Rail Crew Resource Management
Pilot Course

Participant's Manual

Version 1.2(E)
Engineering
2005

Railroad Crew Resource Management (CRM) Training Course

Engineering Track

(Insert Date Here)

Registration and Introductions

- Safety Briefing
- Registration
- Introductions

Group Discussion

What are some things you do to ensure safety on the job, on a daily basis?

Class Schedule

Morning: Modules 1-3

Afternoon: Modules 4-6

Endorsement

- "Crew Resource management is a fantastic program. It fits with our safety mission. I whole-heartedly believe in and endorse this program."

Overall Course Objectives

- Understand what CRM is and what it is not
- Understand the loss and gain of situational awareness
- Understand that safety hinges on both individual and team actions

Overall Course Objectives

- Know techniques and attitudes that foster effective communication within and between teams
- Be able to describe how job safety is affected by circumstances both on and off the job
- Know CRM practices and appreciate their value in improving railroad safety

Course Outline

1. Introduction/Defining CRM
2. Technical Proficiency
3. Situational Awareness
4. Communications
5. Teamwork
6. Assertiveness

Where is Fatigue?

- How is fatigue related to CRM?

Module 1: Introduction

- Explain where CRM techniques originated
- Describe the difference between CRM and crew management
- Describe how CRM can be used to reduce human error accidents
- Name the five main areas of CRM practices

CRM

- A crew's effective use of all available resources to achieve safe and efficient train operations

Crew Concept Discussion

- Definition of a crew: "Any group of people working at tasks designed to accomplish a common mission, goal, or objective."

Two Types of Railroad Teams

- **ELEMENTAL TEAM–**Basic teams that carry out functions at the railroads
  Example: *Road Crew or MOW Crew*
- **INTERACTIVE TEAM–Formed when an elemental team must interact with an outside individual or another elemental team(s) to safely carry out an activity**
  Example: *Dispatcher, MOW crew, and Road crew working together to move train through a work area*

Elemental teams
(by functional areas)

TRANSPORTATION
Road Crews
Yard Crews
Dispatchers
Hostlers

ENGINEERING
Section Gangs
Production Gangs
Structures (B&B)
Signal Maintainers
Electrical/Catenary Crews

MECHANICAL
Locomotive Repair Shop Crews
Locomotive Servicing Crews
In/Outbound Inspection Crews
Car Repair Shop Crews

CRM

- A crew's effective use of all available resources to achieve safe and efficient train operations

Resources?

- Equipment
- Computer Resources, Paperwork
- People

What CRM is NOT

- NOT: A crew calling program
- NOT: A quick fix that can be implemented overnight
- NOT: A short-term accident-reduction program

CRM is……

- A human factors training program based in safety
- Process that addresses the entire crew and other related staff
- Heightened awareness of attitudes and behaviors of crewmembers and their impact on safety

CRM is……

- Team-based framework through which to evaluate conditions, apply rules, and perform work tasks *safely*
- Forum that encourages individuals to examine their behavior and make adjustments to improve teamwork
- Focuses on effectiveness of the team rather than just the competence of individuals

History & Background of CRM

- Started in airlines
- Moved outside the cockpit
- Moved into other industries
- Similarity between tasks/teams
- NTSB recommends CRM for rail

Butler, Indiana

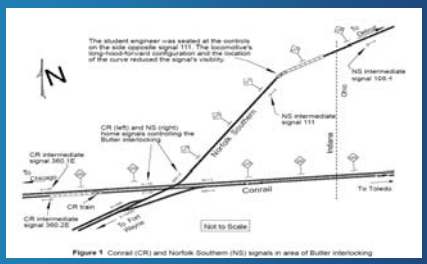
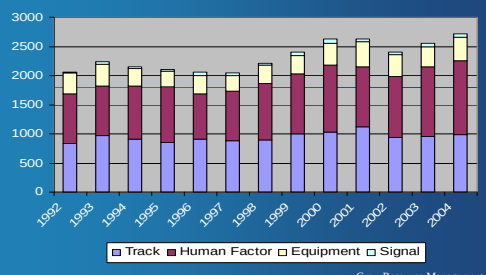
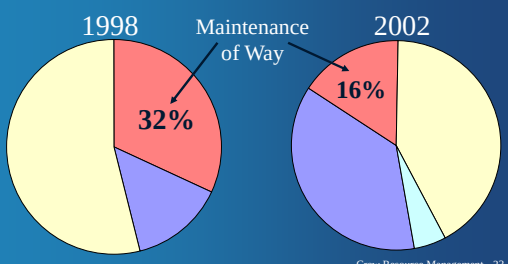


Figure 1 Conrail (CR) and Norfolk Southern (NS) signals in area of Butler interlocking

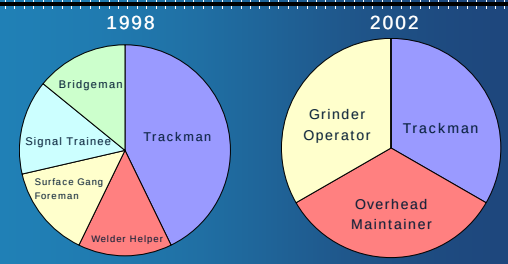
Why CRM?



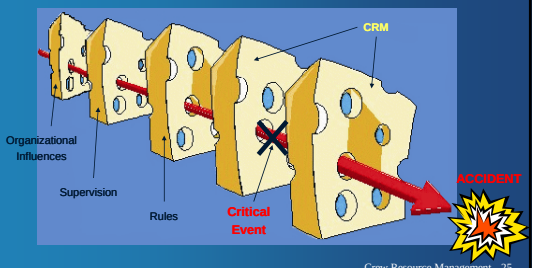
Railroad Employee Fatalities by Craft



MOW Fatalities by Position



Swiss Cheese Model

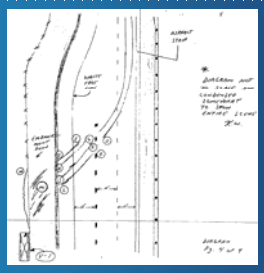


Benefits of CRM Practices

- Increased safety
  - Decrease errors that result in accidents
  - Accidents are costly
- Intangible benefits

Split Switch

"When Does the Job End?"



Trackman Falls

Main CRM Elements

- Technical Proficiency
- Situational Awareness
- Communication
- Teamwork
- Assertiveness

Break

Module 2: Technical Proficiency

Learning objective:

- Name the three elements of technical proficiency as related to CRM practices

Elements of Technical Proficiency

1. Knowing your equipment
2. Knowing your procedures
3. Skilled performance

Technical Proficiency

- Evaluating the technical proficiency of fellow crewmembers
  - New rules/procedures
  - New crewmembers

"Go Back to the Truck and Come Pick Me Up."

Module 3: Situational Awareness

Learning objective:

- Understand situational awareness and how job safety is affected by circumstances both on and off the job

Specific Learning Objectives: Situational Awareness

- State the two elements of situational awareness
- Describe how a team/crew's perception of the situation is adopted
- Describe personal and team cues that indicate potential safety breakdowns

Specific Learning Objectives: Situational Awareness (cont.)

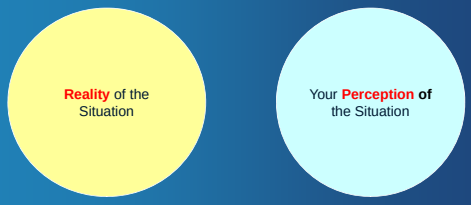
- Describe the potential impact of stress and fatigue on worker perceptions of developing situations
- Explain to a co-worker why maintaining situational awareness is so important to job safety
- List four good habits that individuals can develop to maintain situational awareness on a team

Situational Awareness

1. Reality versus Perception of Situation
2. Situational Cues
3. Steps in Maintaining Situational Awareness
4. Steps in Regaining Situational Awareness
5. Maintaining and Recognizing a Loss of Situational Awareness
6. Fatigue

Situational Awareness

Reality/Perception of Situation



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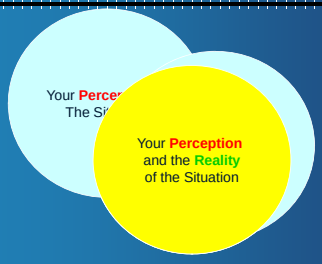
Situational Awareness

Truck Gas Compartment Explosion

Crew Resource Management 41

Situational Awareness

Accidents Caused by Loss of Situational Awareness



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Cues

- Environmental
  - Equipment
  - Crewmember
- Personal

Are Cues Valid?

- Are equipment, crewmember, and personal cues always correct?

Steps in Maintaining Situational Awareness

- Planning and preparing
- Avoiding distractions
- Distributing workload
- Prioritizing your decisionmaking
- Communicating with your crewmembers
- Recognizing a deteriorating situation

Steps in Regaining Situational Awareness

- Communicate
- Resolve
- Monitor

Maintaining or Recognizing a Loss of Situational Awareness

- Most likely to maintain or recognize a loss of situational awareness when we
  - Operate under low stress
  - Request and accept feedback from fellow crewmembers
  - Develop skills for questioning our own knowledge and experience
  - Are not fatigued

Fatigue

- What is fatigue?
- What are some factors that lead to fatigue?
- What are some specific characteristics of railroading that could potentially lead to fatigue?
- What are some symptoms of fatigue?

Lunch Break

Module 4: Communication

Objective: Know techniques and attitudes that foster effective communication within and between teams

Learning Objectives: Communication

- List six ways information should be communicated in order to be effective
- Demonstrate techniques used in two-way communication
- Explain the pros and cons of different non-face-to-face communication

Learning Objectives: Communication (cont.)

