Human-Centered Incident Investigation Methods
for the Railroad Industry

A one-day educational conference on state-of-the-art incident investigation and corrective action tools and techniques to increase rail industry safety

Wednesday, June 19, 2002
Hyatt Regency O’Hare, Chicago, IL

Sponsored by:
Federal Railroad Administration
Office of Research and Development
Human Factors Program

Hosted by:
Foster-Miller, Inc., Waltham, MA

This document is available to the U.S. public through the National Technical Information Service, Springfield, VA 22161.
NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof.

NOTICE

The United States Government does not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the objective of this report.
Abstract

This report presents a summary of a one-day educational conference on human-centered incident investigation methods for the railroad industry. Fifty-seven participants from the railroads, rail labor, government, and consulting/academia attended the one-day conference, held in Chicago, IL. Mr. George Gavalla, Federal Railroad Administration (FRA) Associate Administrator for Safety, provided the opening remarks. Speakers included representatives from the FRA, railroads, labor, the National Transportation Safety Board, and the Mine Safety and Health Administration. Two panel discussions addressed how to create a more collaborative incident investigation environment, and future challenges in incident investigation. Several key themes emerged from the conference: railroads are slow to adopt a human-centered approach to incident investigation, but recognize the importance of such an approach; different railroads are taking different approaches to the incorporation of human-centered approaches-some are bottom-up while others are top-down; and the next big challenge in incident investigation in the railroad industry is to study near-miss data, as well as the unsafe acts and conditions that lead to near-misses and more serious incidents. Conference participation and discussion suggest several opportunities for the FRA to continue its efforts to improve railroad safety. These include (1) improvements to FRA’s website to incorporate incident prevention methods and “best practices” from the industry, (2) examination of near-miss data collection and analysis methods, and (3) sponsorship of a follow-up conference in 2-3 years to continue facilitating the sharing of “best practices” across the railroad industry.
## SI* (MODERN METRIC) CONVERSION FACTORS

### APPROXIMATE CONVERSIONS TO SI UNITS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>When You Know</th>
<th>Multiply By</th>
<th>To Find</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>in</td>
<td>inches</td>
<td>25.4</td>
<td>millimeters</td>
<td>mm</td>
</tr>
<tr>
<td>ft</td>
<td>feet</td>
<td>0.305</td>
<td>meters</td>
<td>m</td>
</tr>
<tr>
<td>yd</td>
<td>yards</td>
<td>0.914</td>
<td>meters</td>
<td>m</td>
</tr>
<tr>
<td>mi</td>
<td>miles</td>
<td>1.61</td>
<td>kilometers</td>
<td>km</td>
</tr>
<tr>
<td>in²</td>
<td>square inches</td>
<td>645.2</td>
<td>millimeters squared</td>
<td>mm²</td>
</tr>
<tr>
<td>ft²</td>
<td>square feet</td>
<td>0.093</td>
<td>meters squared</td>
<td>m²</td>
</tr>
<tr>
<td>yd²</td>
<td>square yards</td>
<td>0.836</td>
<td>meters squared</td>
<td>m²</td>
</tr>
<tr>
<td>ac</td>
<td>acres</td>
<td>0.405</td>
<td>hectares</td>
<td>ha</td>
</tr>
<tr>
<td>mi²</td>
<td>square miles</td>
<td>2.59</td>
<td>kilometers squared</td>
<td>km²</td>
</tr>
<tr>
<td>fl oz</td>
<td>fluid ounces</td>
<td>29.57</td>
<td>milliliters</td>
<td>ml</td>
</tr>
<tr>
<td>gal</td>
<td>gallons</td>
<td>3.785</td>
<td>liters</td>
<td>l</td>
</tr>
<tr>
<td>ft³</td>
<td>cubic feet</td>
<td>0.028</td>
<td>meters cubed</td>
<td>m³</td>
</tr>
<tr>
<td>yd³</td>
<td>cubic yards</td>
<td>0.765</td>
<td>meters cubed</td>
<td>m³</td>
</tr>
<tr>
<td>oz</td>
<td>ounces</td>
<td>28.35</td>
<td>grams</td>
<td>g</td>
</tr>
<tr>
<td>lb</td>
<td>pounds</td>
<td>0.454</td>
<td>kilograms</td>
<td>kg</td>
</tr>
<tr>
<td>T</td>
<td>short tons (2000 lb)</td>
<td>0.907</td>
<td>megagrams</td>
<td>Mg</td>
</tr>
</tbody>
</table>

### APPROXIMATE CONVERSIONS FROM SI UNITS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>When You Know</th>
<th>Multiply By</th>
<th>To Find</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>millimeters</td>
<td>0.039</td>
<td>inches</td>
<td>in</td>
</tr>
<tr>
<td>m</td>
<td>meters</td>
<td>3.28</td>
<td>feet</td>
<td>ft</td>
</tr>
<tr>
<td>m</td>
<td>meters</td>
<td>1.09</td>
<td>yards</td>
<td>yd</td>
</tr>
<tr>
<td>km</td>
<td>kilometers</td>
<td>0.621</td>
<td>miles</td>
<td>mi</td>
</tr>
<tr>
<td>mm²</td>
<td>millimeters squared</td>
<td>0.0016</td>
<td>square inches</td>
<td>in²</td>
</tr>
<tr>
<td>m²</td>
<td>meters squared</td>
<td>10.764</td>
<td>square feet</td>
<td>ft²</td>
</tr>
<tr>
<td>m²</td>
<td>meters squared</td>
<td>1.195</td>
<td>square yards</td>
<td>yd²</td>
</tr>
<tr>
<td>ha</td>
<td>hectares</td>
<td>2.47</td>
<td>acres</td>
<td>ac</td>
</tr>
<tr>
<td>km²</td>
<td>kilometers squared</td>
<td>0.386</td>
<td>square miles</td>
<td>mi²</td>
</tr>
<tr>
<td>ml</td>
<td>milliliters</td>
<td>0.334</td>
<td>fluid ounces</td>
<td>fl oz</td>
</tr>
<tr>
<td>l</td>
<td>liters</td>
<td>0.264</td>
<td>gallons</td>
<td>gal</td>
</tr>
<tr>
<td>m³</td>
<td>meters cubed</td>
<td>35.71</td>
<td>cubic feet</td>
<td>ft³</td>
</tr>
<tr>
<td>m³</td>
<td>meters cubed</td>
<td>1.307</td>
<td>cubic yards</td>
<td>yd³</td>
</tr>
<tr>
<td>g</td>
<td>grams</td>
<td>0.035</td>
<td>ounces</td>
<td>oz</td>
</tr>
<tr>
<td>kg</td>
<td>kilograms</td>
<td>2.202</td>
<td>pounds</td>
<td>lb</td>
</tr>
<tr>
<td>Mg</td>
<td>megagrams</td>
<td>1.103</td>
<td>short tons (2000 lb)</td>
<td>T</td>
</tr>
<tr>
<td>°C</td>
<td>Celsius</td>
<td>1.8C + 32</td>
<td>Fahrenheit</td>
<td>°F</td>
</tr>
</tbody>
</table>

### TEMPERATURE (exact)

<table>
<thead>
<tr>
<th>°F</th>
<th>Fahrenheit temperature</th>
<th>°C</th>
<th>Celsius temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>5(F-32)/9</td>
<td>1.8C + 32</td>
<td>3°F</td>
<td>1.8C + 32</td>
</tr>
<tr>
<td>or (F-32)/1.8</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### ILLUMINATION

<table>
<thead>
<tr>
<th>fc</th>
<th>foot-candles</th>
<th>10.76</th>
<th>lux</th>
</tr>
</thead>
<tbody>
<tr>
<td>fl</td>
<td>foot-Lamberts</td>
<td>3.426</td>
<td>cd/m²</td>
</tr>
</tbody>
</table>

### FORCE and PRESSURE or STRESS

<table>
<thead>
<tr>
<th>lbf</th>
<th>poundforce</th>
<th>4.45</th>
<th>newtons</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>psi</td>
<td>poundforce per square inch</td>
<td>6.89</td>
<td>kilopascals</td>
<td>kPa</td>
</tr>
<tr>
<td>N</td>
<td>newtons</td>
<td>0.225</td>
<td>poundforce</td>
<td>lbf</td>
</tr>
<tr>
<td>kPa</td>
<td>kilopascals</td>
<td>0.145</td>
<td>poundforce per square inch</td>
<td>psi</td>
</tr>
</tbody>
</table>

* SI is the symbol for the International System of Units

536-Conversion Factors

(Revised January 1992)
Contents

Acknowledgements ................................................................................................................... vii
1 Introduction ......................................................................................................................... 1
  1.1 Background .................................................................................................................... 1
  1.2 Conference Goals ......................................................................................................... 2
  1.3 Organization of the report ............................................................................................ 2
2 Presentations ....................................................................................................................... 3
  2.1 Investigating for Human Factors in Rail Accidents and Incidents............................... 3
  2.2 Incorporating a Human Factors Approach in Accident Investigations at Canadian Pacific Railway ........................................................................................................... 3
  2.3 Getting to the Causal Roots of Incidents: An Examination of the Working Interface ............................................................................................................................... 3
  2.4 The Anatomy of a Cooperative Safety Committee: The CSX Experience .................. 3
  2.5 Panel Discussion: Creation of a Collaborative Incident Investigation Environment ................................................................................................................................. 4
  2.6 Things that go Bump in the Day: Diminished Alertness Accidents in Broad Daylight ................................................................................................................................. 5
  2.7 Accident Investigation Fundamentals-Human Factor Analysis .................................... 5
  2.8 MSHA’s Accident Reduction Program ........................................................................... 5
  2.9 Safety in Practice: A Shortline Railroad's Experience .................................................... 6
  2.10 Panel Discussion: Future Challenges in Investigating and Correcting Incidents in the Railroad Industry ................................................................................................. 6
3 Key Themes ....................................................................................................................... 9
4 Recommendations ............................................................................................................. 11
5 References ....................................................................................................................... 13

Appendix A: Conference Attendees ....................................................................................... 15
Appendix B: Conference Final Program ................................................................................ 17
Appendix C: Speaker and Panelist Presentations .................................................................... 19
Illustrations

Figure 1. Heinrich’s Triangle........................................................................................................ 10
## Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASRS</td>
<td>Aviation Safety Reporting System</td>
</tr>
<tr>
<td>BLE</td>
<td>Brotherhood of Locomotive Engineers</td>
</tr>
<tr>
<td>BNSF</td>
<td>Burlington Northern and Santa Fe Railway</td>
</tr>
<tr>
<td>BRS</td>
<td>Brotherhood of Railway Signalmen</td>
</tr>
<tr>
<td>FAA</td>
<td>Federal Aviation Administration</td>
</tr>
<tr>
<td>FRA</td>
<td>Federal Railroad Administration</td>
</tr>
<tr>
<td>MSHA</td>
<td>Mine Safety and Health Administration</td>
</tr>
<tr>
<td>NASA</td>
<td>National Aeronautics and Space Administration</td>
</tr>
<tr>
<td>NTSB</td>
<td>National Transportation Safety Board</td>
</tr>
<tr>
<td>NTSC</td>
<td>(Volpe) National Transportation Systems Center</td>
</tr>
<tr>
<td>SAIC</td>
<td>Scientific Applications International Corporation</td>
</tr>
<tr>
<td>SIDT</td>
<td>(FRA) Safety Improvement and Development Team</td>
</tr>
<tr>
<td>TCIU</td>
<td>Transportation Communication International Union</td>
</tr>
<tr>
<td>TSB</td>
<td>Transportation Safety Board (of Canada)</td>
</tr>
<tr>
<td>UTU</td>
<td>United Transportation Union</td>
</tr>
</tbody>
</table>
Acknowledgements


The authors express thanks to Dr. Thomas Raslear, FRA Office of Research and Development, for sponsoring this conference, and for his guidance throughout the planning stages. We would also like to thank Mr. George Gavalla, Associate Administrator for Safety, FRA Office of Safety, for speaking at the conference and showing his support.

