)	0.03*** (0.006)

[#]Pre-intervention series runs from 1983-1989; post-intervention series runs from 1990-2002.
*p < 0.10
**p < 0.05
***p < 0.01

Examination of the coefficients on the *TIME* variable (pre-intervention slope) show that a statistically discernible difference existed between KCS and the rest of the industry in the rate of change before the intervention. On the one hand, this questions the use of the remainder of the industry as a comparison group. On the other hand, the fact that the KCS slope was less favorable before the intervention only strengthens the case for a positive impact.[35]

[35] High collinearity might imply that the p-values on the difference-in-difference estimates on β_2 are biased upward.

Table A-3. Coefficient Estimates for KCS and Industry[#]

Variable	I KCS (β) (p-values)	II Industry (β) (p-values)	III β (KCS) - β (Industry) (p-value)
Intercept (β_0)	3.47*** (<0.001)	3.39*** (<0.001)	0.08 (0.65)
TIME (β_1)	0.15*** (0.001)	-0.21 (0.12)	0.36** (0.05)
TPOST (β_2)	-0.51*** (<0.001)	0.25 (0.19)	-0.76* (0.07)

[#]Pre-intervention series runs from 1995-1998; post-intervention series runs from 1999-2002.
*$p < 0.10$
**$p < 0.05$
***$p < 0.01$

ACBL. The analysis of ACBL and its matched industry is identical to the analysis of KCS data. Table A-4 presents the results. Unlike the other two cases, no strong evidence exists of a pre-/post-difference, either in ACBL ($p = 0.13$) or in the remainder of the industry ($p = 0.36$).[36] Examination of the regression coefficients suggests that, if anything, ACBL and the industry experienced a slight decrease in the rate of improvement ($\beta = 0.51$), with the difference between the two being statistically significant ($p = 0.10$). Thus, no indication exists that rules revision had a positive impact on incident rates and slight evidence of a negative impact in this case, which should be regarded with cautiousness as outlined in the report.

Table A-4. Coefficient Estimates for ACBL and Industry[#]

Variable	I ACBL (β) (p-values)	II Industry (β) (p-values)	III β ACBL - β Industry (p-value)
Intercept (β_0)	4.87*** (<0.001)	11.21*** (<0.001)	-6.34*** (0.005)
TIME (β_1)	-0.65*** (0.01)	-0.59*** (0.009)	-0.06 (0.23)
TPOST (β_2)	0.40 (0.22)	0.03 (0.93)	0.37 (0.13)

[#]Pre-intervention series runs from 1990-1994; post-intervention series runs from 1995-2002.
*$p < 0.10$
**$p < 0.05$
***$p < 0.01$

[36] High collinearity might imply that the *p*-values on the difference-in-difference estimates on β_2 are biased upward.

Acronyms

ACBL	American Commercial Barge Lines
ACSNI	Advisory Committee on the Safety of Nuclear Installations
BNSF	Burlington Northern Santa Fe Corporation
CN/IC	Canadian National/Illinois Central
CSXT	CSX Transportation
EOD	employees on duty
FELA	Federal Employer's Liability Act
FRA	Federal Railroad Administration
KCS	Kansas City Southern
PPE	personal protective equipment
Volpe Center	Volpe National Transportation Systems Center