- List some ways that new technologies can change communication patterns
- Illustrate good and bad techniques for communicating in a job briefing

Outline of Module

- Oral communication
- Two-way communication/active listening
- Other communication methods
  - Radio/written/verbal/hand signals
- Job briefing

Surfacing Foreman Struck by Train

Oral Communication

- Clear
- Accurate
- Complete
- Organized
- Concise
- Timely

Two-way Communication/ Active Listening

–Ask questions

–Restating or paphrasing

–Recording information

Other Modes of Communication

- Radio
- Written
- Hand signals

New Technology

- Remote Control
- Cell Phones
- Cell-Based Walkie-Talkie
- Electronic Authority Exchange
- Hi-Rail Limits Compliance System
- Automated Information Exchange

Job Briefing Guidelines

- Plan the job briefing
- Conduct the job briefing
- Brief for special conditions
- Followup by employee in charge
- Debriefing

Active Participation (in job briefing)

- Contribute facts and ideas
- Ask questions
- Listen/stay focused
- Clarify roles and expectations

Module 5: Teamwork

- Understand that safety hinges on both individual and team actions

Learning Objectives: Teamwork

- Explain why optimizing safety involves team responsibility, as well as individual responsibility
- List the benefits of improved team decisionmaking
- Be able to effectively use conflict resolution techniques

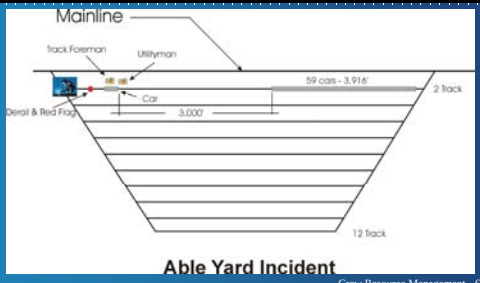
Teamwork

- Definition of a team–crew
- Team decisionmaking
- Conflict resolution

Definition of a Team/Crew

- A crew/team is “any group of people working at tasks designed to accomplish a common mission, goal, or objective”

La Crosse, WI



Able Yard Incident

Team Decisionmaking

Advantages of team decisionmaking

1. More complete information
2. More alternatives
3. Solution is accepted by the group
4. Solutions are accepted more by individuals outside the group

Conflict Resolution

- Causes of conflict
- Effects of conflict
- Win-Win solution
- Conflict resolution techniques

Module 6: Assertiveness

Objective: Understand the proper use of assertive communication

Assertiveness/Proper Challenges of Authority

- Proper assertiveness
  - Asking questions
  - Do not attack the individual
  - Controlling of emotions
- Corporate safety culture
- Taking other people's communication styles into account while being assertive/proactive

Failure to Deploy Crane Outriggers

Review of Each Module

- Introduction
- Technical Proficiency
- Situational Awareness
- Communication
- Teamwork
- Assertiveness

CRM Benefits

- Continental Airlines (trained approximately 2/3 of maintenance workforce in CRM)
  - 66% decrease in ground damage costs
  - 27% fewer occupational injuries
- Maersk (after 4 years of CRM and human factors training)
  - 33% reduction in accidents
  - 15% decrease in insurance premiums as a result

Review

CRM Benefits

- Benefits
  - Increased worker **safety** (saved lives, reduced lost work injuries, fewer equipment failures, reduced fatigue-related accidents)
  - Improved performance (avoid costly errors)
- Costs
  - Will require changes in the railroad culture
  - Ongoing training and evaluation program
  - Organizational commitment to see as many errors as possible eliminated

Review

CSX Sun Kink/Amtrak Derail

NS Student Engineer at Butler, Indiana

Employees Involved in Accident:	• Engineer; NS & Conrail • Conductor; NS & Conrail • Student Engineer; NS
Railroad:	Norfolk Southern Corporation and Consolidated Rail Corporation
Trains:	NS – 255L5; Conrail – TV 220
Location:	Butler, IN
Accident Date and Time:	March 25, 1998, about 4:48 a.m., CST
Type of Accident:	Collision
Fatalities/Injuries:	NS conductor killed; NS engineer and student engineer sustained minor injuries
Property Damage:	NS damages – $187,000 to equipment; $18,000 to track and signals; and $59,000 to cargo Conrail damages – $314,000 to equipment; $33,500 to track and signals; and $4,700 to cargo

The Incident

The accident occurred just before 5:00 in the morning. The weather was cold, approximately 35°F; the visibility was unrestricted at about 10 miles; and there was a slight wind out of the NW that had no effect on the accident.

The southbound Norfolk Southern Corporation (NS) train 255L5, which was en route to Fort Wayne, IN, struck eastbound Consolidated Rail Corporation (Conrail) train TV 220, which was en route to Columbus, OH. The collision occurred where the NS Huntington District and the Conrail Chicago main lines cross at grade at the east end of the town of Butler, IN. Both locomotives and five cars from the NS train derailed, and three cars from the Conrail train, two with multiple, stacked platforms, derailed. The NS conductor was killed; the engineer and student engineer sustained minor injuries. The two Conrail crewmembers were not injured.

Conrail

The Conrail train proceeded into the interlocking according to the signal system and with the authority of the controlling dispatcher.

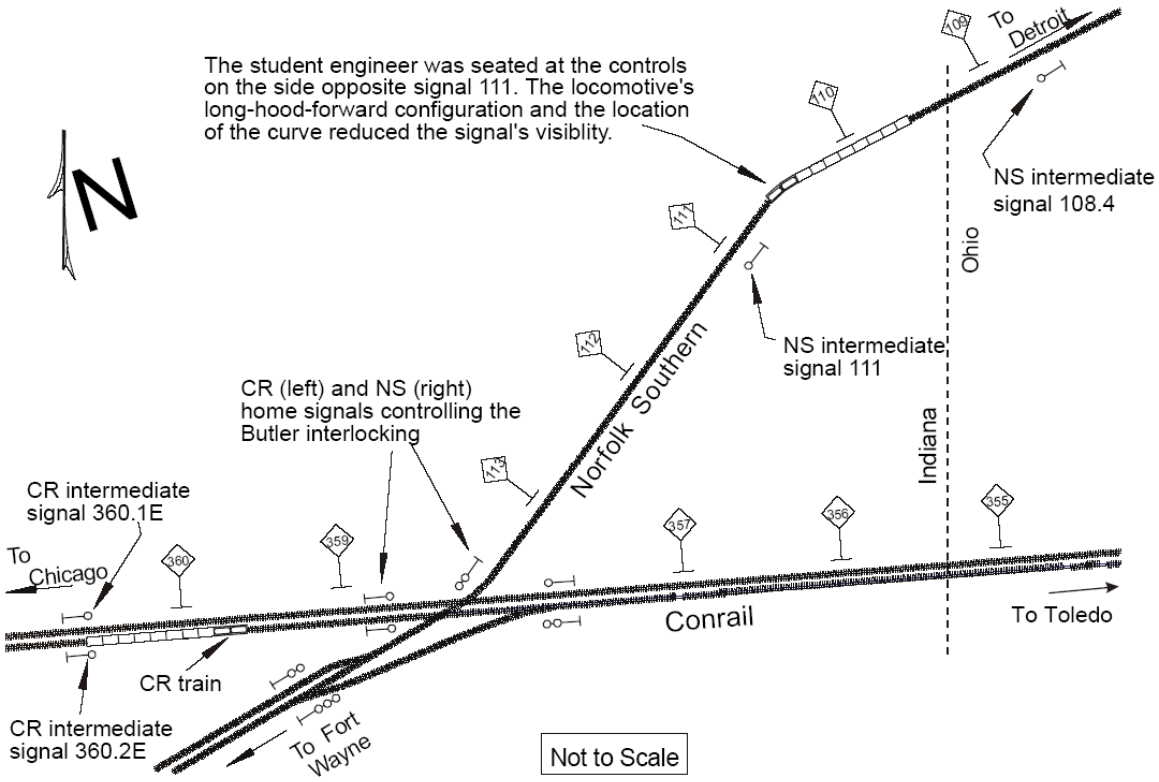


Figure 1. Conrail (CR) and NS signals in area of Butler interlocking.

NS

On an uneventful trip from Peru to Detroit, 2 days previous, the conductor of the crew instructed the student engineer that it was the practice of the (*this*) crew not to call clear signals (an NS Rules violation; Rule 34 requires all signals to be clearly called).

On the night before the accident, at 11:35 p.m., the NS crewmembers, an engineer, a student engineer, and a conductor, reported for duty at the Detroit Terminal. After reading their orders and clearing them with the train dispatcher, the crewmembers boarded the two-unit locomotive consist at the round house and proceeded to their train in the Triple Crown facility. The train, consisting of 85 loaded road-railer type cars, departed the facility about 2:30 a.m., after crewmembers had performed the required air brake tests.

After leaving the terminal area, about 2:35 a.m. and approximately 114 miles northeast of the accident, the engineer turned the train's operation over to the student engineer. The train continued southwest toward Fort Wayne. The student engineer reported nothing unusual about the train's handling before the accident.

The locomotive was being operated with the long hood forward, with the student engineer seated at the controls on the right side of the lead locomotive; the conductor and engineer were seated

on left side, with the engineer in the forward seat and the conductor directly behind him in the rear seat. The engineer's operating position visibility to the left side of the locomotive is limited when it is being operated in this mode. The student said that he had never been formally trained in long-hood-forward operation and had operated in this mode only once before, on the trip with the same crew from Peru, IN, to Detroit, MI, that concluded the day before the accident.

The student engineer said that the conductor and engineer did not call clear signals. The engineer agreed that the conductor had told the student upon going on duty at Peru that it was the practice of the crew not to call clear signals. NS operating Rule 34 requires that crewmembers call, or orally communicate, all signals encountered.

The student engineer said that the engineer and conductor both started reading what he thought were paperback books shortly after 3:00 a.m., about 30 minutes after departing Detroit. Two paperback books were found on the floor of the lead locomotive after the accident. The student engineer also said that about 30 minutes to 1 hour before the collision, the conductor or the engineer turned off the overhead light on the left side of the control compartment. The student said that he left the light on above his position to better observe the controls. The student was unsure how long the light was out on the other side of the cab, stating, "It could have been a half-hour, it could have been an hour. I don't know." He said that during the time the light was off, he did not talk to the engineer or the conductor or hear them talking to each other. He was unable to state with certainty whether the engineer or the conductor was asleep while the light was out, only that no communication occurred between himself and the other crewmembers during that time.

The student engineer said that as he approached Butler, intermediate signal 108.4 was displaying a clear indication, which he radioed over the road channel. He did not see signal 111, the next intermediate signal on the left side of the track and the last intermediate signal before the home signal at milepost (MP) 113.9, Butler interlocking. Locomotive event recorder data indicated that the train was traveling approximately 60 mph (the maximum speed) as it passed signal 111. According to the student engineer, when it seemed the train had gone too far without encountering signal 111, he asked the conductor and engineer about the signal location. He said that he began slowing the train as the stop signal at Butler interlocking became visible and that "…Howard [the conductor] was coming across, and we saw it together; actually, and he said it [the home signal] was all red." The student engineer said he was already in dynamic braking and was applying more air brake when he heard the air brakes go into emergency. He said that he thought the engineer had applied the emergency brake using the valve on the left side of the cab. The student engineer then placed the automatic brake valve handle in the emergency position.

The Accident

As the NS train approached Butler interlocking, the student engineer stated that he realized a collision was imminent when he saw the other train going across the crossing. He said he shouted, "We've got to get out of here" twice and turned to leave by the door behind his position. The conductor was the first to exit, followed by the student. The engineer stated that he saw both the conductor and student exit before he exited behind them.

The student engineer stated that as he went down the locomotive stairwell and saw the proximity of the oncoming train; he jumped, landing in some water. The student could not recall whether the conductor jumped but did recall him being on the platform. The engineer stated the conductor was out of sight when he exited the cab and jumped from the locomotive.

Tasks

1. What are some of the factors that led up to this accident?

2. What was the critical event that caused this accident?

3. What action(s) could the student engineer have taken to avoid this accident situation?

4. What do you think should be done to protect the employee from being unduly exposed to this type of situation in the future?