We would also like to thank Ms. Susan McDonough, of Foster-Miller, Inc., for her excellent program administration skills and her time in helping to coordinate and arrange this conference. And lastly, we would like to thank Ms. Sarah Acton, also of Foster-Miller, Inc. for her support during the conference.

Most importantly, we would like to thank all of the speakers and panelists who volunteered their time and resources to be present and participate in the conference. Their efforts and the energy that they contributed made the conference a success. And finally, thanks to all those who attended the conference. They showed that they have a genuine interest in incorporating human factors into their incident investigations, and are willing to learn and grow.
1 Introduction

This report summarizes a one-day conference sponsored by the FRA Office of Research and Development Human Factors Program held in Chicago, IL, on June 19, 2002. The conference focused on how railroads can and do incorporate human-centered approaches to their incident investigations. Human-centered incident investigation methods emphasize multiple root causes, and focus on the acts of, and conditions created by, individuals at all levels of an organization, not just the operator who was closest in time and space to the incident.

A total of 57 railroad and safety professionals attended the conference. Participants included representatives from all Class I railroads; several shortline, regional and commuter/passenger railroads; the FRA Office of Research and Development and Office of Safety (from both FRA Headquarters and various FRA Regions across the United States); operating and non-operating craft labor unions; and government agencies responsible for safety, including the U.S. National Transportation Safety Board, Transportation Safety Board of Canada, and U.S. Mine Safety and Health Administration. A list of attendees is provided in Appendix A.

1.1 Background

The FRA Office of Research and Development Human Factors Program is responsible for a wide array of technical activities in a number of different program areas. One of these areas is railroad yard safety. The FRA Office of Research and Development Human Factors Program began examining railroad yard worker safety issues in 1995. This effort culminated in a recently published report (Reinach and Gertler, 2001). Among other results, this analysis found that railroads use a variety of techniques to investigate personal injuries and accidents. Specifically, some railroads do not incorporate any type of human-centered approach to their investigations, while others do. And of those who do, there are different approaches. Consequently, the report made several recommendations to address a perceived need within the railroad industry to better understand the benefits and methods of a human-centered approach to incident investigation. One of these recommendations was to facilitate the sharing of “best practices” across the railroad industry to disseminate the “state-of-the-art” in human-centered incident investigations. This recommendation led to the development and planning of a one-day educational conference for the benefit of the railroad industry.

The FRA Office of Safety supported this human factors educational initiative. Traditionally, the Office of Safety has focused on accidents due to some type of “hardware” failure, such as track, signal and mechanical problems, that led to train accidents. Recently, however, the Office of Safety has begun to recognize the importance and significance of human factors in the railroad industry, and in particular, its role in railroad safety. For example, a 2001 Office of Safety report (FRA, 2001; p. 3) that analyzed 1997 railroad employee fatalities notes that “Fatalities usually resulted from a chain of events or the errors of more than one individual…. [And that] nearly 40 percent [of the fatalities]…involved three or more PCFs [possible contributing factors].” In addition to its own initiatives to address many of these human factors issues, the Office of Safety has partnered closely with the Office of Research and Development in recent years. This strategy has allowed the FRA to leverage its human factors expertise in tackling many of these issues. This conference is one more example of this partnership.
1.2 Conference Goals
The overall purpose of the conference was to help the railroad industry begin to move toward a more human-centered, multiple-cause, approach to incidents and their investigations, in order to further improve safety in rail transportation. To this end, the conference had four specific goals, which were conveyed to conference attendees at the beginning of the day. They were to:

1. Create and facilitate an open exchange of information and ideas among attendees.
2. Enable the sharing of “best practices” across the industry.
3. Encourage attendees to think of incidents as having multiple causes, or contributing factors.
4. Promote the idea of looking at contributing factors at all levels of an organization.

1.3 Organization of the report
This report is organized into several sections. Section 2 presents brief summaries of each of the presentations. Section 3 describes the key themes that emerged from the conference presentations and discussions. Section 4 presents recommendations derived from the conference activity. Section 5 contains a set of references for this report. A number of appendices are also included, and make up the bulk of the report. Appendix A contains a list of the conference attendees. Appendix B contains a copy of the conference program. And finally, Appendix C contains copies of speakers’ presentations, as well as presentations from those panelists who elected to use presentations to augment their discussions.
2 Presentations

This section provides brief summaries of each of the eight presentations and two panel discussions. For complete copies of presentations, see Appendix C.

2.1 Investigating for Human Factors in Rail Accidents and Incidents
Ms. Elizabeth McCullough, Manager, Human Performance Division of Transportation Safety Board (TSB) of Canada, presented a systematic and integrated process that she and her TSB colleagues developed to investigate transportation incidents for human factors. Ms. McCullough’s method applies several accepted human factors methodologies in a seven-step investigative process that culminates in a risk assessment and the identification of safety deficiencies in a transportation system. A major advantage of such a system is that it focuses on safety actions to prevent further incidents.

2.2 Incorporating a Human Factors Approach in Accident Investigations at Canadian Pacific Railway
Ms. Faye Ackermans, General Manager, Safety and Regulatory Affairs at Canadian Pacific Railway (CPR), discussed her ongoing effort to incorporate human factors into CPR’s incident investigation process. The underlying human factors theories (e.g., error causation) behind her methods are the same as those discussed by Ms. McCullough in her presentation; the major difference is that Ms. Ackermans’ presentation focused on the real-world application of some of these methods at CPR. Ms. Ackermans discussed the initial resistance she met when applying these methods, and the resultant modifications she had to make to gain acceptance from both front-line managers and higher-level railroad officers. One of the products from Ms. Ackermans’ effort has been the development of portable decision-aids and tools to incorporate human factors principles into daily investigation methods.

2.3 Getting to the Causal Roots of Incidents: An Examination of the Working Interface
Mr. Jack Balsamo, Principal Consultant, BST, Inc., discussed the importance of understanding the antecedents and consequences of at-risk behaviors to determine why and how these behaviors may be present in a system. The focus of Mr. Balsamo’s talk was on preventative efforts to study and promote worker behaviors before incidents occur. However, incident data can be used to direct preventative safety efforts by targeting and modifying those risky behaviors associated with the incident under investigation.

2.4 The Anatomy of a Cooperative Safety Committee: The CSX Experience
Mr. Jerry Gibson, Locomotive Engineer, and Mr. Art Zima, Trainmaster, from CSX Transportation discussed CSX Transportation’s approach to local safety committees. CSX Transportation has adopted a hands-off approach of allowing local labor to elect representatives from among their own crafts to participate on the safety committee. Basic tenets that Mr. Gibson and Mr. Zima suggested were key ingredients to a successful safety committee were trust, respect for one another, teamwork, and acceptance of change. The safety committee model that began in Wyoming Yard in Western Michigan is now being introduced in other parts of the CSX
2.5 Panel Discussion: Creation of a Collaborative Incident Investigation Environment

This panel focused on exploring ways in which the railroad industry can create a more collaborative and open incident investigation environment. Each panelist was given 10 minutes to share his thoughts and experiences on how this type of environment may be fostered. To help provide some focus, panelists were provided ahead of time with a sample set of questions that they could choose to address during the panel. The questions were:

- How can an organizational culture that is more focused on identifying unsafe conditions and less focused on assigning blame be developed and cultivated?
- What are the barriers to this type of environment (e.g., pressure from above to show zero accidents or injuries; pressure from peers; protection from self-incrimination)?
- How may (some of) these barriers be overcome?
- What union, carrier and government resources (staffing, equipment, policies, money, regulations, formal support) are necessary to make this happen?
- What are the roles of the carriers, labor unions and the FRA with respect to creating and fostering this type of environment?

After each panelists spoke for 10 minutes, the moderator opened the floor to questions from the audience. Panel participants were the following four individuals:

- Mr. Royal Gelder, Director, Risk Management and Planning for the Belt Railway Company of Chicago
- Mr. Jeff Blomgren, Assistant General Manager, Employee Safety for CSX Transportation
- Mr. Robert Harvey, Regulatory Research Coordinator for the Brotherhood of Locomotive Engineers
- Mr. Tim DePaepe, Director of Research for the Brotherhood of Railway Signalmen

The discussion was moderated by Mr. Michael Coplen, Human Factors Program Manager for the FRA Office of R&D.

Several barriers and solutions emerged from the panel discussion. Some ideas were promoted by one panelist, while others were the concurrence of several panelists. Ideas that were put forward include:

- There is a need within the industry to share “best practices” using means such as this conference, to help improve safety.
- Use the SOFA process as a model for (1) joint industry-labor cooperation and (2) development of immediately applicable results to improve safety.
- There is currently a fear of being disciplined, of losing income, and/or being fired, when reporting injuries. A recommendation was made to do away with automatic dismissals and stop looking for blame when investigating incidents. This will help to open communication and thus, to improve incident investigations.
• Both management and labor may need to “set aside concerns about FELA” to obtain greater cooperation.

• CSX Transportation has stopped requiring an automatic discipline hearing after every injury. The number of injuries reported has increased, as expected, but this reflects an increase in reporting, not a decrease in safety. Many of the less serious injuries are now being reported, which enables the railroad to identify hazards they may not have been able to identify previously.

• One panelist suggested that an injury ratio plotted over time, such as injuries per 200,000 labor hours, is a step wise process, and that a railroad’s performance will naturally improve and then plateau. The focus should not be on the actual injury ratio for a given year, but rather the rate of improvement in the ratio. When the injury ratio plateaus, this suggests new tactics are needed to further improve safety. Another panelist felt that injury ratios can act to improve safety by serving as an incentive. He cited the Harriman Award as an example of such an incentive.

2.6 Things that go Bump in the Day: Diminished Alertness Accidents in Broad Daylight

Dr. Gerald Weeks, Chief of the Human Performance and Survival Factors Division in the Office of Railroad, Pipeline and Hazardous Materials Investigations at the National Transportation Safety Board (NTSB), spoke at lunch about two recent transit accidents that his office investigated. Although fatigue was implicated in both accidents, Dr. Weeks emphasized the safety deficiencies that existed in the system. In one case, the transit authority policy did not require safety-critical employees to report medications that may impair their performance. In the other case, the transit authority lacked educational awareness training on sleep disorders such as sleep apnea, that may affect the performance of its operators. Dr. Weeks also discussed recommended safety actions that the transit authority may introduce to prevent similar occurrences.

