Example of Investigation Best Practices

Interim Findings from an Evaluation of Canadian Pacific Railway's Investigation of Safety-Related Occurrences Protocol (ISROP)

Mary Lee

(617-494-3157, mary.lee@volpe.dot.gov)

Joyce Ranney

(617-494-2095, ranney@volpe.dot.gov)

U.S. Department of Transportation
Research and Innovative Technology Administration

Presentation Objectives

- Provide an overview of the ISROP evaluation
- Describe the ISROP process using a case study sample investigation
- Show interim findings from the ISROP evaluation

Overview of Evaluation

Purposes of the Evaluation

- Provide Canadian Pacific Railway a better understanding of the impact of ISROP and and how to improve it
- Support the Federal Railroad Administration (FRA) Human Factors R&D Program in identifying leading indicators of safety and alternative ways to measure safety programs (other than injury rates)
- Distribute lessons learned to the railroad industry

Evaluation Overview

Team

Government

- FRA Human Factors R&D Program
- Volpe Center

Technical Support

- WreathWood Group
- University of Connecticut

Participants

- Canadian Pacific Railway and Canadian Auto Workers Union
  - Health and Safety Committees from three Mechanical sites in Canada
  - Mechanical Services Policy Committee
  - Safety and Environmental Services

Phases

Baseline (2004-2005)

- ✓ Surveys
- ✓ Interviews and Focus Groups
- ✓ Feedback Sessions
- ✓ Initial Operating Data Analysis

Mid-Term (2005-2006)

- ✓ Logic Model Workshops
- ✓ Case Study Analysis

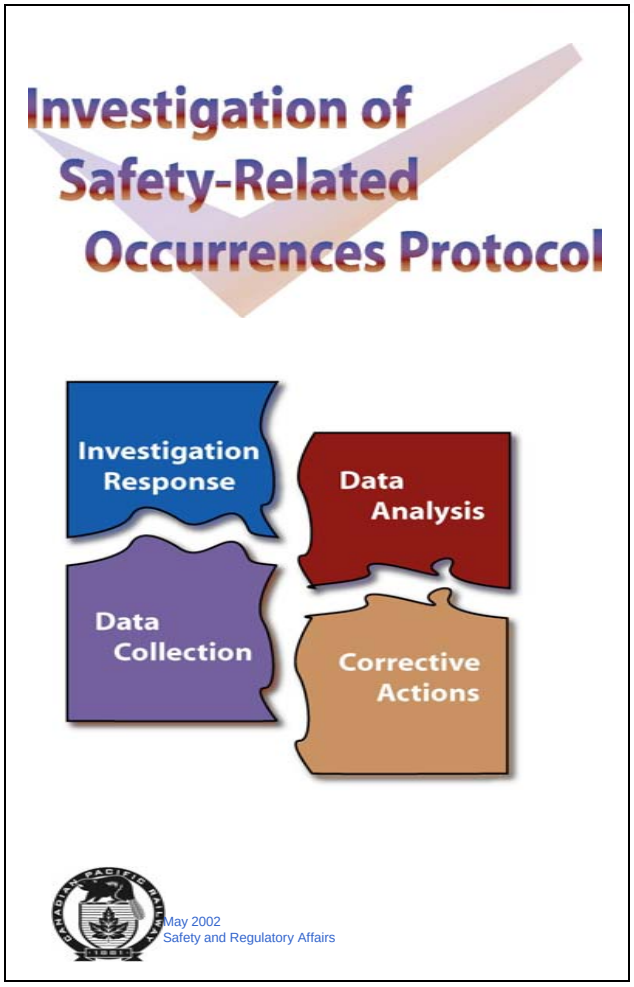
Final (2007-2008)

- Surveys
- Interviews and Focus Groups
- Final Operating Data Analysis
- Feedback Sessions
- Final Report

ISROP Case Study

What is ISROP?