Split Switch Derailment

Employees Involved in Accident:	• Conductor • Engineer • Dispatcher • Signal Maintainer
Railroad:	Norfolk Southern Railway
Location:	Farragut, TN
Accident Date and Time:	September 15, 2002, 11:20 a.m., EST
Type of Accident:	Derailment
Fatalities/Injuries:	No fatalities or serious injuries
Property Damage:	$1.02 million

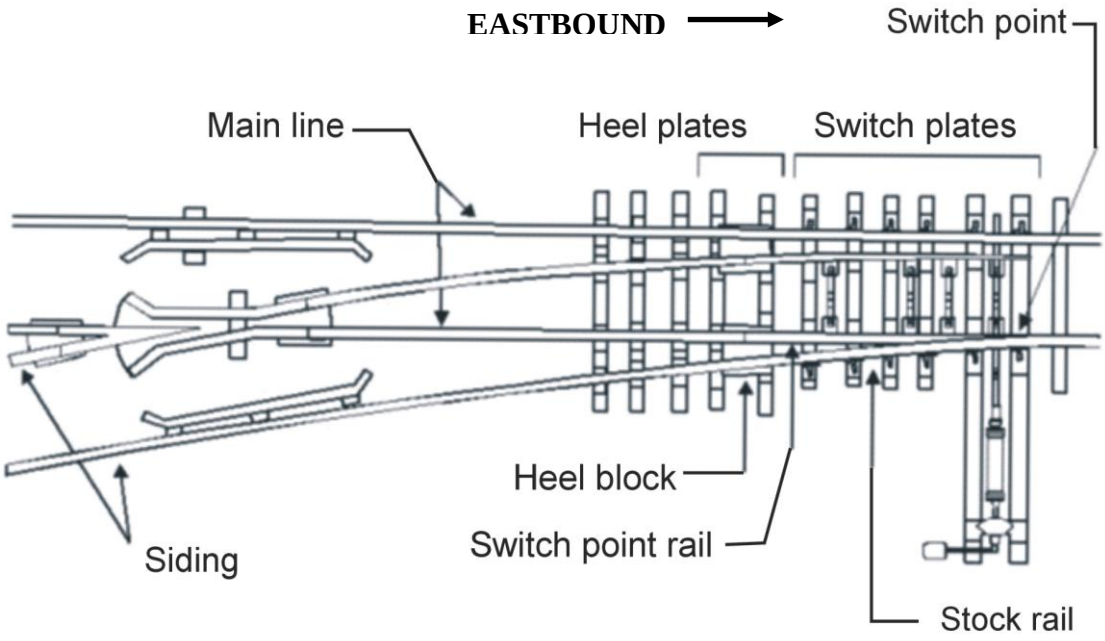
The Incident

At 8:30 a.m., eastbound NS train No. 721, en route to Knoxville, TN, passed over a spring switch from the Boyd Siding onto the main track. About an hour later, eastbound train No. 703, traveling on the main track, received an unexpected restricting signal indication at the west end of Boyd Siding, which is approximately 2 miles from the east end of Boyd Siding. This signal indication required that the crew slow the train from the normal track speed of 50 mph to a speed, not to exceed 20 mph, that would allow the train to stop within half the visual range and short of any obstructions. The train crew reduced the train's speed and reported the signal indication to the train dispatcher, as the operating rules required.

At the east end of the siding, the crew of train 703 stopped short of the spring switch so the conductor could look at the switch before proceeding. He found that the left switch point (when facing west) was not seated tightly against the stock rail but instead had a 1/4-inch gap. After operating the spring switch through its motion several times, the conductor found that the left switch point still failed to close completely, leaving about an 1/8-inch gap between the switch point and the stock rail.

The engineer of train 703 radioed the train dispatcher and reported that the switch points had not lined "back all the way to line up for the main line; you might need somebody to look at it." The dispatcher replied, "Alright, I'll get somebody headed that way." Because an eastbound train movement was a trailing movement that would tend to force the switch points back into the correct position, train 703 proceeded through the switch at restricted speed without incident.

About 9:45 a.m., just after train 703 had cleared the switch, the train dispatcher called a signal maintainer to inspect the spring switch. The dispatcher advised the signal maintainer that he did not have to hurry because no trains were due to arrive at the switch soon. The maintainer ate breakfast and departed his home at about 10:20 a.m., arriving at the switch at approximately 11:00 a.m. The signal maintainer said that as he approached the switch, he could see the signal controlling westbound train movements and noted that it was showing a clear aspect, indicating that the switch gap had closed after train 703's movement over it.



The signal maintainer said that when he arrived at the switch, he noted that the points appeared to be properly positioned. He said that he visually inspected the switch and noticed that the switch plates, while not really dry, "looked like they could use a little oil." He said that he put oil on each switch plate. He walked from the heel block to the switch point and did not see anything unusual.

In order to make an internal inspection of the switch to determine why the spring switch had gapped, the signal maintainer was required to get a track warrant to occupy the track and inspect the mechanical movement of the switch. The signal maintainer called the train dispatcher and told him that the switch appeared to be aligned properly and asked about a track warrant and any expected train traffic. The dispatcher told the signal maintainer that a freight train (train 15T) and a coal train were en route westbound toward the switch. The signal maintainer replied, "Okay, all right, I will wait till these two [trains] get by [the switch] and holler at you."

The signal maintainer, while waiting on the north side of the main line adjacent to the switch, heard the crew of train 15T call out the clear signal at east Boyd. According to event recorder data, train 15T approached the switch at about 38 mph. The engineer stated that as the locomotives moved over the switch, he felt a slight tug, and he, along with the conductor, looked back and saw the train starting to derail. The train went into emergency braking at that time. The engineer said he immediately saw what appeared to be a smoke cloud coming from the train. The engineer radioed the train dispatcher by using the emergency 911 radio tone and advised him of the derailment and of the smoke. The signal maintainer also called the dispatcher, approximately 11:20 a.m., to report the derailment.

Examination of the switch during the post-accident investigation showed that a bolt was missing from the No. 4 throw rod. A piece of the missing bolt was wedged between the south spring point and the stock rail, keeping the point from properly contacting the stock rail.

Tasks

1. Determine who comprised the crew assigned to safely accomplish the task of safely moving trains through the switch.

2. What was the critical event?

3. What do you see as some errors after the critical event?

4. What might be some other factors involved in the accident besides the factors already discussed?

5. Determine how operational testing can be used to break error chains such as the one that caused this incident.

"When Does the Job End?"

Employees Involved in Accident:	• Truck Driver • Track Foreman • Trackmen (3)
Railroad:	Burlington Northern Santa Fe Railroad Company (BNSF)
Crew:	Section Track Crew
Location:	San Bernardino, CA
Accident Date and Time:	June 18, 1997, 3:29 p.m., PST
Type of Accident:	Truck left road, rolled down embankment, and overturned
Fatalities/Injuries:	1 fatality –track foreman
Property Damage:	Value unspecified in report – loss of truck and some equipment

The Incident

The BNSF MOW crew reported for duty at 6 a.m., on June 18, 1997, at the San Bernardino Rail Yard. Before to departure, the driver performed a safety check of the BNSF truck. The foreman conducted a safety job briefing on the day's activities with the section track crew. At approximately 6:30 a.m., the crew departed the yard en route to E Street in Hesperia, CA. The crew was assigned to add walkways for pedestrian traffic at E Street by extending the existing concrete crossing panels. The driver and track foreman were in the front seat, and three trackmen were seated in the rear seat. At approximately 8 a.m., upon arriving at the job site in Hesperia, the foreman called the BNSF train dispatcher and informed him that the Lucerne Valley Subdivision was out of service.

Upon arriving at E Street, the foreman contacted the BNSF track supervisor and informed him that there were some bad ties at each end of the crossing. The foreman was instructed to replace the ties and informed that the track supervisor would come and inspect the job site later. Between 9:30 a.m. and 12 p.m., the crew replaced three ties on the east end and two ties on the west end of the crossing. The concrete crossing panels were then placed next to the previously installed panels to extend the pedestrian crosswalk. The welding foreman arrived at the crossing to weld the angle iron surrounding the concrete crossing panels. At about 12:30 p.m., the welding foreman asked the track foreman to take the crew back to the section house in Hesperia to get more welding rods so he could complete the project.

The crew departed E Street and went to the section house to obtain the welding rods as requested. Returning to E Street, the crewmembers delivered the welding rods and ate their lunch. After lunch, at 1:30 p.m., the crew cleaned up the scrap around the job site. The foreman instructed the driver to take the crew back to the section house where they unloaded the scrap from the truck. At 2:30 p.m., the foreman contacted the roadmaster and informed him that the job was completed and that they were returning to the yard in San Bernardino.

Traveling up Main Street in Hesperia, the foreman instructed the driver to stop at a hamburger restaurant so he could use the restroom. When the foreman returned, the crew got back into the

truck and departed for San Bernardino. At 2:45 p.m., the crewmembers entered Interstate Highway 15 and drove in the slow lane at about 55 mph. At approximately 3:20 p.m., they merged onto Interstate Highway 215 and stayed in the slow lane traveling at about 55 mph. The sky was clear and visibility good. The temperature was 97° F.

The Accident
While southbound on Interstate 215 at 3:30 p.m., the truck drifted to the right onto the dirt shoulder, continuing for approximately 300 feet. The driver then attempted to re-enter the highway, veering to the left. The driver was unable to regain control of the truck and over-corrected back to the right. As a result, the truck went over an embankment, overturned, and rolled onto the perimeter fence, coming to rest on top of the track foreman who had been partially ejected.