2.7 Accident Investigation Fundamentals-Human Factor Analysis

Mr. Terry Doyle, Railroad Safety Specialist, FRA Office of Safety, described FRA’s accident investigation methods. Mr. Doyle discussed FRA’s internal initiatives to promote and disseminate human factors approaches to its incident investigations. According to Mr. Doyle, FRA’s Safety Improvement and Development Team (SIDT) has developed several training courses that help FRA safety inspectors build human factors investigation skills. Mr. Doyle discussed several of these courses, among them an Accident Fundamentals Course that includes seven “elements” of an investigation. The focus of these courses is to build a foundation for inspectors to identify the unsafe acts and conditions that allowed an incident to occur.

2.8 MSHA’s Accident Reduction Program

To give some outside perspective on incident investigations, Mr. Terry Marshall from the Accident Reduction Program of the U.S. Mine Safety and Health Administration (MSHA) was invited to share his program’s initiatives. Whereas railroads must report incidents to the FRA, the mining industry must report incidents to MSHA. Mr. Marshall discussed MSHA’s accident reporting requirements, its accident investigation methods and tools, and industry partnerships.
MSHA began in 1977 and has been providing safety-related support to the mining industry since that time. Mr. Marshall’s presentation demonstrated that MSHA views itself as a partner to the mining industry, not just a regulatory agency. Mr. Marshall provided illustrations of this support, including examples from MSHA’s incident report form and its website, which shares best practices across the mining industry. In terms of incident investigations, beginning in 2001, MSHA initiated training for its investigators using commercially available TapRooT® and Root Cause Tree® root cause analysis methods.

2.9 Safety in Practice: A Shortline Railroad’s Experience

Mr. Wade Swindle, Safety Coordinator from the Cedar Rapids and Iowa City Railway Company, discussed his railroad’s safety initiatives. Mr. Swindle touched briefly on his railroad’s safety culture and keys to change: commitment, communication and accountability. He also discussed several safety partnerships between various levels of management and front-line management and employees. He cited a number of communication tools, including job safety briefings, suggestion boxes, signs and a safety hotline. He also discussed the elements of their safety committees (including review of recent incidents) and safety audits, as well as how they conduct job safety briefings.

2.10 Panel Discussion: Future Challenges in Investigating and Correcting Incidents in the Railroad Industry

This panel focused on identifying issues and challenges related to the future of incident investigation within the railroad industry. Each panelist was given 10 minutes to share his thoughts and experiences regarding future challenges. To help provide some focus, panelists were provided ahead of time with a sample set of questions that they could choose to address during the panel. The questions were:

- How will the increasing presence of technology change the nature of incidents and incident investigation?
- Do you expect an increase in the number of security-related incidents? How might your railroad prepare for this?
- What resources will be necessary to address some of the issues raised earlier in the conference?
- What will be the role of labor contract negotiations (e.g., piloting new safety initiatives; built-in protection of those who report incidents to the railroad, etc.)?
- What organizational culture issues will need to be addressed? How may these be addressed?
- How will the nature of incidents, incident investigation, and corrective action implementation change?
- What would you like to see change in the future?

After each panelists spoke for 10 minutes, the moderator opened the floor to questions from the audience. Panel participants were the following four individuals:

- Mr. James Stem, Alternate National Legislative Director for the United Transportation Union
- Mr. Ray Grygiel, General Chairman, Brotherhood of Railway Carmen Division of the
Transportation Communication International Union

- Mr. Michael Hartung-Shuster, General Director, Safety Reporting and Analysis for BNSF Railway
- Mr. Preston Claytor, Vice President, Safety and Operating Practices for Rail America

The discussion was moderated by Ms. Judith Gertler, Manager of the Human Performance and Operations Research Division at Foster-Miller, Inc.

Participants identified the following challenges for the future of incident investigations:

- Operator fatigue is still a problem that needs to continue to be understood and addressed by the industry and labor together.
- Rail management and labor need to continue to work together to develop an atmosphere of trust. Once this trust exists, advances will be made in incident investigations.
- Due to limited resources, small railroads need to help each other and share information with regard to incident investigation methods.
- Railroads need to begin to focus their incident investigations on near-misses, unsafe behaviors and hazards. Examination of these will help to further reduce the number of actual injuries and accidents.
3 Key Themes

Several key themes emerged from the conference. They are briefly presented below.

- **Both presenters and conference participants used a number of key words repeatedly during the course of the day.** These words included: trust, empowerment, communication, change, culture, discipline (fear of, waive), recognize problems, training, commitment.

- **Railroads are slow to adopt a human-centered approach to incident investigation, but recognize the importance of such an approach.** Attendance by such a diverse set of railroads and labor organizations suggests that the industry is interested in learning more about human-centered approaches to improve safety. A negative organizational culture appears to exist within the railroad industry. This culture acts as a barrier to incorporating more human-centered approaches. However, railroads are beginning to recognize this, and many are beginning to address this negative culture using a variety of innovative means. For example, railroads are beginning to recognize that the old methods of discipline and blame are not essential to identifying and removing the root causes of incidents and improving safety. In fact, they are discovering that these methods are often barriers to the free exchange of information. Further, many attendees recognized or were familiar with James Reason’s model of human error that takes into account both unsafe acts and unsafe latent conditions, both of which combine to lead to an incident. Many attendees were also familiar with the concept that incidents have not one cause, but multiple causes. This is a necessary and critical first step toward adopting a human-centered approach to incident investigation.

- **Different railroads are taking different approaches to the incorporation of human-centered approaches.** Some are bottom-up while others are top-down. For example, some railroads are letting local management and labor work collaboratively to address safety at a local level; that is, they give local employees more autonomy. Others are “re-inventing” themselves from the top-down through changes in management and management decisions, to incorporate human-centered approaches to incident investigations. Some railroads are even hiring human factors professionals to re-tool their incident investigation procedures. It is clear that there needs to be a “fundamental change in [the railroad] culture” to conduct human-centered incident investigations such as root cause analyses.

- **The next big challenge in incident investigation in the railroad industry is to study near-miss data, as well as the unsafe acts and conditions that lead to near-misses and more serious incidents.** Several speakers and panelists made direct reference to a well-known model of safety known as “Heinrich’s Triangle” (or simply the “safety triangle” or the “DuPont triangle”). Originally developed by Heinrich in the 1930’s, Heinrich, Petersen and Roos (1980) describe the theoretical relationship among major injuries, minor injuries, and non-injury accidents (i.e., mishaps or near-misses). Figure 1 illustrates this relationship. For every one major (i.e., lost work time) injury, Heinrich et al. estimated there are 29 minor injuries, 300 mishaps (accidents that don’t result in an injury, but could have under other circumstances), and an unknown number, possibly thousands, of unsafe acts and conditions. Heinrich et al. developed these proportions based on earlier research on injury data from a number of industrial facilities. According to their model, collection and analysis of the near-misses and unsafe acts and conditions at the base of the triangle are important in understanding and preventing the minor and major injuries higher up in the triangle, and
offer more opportunities for injury prevention. One speaker noted that his railroad already examines near-misses as part of their monthly safety committee meetings; it is likely that other railroads may be doing something similar.

Figure 1. Heinrich’s Triangle
4 Recommendations

Conference participation and discussion suggest several opportunities for the FRA to continue its efforts to improve railroad safety.

- The FRA should consider modeling part of its website after MSHA’s website (www.msha.gov). MSHA’s website includes a variety of helpful resources to both mine managers and miners, including accident prevention techniques. Some of these resources include “accident buster tips,” “safety slogans,” solutions to certain types of accidents, “safety ideas and tips” for specific categories of mining operation, “best practices” for certain types of operation, and numerous “hazard alerts and bulletins.” Many of these resources were likely based on their accident investigations. The FRA may consider compiling and sharing these types of safety tools based on its accident investigations. The FRA may also serve as a clearinghouse for FRA- and industry-provided “best practices” and accident reduction tools and techniques. In doing so, FRA would continue to help the railroad industry help itself by disseminating safety-related information and accident reduction methods.

- The FRA should consider initiating exploratory research to examine methods of collecting and analyzing near-miss (a.k.a. close-call, mishap, or near-incident) data to identify those hazards that are present before they cause an incident. This research could focus on how the FRA could collect these data in a centralized system, and/or how railroads could collect these data for their own benefit. There are several benefits of a near-miss data collection and analysis system. First, since there has not been any type of loss or damage, the incident scenario and root causes can be explored in an open and non-adversarial environment. Second, because no one was injured or killed, those involved in the incident (i.e., with firsthand knowledge of the incident sequence) are available to be interviewed. Third, according to “Heinrich’s Triangle,” near-miss data offer many opportunities to root out hazards before they result in personal or property loss. Further, railroads continue to improve safety, and thus, at some point, the injury and incident ratios will be at such a low level that further reductions will be very difficult. At this point, the focus may need to change from reducing incidents after they occur to reducing incidents before they occur (i.e., near-misses). Addressing near-misses is also pro-active, which is a more favorable approach to safety than reactive efforts. Reinach and Gertler (2001) made a similar recommendation in their report to the FRA. Their recommendation was to examine the feasibility of a nationwide railroad near-miss reporting system, similar to the Aviation Safety Reporting System, or ASRS, sponsored by the Federal Aviation Administration (FAA) and administered by the National Aeronautics and Space Administration (NASA).

- The FRA should consider conducting a follow-up conference in 2-3 years to continue facilitating the sharing of “best practices” across the railroad industry. This will also help the FRA determine whether its research program should focus more resources to help the railroads adopt human-centered approaches to their incident investigation methods, and their safety prevention programs in general.
5 References