- A process Canadian Pacific Railway developed for incorporating human factors into the day-to-day investigation of accidents and incidents
  - Only required for most severe, but some places use it for all
- Tools:
  - Training
  - Manual for detailed reference
  - Field guide for quick instruction
  - Note pad for record keeping
  - Report templates

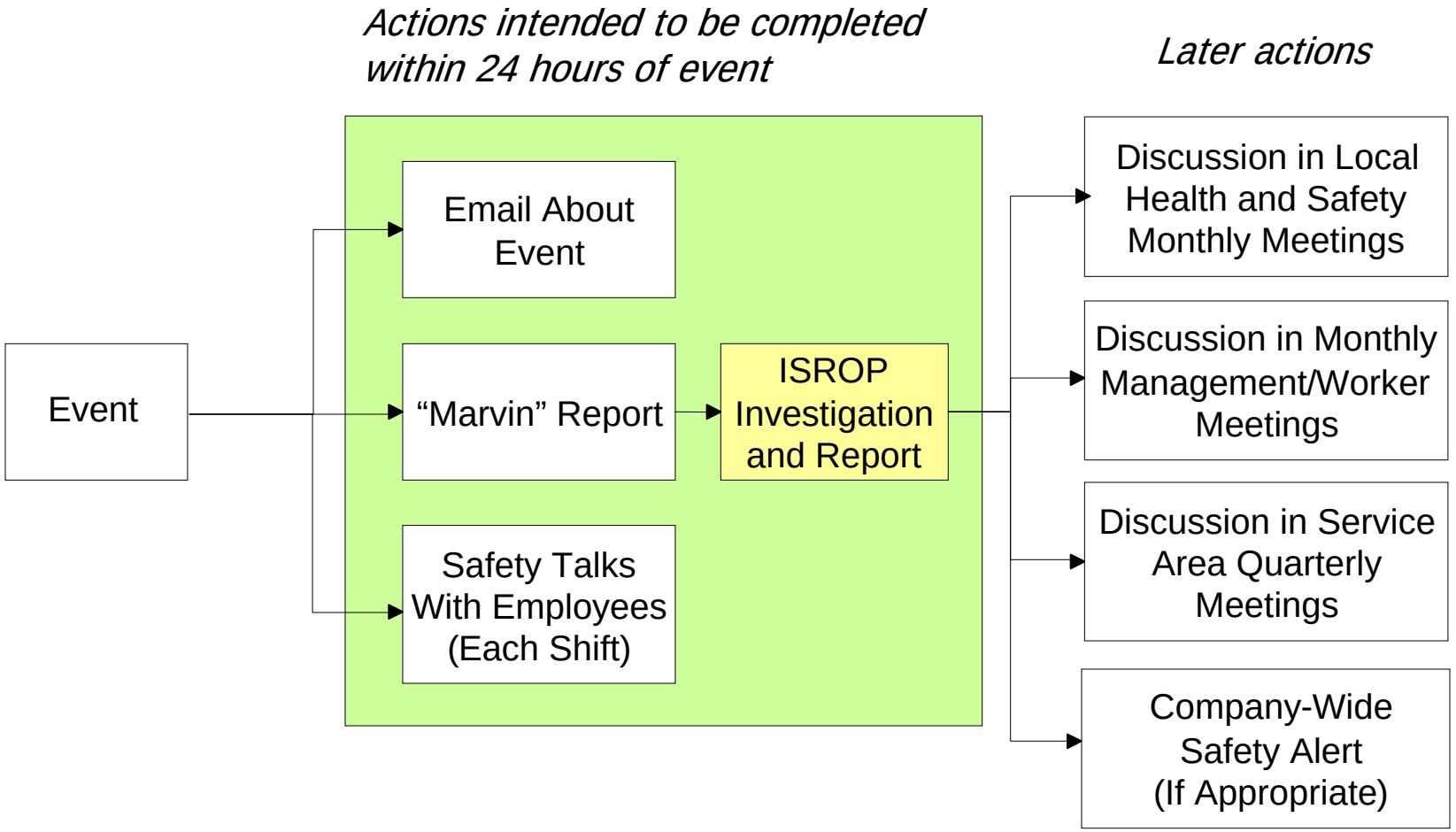


ISROP Goals

- What ISROP should do:
  - Standardize investigation procedures
  - Improve amount and type of data collected
  - Improve data analysis
  - Improve understanding of root causes
  - Help develop and implement more effective corrective actions

- What ISROP should not do:
  - Change labor relations investigation and statement process
  - Change the disciplinary system
  - Significantly increase work load
  - Conflict with other processes and training