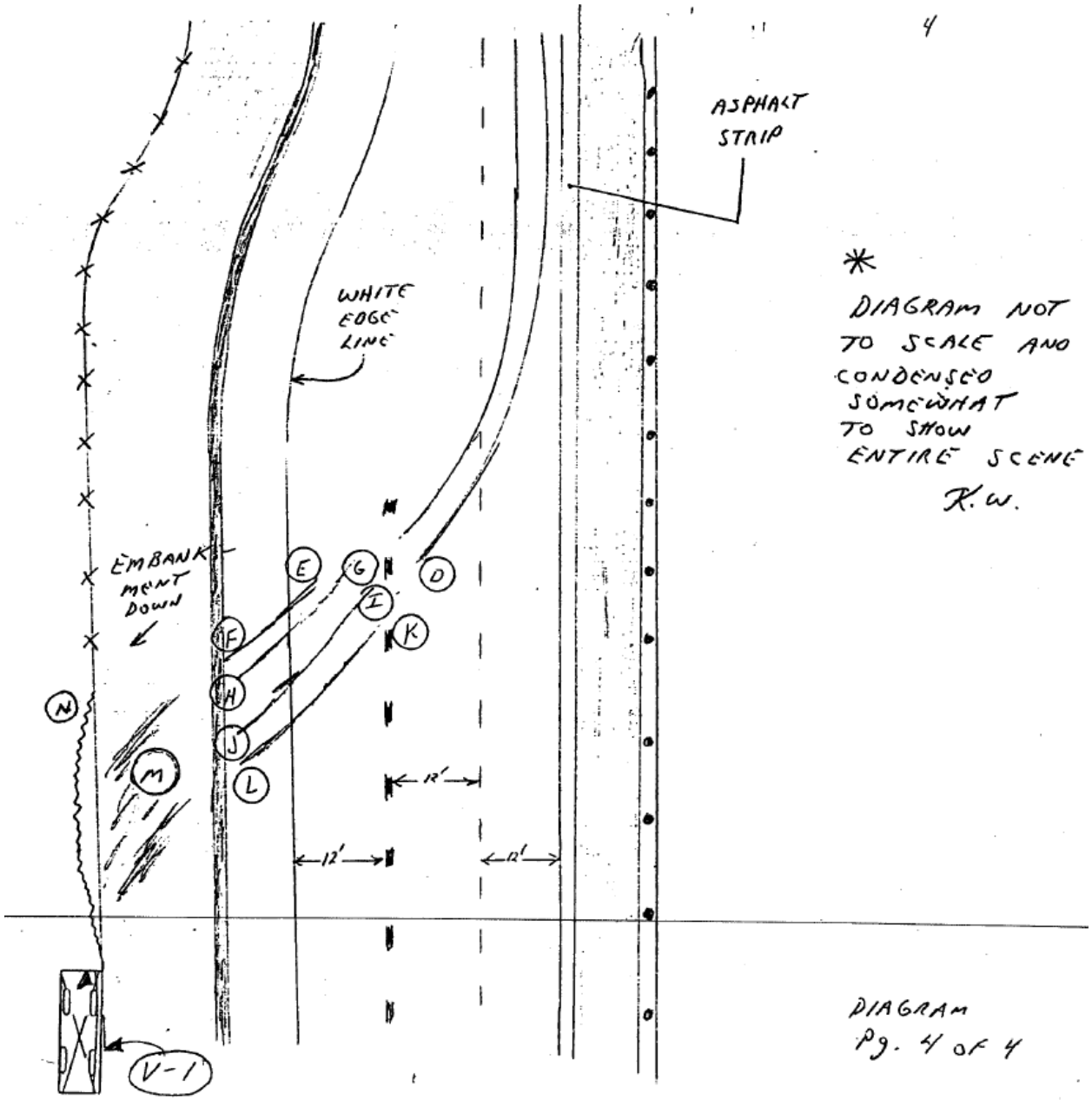
Post-Accident Investigation
The California Highway Patrol (CHP) accident report and the interviews of witnesses at the scene of the accident revealed that the driver of the BNSF truck had apparently fallen asleep, allowing the truck to leave the highway. Then, while attempting to re-enter the highway, the driver lost control of the truck, resulting in the truck going over the embankment and turning over. The passenger was partially ejected, and the vehicle rolled over and came to rest on top of him. According to the CHP report, the victim had not been wearing a seat belt at the time of the accident. Following the accident, as required by law, the driver and passengers were tested for drugs with negative results.

Tasks

1. When did the team break down in this scenario?

2. How would you rate the crew's safety procedures and teamwork throughout the day up to that point? What were some things that they did right?

3. What actions could have prevented this accident?



California Highway Patrol Diagram of Accident Site
Source: FRA 1997 Rail Employee Fatality Study

Trackman Falls From Bridge

Employees Involved in Accident:	• Trackman • Foreman • Tamper Operator • Other Track Workers
Railroad:	Iowa Interstate Railroad (IAIS)
Track Area:	Ballast Deck Bridge
Location:	Rock Island, IL
Accident Date and Time:	October 8, 1998, 3:25 pm, CST
Type of Accident:	Slip, fall
Fatalities/Injuries:	One fatality: Trackman, 41 years of age, 6 months experience
Property Damage:	N/A

The Incident

The trackman regularly reported for duty at 7 a.m., Monday through Friday. On October 8, 1998, he met the Bureau Section Foreman (foreman) at the foreman's residence and rode to Rock Island with him in a company vehicle. Upon arriving at Rock Island, the trackman and foreman had a brief conversation with the roadmaster (supervisor) about the day's assignments and location of the tie gang's equipment. They proceeded to the tie-up point and assisted with the tie installation efforts throughout the day.

The tie gang came out of the Arsenal Switch (MP 181.7) that morning to install ties between that switch and the west end of Rock Island Yard (MP 181.4). The bridge over Sylvan Slough lies between those two points of the railroad (MP 181.6). The tie gang was set up to work in an easterly direction. After approximately 1 hour, the gang cleared the single main track at the Arsenal Switch.

The employees worked different jobs within the structure of assignments necessary to complete the tie installation process. Typically, employees would work the forward (lead) jobs in the tie installation and then pick up tasks behind the gang activity as it progressed eastward. It is significant to note that the supervisor, who had been with the gang most of the day, left the job site to attend to other responsibilities (he departed at approximately 1:45 p.m.). Before departing the work site, he discussed placing another previously designated employee as the Employee in Charge (EIC).

The trackman was working on a single main track within yard limits (non-signal territory) near the center portion of the bridge. The accident site was 193 feet and six inches west of the east abutment; the bridge's length was 602 feet. The through-plate girder structure had openings approximately 24 inches by 11 feet along both sides of the bridge. Due to the previous and ongoing tie installation, the ground was not level where the ties had been installed.

Ballast sections outside the rails were uneven because the ballast had not been regulated. Uneven footing in conjunction with tie installation was a normal condition.

The weather was clear, sunny, and warm, with a temperature of 70° F. The wind was calm.

The Accident

The tamper operator, who was the only eyewitness to the accident, was working next to the trackman installing plates on crossties before returning to his responsibilities on a tamper. The operator asked the trackman, who acknowledged the request, to continue installing the plates on the crossties while he caught up with tamping the ties.

Before the accident, the trackman was in a standing position straddling the south rail, in the vicinity of a rail lifter machine (plater). The trackman was facing eastward (in the direction of the work), and, as he turned to look behind him (westward), he lost his balance and fell southward, with the back of his legs and back hitting first, contacting the outside ballast section between the outer edge of the south rail and the retaining plate.

The trackman's momentum during the fall carried him into an opening (approximately 24 inches wide by 11 feet long) between the ballast deck's retaining plate and the through plate girder structure (the inside vertical face of the girder).

The trackman fell into the opening in a folded position with his feet and legs pointing upward; then he disappeared from view. After shutting off his tamper and moving to the opening, the operator observed the trackman holding onto the edge of one of the bridge's lower structural beams. The operator talked with the trackman very briefly and ran eastward for help by shouting and waving his arms to attract attention. As soon as other employees responded, the operator returned to the point of the accident. Upon arriving at the opening, he observed the water swirling where the Trackman had entered. The time was 3:25 p.m.

After becoming aware of the accident, several coworkers descended on foot from the east end of the bridge to the shoreline. Several accounts indicated that the trackman surfaced after initial entry into the river. He was struggling, went under, and resurfaced. One of the employees entered the river in a rescue attempt. After this employee swam 30 to 40 feet from shore, the trackman sank out of sight. Swift currents and cold water (65° F) forced him to turn back, for fear that he would suffer the same fate. A second employee waded into the water, but was warned by the first employee that a rescue was not safe.

Multiple rescue requests were made by tie gang employees (by calling 911 via cellular telephone or radio). Rock Island Police Department (RIPD) and other public rescue personnel responded to the emergency calls. An Arsenal rescue boat and personnel also responded. Both teams worked the area to retrieve the trackman. The body was recovered at 5:30 p.m., 200 yards down river, according to reports. Attempts to revive the trackman proved unsuccessful. The trackman had been submerged for approximately 2 hours.

A Rock Island Emergency Response ambulance transported the trackman's body to a local hospital. The employee was pronounced dead on arrival.

Post-Accident Investigation
On October 9, 1998, the Federal Railroad Administration (FRA) began its investigation into the fatality. FRA did not take any exceptions to the equipment used. Investigators concluded that the tie gang's equipment did not contribute to the accident. The operator stated that the trackman was partially outside the limits of the track's outer rails on the bridge just prior to falling.

Initial interviews with MOW employees and supervisors resulted in conflicting reports about the quality and content of job briefings and the participation of MOW and contractor employees at these briefings. Subsequent interviews confirmed that adequate job briefings on Bridge Worker Safety regulations did not take place. Interviews also revealed a general lack of knowledge by some engineering personnel relative to hazard recognition and preventative measures required while working on a railroad bridge. In addition, the investigation revealed that the railroad's prompt rescue efforts, except for the one employee's failed attempt, seemed ill conceived or non-existent.

After observing the general layout of the work site and point of the accident, investigators measured the distance from the outer edge of the south rail, over which the trackman was standing, to the edge of the opening at 56 ½ inches. The opening measured 24 inches wide and approximately 11 feet long. The opening was obviously large enough for a body to pass through. The water below the bridge exhibited swift currents. Undertow currents were reportedly common knowledge for the area, as several accidents had occurred on that portion of the river annually.

The distance from the top of the retaining plate to the top surface of the lower edge (the flange/tee portion) of the beam directly below was 53 inches. (This was the edge the employee was holding onto before falling.) The distance from the top of the retaining plate to the top of the edge of the outer girder beam (lower portion) was approximately 62 inches. The distance from the top edge of the retaining plate to the surface of the water was approximately 28 feet and 2 inches.

The distance of the trackman's fall was 17 feet (as calculated by the overall distance of 28 feet and 2 inches minus the distance from the edge of the beam underneath the retaining plate and the height of the trackman, approximately 6 feet and 2 inches). The height and length of the bridge qualified the bridge under FRA's Bridge Worker Protection regulations.

The Arsenal Police, RIPD, local coroner's office, and the IAIS conducted investigations into circumstances surrounding the employee's death. IAIS officials telephoned the National Transportation Safety Board (NTSB) personnel on October 9, 1998, to advise them of the known details surrounding the accident. NTSB did not investigate.

The coroner's office ordered toxicological testing. The toxicology tests were negative. The Rock Island County Department of Public Health listed asphyxia due to drowning as the cause of death.

Tasks

1. Who makes up this crew? Are these team members an elemental or interactive crew? Justify your answer.

2. What was the trackman's situation when he lost his balance?

3. What parts of this scenario relate to the need for improved communications?

"Go Back to the Truck and Come Pick Me Up."

Employees Involved in Accident:	• Signal Trainee • Signal Maintainer • Amtrak's Trouble Desk • Block Operator (in Hudson Tower) • Engineer of Eastbound Train
Railroad:	National Railroad Passenger Corporation (Amtrak)
Crew:	Signal Maintainer and Signal Trainee
Location:	Harrison, New Jersey
Accident Date and Time:	Feb. 4, 1998, Between 8:15 p.m. and 8:30 p.m. EST
Type of Accident:	Signal Trainee (5 months service) struck and killed by train
Fatalities/Injuries:	One fatality
Property Damage:	N/A

The Incident

The east-end limits of Hudson Interlocking were near MP 7.3 of Amtrak's Northeast Corridor main line in Harrison, NJ. At this location, the railroad comprised three east/west-oriented tracks identified from north to south as Track Nos. 1, 2, and 3. Amtrak intercity passenger trains and New Jersey Transit (NJT) commuter trains operated over this high traffic density railroad. Track Nos. 2 and 3 were predominately used by trains traveling to and from New York City's Penn Station. Track No. 1 was predominately used by train traffic to and from Hoboken, NJ. Trains operating over this railroad were governed by Northeast Operating Rules Advisory Committee, and the method of operation was controlled by Automatic Block Signals supplemented by a Cab Signal System. The maximum authorized timetable speed was 70 mph.