### Appendix A: Conference Attendees

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ms. Faye Ackermans</td>
<td>General Manager- Safety and Regulatory Affairs</td>
<td>Canadian Pacific Railway</td>
</tr>
<tr>
<td>Ms. Sarah Acton</td>
<td>Project Engineer</td>
<td>Foster-Miller, Inc.</td>
</tr>
<tr>
<td>Mr. Jack Balsamo</td>
<td>Principal Consultant</td>
<td>BST, Inc.</td>
</tr>
<tr>
<td>Ms. Lisa Benthien</td>
<td>Economist</td>
<td>Federal Railroad Administration</td>
</tr>
<tr>
<td>Mr. Bob Bernard</td>
<td>Vice President &amp; Chief Safety Officer</td>
<td>CSX Transportation</td>
</tr>
<tr>
<td>Mr. Jeff Blomgren</td>
<td>Assistant General Manager - Employee Safety</td>
<td>CSX Transportation</td>
</tr>
<tr>
<td>Mr. Preston Claytor</td>
<td>Vice President- Safety and Operating Practices</td>
<td>Rail America</td>
</tr>
<tr>
<td>Mr. Mike Coplen</td>
<td>Human Factors Program Manager</td>
<td>Federal Railroad Administration</td>
</tr>
<tr>
<td>Mr. Tim DePaepe</td>
<td>Director of Research</td>
<td>Brotherhood of Railway Signalmen</td>
</tr>
<tr>
<td>Mr. Terry Doyle</td>
<td>Railroad Safety Specialist</td>
<td>Federal Railroad Administration</td>
</tr>
<tr>
<td>Mr. Ralph Elston</td>
<td>Deputy Regional Administrator</td>
<td>Federal Railroad Administration</td>
</tr>
<tr>
<td>Mr. Carl Fields</td>
<td>Investigator BLE Safety Task Force</td>
<td>Brotherhood of Locomotive Engineers</td>
</tr>
<tr>
<td>Mr. George Gavalla</td>
<td>Associate Administrator for Safety</td>
<td>Federal Railroad Administration</td>
</tr>
<tr>
<td>Mr. Roy Gelder</td>
<td>Director, Risk Management and Planning</td>
<td>Belt Railway Company of Chicago</td>
</tr>
<tr>
<td>Ms. Judy Gertler</td>
<td>Human Performance and Operations Research Manager</td>
<td>Foster-Miller, Inc.</td>
</tr>
<tr>
<td>Mr. Jerry Gibson</td>
<td>Locomotive Engineer</td>
<td>UTU-E / CSX Transportation</td>
</tr>
<tr>
<td>Ms. Cindy Gross</td>
<td></td>
<td>Federal Railroad Administration</td>
</tr>
<tr>
<td>Mr. John Grundmann</td>
<td>Assistant VP, Safety</td>
<td>BNSF Railway</td>
</tr>
<tr>
<td>Mr. Ray Grygiel</td>
<td>General Chairman</td>
<td>Brotherhood Railway Carmen Division, TCIU</td>
</tr>
<tr>
<td>Mr. Pete Hall</td>
<td>Director, Safety</td>
<td>Amtrak</td>
</tr>
<tr>
<td>Mr. Mike Hartung-Shuster</td>
<td>Director of Government Reporting</td>
<td>BNSF railway</td>
</tr>
<tr>
<td>Mr. Bob Harvey</td>
<td>Regulatory Research Coordinator</td>
<td>Brotherhood of Locomotive Engineers</td>
</tr>
<tr>
<td>Mr. Larry Hasvold</td>
<td>Regional Administrator</td>
<td>Federal Railroad Administration</td>
</tr>
<tr>
<td>Ms. Kim Hirchak</td>
<td>Safety Officer</td>
<td>Metra Railroad</td>
</tr>
<tr>
<td>Mr. Steve Hursh</td>
<td>Program Manager</td>
<td>SAIC</td>
</tr>
<tr>
<td>Mr. Scott Kaye</td>
<td>Railroad Project Coordinator</td>
<td>Federal Railroad Administration</td>
</tr>
<tr>
<td>Mr. Bob Keane</td>
<td>General Director Risk Management</td>
<td>Canadian National Railroad/Illinois Central Railroad</td>
</tr>
<tr>
<td>Mr. Steve Kenyon</td>
<td>General Manager - Safety</td>
<td>Union Pacific Railroad</td>
</tr>
<tr>
<td>Dr. Susan Labin</td>
<td>Director of Evaluation</td>
<td>Temple University</td>
</tr>
<tr>
<td>Mr. Moses Lacy</td>
<td>Manager - Safety Rules</td>
<td>Metra Railroad</td>
</tr>
<tr>
<td>Name</td>
<td>Position</td>
<td>Organization</td>
</tr>
<tr>
<td>--------------------</td>
<td>-----------------------------------------------</td>
<td>---------------------------------------------------</td>
</tr>
<tr>
<td>Mr. Jim Lankford</td>
<td>Superintendent</td>
<td>Lake Michigan &amp; Indiana Railroad</td>
</tr>
<tr>
<td>Mr. Tom Leopold</td>
<td>General Director, Safety &amp; Rules</td>
<td>Kansas City Southern Rail Network</td>
</tr>
<tr>
<td>Mr. Rick Marceau</td>
<td>Vice President</td>
<td>United Transportation Union</td>
</tr>
<tr>
<td>Mr. Terry Marshall</td>
<td>Mechanical Engineer, Accident Reduction Program</td>
<td>Mine Safety and Health Administration</td>
</tr>
<tr>
<td>Mr. Lou Mayden</td>
<td>Manager Safety</td>
<td>Indiana Harbor Belt Railroad</td>
</tr>
<tr>
<td>Mr. Rich McCord</td>
<td>Field Director</td>
<td>Federal Railroad Administration</td>
</tr>
<tr>
<td>Ms. Beth McCullough</td>
<td>Manager, Human Performance Division</td>
<td>TSB Canada</td>
</tr>
<tr>
<td>Ms. Susan McDonough</td>
<td>Program Administrator</td>
<td>Foster-Miller, Inc.</td>
</tr>
<tr>
<td>Mr. Jeff Moller</td>
<td>Director, Casualty Prevention</td>
<td>Association of American Railroads</td>
</tr>
<tr>
<td>Dr. Jordan Multer</td>
<td>Manager, Human Factors Rail Program</td>
<td>Volpe NTSC</td>
</tr>
<tr>
<td>Mr. Chuck Mundy</td>
<td>Vice President</td>
<td>American Train Dispatchers Department / BLE</td>
</tr>
<tr>
<td>Mr. Jim Phelan</td>
<td></td>
<td>Federal Railroad Administration</td>
</tr>
<tr>
<td>Dr. Joyce Ranney</td>
<td>Organization and Behavior Specialist</td>
<td>Volpe NTSC</td>
</tr>
<tr>
<td>Dr. Esa Rantanen</td>
<td>Assistant Professor</td>
<td>University of Illinois</td>
</tr>
<tr>
<td>Dr. Tom Raslear</td>
<td>Senior Human Factors Program Manager</td>
<td>Federal Railroad Administration</td>
</tr>
<tr>
<td>Mr. Stephen Reinach</td>
<td>Senior Engineer</td>
<td>Foster-Miller, Inc.</td>
</tr>
<tr>
<td>Mr. John Reininger</td>
<td>Director-Dispatching Practices &amp; Quality Assurance</td>
<td>Union Pacific Railroad</td>
</tr>
<tr>
<td>Mr. Steve Roop</td>
<td>Director Multimodal Freight Transportation Program</td>
<td>Texas Transportation Institute</td>
</tr>
<tr>
<td>Mr. Don Scott</td>
<td>System General Road Foreman</td>
<td>National Railroad Passenger Corporation</td>
</tr>
<tr>
<td>Mr. Andrew Smith</td>
<td>Business Development Manager - Transport</td>
<td>Lloyd's Register Americas, Inc.</td>
</tr>
<tr>
<td>Mr. James Stem</td>
<td>Alternate National Legislative Director</td>
<td>United Transportation Union</td>
</tr>
<tr>
<td>Mr. Wade Swindle</td>
<td>Safety Officer</td>
<td>Cedar Rapids and Iowa City Railway Co.</td>
</tr>
<tr>
<td>Mr. Joe Szabo</td>
<td>State Legislative Director</td>
<td>United Transportation Union</td>
</tr>
<tr>
<td>Ms. Tammy Wagner</td>
<td>Regional Crossing Manager</td>
<td>Federal Railroad Administration</td>
</tr>
<tr>
<td>Dr. Jerry Weeks</td>
<td>Chief, Human Performance Investigation Division</td>
<td>National Transportation Safety Board</td>
</tr>
<tr>
<td>Mr. Barry Wells</td>
<td>Director of Safety</td>
<td>Norfolk Southern Railroad</td>
</tr>
<tr>
<td>Mr. Art Zima</td>
<td>Trainmaster</td>
<td>CSX Transportation</td>
</tr>
</tbody>
</table>
Appendix B: Conference Final Program

7:30 a.m.  Registration and continental breakfast

8:30 a.m.  Introductions
- Thomas Raslear, Senior Human Factors Program Manager, FRA Office of R&D

Opening Remarks
- George Gavalla, Associate Administrator for Safety, FRA Office of Safety

Goals for the Day
- Stephen Reinach, Senior Engineer, Foster-Miller, Inc.

8:45 a.m.  “Investigating for Human Factors in Rail Accidents and Incidents”
- Elizabeth McCullough, Manager, Human Performance Division, Transportation Safety Board of Canada

9:15 a.m.  “Incorporating a Human Factors Approach in Accident Investigations at Canadian Pacific Railway”
- Faye Ackermans, General Manager, Safety and Regulatory Affairs, Canadian Pacific Railway

9:45 a.m.  “Getting to the Causal Roots of Incidents: An Examination of the Working Interface”
- Jack Balsamo, Principal Consultant, BST

10:15 a.m.  Break

10:45 a.m.  “The Anatomy of a Cooperative Safety Committee: The CSX Experience”
- Jerry Gibson, Locomotive Engineer, UTU-E/CSX Transportation, and Art Zima, Trainmaster, CSX Transportation

11:15 a.m.  Panel Discussion: “Creation of a Collaborative Incident Investigation Environment”
- Royal Gelder, Director, Risk Management and Planning, Belt Railway Co. of Chicago
- Jeff Blomgren, Assistant General Manager, Employee Safety, CSX Transportation
- Robert Harvey, Regulatory Research Coordinator, Brotherhood of Locomotive Engineers
- Tim DePaepe, Director of Research, Brotherhood of Railway Signalmen

Moderator: Michael Coplen, Human Factors Program Manager, FRA Office of R&D

12:30 p.m.  Break for lunch

Luncheon Speaker: “Things that go Bump in the Day: Diminished Alertness Accidents in Broad Daylight,”
Gerald Weeks, Chief, Human Performance and Survival Factors Division, Office of Railroad, Pipeline and Hazardous Materials Investigations, NTSB

2:00 p.m.  “Accident Investigation Fundamentals-Human Factor Analysis”
- Terence Doyle, Railroad Safety Specialist, FRA Office of Safety

2:30 p.m.  “MSHA’s Accident Reduction Program”
- Terry Marshall, Mechanical Engineer, Accident Reduction Program, U.S. Mine Safety and Health Administration

3:00 p.m.  “Safety in Practice: A Shortline Railroad’s Experience”
- Wade Swindle, Safety Officer, Cedar Rapids and Iowa City Railway Co.

3:30 p.m.  Break

3:45 p.m.  Panel Discussion: “Future Challenges in Investigating and Correcting Incidents in the Railroad Industry”
- James Stem, Alternate National Legislative Director, United Transportation Union
- Ray Grygiel, General Chairman, Brotherhood of Railway Carmen Division, Transportation Communication International Union
- Michael Hartung-Shuster, General Director, Safety Reporting and Analysis, BNSF Railway
- Preston Claytor, Vice President, Safety and Operating Practices, Rail America

Moderator: Judith Gertler, Manager, Human Performance and Operations Research Division, Foster-Miller, Inc.