ISROP Is Part of a Larger Process



Case Study – Jacking Incident

- A loaded boxcar that was jacked to change a wheelset suddenly dropped striking an employee on his hardhat

- A thorough ISROP investigation was conducted

Initial Response

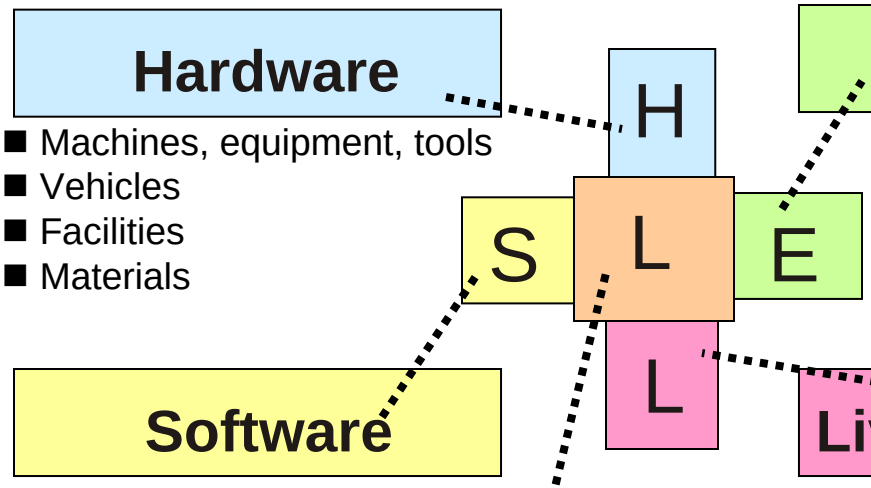
- Secured the scene, so nothing would be changed

- Gathered investigation team
  - 3 managers (local and from other locations)
  - 3 Health and Safety labor representatives (local and from other locations)
  - 3 employees involved
  - Other employees on duty nearby

Data Collection

- Measurements
- Photos
- Interviews
- Reenactment

SHELL Model



Hardware

- Machines, equipment, tools
- Vehicles
- Facilities
- Materials

Environment

- Physical agents
- Biological
- Hygiene
- Weather

Outside 0 Celsius

Software

- Policies, regulations
- Processes e.g. job briefing, hazard identification
- Training, identification

Normal jacking practices

Liveware-Peripheral

- Communication
- Interaction
- Organizational
- Supervision
- Associations and unions