The Accident

On the day of the accident, the trainee reported for his assigned shift at 3 p.m. at Hudson Interlocking. The signal maintainer, who was instructing the trainee, reported for duty at Swift Interlocking, approximately 2 miles away. The signal maintainer called the trainee and instructed him to drive the company truck and meet him at Swift.

The signal maintainer and trainee worked at Swift until approximately 7 p.m. They were instructed by Amtrak's Trouble Desk to turn on the switch heaters at Hudson Interlocking. The signal maintainer told the trainee to take the company truck to Hudson Tower and meet him there. The signal maintainer drove his privately owned vehicle and parked it at Hudson Tower. They then traveled by company truck to the east end of Hudson Interlocking. At approximately 8 p.m., they parked the truck on the north side of the right-of-way and climbed up the railroad embankment to track level.

The embankment at this location was approximately 20 feet high. The switch heater control boxes were located adjacent to the Port Authority Trans Hudson (PATH) third rail on the north

and south sides of Amtrak's trackage. After turning on the heaters for Power Operated Switches Nos. 65 and 61, they continued walking west. The signal maintainer instructed the trainee to return to the truck and to pick him up at the west end of Hudson Interlocking. The trainee left to get the truck while the signal maintainer continued walking westward to turn on the remaining switch heaters. The trainee had to walk eastward and cross over the main line tracks to reach the truck. The signal maintainer completed the ignition of the remaining switch heaters at approximately 8:40 p.m.

Weather at the time of the accident was rainy and cold, with an approximate temperature of 35º F. Visibility was reported to be poor due to the wind-driven rain.

When the signal maintainer arrived at the pre-arranged meeting point, the trainee was not there. The signal maintainer radioed the block operator in Hudson Tower to ask if he had seen the trainee. The block operator informed the signal maintainer that he had not spoken with or seen the trainee recently. The signal maintainer then walked approximately 1/2 mile eastward to his vehicle at Hudson Tower and drove to where the company truck was still parked. Not finding the trainee at the truck, he climbed up the embankment and discovered the body of the trainee lying on the north rail of Track No. 1. He notified Hudson Tower at 9:15 p.m., and emergency responders were summoned.

Evidence at the scene indicated that the trainee was struck by a fast-moving train traveling eastbound on Track No. 2. The impact propelled the body approximately 100 feet to the southeast. A broken flashlight, work gloves, knit cap, and hard hat were found at the scene at various locations between the estimated point of impact on Track No. 2 and the location where the body was found on Track No. 1.

Post-Accident Investigation

The investigation did not identify any witnesses to the accident. Crewmembers of trains operating through the area during the approximate time of the accident reported nothing unusual. The engineer of one eastbound train reported seeing the signal maintainer at the west end of Hudson Interlocking at approximately 8:46 p.m. He did not report seeing the trainee. Inspection of equipment operating eastbound during the approximate time of the accident revealed nothing to indicate which train may have struck the trainee. Crewmembers on PATH trains were solicited for information, but no unusual observations were reported.

The question of compliance with Roadway Worker Protection (RWP) requirements while performing work in an interlocking were studied. The signal maintainer stated that they had completed a job briefing in the company vehicle before entering the track area. However, no written evidence existed, and none was required, to support this briefing. In addition, the signal maintainer and trainee did not establish on-track protection while work was being performed in the interlocking.

The investigation revealed that four trains traveled eastbound on Track No. 2 between the hours of 8:18 p.m. (the approximate time the signal maintainer and trainee parted company) and 8:46 p.m. The 8:46 p.m. time was used as a cutoff because the engineer reported seeing the signal maintainer at the west end of the interlocking but indicated he did not see the trainee. It appears

that the trainee had already been struck by this time. In addition, the signal maintainer stated that the trainee had no work to perform other than going to the truck. Therefore, considering the weather conditions, it was extremely improbable that the trainee would stay on the tracks any longer than absolutely necessary. Therefore, since the signal maintainer and trainee parted company at approximately 8:18 p.m., it was believed that the trainee was struck shortly thereafter by an eastbound train.

This conclusion was based on the physical evidence discovered at the scene. The trainee's broken flashlight was found in the gage of Track No. 1 directly across from the location on Track No. 2 where it appears he was struck. His body was propelled in a southeasterly direction until landing on the north rail of Track No. 1. Work gloves, knit cap, hard hat, and work boots were all found at the scene, indicating the direction of travel. The trainee was also wearing a reflectorized vest for visibility. NJT and Amtrak officials held eastbound trains in Penn Station to inspect them for physical evidence to determine which train had struck the trainee. Due to the rainy weather conditions, there was no evidence found on the rolling stock. Statements were taken from the engineers and crewmembers of trains that had passed Hudson Interlocking at the approximate time of the accident. There were no exceptions taken by anyone, and no one reported seeing the trainee. Eastbound PATH train crewmembers were solicited for information, but nothing unusual was reported. Investigators concluded that the signal maintainer was the last person to see the trainee alive and also the person to find the body about 1 hour later.

Extenuating circumstances may have contributed to the fatal injuries suffered by the signal trainee. Visibility was poor due to the weather conditions. In addition, looking west from the site of the accident, there were many bright external lights that could have been mistaken for a train headlight. Additionally, the trainee had only 5 months service time on the railroad, 4 of which was spent at Penn Station, NY, where the track speed was approximately 10 miles per hour. He had been working on the main line for 3 weeks at the time of the accident; the track speed through Hudson Interlocking was 70 mph. The trainee had completed RWP and other safety-related classes at the time he was hired in September 1997, which qualified him as a watchman following just 60 days on the job. However, his inexperience with high-speed trains and lack of training on the physical characteristics of track at his new location were severe safety impediments. FRA Post-Accident Toxicological Tests were performed on the trainee. The results were negative.

Tasks

1. What key elements of technical proficiency were missing in this scenario?

2. What could the signalman have done to prevent this accident?

3. Who else could have intervened to prevent this accident?

Truck Gas Compartment Explosion

Employees Involved in Accident:	• 2 Foremen • 4 Laborers • 1 Assistant Foreman
Railroad:	Soo Line Railroad
Track Area	Yard Track
Location:	Milwaukee, WI
Accident Date and Time:	January 8, 1997, 11:25 a.m., CST
Type of Accident:	Gas Explosion
Fatalities/Injuries:	One fatality: Assistant Foreman, Age–52, Length of Service–32 years
Property Damage:	Unknown

The Incident

On January 8, 1997 at 7:00 a.m., the Glendale Yard Section Gang (Gang A), comprising a foreman, an assistant foreman, and a laborer, reported for duty at Glendale Yard, Milwaukee, WI. The assignment for the day was to repair Yard Track No. 2, which had been damaged by a derailment that occurred on January 6, 1997.

Gang A secured the tracks that they would occupy and set the F-800 hi-rail truck on the north yard lead heading north. Gang A backed down Track No. 3 and began work on Track No. 2. They removed 600 feet of rail that had been dislodged during the derailment. The east rail of this section of Track No. 2 was removed and laid in the middle of Track No. 2. As Gang A completed this task, Gang B, consisting of a foreman and three trackmen, arrived at the south end of the yard. The Gang B truck was on Track No. 3. After the two foremen discussed the job, Gang B began pulling spikes and cleaning the plates to relay the rail. Gang A began doing the same after the rail was removed.

The Gang A crew worked south with their hydraulic spike puller toward Gang B. The plate cleaning was completed about 10:45 a.m. The two gangs then laid about six rail lengths of rail into the plates starting from the south end of the damaged track. The assistant foreman of Gang A used the cutting torch to cut track bolts from two rail joints and let a Gang A laborer cut one of the bolts. The laborer asked to cut some bolts for the experience. The Gang B foreman took the torch and was cutting bent bolts out of the west rail. He then gave the laborer a chance to cut some additional bolts. The laborer cut one bolt before the torch flame was extinguished.

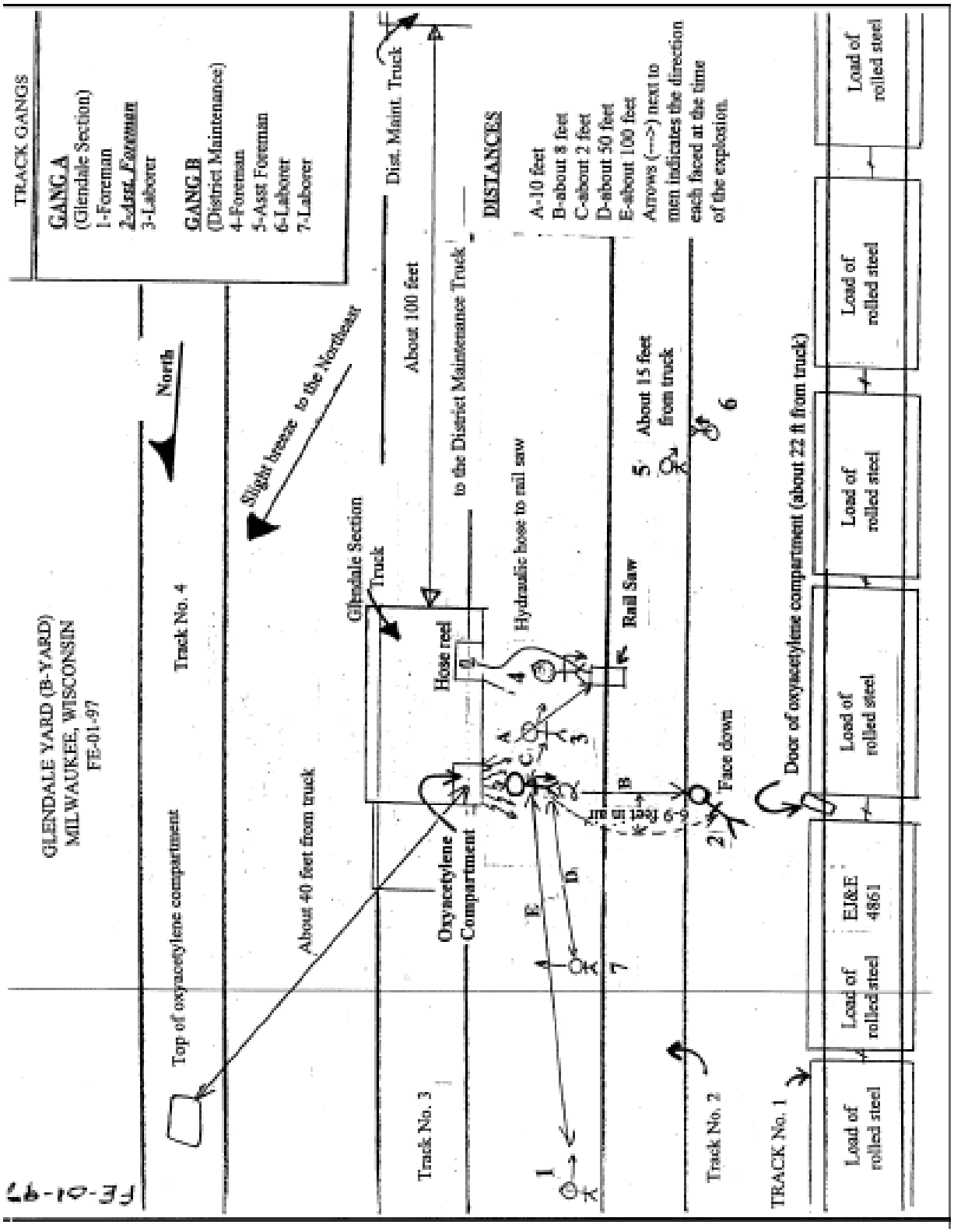


Figure of Accident Scene
Source: FRA 1997 Fatalities Report FE-01-97

The laborer tried unsuccessfully to reignite the torch and, after two attempts, was told by the Gang B foreman to put the torch away.