5:00 p.m.  Adjourn
Appendix C contains copies of presentations for those speakers and panelists who made their presentations available. Note that panelist presentations were optional.
The TSB

- Independent multi-modal accident investigation agency
- Separate regulation and enforcement functions from accident investigation function
- Separate accident investigation from criminal and civil proceedings
- Sole purpose is to advance transportation safety. The TSB:
  - Does not regulate
  - Does not enforce
  - Does not assign blame
  - Does not apportion liability

TSB Approach

- Advance Safety through the identification and validation of Safety Deficiencies that are found through the investigation process
- Focus is on Why and How
- Communicate to the authorities who can best effect change such as:
  - the regulator
  - the transportation industry

Investigation Methodology

- Events & Factors Analysis
- Risk Assessment Process
- Defence (Barrier) Analysis
- Risk Control Option Analysis
- Preventive Measures

- Occurrence Events
- Data Collection
- Initial Assessment
- Preventive Measures
Human Error

• All components of the system have the potential to contribute error to that system
• It is better to explain behaviour than label it
• Need to determine why individuals’ assessments and actions seemed reasonable given the circumstances

An Integrated Process for Investigating Human Factors

The Need

• “Lack of specification of the deficiency of performance... practically precludes the determination of what actually happened and what specific mods might reduce the likelihood of these deficiencies.”
  
  Wilde et al., 1980

The Basic Premise

• “a systematic approach.... is crucial since it would encourage the consideration of multicausality”
  
  Kennedy, R
An Integrated Process for Investigating Human Factors

How People are Involved in Occurrences

- Directly, as a contributor through unsafe acts
An Integrated Process for Investigating Human Factors

How People are Involved in Occurrences

- Directly, as a contributor through unsafe acts
- Directly, as a receiver of unsafe conditions
- Indirectly, as a contributor to unsafe conditions through unsafe acts
An Integrated Process for Investigating Human Factors

Seven Step Process

- Collect Occurrence Data
- Determine Occurrence Sequence
- Identify Unsafe Acts/Decisions and Conditions
- Identify the Error Type or Adaptation
- Identify the Failure Modes
- Identify the Behavioural Antecedents or Unsafe Conditions/Underlying Factors
- Identify the Potential Safety Deficiencies
Step 1 - Collect Occurrence Data

Step 2 - Determine Occurrence Sequence

Step 3 - Identify Unsafe Acts & Conditions
Step 4 - Identify the Error Type

Did the action go as planned?

**NO**
- Unintentional Action
  - Error in Execution
  - Unsafe Act & Decision

**YES**
- Intentional Action
  - Error in Planning

---

Step 4 - Identify Error Type

**Basic Error Types**
- Slip
- Lapse
- Mistake
- Adaptation

**Skill-based**
- Attentional Failure
- Memory Failure

**Rule-based & Knowledge-based**
- Misapplication of Good Rules
- Application of Bad Rules

---

Step 5 - Identify Failure Modes

**Skill-based**
- Inattention
- Overattention

**Rule-based**
- Misapplication of Good Rules
- Application of Bad Rules

**Knowledge-based**
- Biases
- Heuristics
Step 6a) Identify Underlying Factors

6b) Repeat if Necessary

- **Definition:** Any factors in the work system that facilitate the expression of an unsafe act

- **Factors:** unsafe acts/decisions & unsafe conditions
  - Intrinsic Factors: physical, physiological, psychological, psychosocial
  - Extrinsic Factors: environmental, task, management, organizational

- Repeat the process until the underlying factors (unsafe conditions) worthy of risk analysis have been identified

---

**INTEGRATED PROCESS FOR INVESTIGATING HUMAN FACTORS**

- Identify Unsafe Conditions
- Identify Unsafe Acts
- Determine Occurrence Sequence
- Collect Occurrence Data
- Identify Error Adaptation Type
- Identify Unsafe Conditions/Underlying Factors
- Identify Failure Modes
- Identify Potential Safety Problems

Step 7 - Identify Potential Safety Deficiencies

- Formulation of safety problems associated with unsafe conditions/underlying factors identified in Step 6

- Linkage of potential safety deficiencies to unsafe acts/decisions as causal to an occurrence
Investigation Methodology

An Integrated Process for Investigating Human Factors

Application and Utility

- Systematic approach to investigations
- Focused safety action
- Data recording guides data collection
Human – Centered Incident Investigation Methods for the Railroad Industry

Incorporating a human factors approach to investigating rail accidents at Canadian Pacific Railway

CPR - Our Network

Transcontinental/Transborder
Human Factors Approach to Investigating Accidents

- Train accident performance metrics
- Efforts to diagnose and mitigate human error
  - Fatigue management
  - Crew resource management
  - Accident/ incident investigation
- HF accident/ incident investigations
  - Track Occupancy Permit violations
  - Mainline collision
  - Northern Alberta
  - Rail Traffic Control
  - Employee fatality
- Human factor investigation tools
- Summary of experience

Train Accident Performance Metrics

- Cardinal Rule violations
- Accidents at road/rail intersections (crossings)
- Trespasser accidents
- Non-accident releases of Dangerous Goods
- Train accidents
  - FRA Reportable
  - Non-FRA Reportable

Frequency of FRA-Reportable Train Accidents

<table>
<thead>
<tr>
<th>Year</th>
<th>Frequency/million train miles</th>
<th>Other/ Under Investigation</th>
<th>Third Party</th>
<th>Operational Error</th>
<th>Equipment &amp; Infrastructure Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>5.7</td>
<td>1.0%</td>
<td>1.0%</td>
<td>3.5%</td>
<td>4.1%</td>
</tr>
<tr>
<td>1997</td>
<td>5.5</td>
<td>1.0%</td>
<td>1.0%</td>
<td>3.5%</td>
<td>4.1%</td>
</tr>
<tr>
<td>1998</td>
<td>5.3</td>
<td>1.0%</td>
<td>1.0%</td>
<td>3.5%</td>
<td>4.1%</td>
</tr>
<tr>
<td>1999</td>
<td>5.1</td>
<td>1.0%</td>
<td>1.0%</td>
<td>3.5%</td>
<td>4.1%</td>
</tr>
<tr>
<td>2000</td>
<td>4.9</td>
<td>1.0%</td>
<td>1.0%</td>
<td>3.5%</td>
<td>4.1%</td>
</tr>
<tr>
<td>2001</td>
<td>4.7</td>
<td>1.0%</td>
<td>1.0%</td>
<td>3.5%</td>
<td>4.1%</td>
</tr>
</tbody>
</table>
Frequency of Non-FRA Reportable Train Accidents

Cardinal Rule Violations - Canada

Human Factors Investigations

Track Occupancy Permit Violations

- September 1997, consultant’s report received
- 1998
  - Forms used in field changed
  - TOP refresher training to engineering
- In April, 1999
  - Despite best efforts, TOP violations continue to increase
  - Transport Canada prohibit use of sub-foremen procedures
  - Clearance form revised
  - 3 System Special Instructions issued
  - Limit of 3 sub-foremen
  - Q&A package
  - Transport Canada direction lifted August 1999
- Fall 1999 - Track diagrams issued with timetables
- 2000 - computer terminals on-track tested
Track Occupancy Permit Violations

Strengthening the Defences

Radio Communication Procedures
- July 98
- Aug 99

Forms or Processes Changed
- Sept 98
- May 98
- Aug 99

Training and Instructions
- Q4 98
- Q3 99

Computers
- Dec 2000

Track Occupancy Permit Violations

<table>
<thead>
<tr>
<th>Year</th>
<th>Violations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>36%</td>
</tr>
<tr>
<td>1997</td>
<td>22%</td>
</tr>
<tr>
<td>1998</td>
<td>36%</td>
</tr>
<tr>
<td>1999</td>
<td>22%</td>
</tr>
<tr>
<td>2000</td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td></td>
</tr>
</tbody>
</table>
Human Factors Investigation
Train Collision - Kemnay, Manitoba

- September 30, 1998, hired human factor specialist
- October 20, 1998, two trains collided at 1 a.m.

Kemnay - 1998

- Discipline waived with approval of vice-president of transportation and the general manager of district.
- Series of human factors interviews conducted
- Draft report
  - Not well received
  - Not what Ops expected to see (did not blame the employee)
- Final report
  - Fatigue
  - Accuracy of train line - ups
  - Booking rest
  - Teamwork & communication in cab of locomotive
  - In depth understanding vs training
  - Interaction between rail traffic controller and crew
  - Assumptions made and their impact on situational awareness
  - General compliance with rules
  - Visibility of rear-end marker

Human Factors Investigations
Train Accidents in Northern Alberta - 1999
Train Accidents in Northern Alberta

Who
- 192 operating employees

Why
- High frequency of accidents

What
- Local managers up to general manager
- Union leaders up to general chairman
- Discipline waived
- Interviews rather than investigations (format statements)
- Detailed flow charts
- Possible contributing factors
- Root causes
- High level contributing factors
- Follow-up interviews
- Employee survey

Findings
- 84 accidents/incidents investigated
  - Run-through switches
  - Shoving equipment over derails or stop blocks
  - Sideswiping equipment
  - Cardinal Rule violations

- Three broad categories of error
  - 20% slips and lapses
  - 56% mistakes
  - 23% violations

Unsafe Acts

Unintended action

Intended action

Violations

Routines violations
Exceptional violations
Acts of sabotage

Rule-based mistakes
Misapprication of good rule
Application of bad rule

Knowledge-based mistakes
Many variable forms

Memory failures
Omitting planned items
Place-losing
Forgetting intentions

Slip

Lapse

Mistake

Basic error types

Attentional failures
Intuition
Omission
Reversal
Misordering
Mistiming

Unintended action

Unsafe Acts

Unintended action

Intended action

Taxonomy of unsafe acts (From Reason, 1997)
Train Accidents in Northern Alberta (cont'd)

Findings

- Most frequent "high level" contributing factors
  - 52% Lack of teamwork
  - 48% Operating based on assumptions
  - 47% Technical/operating errors; lack of knowledge
  - 39% Rule violations
  - 31% Lack of vague communications
  - 27% Poor situational awareness

- Two key variables
  - 25% of accidents occurred between the 4th and 5th hour on duty
  - 45% of employees had 5 years or less experience

Train Accidents in Northern Alberta (cont'd)

Interventions

1. Wide distribution of incident investigations
   (communication from management)
2. Structured job-briefing checklists
3. Crew Resource Management training program
4. 30-Day Proficiency Test follow-up for rule violations
5. Operating procedures at one customer siding changed
6. Switch target changed
7. Incidents used in scenario-based training

Train Accidents in Northern Alberta (cont'd)

Safety Policy

"No job on our Railway will ever be so important that we can't take the time to do it safely"

Employee Edmonton

"Changing people’s attitudes is the only way to create a safer work place. This will take a long-term commitment and must be undertaken by all of us - not just one manager and a few believers"
Human Factors Investigations

Rail Traffic Controller Errors

- Review of Cardinal Rule violations
- Employee/management committee review:
  - form layout
  - order information presented on computerized dispatching system
  - overlapping information on adjoining subdivisions
  - database to collect factors

Employee fatality investigation

- no witnesses
- HF investigation used to probe "culture" of the workgroup
- findings extremely controversial
- not accepted by unions or management

Human Factors Investigations - Next Step

- Creation of new tools to incorporate human factors into day-to-day investigation of accidents / incidents
- Investigation processes and tools will be brought together in one manual (draft)
- Human factors "tools" include:
  - data collection guide
  - corrective action guide
  - "info-flip"
- Modeled on "SHEL(L)"