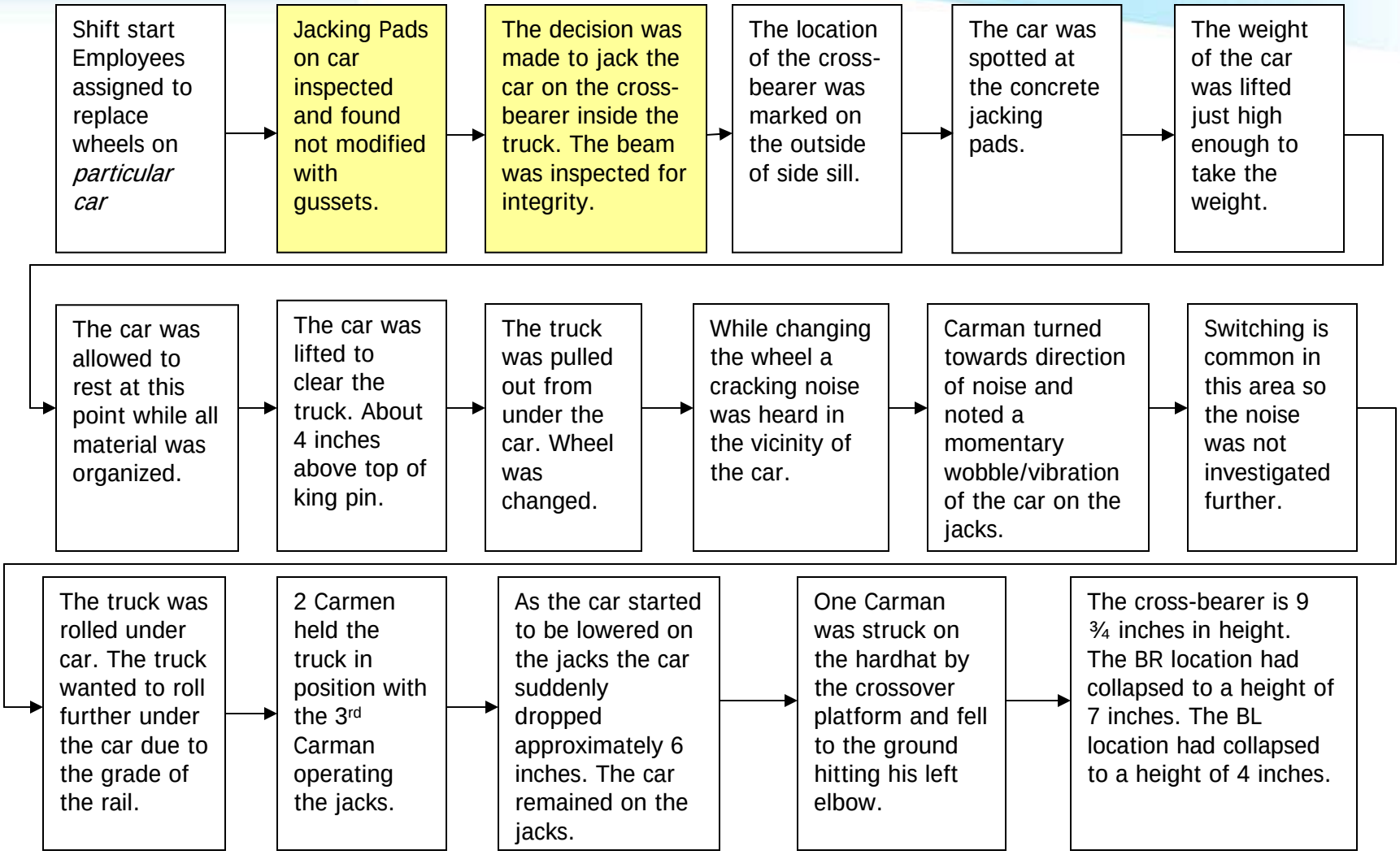
Liveware-Central

- Memory
- Attention
- Workload
- Expectation
- Fatigue, stress

Interview with employees

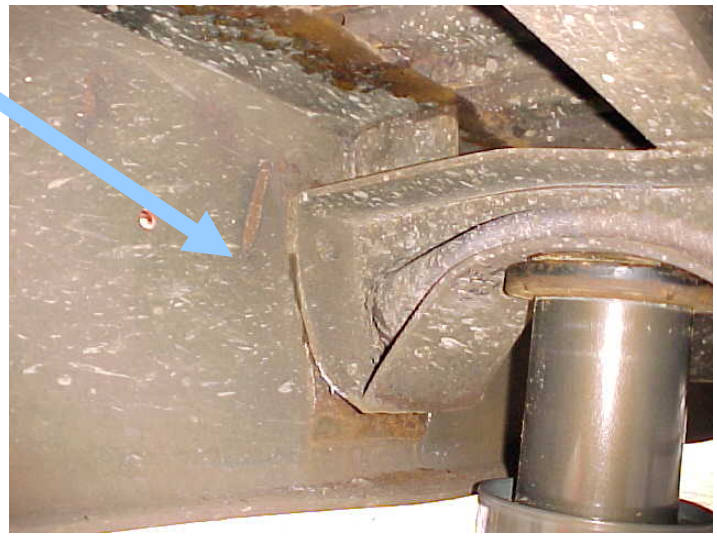
(The SHELL model was developed by Edwards and modified by Hawkins)