The laborer said he thought he heard the Gang A assistant foreman say, "The tanks are off." The laborer asked the Gang B foreman to check the torch to assure that the torch valves were properly turned off, which the Gang B foreman did. The laborer said he did not check the tanks to see if they had been shut off. The laborer did say he purged the gas lines. The laborer put the torch and hoses away and shut the oxygen/acetylene compartment (gas compartment) door. The truck was moved approximately 100 feet north to a rail joint from which bars had been cut.

The Gang A assistant foreman was going to saw off about 3 inches of rail to eliminate a broken rail end. The Gang B foreman told the assistant foreman that he would saw this rail end, as the assistant foreman had sawed the previous ones. The saw, hydraulic-powered from the F-800 truck, was operated from the same side of the truck as the gas compartment. The hydraulic hose reel was in a rear compartment on the left side of the truck. The rail was being cut 10 feet away from the gas compartment.

The temperature was 25º F, and the weather was clear with a light breeze from the southwest.

The Accident

The Gang B foreman ran the saw, and the laborer from Gang A assisted him in setting up the saw. This laborer was about 2 to 3 feet south of the Gang A assistant foreman. The Gang A assistant foreman was standing between Track Nos. 2 and 3 in front of the gas compartment with his back to the truck. Shortly after the saw started cutting rail, the gas compartment exploded. The top of the gas compartment blew off, and the door blew out, striking the assistant foreman. The Gang A assistant foreman was thrown up in the air about 6 to 9 feet. He landed on his chest and face on the frozen ground between Track Nos. 1 and 2.

Immediately after the explosion, two laborers aided the Gang A assistant foreman and said he was breathing and had a pulse. They covered him with their coats. At the same time, the Gang B foreman ran to call for help, and the Gang A foreman turned off the section truck. The Gang A foreman saw a small fire burning the mat on the floor of the exploded gas compartment, and he put the fire out with an extinguisher.

Post-Accident Investigation

An examination of the gas compartment showed little carbon on the walls of the cabinet. The acetylene tank was turned off, but the oxygen tank shut-off valve was a half turn open. Oxygen may have accumulated in the bottom of the gas compartment and mixed with a small amount of acetylene. The saw produced sparks that were thrown toward the truck. The gas compartment doors were closed, but a 2-inch drain hole in the bottom of the gas compartment may not have had a plastic plug in place. The location of the small fire in the bottom of the gas compartment was near the drain hole. A spark from the saw could have caused a mixture of oxygen and acetylene vapors in the gas compartment, exiting through the drain hole, to explode.

The gas compartment lacked a poster on Oxyacetylene Operation Safety, and neither torch hose was equipped with back flow valves.

Tasks

This scenario is primarily used to illustrate situational awareness principals. However, the questions will allow you to identify instances where other CRM principles were either practiced or could have been practiced better.

1. Who are the principal team members in this scenario? Do these team members represent an elemental team or an interactive team? Why?

2. What areas of this incident demonstrate a lack or need for improved technical proficiency by the crewmembers?

3. Describe what you think the individuals involved in this incident believed the situation to be? Is situational awareness gained or lost in this incident?

4. Describe some items that could have had improved communications.

5. What are some parts of this scenario that relate to the need for improved teamwork?

Surfacing Foreman Struck by Train

Employees Involved in Accident:	• Track Surfacing Gang Foreman (44 years old, 23 years service) • 2 Bridge Foremen • Assistant Bridge Foreman
Railroad:	Union Pacific Railroad
Location:	Waukegan, IL
Accident Date and Time:	October 11, 1998, 10:17 a.m., CST
Type of Accident:	Surfacing Gang Foreman Struck by Train
Fatalities/Injuries:	One fatality: Surfacing Gang Foreman
Property Damage:	None

The Incident

On October 11, 1998, a Union Pacific Railroad (UP) Bridge Construction Group returned to the previous days work site (Roscoe Street) at 7:30 a.m. to install new track panel that they had readied the day before. The Bridge Group comprised UP Bridge Gangs from Crystal Lake, Jefferson Park, and Chicago, IL (Gang No. 3655), and Highland Park, IL (Gang No. 3656). A supervisor was also present at the bridge. The supervisor conducted a job briefing for the two Bridge Gangs to explain the work to be performed. The supervisor stated that the On-Track-Safety (OTS) guidelines for the group would remain the same as the previous day; however, at least one employee was present who had not worked the previous day. This job briefing also did not designate the EIC. Furthermore, several bridge employees were not present at the job briefing. Two bridge employees were placing the south red and red/yellow boards for the Form B, and two other bridge employees were unloading tools, preparing an air compressor, and placing hose for the track panel replacement during the job briefing. Moreover, these employees were not offered a job briefing when they finally did enter the work area. Additionally, a Bridge Department Burro crane operator, who assisted in removing the rails, ties, and ballast from Track No. 2 at Roscoe Street, was at the location.

The Highland Park (HP) bridge foreman, who held the Form B, appeared to be considered the EIC by most of the group, but he had not been so designated in a job briefing. In similar bridge jobs, the Jefferson Park (JP) bridge foreman**,** who was in the company truck on Roscoe Street, had been the employee whose responsibility was to be at the job site notifying employees of the train's approach and then notifying the Form B foreman that all employees were notified and cleared. This designation was not mentioned in any of the job briefings the day of the incident.

A Form B was in effect on both main tracks from MPs 4.5 to 5.0 and was issued under the name of the HP bridge foreman. The foreman also had a Track and Time Authority for the work area with the limits being Control Point Deering, MP 3.3, to Control Point RP (Roscoe Street location), MP 10.6 on Track No. 2.

A Track Gang, comprising a foreman and two trackmen, arrived at the work site after the supervisor gave his briefing, and they were not briefed concerning the OTS in effect at the job

site by anyone else. The Track Gang helped the Bridge Group connect the rail ends of the replacement track panel to the existing track.

Soon a Bridge Department Crane Group entered the limits of the Form B from the south on Track No. 1. The Crane Group had contacted the HP bridge foreman on radio channel # 3 for permission to enter the Form B area. When the Crane Group entered the Form B limits, they were not briefed concerning OTS by the bridge foreman who held the Form B or by anyone else.

On this same day, a UP Surfacing Gang reported for duty in Waukegan, IL at 6:00 a.m. The Track Surfacing Gang comprised a foreman and three machine operators. They were using their Mark III tamper, helper tamper, and ballast regulator. In the morning, the Surfacing Group had a job briefing at Clybourne which described the work to be done and how they would proceed from their present location toward the Roscoe Street job site up to the Form B area. The Surfacing Gang foreman had a Track and Time Authority on Track No. 2 with the limits being the same as the HP bridge foreman's Track and Time Authority. These Track and Time Authorities were issued jointly, not consistent with the Part 214 Roadway Workplace Safety Regulation in effect at the time of the incident.

Before arriving to the site, the Surfacing Gang foreman attempted to contact the HP bridge foreman on UP radio channel # 2, which the surfacing group normally monitored. The Surfacing Gang foreman had used a radio in the Mark III tamper in his initial attempts to contact the HP bridge foreman. He also had a handset radio. However, the HP bridge foreman was on UP channel # 3, which was the radio channel that trains on the Kenosha Subdivision used.

While the Track Gang, Bridge Group, crane operator, and ground man worked on the bridge, the Surfacing Gang foreman walked toward the Roscoe Street job site from the south and met the HP bridge foreman who verbally gave him permission to have his machines enter the Form B limits. His machines were at MP 4.5 on Track No. 2. After giving the Surfacing Gang foreman permission, the HP bridge foreman went to the location of his company vehicle, under the bridge on Roscoe Street, as he had heard radio conversations concerning the movement of a south bound commuter train, and he preferred to use the higher powered truck radio to communicate with trains.

When the Surfacing Gang's machines arrived at the job site, they started working on regulating the piles of ballast, checking the line of track, lining and surfacing the track. Some of the members of the groups working at the bridge stated they were not told of the approach of the crane and/or surfacing group. They stated that the machines approached very close to the bridge location before they were notified of them. When the Surfacing Group entered the Form B limits, they were not briefed concerning OTS by the bridge foreman or anyone else. Sometime during this period, the engineer of Metra Commuter Train No. 330, operating on Track No. 1, contacted the HP bridge foreman and asked for permission to enter the Form B limits. The HP bridge foreman was in his company truck with the JP bridge foreman. The HP bridge foreman told the train to stand by.

The Accident
The supervisor and an assistant bridge foreman, who were standing together, had seen a headlight approaching from the north. The assistant foreman walked to the dead track area above the location of the bridge foremen in the company vehicle on Roscoe Avenue. The assistant foreman using a handset radio, informed the workers to clear. Unfortunately, when the assistant foreman was notifying employees, the Surfacing Gang foreman was in the bridge area, behind the Mark III tamper in a crouched position (not visible). The assistant foreman called the HP bridge foreman and informed him everyone was in the clear. The HP bridge foreman then cleared Commuter Train No. 330 to enter his Form B limits at MP 5.0 on Track No. 1, at maximum authorized speed.

The Mark III tamper operator and the Surfacing Gang foreman were not notified of the approaching commuter train. The Mark III tamper operator had surfaced and lined through the bridge area. When the Mark III tamper operator had cleared the south end of the bridge, the Surfacing Gang foreman walked southward from behind the tamper to a location between Tracks Nos. 1 and 2. The locomotive event recorder showed a series of 6 whistles by the engineer of Commuter Train No. 330, which ended approximately 22 seconds before the incident, but that the bell was ringing up to the time of the incident. The engineer stopped sounding his whistle a considerable distance from the roadway workers (approximately 1/4 mile to 1/8 mile from the work site), in non-compliance with railroad operating rules. The Surfacing Gang foreman was standing on the east tie end of Track No. 1 when he was struck and killed by southbound Train No. 330. When struck, the foreman was approximately 11 feet south of the bridge and adjacent to the operator's compartment of the Mark III tamper.

Tasks

1. List the different groups working at Roscoe Street.

2. What was the initial error?

3. Why is it important for team situational awareness to have everyone in the interactive team to be present at the job briefing?