SHEL(L): Interaction of people with the system – puts emphasis on the interfaces

- Hardware
- Software
- Environment
- Liveware - Peripheral
- Liveware-Central

- machines, equipment, tools
- policies, regulations
- physical agents
- memory
- communication
- hardware
- software
- facilities
- processes e.g. job briefing
- interaction
- training, identification
- hazards
- organizational
- memory
- attention
- workload
- expectation
- fatigue, stress
- interactions
- associations and unions

Employee/management committee review:
Data Analysis – Events Diagram

- Put yourself inside the events
- Try not to let the known outcomes distort your analysis

Data Collection Guide

A series of 27 separate checklists grouped in 4 categories

- Individual factors
  - attention
  - memory
  - experience / knowledge / training
  - fatigue
  - alcohol / drugs

- Interaction with others
  - communication
  - organizational factors
  - supervision

- Policies, procedures, environment
  - rules, procedures
  - written information
  - immediate environment

- Equipment and other hardware
  - workspace and comfort
  - physical space and arrangement

Data Analysis – Determine Safety Concerns, Risks and Priorities

Risk of Recurrence Assessment Matrix

<table>
<thead>
<tr>
<th>Severity / Consequence</th>
<th>Minimal 1</th>
<th>Marginal 2</th>
<th>Serious 3</th>
<th>Critical 4</th>
<th>Catastrophic 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequent</td>
<td>low 5</td>
<td>medium 10</td>
<td>high 15</td>
<td>very high 20</td>
<td>very high 25</td>
</tr>
<tr>
<td>Probable</td>
<td>low 4</td>
<td>medium 8</td>
<td>high 12</td>
<td>high 16</td>
<td>very high 20</td>
</tr>
<tr>
<td>Occasional</td>
<td>very low 2</td>
<td>low 6</td>
<td>medium 9</td>
<td>high 12</td>
<td>high 15</td>
</tr>
<tr>
<td>Remote</td>
<td>very low 3</td>
<td>low 4</td>
<td>medium 8</td>
<td>medium 10</td>
<td></td>
</tr>
<tr>
<td>Improbable</td>
<td>very low 1</td>
<td>very low 2</td>
<td>very low 3</td>
<td>low 4</td>
<td>low 5</td>
</tr>
</tbody>
</table>

- Use to guide development of corrective actions
**Corrective Action Guide**

- Suggested types of corrective actions appropriate for the factors, depending on underlying cases
- Individual factors, issue of processing information
  - lack of attention
  - memory
  - experience / knowledge / training
  - poor decision-making
- Causes / possible corrective actions

<table>
<thead>
<tr>
<th>Cause</th>
<th>Corrective Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slip / lapse</td>
<td>Location and design of physical defences such as switch targets, guard rails</td>
</tr>
<tr>
<td></td>
<td>Job memory aids</td>
</tr>
<tr>
<td></td>
<td>Task rotation</td>
</tr>
<tr>
<td>Mistake</td>
<td>Job orientation (briefing)</td>
</tr>
<tr>
<td></td>
<td>Retraining</td>
</tr>
<tr>
<td>Violations</td>
<td>Increased proficiency testing</td>
</tr>
<tr>
<td></td>
<td>Discipline</td>
</tr>
</tbody>
</table>

---

**The New “Tools”**

*Their Purpose*

- Standardize investigative procedures
- Improve amount and type of data collection
- Improve ability to determine underlying factors
- More effective corrective actions

*What They Will Not Do*

- Change current structure of investigations and statement taking
- Change the current discipline system
- Cause a significant increase in work or time
- Conflict with existing processes and training

---

**Summary: CPR Experience With a Human Factors Approach**

- We are four years into our journey
- Excellent acceptance by some managers and employees
- Suspicion and distrust by others
- Next step is to incorporate into Front Line Manager’s investigation processes and thinking

*Fundamental change in culture*
Getting to the Causal Roots of Incidents:

An Examination of the Working Interface

Presented by: Jack Balsamo
Principal Consultant · BST, Inc.
jack.balsamo@bstsolutions.com

Objective:

To create an understanding of the “working interface” concept, understand its practical application, and utilize the principles going forward.

Working Interface Defined:

The intersection of behavior with systems and/or conditions.

- Behavior- observable action
- Conditions- Physical working environment.
- Systems- Procedural guidelines written or unwritten that are intended to influence behavior or do influence behavior.
Avoid Oversimplification:

- There are incidents that occur in absence of a working interface. They are rare; beware when “many” exist in your findings.
- Common evidence from Corrective Action statements:
  - “I counseled the employee”.
  - Fix-its: “We painted a line on the platform”.

Investigation?

2 ways to think about it:

1. “INVESTIGATE”
   - Criminals
   - Gather Evidence
   - Trial
   - Conviction
   - Punishment

   Short-term: “capture those who caused this”

2. “INVEST”
   - R = Reduction
   - O = Of
   - I = Injuries

   Prevention of future injuries has greater reward than managing existing ones. Utilize a process that gets as close to the truth as possible and focuses on changing the accident causing system.
Utilizing Incidents for ROI

1. Define Critical Behaviors.
2. Measure the frequency of their occurrence.
3. Provide frequent information about how often those behaviors occur and why (systems/conditions).
4. Action plan ways to improve the 3 interface components: safe behavior and prevent risk.

Understanding the Behavioral Interface:

RESULT

Fatality

LT

Rec

1st Aid

*Systems and Conditions

Event

At-Risk Behavior

Enabled

*Difficult

*Non-enabled

Behavioral Sequence of Events:

An Incident Occurs.
You begin trying to talk to people involved and witnesses: what do you need to looking for?

“What” first...then “WHY”
Sample Incident Report

As a mechanic was breaking into a hydraulic line, his helper was burned on the face by fluid escaping from the flange that the mechanic was opening.

Breaking Down the Behavioral Interfaces

- Helper was standing in the path of potential escaping fluid (Line of Fire)
- Line was being opened without blocking and bleeding pressure (Lock and Tag)
- Helper was not wearing face protection (PPE)

ABC Analysis: 1 per risk
Now Focus on “WHY”

- Antecedent = in a hurry, never had a problem before, didn’t think it was necessary in this situation, 5 minutes before shift end, Night shift
- Behavior = Line was being opened without blocking and bleeding.
- Consequence = Injury, save time, go home faster, satisfy supervisor
3 Factors That Affect Consequences

**Timing**
- Sooner / Later

**Consistency**
- Certain / Uncertain

**Significance**
- Positive / Negative

---

**Getting Proactive by Addressing the Antecedents and Consequences:**

**Action Planning**

Behavior: not bleeding a hydraulic line

Example antecedent: “Didn’t think it was necessary”.

In the scheme of a singular event you will want to “counsel the employee”. In reality there are many times where someone may not think about the appropriate safety precaution.

There is almost universal value in having people engaged in a practice of conversation about such issues (“feedback”).

*Action Plans should include line-items that address all possible antecedents and consequences!*

---

**Utilizing Incidents for ROI**

1. **Define Critical Behaviors.**
   (Break your existing injury information down to the behavioral level)

2. **Measure the frequency of their occurrence.**
   (Monitor the behaviors that create the highest level of risk at the point of risk, not just injury)

3. **Provide frequent information about how often those behaviors occur and why.**
   (Talk to people about their situations and when those risks occur (systems and conditions))

4. **Action plan ways to promote safe behavior and prevent risk.**
   (Use ABC analysis to understand and improve the antecedents and put more SC+ consequences in place for critical behaviors done safely and prioritize which systems and behaviors will get most of your limited resources.)
Getting to the Causal Roots of Incidents:

An Examination of the Working Interface

Presented by: Jack Balsamo
Principal Consultant · BST, Inc.
jack.balsamo@bstsolutions.com
Belt Facts

- 475 Employees
- 28 Miles of two-main track mainline
- Single crest/two classification yard hump facility
- All within Cook County, Illinois
- Connects to all Chicago carriers except IAIS
- Handled 2.2 million cars in 2001
- Incorporated in 1882 and operated as joint facility until 1989
- Stand-alone operating agreement effected 1990
- 88 Percent of manhour exposure directly involves yard switching

What We Have Done to Continue the Evolution

- Unprecedented and sustained effort to clean the property and the will to keep it so
  - Remove a source of bad attitude/"They don't care" mentality
  - Visible effort, high impact, immediate results
- Restructured employee safety committee
  - Led by employees, NOT management
  - Focus on the right tasks, only issues that cannot be corrected locally
  - Management helps by building confidence in decisions so "Empowerment" and "Trust" are meaningful
    - PPE Evaluation
    - Industry Switch Track Audit Program

What We Have Done to Continue the Evolution (continued)

- Involve Federal Railroad Administration
  - Visible partnership at meetings and in the field
  - Opens communication with Labor and Management
  - FRA buys in and becomes/owns part of the process
- Align Management to sustain change and focus on behavior
  - Observe, reinforce, coach, share the expectation
  - Discipline must be utilized and it must be consistent
  - "Non-traditional" departments can help
    - Risk Management, Real Estate, Labor Relations, Human Resources, Purchasing
  - Department head individual safety interview with every employee
What We Have Done to Continue the Evolution (continued)

- Advertise safety in all ways possible
  - Publications
  - Incentive programs
  - Wearing PPE and evaluating new and improved gear
  - Equipment and tool inspections and procurement

---

Belt Railway and all Reporting Roads
Annual FRA Ratio 1985 to 2001

- Our results have been in steps
- Each step requires reinforcement and evolution of method
Things that go Bump in the Day:
Diminished Alertness
Accidents in Broad Daylight
Gerald D. Weeks, Ph.D.
Chief, Human Performance & Survival Factors Division

Maryland Transit Administration
Light Rail Vehicle Collisions
With Bumping Posts at Baltimore Washington International Airport Station
February 13, 2000
August 15, 2000
NTSB Investigation Team

- **Member** - John Hammerschmidt
- **Investigator in Charge** - Bob Campbell
- **Event Recorders** - Dave Case
- **Human Performance** – Rick Narvell
- **Mechanical** – Russ Quimby

NTSB Team (cont’d)

- **Operations** – George Cochran
- **Signals** – Ruben Payan
- **Survival Factors** - Rick Downs
- **Track** – Bob Campbell
Parties to Investigation

- Maryland Transit Administration
- Maryland Department of Transportation
- BWI Airport Fire & Rescue
- BWI Police Department

The February Accident

Train Operations

- The train operator reported for duty at 9:30 a.m. for his 10:01 a.m. assignment
- Departed Pennsylvania Station in downtown Baltimore for Baltimore/Washington International Airport Station at 10:44 a.m.
- Took lunch break at 12:30 p.m.