Events Diagram

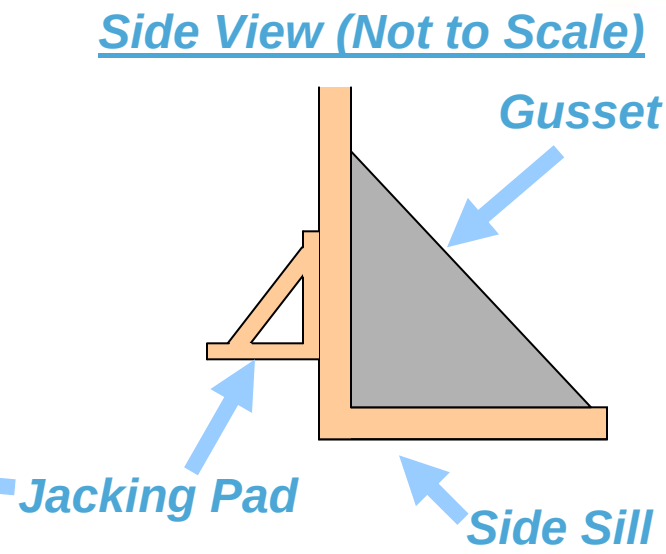


Some Key Events

- Carmen assigned to change a wheelset on a loaded boxcar
- They realized jacking pads were unsafe, since no gusset had been added when the car was modified to carry additional weight (70 tons → 100 tons)
- The carmen took advice from others who said they had placed jacks under cross-bearers in the past
- The car suddenly dropped about 7” due to cross-bearer collapse
- A carman was struck on his hardhat causing him to fall to the ground
- ***If the car had fallen off the jacks, there could have been one or more serious injuries or fatalities…***

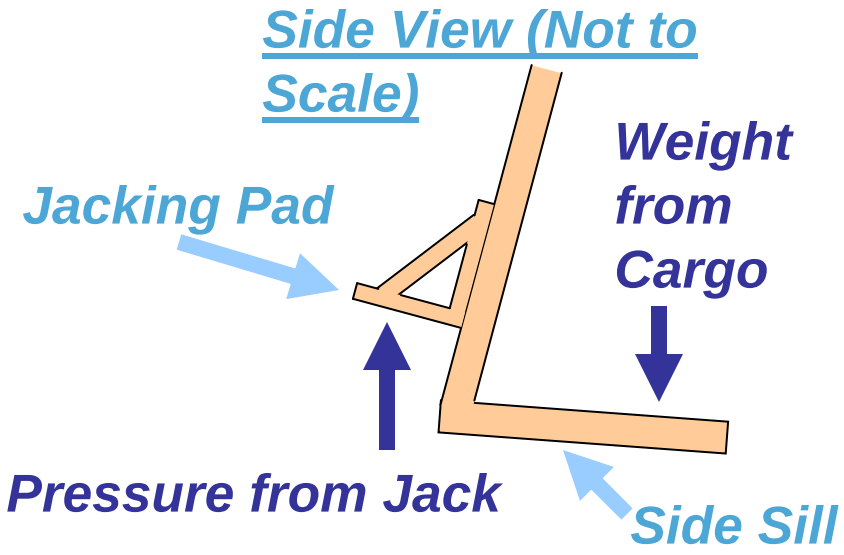


What is a Jacking Pad and Gusset?



- The gusset is a steel plate welded inside the car to help keep the jacking pad parallel to the ground