4. Why do job briefings need to be updated during the day?

5. List the breakdowns in communication.

6. What was the last type of communication that might have stopped this accident from occurring?

La Crosse, WI

Employees Involved in Accident:	• Engineer • Conductor • Utility Man • Train Master • Yardmaster
Railroad:	BNSF
Location:	La Crosse, WI
Accident Date and Time:	February 6, 2004, 7:45 a.m.
Type of Accident:	Run over red flag, yard derailment
Fatalities/Injuries:	None
Property Damage:	Unknown

The Incident

At approximately 7:45 a.m., a track maintenance foreman reported to the yard office and informed the yardmaster that he would be working at the west end of the yard with a contractor constructing a highway overpass. He further informed the yardmaster that he would be working on Tracks 2 and 12. Subsequently, the foreman asked for permission to take the west end of Track 2 out of service. The yardmaster granted permission and the west end of Track 2 was taken out of service. Per the Safety Rules, the foreman erected a red flag and installed a portable derail to the track. While the yardmaster assumed that the foreman had put up a flag and derail, no communication had occurred between the foreman and yardmaster to confirm that fact.

Later in the morning, the yardmaster decided to place a car at the west end of Track 2. He contacted the foreman and asked if there was room at the west end for the car and still provide MOW protection. The foreman confirmed that there was room for the car. He then moved his flag and derail approximately 70 feet west to accommodate the single freight car. He did not communicate to the yardmaster that he had to move his flag and derail to accommodate this move.

Shortly thereafter, a switch crew placed a single freight car at the west end of Track 2. This resulted in the freight car resting approximately one car length (or less) from the red flag and derail.

An engineer and conductor reported for duty at 12:01 p.m. on February 6, 2004 at the yard. This crew was assigned to operate a freight train from Able Yard to Chico Yard, a distance of approximately 100 miles. The 3916 foot long train consisted of 59 cars, 43 loads, and 16 empties, weighing 5359 tons, with approximately 90.8 tons per operative brake. The train was sitting at the east end of Track 2.

Before departing Able Yard, the crew was instructed by the yardmaster to pick up an additional car that was sitting at the west end of Track 2. The yardmaster also informed the crew that a utility man would be assigned to their crew to facilitate the pick up.

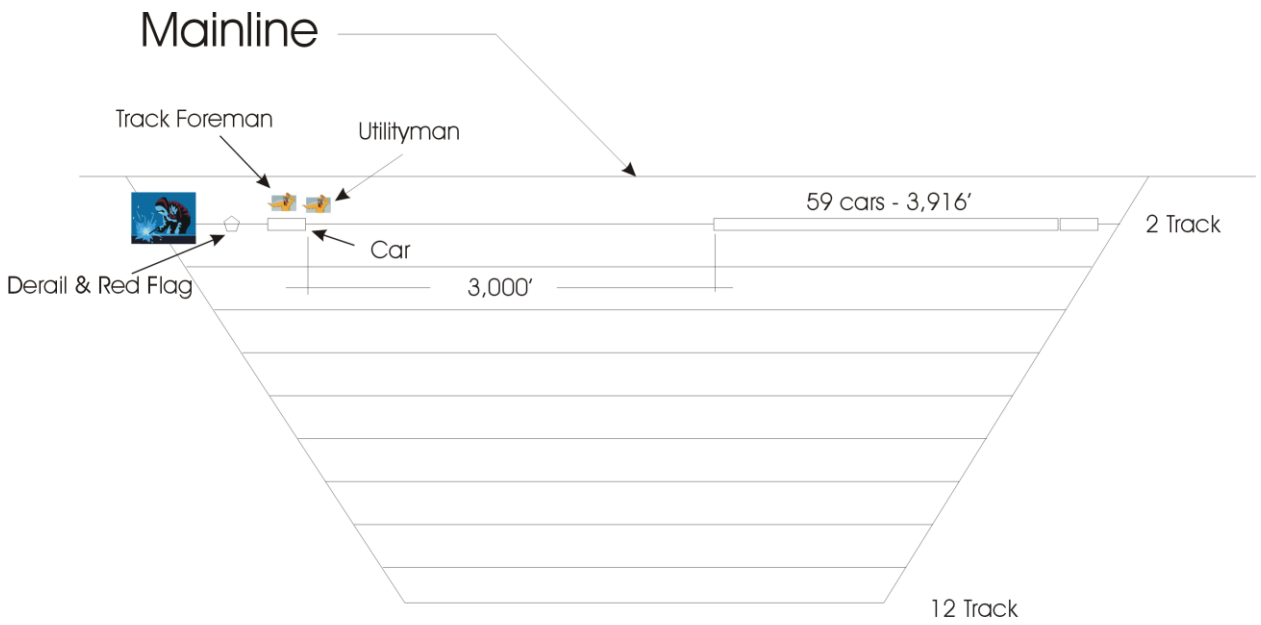
A safety briefing was conducted between the conductor and the utility man concerning the pick up. The fact that the train had approximately 60 cars and had to shove a considerable distance (approximately 3000 feet) were discussed. The conductor returned to his train and briefed the engineer on the work to be done.

The utility man arrived at the location of the single car to be picked up and began the shoving movement by instructing the engineer to shove back 40 car lengths. He did this knowing that more than 40 car lengths were available for the movement. He also met the foreman at this location and noticed the red flag. He did not notice the derail.

The utility man stated he gave the following instructions to the engineer, a second 40 car call, "20 cars," "10 cars," "5 cars," "3 cars," and "1 long car." The train was moving at approximately 4-6 mph, when at a distance of approximately 25 to 35 feet from the single car to be picked up, the utility man radioed the crew saying, "That will do."

The Accident

The train coupled to the signal car shoving it down Track 2, running over the foreman's red flag, striking a derail, and derailing the single car into the MOW work area at approximately 12:50 p.m. No injuries occurred.



Able Yard Incident

Tasks

1. Determine who comprised the team assigned to safely accomplish the task of picking up the single freight car.

2. What were some of the human errors that contributed to this incident?

3. When did the error chain begin?

4. Identify specific CRM principles that were violated in this scenario.

CRM PRINCIPLES

Failure to Deploy Crane Outriggers

Employees Involved in Accident:	• Crane Operator, 47 years old, 27 years experience • Track Foreman • Trackmen
Railroad:	Grand Trunk Western Railway Company
Location:	Lake Orion, MI
Accident Date and Time:	December 10, 1997, 11:45 a.m., EST
Type of Accident:	Crane fell over killing operator
Fatalities/Injuries:	1 fatality
Property Damage:	Unknown

The Incident

On December 10, 1997, a crane operator, upon returning from vacation, reported for duty at 9:30 a.m., EST, at Pontiac, MI. The crane operator deadheaded Crane LGC 9503 approximately 8 miles from Pontiac, arriving at Lake Orion, MI, at about 11:00 a.m. The track foreman, crane operator, and three trackmen had a job briefing about aligning the new track with the crane. After the job briefing, the crane operator moved the crane to the end of the new track. The sky was cloudy, and it was snowing. The temperature was 30º F. Approximately 3 inches of snow were on the ground. The ground in the immediate area was soft and muddy because of the new track construction.

The crane operator had been trained September 11 through 14, 1995, to operate the Little Giant Crane, which weighed a total of 68,700 pounds. Crane 9503 was a 1995 model, 18-ton Little Giant Crane with a 48-foot telescopic boom.

The new track was approximately 120 feet long with one 39-foot track panel lying on top of the extreme end of the track. After the trackmen set the wood blocking in place, the outriggers were placed on the blocking. Then the cable sling was hooked to the track panel, and the panel was moved from the top of the new track to approximately 20 feet south and set on the ground. Afterwards, the cable sling was unhooked from the panel and attached to the end of the new track. The crane operator moved the track in a southward direction approximately 3 or 4 inches. The operator stopped the move and dismounted the crane. The foreman and operator agreed that the track would be easier to align from the opposite end of the track near the frog.

The crane operator then moved the crane eastward to the opposite end of the track and stopped the rear end of the crane near the frog. At the precise location where the left front (south) rail wheel was sitting on the track, the cross level measured 2 ½ inches deviation from zero. The unloaded cross level deviation, plus a 4 ¾-inch void under the track ties, created a 7 ¼-inch loaded cross level deviation. The foreman had another job briefing with the crane operator and the three trackmen. The foreman indicated that he was aware of the cross level condition of the track and of the void under the ties, and he had discussed this matter with the crane operator.

The crane operator was of the opinion that the skeletonized track should move fairly easily. It was decided that they would attempt to align the track to the south from that point.

At 11:45 a.m., the trackmen hooked the sling to the track structure. The crane was facing in a westward direction while the operator attempted to align the track in a southward direction. At this time, the boom was extended to 43 feet 6 inches. The piston cylinder located between the body of the crane and the boom extended outward 19 inches, putting the boom of the crane at 16 ½ degrees.

The Accident
The crane operator made an attempt to raise the load and swing the boom to the south without the use of the outriggers. The foreman saw the rail wheels at the rear of the crane lifting up from the rail and notified the operator. According to the witnesses, the operator stopped the move, and almost immediately, accelerated the engine and made a short side movement to the north. Then, in a jerking movement, he tried to move the boom to the south. The crane tipped over to the south, pinning the crane operator inside the control compartment (the operator's compartment of the crane was located on the front (south) side of the crane).

The Oakland County Sheriffs' Department and Oakland County Response Team arrived at 11:55 a.m. The Orion Township Fire Department arrived at 12:01 p.m. Air bags and wood blocking were used to lift the crane to remove the operator's body from the control compartment.

Tasks

1. Where is the example of lack of assertiveness in this scenario?

2. What are some of the cues that might have led the team members to think that in this situation, the crane needed to put its outriggers down?