Train Operations (cont’d)

- Departed on second trip south to BWI from Penn Station at 1:51 p.m.
- Last signal displayed an approach signal - yellow aspect
- Collision at 2:37 p.m.
Passenger Statements

• At North Linthicum Station, the operator failed to respond to a green signal for 10 to 15 seconds and shook his head and body before moving forward
• Operator appeared to have fallen asleep while entering BWI Station

February Operator Post-Accident Toxicological Tests

• Specimens collected 4 ½ hours after the accident
• Tests were positive for:
  – Benzoylecgonine
  – Codeine
  – Morphine

Medications Used by the February Operator

• Acetaminophen and oxycodone
• Acetaminophen and codeine
Cocaine Use by the February Operator

• Benzoylcegonine indicated likely withdrawal phase from cocaine
• Withdrawal phase associated with sedation

Conclusion

• The effects of the prescription pain-relieving medications and/or recent cocaine use impaired the performance of the operator in the February accident

Conclusion

• Because the MTA did not require safety sensitive employees to report their use of prescription and over-the-counter medications, it lacked information that could have had a bearing on the conditions and performance of such employees
Drug Regulations (Federal) Pertaining to Prescription and Over-the-Counter Medications

- FTA (49 CFR 653) – None
- FRA (49 CFR 219.103b) – “this subpart does not restrict any discretion available to the railroad to require that employees notify the railroad of therapeutic drug use or obtain prior approval for such use”

Recommendation to the Federal Transit Administration

Authorize and encourage rail transit systems to require their employees in safety-sensitive positions to inform the rail transit system about their use of prescription and over-the-counter medications so that the rail transit system can have qualified medical personnel determine the medication’s potential effects on the employee performance. (R-01-25)

The August Accident Train Operations

- The train operator reported for duty at 3:00 a.m.
- Completed one round-trip from Penn Station to the BWI Station and was making another identical trip when the accident occurred
Train Operations (cont’d)

- Observed lowered crossing gates at the last grade crossing before BWI Station
- Observed that the signal at Milepost 115 displayed a restricting signal - red over yellow aspect
- Collision with bumping post at 7:14 a.m.

Obstructive Sleep Apnea (OSA)

- Operator clinically tested for sleep disorders after the accident
- Diagnosis: severe obstructive sleep apnea
- Chronic disorder often present for years before diagnosed
- Excessive daytime sleepiness is almost uniformly present

Risk Factors for Obstructive Sleep Apnea

- Male
- Overweight
- Over 40 years old
Conclusions

• The August operator was suffering from severe obstructive sleep apnea at the time of the accident
• The fatigue he was experiencing due to undiagnosed obstructive sleep apnea likely caused the operator to fall asleep as the light rail vehicle approached the station

Recommendation to U.S. rail transit systems

Ensure that your fatigue educational awareness program includes the risks posed by sleeping disorders, the indicators and symptoms of such disorders, and the available means of detecting and treating them.

(R-01-27)

©James Reason, 1997, Managing the Risks of Organizational Accidents
FRA Administrator’s Objective

“…..reducing numbers, frequency and severity of rail-related accidents and crashes, fatalities and injuries.”

The Goal of this conference certainly supports this objective, and we appreciate the interest and participation of such a wide group of people on this topic.

Human Factor Caused Accidents and Injuries

The Year 2001 was the best year in the past five years:

• Human Factor Accidents were down 16%
• Human Factor Injuries were down 11%

So far this year:

• Human Factor Accidents are down 7%
• Human Factor Injuries are down 28%
**Human Factor Cause Relationships**

Safety, productivity and quality of life on the job all contribute to human factor caused accidents and injuries.

Training, staffing, work/rest scheduling, rules and operating practices, and situational awareness factors all have a bearing on safety in general, and human factor failures specifically.

FRA recognizes this, and these elements are closely examined in all of our accident investigation endeavors.

Recognizing these elements also contributes to the success of any of our safety initiative involvements such as SOFA and our Focused Inspection Process.

---

**FRA’s Strategy**

To accomplish any safety improvement we must first isolate the problem areas. This is accomplished by:

- Reviewing Railroad Accident And Employee On-duty Injury Data.
- Conducting On-site Inspections and On-Board Train Inspections.
- Reviewing Part 217 Operational Tests and Inspection Records.
- Accompanying Carrier Officials on Operation Tests & Inspections.
- Conducting Thorough Accident and Incident Investigations.
- Providing Relevant Training to the FRA Inspector Workforce.

---

**Safety Improvement and Development Team (SIDT)**

The SIDT Team is primarily responsible for developing and delivering technical training to the FRA inspector work force.

The Team is comprised of a Training Specialist in each of the following disciplines.

- Operating Practices
- Hazardous Materials
- Track
- Signals and Train Control
- Motive Power and Equipment
Training Focused on Human Factor Issues

The following courses have been developed and delivered by the SIDT Team to assist our inspector workforce improve awareness associated with the many unsafe behaviors and conditions generally associated with human factor related accidents, injuries and fatalities, and to investigate them.

• Basic Investigative Skills
• Accident Investigation Fundamentals
• Train Handling Techniques
• Part 217 – Operating Rules

The Basic Investigative Skills course is designed to develop and improve skills in the following areas and is offered to inspectors in all disciplines:

1. Interviewing Skills
2. Note Taking Accident Investigations
3. Photography.

NOTE: This course is a pre-requisite to the Accident Investigation Fundamentals course.

Accident Investigation Fundamentals

This course covers the following:
• FRA’s Authority To Investigate
• Establishing Investigative Priorities, Mind Mapping, and Investigative Action Plans.
• Communication guidelines.
• NTSB and OSHA Joint Investigations
• Information Gathering – Seven Elements of Accident Investigations.
• Drug and Alcohol Issues.
• Event Recorders.
• Hazardous Materials.
• Report Writing.
Elements of a Thorough Accident Investigation

The *Accident Fundamentals Course* includes a training module that specifically addresses accidents and incidents where there is suspected human factor issues.

The module identifies *Seven Elements of a Thorough Accident Investigation.*

These elements are not included in any priority order, but must all be addressed during the investigation.

---

**Element #1**

Evaluate all applicable rules or standards, and ascertain whether or not there are conflicts amongst them.

Determine if the applicable rules are clear and unambiguous.

---

**Element #2**

Analyze all applicable Railroad Operational or Safety Tests data, and determine if the company requires job briefings.

If job briefings are required, give the details, including whether or not the requirements are followed.
Element #3

In addition to interviewing the people directly involved in the accident, conduct a number of additional interviews (six or so) with people also assigned to the facility, but not involved in the accident.

Ascertain from them, whether rules compliance is strictly enforced, or if shortcuts are common and encouraged.

Determine if Operational Pressures sometimes cause supervisors to encourage or overlook rules infractions.

Element #4

If the accident or injury occurs at a location that is an industrial facility, do OSHA and/or state safety rules apply?

If so, is OSHA or the PUC going to cite these rules as casual?

Element #5

As an accident investigator, develop a checklist for the yard or facility, and for the person or persons that were involved in the incident.

These checklists will vary for different types of facilities (railroad yards/property; industrial facility) and for the person or persons involved (duties will vary by job type).

The checklist will represent a Job Task Analysis designed to help determine what duties are required, what procedures are specified, what rules and special instructions in effect, etc.
Element #6
Evaluate any risks involving loss of *Situationa Awareness* that could have jeopardized the employee’s safety during the performance of their assigned tasks.
Determine if the company has a *Crew Resource Management* program in effect, and if the employees involved had received training in it.

Element #7
If FRA rules are involved, the investigation has to include a significant number of comprehensive interviews with a broad representation of all employees at the facility.
This would include officers, other crew members, and other crafts of employees working at the facility.
The people directly involved in the incident would be given the FRA Drug and Alcohol Questionnaire.

Investigating Accidents is Not Enough, Prevention is the Goal
FRA is proactive in the prevention of accidents and injuries through our *Focused Inspection* process and supports these efforts through training in:
- Train Handling Techniques and On-Board Inspections
- Part 217 Operating Rules and Operational Tests
FRA’s Focused Inspection Approach

- Identify the locations where accidents and injuries are occurring.
- Identify the railroad or railroads that have habitually high numbers of accidents or injuries or those where accidents and injuries are on the rise.
- Identify the causes of all accidents and injuries; either reportable or accountable.
- Identify the rules or regulations that cause the majority of accidents and injuries.
- Identify patterns: day of week, time of day, specific crews, specific locations, etc.
- Identify where and how to effectively focus inspection activities.

Conduct On-Site Inspections

- Inspections must focus on the causes of accidents and injuries.
  - It is essential that the inspector record all defects and deficiencies in order to maintain a factual database.
  - Categorize the findings of these inspection activities for further analysis.

Part 217 Operational Tests and Records Review

The objective is to compare FRA findings with those of the carrier officials to determine if the carrier’s program of operational tests and inspections is effectively implemented.

- Acquire and review the carrier’s program.
- Determine if carrier officers comply with program requirements.
- For specific locations, compare carrier findings with FRA findings and normalize the data.
- Does the carriers testing focus on the “root causes” of the accidents and injuries at that location?
Accompany Carrier Officials On Operational Tests

- Are tests conducted in accordance with program requirements?
- Do carrier officials concentrate on relevant rules?
- Do carrier officials take appropriate action when deficiencies are observed?
- The Inspector will determine if the carrier officials accurately record the results of their operational tests and inspections?

Correction Process

- Utilize performance based oversight to correct identified problems.
- Meet with the carrier officials to:
  1. Develop Problem statements.
  2. Agree on standards that the carrier can achieve.
  3. Set time limits and allow opportunity for results.
  4. Offer FRA assistance.
- Carrier must understand it is accountable for its actions and there will be consequences for inaction.
- FRA follow-up is the most important element.

Carrier Accountability

To insure Carrier Accountability, FRA will:

- Conduct timely follow-up inspections.
- Determine if the inspection results are consistent with the carrier action plan.
- Immediately address any discrepancies with the carrier.
Agency Mission:
The mission of the Mine Safety and Health Administration (MSHA) is to administer the provisions of the "Federal Mine Safety and Health Act, 1977 (Mine Act)", and to enforce compliance with mandatory safety and health standards as a means to eliminate fatal accidents; to reduce the frequency and severity of nonfatal accidents; to minimize health hazards; and to promote improved safety and health conditions in the Nation's mines. MSHA carries out the mandates of the Mine Act at all mining and mineral processing operations in the United States, regardless of size, number of employees, commodity mined, or method of extraction.

MSHA Involvement in your Information Exchange Workshop

...governing agencies responsible for injury and accident collection......lessons learned......
The Accident Reduction Program

Today, I will

- Introduce and explain the program
- Discuss ARP efforts
- Discuss MSHA’s Accident Reporting Requirements
- Discuss MSHA’s Accident Investigations
- Discuss Data Collection & Storage by MSHA
- Discuss MSHA’s Accident Investigation Techniques/Tools
- Discuss Industry Partnerships

MISSION: Address root causes of accidents, injuries, and near misses with an emphasis toward providing engineering controls and solutions to reduce or eliminate future accidents and injuries.
Accident Reduction Program puts another “HOW” into the MSHA mission.

We strive to determine the underlying cause of accidents AND identify solutions (both technical and procedural) on how these accidents can be prevented.

Accident Reduction Program

Statistics
Tell where problems exist
Tell Who - What - Where

BUT
Don’t tell how to fix the problem

Accident Reduction Program
Areas in which ARP directs its efforts:

- Collect and analyze information
- Develop and Share Solutions
- Assist Implementation of those solutions
Accident Reduction Program

Multi-faceted approach:
- Internet
- Outreach - Trade Shows, Associations, Labor Unions, Manufacturers.
- Site visits - Participants include Enforcement (compliance assistance specialists), EFS and Technical Support.