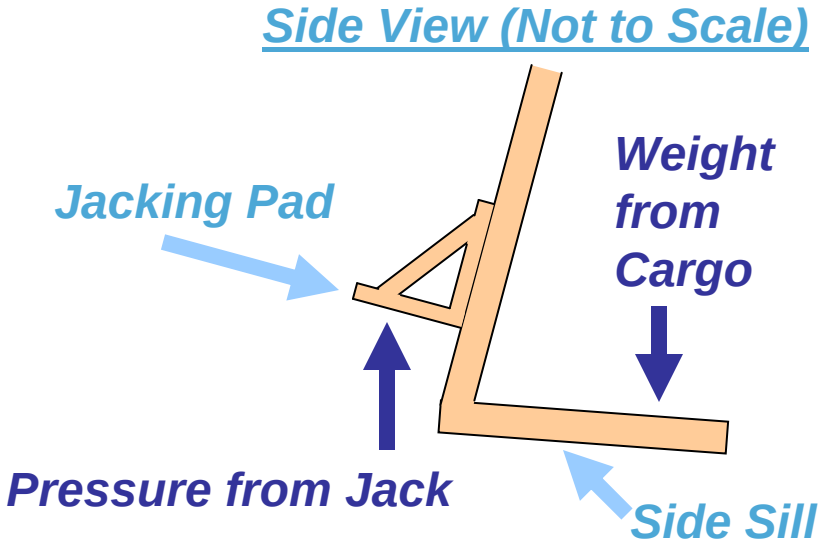
Potential Problem Without Gusset



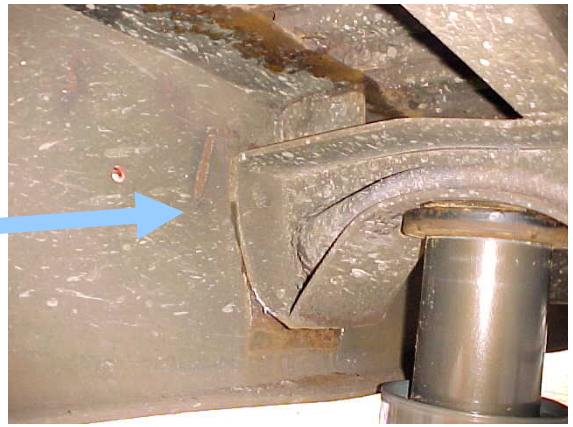
- Without the gusset, the side sill could bend and the jack could kick out (because the jacking pad would not be level)

Safety Concerns

1. Without gussets the jacks could kick out



2. Cross-bearer will not support weight of loaded car



Estimated Risk of Recurrence

- Risk is calculated by multiplying frequency and severity

		Severity (Potential Consequence)				
		Minimal 1	**Marginal 2**	**Serious 3**	**Critical 4**	**Catastrophic 5**
Frequency	**Frequent 5**	low 5	medium 10	high 15	very high 20	very high 25
	Probable 4	low 4	medium 8	high 12	high 16	**very high 20**
	Occasional 3	very low 3	low 6	medium 9	high 12	high 15
	Remote 2	very low 2	low 4	low 6	medium 8	medium 10
	Improbable 1	very low 1	very low 2	very low 3	low 4	low 5

- The investigation team rated the two safety concerns:
  - Without gussets the jacks could kick out: 4 x 5 = 20 (very high)
  - Cross-bearer will not support weight: 4 x 5 = 20 (very high)

Corrective Actions

- Advise employees locally and across the company with a Safety Alert
  - Cross-bearers not to be used for jacking
  - If jacking pads are not reinforced, loaded cars should be lifted with a crane
- Issue “Mod” to reinforce jacking pads

Mechanical Services 008-04

Safety Alert

Incident – On November 29, 2004, the B-end of loaded boxcar CP 214873 was being jacked to change wheelset #2. The jack was placed under the first large cross-member (cross-bearer) inboard of the truck. When the wheelset had been changed and the jack was being operated to lower the car onto the truck, the car suddenly dropped approximately 6" to 12". One carman was struck on his hard hat by the cross-over platform as the car dropped. He then fell to the ground injuring his left elbow.

Investigation – Inspection of the cross-bearer revealed that it had crushed at the locations of the jacks. It has been common practice to jack cars such as these at the cross-bearers because the jacking pads may be inadequate to support the weight of the loaded car. Many 70-ton boxcars have been upgraded to 100-ton capacity but jacking pads were not reinforced.

Corrective Action – Loaded boxcars should not be jacked at the cross-members. Loaded boxcars which have been upgraded from 70-ton to 100-ton capacity should not be jacked at the jacking pads if the pads have not been reinforced. These upgraded cars, when loaded, should only be lifted with a crane following approved procedures.

CPR will implement a program to reinforce the jacking pads of all affected cars. CPR cars known to require this work are in series CPAA 211000 - 249 and CP 214000 - 876. Other cars, both CPR and foreign, may be affected. Assume that the jacking pads of any loaded 100-ton boxcar are inadequate until it can be confirmed otherwise.

More Information – CPR Equipment Engineering can advise if a car has been upgraded from 70-ton to 100-ton and if jacking pads have been reinforced.

▲ Do not jack cross-bearers

▲ Crushed cross-bearer

During any lifting or jacking situation, safety of personnel is the first and foremost concern and all appropriate caution should be taken.