3. What kind of technical proficiency was the crane operator lacking?

4. Identify other CRM principles that were violated in this scenario.

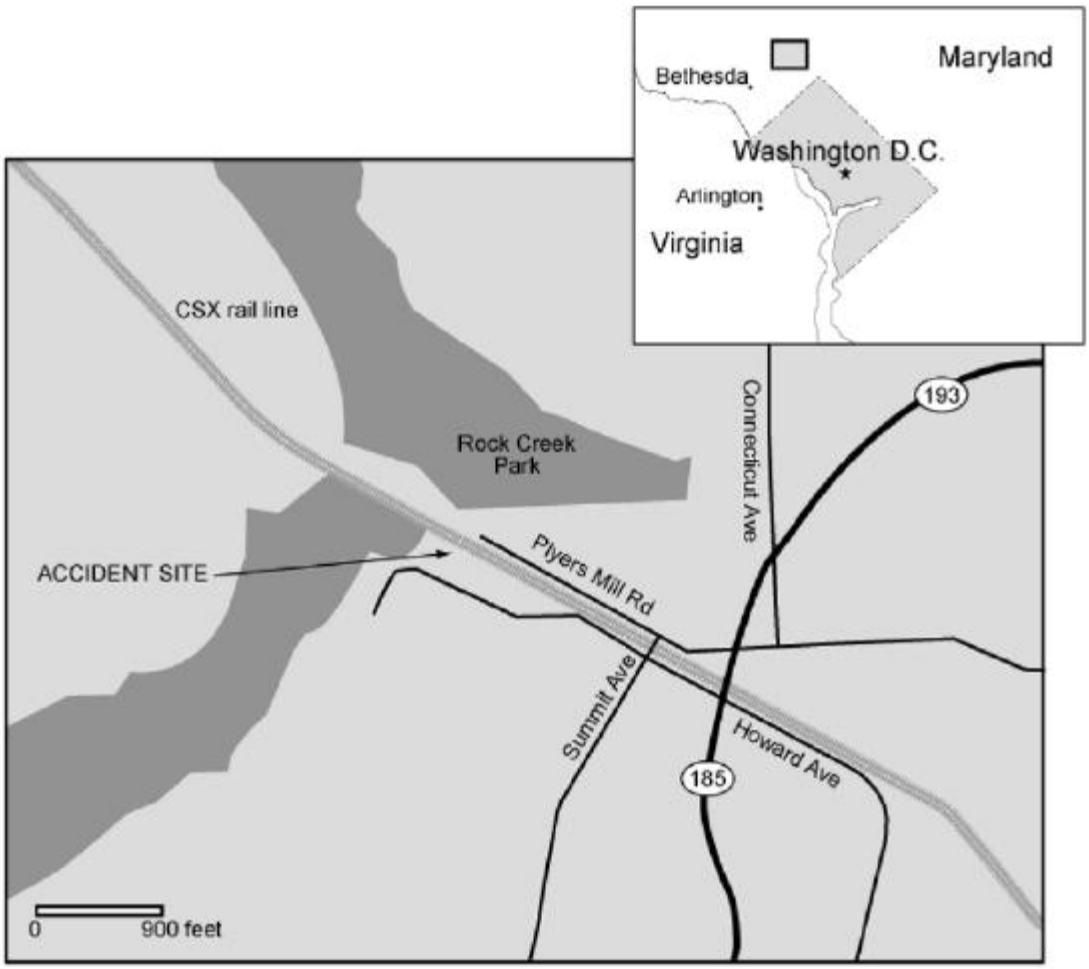
CRM PRINCIPLES

CSX Sun Kink/Amtrak Derail

Employees Involved in Accident:	• Surfacing Team • Track Inspector • Section Foreman
Railroad:	Amtrak
Crew(s):	Surfacing Team
Location:	Kensington, MD
Accident Date and Time:	July 29, 2002, 1:55 p.m., EST
Type of Accident:	Derailment
Fatalities/Injuries:	No fatalities/ 95 injuries (16 serious injuries)
Property Damage:	In excess of $14.3 million

The Incident

The derailment occurred on the CSXT Transportation's Metropolitan Subdivision of the Baltimore Service Lane on the No. 1 main track in double main track territory at MP 11.78. The main tracks were parallel, with No. 1 main track on the north side and No. 2 main track on the south side. Both main tracks were bi-directional. Typical daily train counts were 22 passenger trains per day Monday through Friday (Maryland Rail Commuter (MARC) and Amtrak trains) and 2 passenger trains per day (Amtrak trains) on weekends. In addition, approximately 15 freight trains operated each day. The train traffic for the 12-month period between July 1, 2001, and June 30, 2002, accounted for an annual gross tonnage of 59.63 million tons. The tracks were oriented, both geographically and by timetable, in a westward to eastward direction. The MP numbering decreased in the eastward timetable direction. The main tracks had a maximum allowable operating timetable speed between MP 10.6 and MP 12.2 (which included the point of derailment) of 70 mph for passenger trains and 55 mph for freight trains. The accident train was restricted to 60 mph because of a speed-restricted mail-handling car at the rear of the train.



Accident Location in Kensington, MD
Source: NTSB Accident Report

The Accident

Amtrak train No. 30 departed Chicago at 7:00 p.m. on July 28, 2002, en route to Washington, DC. Before departure, the train was given a successful FRA Class 1 brake test and a pre-departure equipment inspection. The train makeup out of Chicago was the same as at the time of the accident, except for a material handling car and an express car that were replaced in Toledo, OH. The train and engine crews involved in the accident had boarded the train in Pittsburgh, PA.

The engineer told investigators that as the train exited a curve just west of MP 11.78, he observed a misalignment in the tangent track ahead. The engineer estimated the track misalignment to be about 18 inches to the right. Although the locomotives passed over the track defect without derailing, 11 of the following cars of the train derailed and departed the roadbed to the north and south. The derailed cars included one baggage car, three sleepers, one diner, four coaches, and two mail-handling cars. Of the derailed cars, two sleepers, one coach, and a diner came to rest on their sides.

According to event recorder data, the engineer made an initial application of the train air brake system approximately 1,150 feet before the derailment. The engineer briefly increased the

service brake application before placing the brake handle in emergency. The event recorder data indicated that a separation in the train line (due to the derailment) had initiated an emergency brake application just before the engineer placed the brake handle in emergency. The train's locomotives came to a stop about 400 feet beyond the point of the emergency brake application.

View of Wreckage Looking South
Source: NTSB Railroad Accident Brief RAB-04/05

Preaccident Events

On July 25, 2002, 4 days before the derailment, a track surfacing team was assigned to smooth the track profile between MPs 11.8 and 11.5. The track equipment used for this project was a Fairmont Mark IV tamper and a Kershaw ballast regulator, each with an operator. The tamper operator said he had surfaced approximately 400 feet of track with a 1 1/2-inch track increase in elevation when the tamper experienced mechanical difficulties that rendered it unusable. No track foreman was directly assigned to the tamping crew; however, a CSXT track inspector (also a track foreman) who was in the area to help transport the track maintenance equipment responded to assist the surfacing crew.

Before leaving the job site, the surfacing crew had to make a gradual transition of the track from the raised portion down to the level of the undisturbed portion of track. This area of track is referred to as a run-off. With the tamper unusable, the track crew had to tamp the track by hand, using track tools to manually force ballast under the ties. The track inspector said he was uncertain as to the amount of run-off to be tamped and relied on the tamper operator's discretion and experience. Investigators learned that the tamper operator was not qualified to inspect track or supervise certain renewals/repairs as a track foreman under 49 Code of Federal Regulations

213.7. The track inspector was listed as qualified under 49 CFR 213.7, but investigators found that he was not familiar with the regulations governing the required minimum length of run-off. He was also unfamiliar with CSXT Engineering Department Field Manual Standards in regard to their required length of run-off. The minimum run-off distance for a 1 1/2-inch change in track elevation is 31 feet by Federal regulations and 150 feet by CSXT engineering standards.

The crew hand-tamped one side of the portion of the tie that extended beyond both rails for a distance of approximately 15 crossties, providing a run-off of about 25 feet. This run-off was 6 feet short by minimum Federal requirements and 125 feet short by CSXT standards. In hand-tamping the run-off, the tamping crew and the track inspector did not measure the length of track for the run-off and did not use a string line, the required method of ensuring a correct and consistent taper to the existing track. They placed a jack under each rail of the track then raised the track and eyeballed it for a smooth run-off.

After the track was raised with a track jack, they tamped one side of the tie on the outside of the rail. When the track was raised 1 1/2-inches, a void would exist in the ballast under the tie. The ballast void exists for the entire length of the tie, but maintenance practices primarily focus on the areas nearest the rails. Because the greatest tie loading occurs under the rails, tamping must be done in the rail support area from the end of the tie to a point 13 inches inside the rail. During NTSB interviews, the CSXT track inspector stated that, in the area of the track jack, the crew cross-tamped the tie on the inside of the rail. CSXT maintenance practices stipulate that the proper method for tamping run-off is cross-ramming (eight-point tamping–each side of the tie outside and inside the rail is tamped by persons working opposite each other in pairs).

The surfacing team that was responsible for the track maintenance worked with a local section foreman who was responsible for coordinating communications between the surfacing team, a tie replacement team that was working farther east, and approaching train traffic. The section foreman had positioned himself on a bridge halfway between the two work sites so that he could communicate with both work teams and with approaching trains. Because the section foreman was not actually at the work sites at the time the work was being accomplished, he had little knowledge of how the work was being done.

The section foreman inspected the track after the track inspector and the surfacing team had made the run-off. Both he and the tamper operator told investigators that the track condition was good for only 25 mph and that their intention had been to return the following day to complete the surfacing operation. The section foreman placed a 25-mph slow order, code 141 (Ballast Compacting After Surfacing). This code is defined as "speed shall not exceed 25 mph on high-tonnage tracks until at least 6:00 p.m. on the day that 10 tonnage trains (a train of at least 5,000 gross tons) have passed over the track after the ballast section has been returned to standard." This code also denoted that the track work was complete and that only compaction by train traffic was needed for the slow order to be removed. The slow order should have been code 140 (Surfacing Team), indicating that the surfacing job was not complete. Although the crew was scheduled to return to the site the next day to complete the resurfacing, they did not do so because they had to deal with the effects of a landslide at another location.

The track inspector said he understood that the tamping machine was scheduled to return the following day to finish tamping the track, and he was subsequently aware that it did not return to complete the job. The track inspector did not work on July 27, 2002, which was a Saturday. Because of high ambient temperatures, the track inspector did go to work at about 11:00 a.m. on Sunday, July 28, 2002, to conduct a special track inspection for buckled track due to heat expansion. During this track inspection, he inspected the run-off area by checking the crosslevel (the distance one rail is higher or lower than the other), dimensions, and alignment. The track inspector told investigators that when he inspected the track in the area of MP 11.78, the surface appeared to be without problems and was essentially the same as it had been on the day it was surfaced.

This segment of track, however, was unstable because the efforts to surface this area of track involved raising the track. Raising the track from the roadbed breaks the restraining bond of the ties and the ballast, which allows the rail to expand or contract due to the lack of ballast compaction, the location of the track segment, the length of run-off, and high rail temperature. (The rail temperature was measured as 124° at 2:00 p.m. at Kensington.) Failure to properly adjust rail that has been disturbed may result in a track buckle when rail temperature becomes high enough that thermal expansion and movement of the rail are so great that the track structure cannot be restrained.

The track inspector estimated that by that time, 10 tonnage trains had traversed the area in compliance with code 141, since the run-off was made on July 25, 2002. At 6:00 p.m. on July 28, 2002, he removed the slow order, thus allowing a maximum speed of 55 mph for freight trains and 70 mph for passenger trains. CSXT officials told NTSB investigators that if the section foreman had placed a 25-mph speed restriction with a slow order code of 140, the track inspector would probably have realized that more work was required and would not have removed the slow order.

Tasks

Since this scenario is used as a final review, the questions will allow you to identify instances where CRM principles were either practiced or could have been practiced better.

1. What are some parts of this scenario that exhibit the need for improved technical proficiency by the crewmembers?

2. What are some parts of this scenario that show a loss of situational awareness?

3. What parts of this scenario relate to the need for improved communications?

4. What parts of this scenario could have been improved by increased teamwork?

5. What are some parts of this scenario that relate to the need for improved assertiveness?