All information/solutions developed from our efforts is put onto MSHA's internet site:

www.msha.gov

This site acts as a forum for the mining community to share successful mining techniques and ideas that are used at their operations and may be applicable and helpful to others in the mining industry.
Accident Reduction Program

Ideas ⇒ More Ideas ⇒ Better Ideas

The process is evolving.
Some Methods of Participation

- Suggestion Post Cards
- Tip / Safety Idea Suggestions
- Tips and Safety Idea Implementation
- Accident Investigation Information

Philosophy of Human Centered Data Collection

Heinrich’s Triangle

Figure Source: Reinach, S. and Gertler, J., "An Examination of Railroad Yard Worker Safety", July 2001
DOT/FRA/ORD-01-20
Serious or Disabling

Minor Injuries

Property Damage

Incidents with no visible injury or damage

Source: Bird and Loftus, Loss Control Management, 1982

Method of Data Collection
Proactive vs Reactive aspects of ∆

<table>
<thead>
<tr>
<th>REACTIVE</th>
<th>PROACTIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Accident Investigations</td>
<td>• Self-Reporting</td>
</tr>
<tr>
<td>• Incident Investigations</td>
<td>• Audits &amp; Self-Assessment</td>
</tr>
</tbody>
</table>

Reactive Methods (Data Collection)

• MSHA accident, incident, and exposure reporting requirements
Reporting Requirements
CFR 30, Part 50

- Immediate Notification of Accident (in some cases)
- Mine Accident, Injury, and Illness Report Form 7000-1
- Report of Investigation & Corrective Measures
  (Prepared by company)

MSHA Accident Investigations

- Investigates Immediately Reportable Accidents
- Accident Investigation Team
- MSHA Report prepared by the District having jurisdiction

Data Collection & Storage

- Electronic Storage of 7000-1 into Teradata database
- Company Report stored at the District Level
- MSHA Report stored at the District Level
- MSHA Report on Web Page if it involves a fatality
Data Queries

- Hummingbird GQL used to query Teradata database
- Available to MSHA personnel on MSHA Intranet

7000-1 Data

- Foster-Miller references Form 7000-1 in 7/01 Report
Proactive Methods
(Data Collection)

- Needs to be established by company management
- Industry research data needs to be readily available
- Data fields need to be compatible
- Voluntary pilot programs are recommended

Identification of Critical Data

- Additional critical data fields should be incorporated in reporting formats as identified

Subject Matter Expert (SME) Workgroups

- Required to develop a list of data needed to more effectively assess human factor aspects
- Identify data fields that may require supplemental reporting requirements
- Success requires commitment from all interested parties
MSHA Investigation Techniques/Tools

- TapRoot® - Root Cause Tree® Implementation
- Group training of TapRoot® for MSHA accident investigation personnel initiated in 2001

Root Cause Analysis Training

- Helps identify root causes and provides a mechanism to assure better data collection
- Instills a thought process into the investigator to ask the right question or acquire the right information

Partnering

The key to preventing future accidents and injuries is to have workers, companies, contractors, manufacturers, associations, and government all work together to achieve safety goals.
Accident Reduction Program

In a nut-shell, the ARP is an effort by MSHA to partner with all portions of the mining industry, to improve the safety of mining operations.

www.msha.gov

Thank You
Safety in Practice
“A Shortline Railroad’s Experience”
Wade Swindle
Safety Officer
Alliant Transportation

Work Experiences
- CRIC Railway
- Private Industry
- CRIC Railway

Alliant Transportation
Company Profile
- Cedar Rapids and Iowa City RR a.k.a...CRANDIC
- IEI Barge Services
- Williams Bulk Transfer
- Transfer Services
CIC Safety Program

Safety Culture
- Keys to CIC change
  - Commitment
  - Communication
  - Accountability

Safety Working Relationships

<table>
<thead>
<tr>
<th>Partnerships</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior Management</td>
</tr>
<tr>
<td>Senior Management</td>
</tr>
<tr>
<td>First Line Supervisors</td>
</tr>
<tr>
<td>Employees</td>
</tr>
<tr>
<td>Employees</td>
</tr>
</tbody>
</table>
Communication Tools

<table>
<thead>
<tr>
<th>JSB’s</th>
<th>Safety Slogans</th>
<th>Special meetings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suggestion Box</td>
<td>Contests</td>
<td>Signs</td>
</tr>
<tr>
<td>E-Mail</td>
<td>Safety Hotline</td>
<td>Open door policy of mgmt.</td>
</tr>
<tr>
<td>Safety Committee Meetings</td>
<td>Celebrations</td>
<td>Newsletters</td>
</tr>
</tbody>
</table>

Safety Committee

- Group Committee Membership
- Membership Activities
  - Review close calls and incidents
  - Review clearance issues
  - Discuss Items of concern
  - Vote on the Monthly Safety Slogan.
  - Each department selects 4 safety rules to be focused on for the month.

Other Committee Activities


- Other special assignments.
Special Safety Committee

- Individual Train Service Safety Committee
- Activities include:
  - Bi-monthly meetings
  - Attendance by local FRA representative.
  - Focused effort on changing the Culture in this department.

Incentives

- Safety Goals
- Safety Awards
- Safety Bucks
- Safety Celebration Drawings

Safety Buck
$50
Awarded for submitting the winning slogan in the monthly Safety Slogan Contest.
Keep up the safe world! (For use in the CRANDIC Sailing Company catalog)
Audits

- Supervisors required to perform 4 safety audits per month.
- Safety Department performs 8 per month.
- Audit results

Job Safety Briefings

- Employee JSB’s
  - SOFA
  - Employee empowerment
  - Safety Hazards Encountered
  - Close clearances
  - Defective Equipment

CIC Injury Stat’s

- 1/3 of Incidents are recordable
- Department comparisons
- Strains, sprains
  - Knees and backs
- Tasks performed
### Task

<table>
<thead>
<tr>
<th>Task</th>
<th>% Total Incidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slips, trips, falls</td>
<td>19%</td>
</tr>
<tr>
<td>Mounting/ Dismounting</td>
<td>19%</td>
</tr>
<tr>
<td>Operating Switches Derails</td>
<td>19%</td>
</tr>
</tbody>
</table>

### Training

- New Employees
- Safety Rules
- FRA
- OSHA
- Environmental
- Company Policies and Procedures
- Customer Training
STD

- Short Term Disability
  - 60% of Gross
  - Illness vs. Injury

Exercise Program

- Department Specific
- Mandatory Participation
- Low Impact

Employee Suggested Improvements

- Implemented 200 individual safety improvements
- Changed Switch handles.
- Purchased lighter weight tools
  - Hydraulic tools
Thanks for Listening
Future Challenges in Rail Accident Investigations

James Stem, Alternate National Legislative Director UTU, Representing President Byron Boyd

What We Are Working On

• Safe Work Environment
• Our Job Security
• Our Health Care
• Our Pensions

Cultural Issues

• Reinvestment strategies of railroads
• New territories and company policies because of mergers
• Size of dispatching, territories
Change Is Hard To Accept

To: President Andrew Jackson

The canal system of this country is being threatened by the spread of a new form of transportation known as “railroads.” The federal government must preserve the canals for the following reasons:

One. If canal boats are supplanted by “railroads,” serious unemployment will result. Captains, cooks, drivers, hostlers, repairmen and lock tenders will be left without means of livelihood, not to mention the numerous farmers now employed in growing hay for horses.

Two. Boat builders would suffer and towline, whip and harness makers would be left destitute.

Three. Canal boats are absolutely essential to the defense of the United States. In the event of the expected trouble with England, the Erie Canal would be the only means by which we could ever move the supplies so vital to waging modern war.

As you may know, Mr. President, “railroad” carriages are pulled at the enormous speed of 15 miles per hour by “engines” which, in addition to endangering life and limb of passengers, rear and shout their way through the countryside, setting fire to crops, scaring the livestock and frightening women and children. The Almighty certainly never intended that people should travel at such breakneck speed.

Martin Van Buren
Governor of New York
1829
Goal of All Training:

Create a safe, confident, competent and comfortable worker that will take ownership of their job

Law of Diminishing Returns

The tendency for a continuing application of effort or skill toward a particular project or goal to decline in effectiveness after a certain level of result has been achieved.

Fatigue

- Counter measures – regular schedule
- Calling windows
- 8-hour call
- Should include dispatchers and track inspectors
Fatigue is Cumulative

Focus on Prevention of Future Accidents from Related Causes!
Company Profile

- World’s largest short line and regional railroad operator
  - 48 railroads / 13,000 miles of track
- Formed in 1986 / IPO in 1992
- NYSE Listed: RRA
- Expect 2002 revenues to approach $480M
- Growing organically & through acquisition
- One of the most efficient & profitable rail operators in the world
RA Safety & Operating Practices

J. PRESTON CLAYTOR  
Vice President-Safety Operating Practices

LEE AUMEND  
Manager  
Safety & Training

JR SAMPSON  
Manager  
Safety & Operating Practices

JR SAMPSON  
Manager  
Safety & Operating Practices

GARY VAUGHN  
R.M.S.O.P.  
Lone Star Region

JOHN TEGLOVIC  
R.M.S.O.P.  
Mid-West Region

OPEN  
R.M.S.O.P.

JAMES BECKER  
R.M.S.O.P.  
Western Region

KEVIN MCKINNON  
R.M.S.  
Eastern Region

TOM PAUL  
R.M.S.O.P.  
Sunset Region

BILL MOUNT  
R.M.S.O.P.  
Heartland Region

RA Safety & Operating Practices

R.M.S.O.P.s

- Regional Managers – Safety & Operating Practices
- RMSOPs work for Regional Vice Presidents
- Each RMSOP is a member of the local management team – and not part of the corporate structure
- Main focus of the job is accident and injury prevention
- Education is the main weapon in the war against incidents
- Accident investigation is an important, but secondary, job function

RailAmerica Incident Investigation

- Local Management responsible for accident investigation
- RailAmerica’s size insures that specialized accident investigation expertise is available within the corporation
- RailAmerica maintains relationships of consultants and contractors to aid in accident/incident investigation
American Short Line & Regional Railroad Association

Current members vary in size – from several miles in length to hundreds of miles.
RailAmerica is the largest member as a result of its large number of member companies.

Of the other 400 members, many are "Mom & Pop" operations.
Accident/incident investigation capabilities vary depending on size of the organization.

Two Guys and a Train
Accident/Incident Investigation on Small Railroads

- Even small accidents can cause major problems
- Small railroads may not have the resources to properly investigate accident or incidents
- Prevention measures vary greatly dependant on the organization, not on the size of the railroad
- Major accidents or incidents may require extensive involvement and/or assistance from Federal Agencies such as FRA or the NTSB

Future Challenges in Incident Investigation & Correction

- Communication of root causes and preventative measures is the key
- Some companies such as BNSF share safety information and accident alerts with their short line partners
- ASLRRA shares publishes a monthly Safety Bulletin and promotes safety through seminars and industry awards

What do short lines do with accident/incident information?
Heinrich’s Safety Triangle

Fatalities
Reportables
Non-Reportables
Unsafe Behaviors
Near Misses
Hazards

Safety Comparison

FRA Injury Frequency Rate – 2001-2002

Short Lines
RA 2001
Class I Avg.
2002 Actual