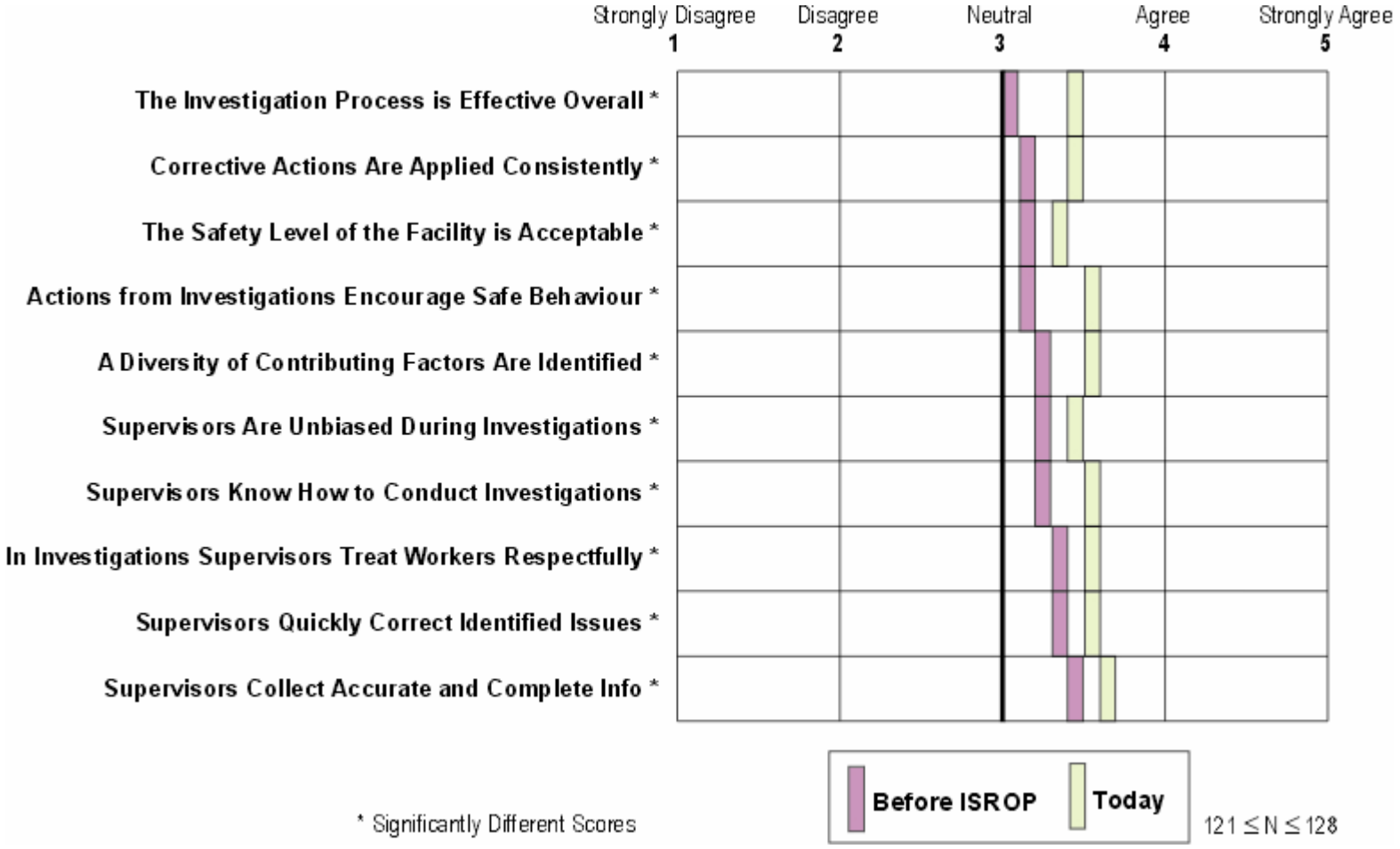
Dave Meyler
General Manager Engineering and Mechanical Technical Services

CANADIAN PACIFIC RAILWAY

Interim Findings

2004 Survey Results

- Responses to a survey in late 2004 indicated that investigations are better "**Today"** (late 2004) than "**Before ISROP"**



2005 Interviews and Focus Groups

- Many managers like the structure of ISROP (although they do not consider some components necessary for less serious incidents)

- People find that ISROP improves the effectiveness investigations by helping them:
  - Collect better information for identifying root causes and corrective actions
  - Use techniques that discourage bias
  - Improve cooperation between labor and management
  - Communicate the results

Case Study Interviews – Overall Impression of ISROP

- ISROP process is considered useful
  - "It's a better way of conducting an investigation. It's a more step-by-step process"
  - "It helps you analyze actions better and figure out in the future what to do better"
  - "It is a more formalized process. It gets you thinking more about the whole accident process"

- Events diagram is highly regarded
  - "The events diagram brings out what happened and what went on in the whole incident"
  - "It gets you to what really relates to the root cause"

Case Study Interviews – Corrective Actions

- ISROP helps identify appropriate corrective actions
  - "It's a more in-depth way of doing things... It's easier to find out what happened and put a corrective action in place"
  - "The corrective action is based on more than just one person thinking in one direction"
  - "The corrective actions are based on safety concerns"

- ISROP encourages more accountability for corrective actions
  - "I like the corrective actions and the *by whom* and *by when*. I believe there should always be a date in there"
  - "The corrective actions, when you get them down and assign them to people, you get a better response that these are followed through"

Case Study Interviews – Business Case

- Costs
  - Investigation team time
  - Corrective actions
    - There were costs associated with communicating with employees, fixing the jacking pads, and using cranes
- Benefits
  - Avoid potential fatalities and injuries
    - Since other places had jacked this way before and were likely to do it again, the corrective actions were needed

Consequences of fatalities and injuries can include:

- Human loss
- Psychological effects on workforce
- Effects on families
- Negative publicity
- Attention from regulatory agencies
- Financial implications
  - *Average FRA injury cost: $47K*
  - *Average fatality cost: $2-3M?*

Case Study – System-Wide Impact

- Corrective actions were not just focused on the individuals involved in the event
- ISROP results led to system-wide improvements
  - Safety Alert issued across company in 2004
  - Updated jacking guidelines prepared in 2006


Mechanical Services 008-04

Safety Alert

Incident – On November 29, 2004, the B-end of loaded boxcar CP 214873 was being jacked to change wheelset #2. The jack was placed under the first large cross-member (cross-bearer) inboard of the truck. When the wheelset had been changed and the jack was being operated to lower the car onto the truck, the car suddenly dropped approximately 4" to 12". One carman was struck on his hard hat by the cross-over platform as the car dropped. He then fell to the ground injuring his left elbow.

Investigation – Inspection of the cross-bearer revealed that it had crushed at the locations of the jacks. It has been common practice to jack cars such as these at the cross-bearers because the jacking pads may be inadequate to support the weight of the loaded car. Many 70-ton boxcars have been upgraded to 100-ton capacity but jacking pads were not reinforced.

Corrective Action – Loaded boxcars should not be jacked at the cross-members. Loaded boxcars which have been upgraded from 70-ton to 100-ton capacity should not be jacked at the jacking pads if the pads have not been reinforced. These upgraded cars, when loaded, should only be lifted with a crane following approved procedures.

CPR will implement a program to reinforce the jacking pads of all affected cars. CPR cars known to require this work are in series CPAA 211000 - 249 and CP 214000 - 876. Other cars, both CPR and foreign, may be affected. Assume that the jacking pads of any loaded 100-ton boxcar are inadequate until it can be confirmed otherwise.

More Information – CPR Equipment Engineering can advise if a car has been upgraded from 70-ton to 100-ton and if jacking pads have been reinforced.

▲ Do not jack cross-bearers

▲ Crushed cross-bearer

During any lifting or jacking situation, safety of personnel is the first and foremost concern and all appropriate caution should be taken.

Dave Heyler
General Manager Engineering and Mechanical Technical Services

CANADIAN PACIFIC RAILWAY

For More Information Please Contact

Mary Lee
Engineering Psychologist
Volpe National Transportation Systems Center
55 Broadway, Cambridge, MA 02142, USA
(617) 494-3157
mary.lee@volpe.dot.gov

Michael Coplen
Human Factors Program Manager
Federal Railroad Administration
Office of Research and Development
1120 Vermont Avenue NW - Mail Stop 20
Washington, DC 20590, USA
(202) 493-6346
michael.coplen@dot.gov