



Rail Crew Resource Management Pilot Course



Participant's Manual

Version 1.1 (M)
Mechanical
2005

Railroad Crew Resource Management (CRM) Training Course

Mechanical Track

(Insert Date Here)

Crew Resource Management 1

Introduction


Registration and Introductions

- Safety Briefing
- Registration
- Introductions

Crew Resource Management 2

Introduction

Group Discussion



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

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Introduction

Class Schedule

Morning: Modules 1-3

Afternoon: Modules 4-6

Crew Resource Management 4

Introduction

Endorsement

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

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Introduction

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

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Introduction

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

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Introduction

Course Outline

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

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Introduction

Where is Fatigue?

- How is fatigue related to CRM?

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Introduction

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

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Introduction

CRM

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

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Introduction

Crew Concept Discussion

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

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Introduction

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 or teams to safely carry out an activity
Example: Dispatcher, MOW Crew, and Road Crew working together to move train through a work area

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Introduction

Elemental teams (by functional areas)

<p>TRANSPORTATION</p> <ul style="list-style-type: none"> Road Crews Yard Crews Dispatchers Hostlers 	<p>ENGINEERING</p> <ul style="list-style-type: none"> Section Gangs Production Gangs Structures (B&B) Signal Maintainers Electrical/Catenary Crews 	<p>MECHANICAL</p> <ul style="list-style-type: none"> Locomotive Repair Shop Crews Locomotive Servicing Crews In/Outbound Inspection Crews Car Repair Shop Crews
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Introduction

Crew Resource Management

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

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Introduction

Resources?

- Equipment
- Computer Resources, Paperwork
- People

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Introduction

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

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Introduction

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

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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
- National Transportation Safety Board recommends CRM for rail

Butler, Indiana

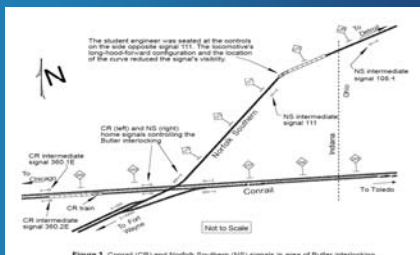
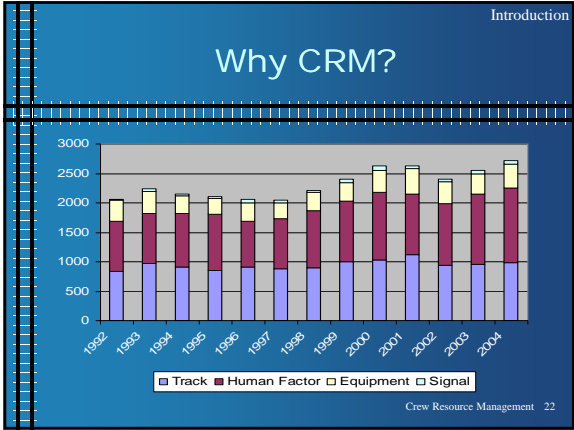
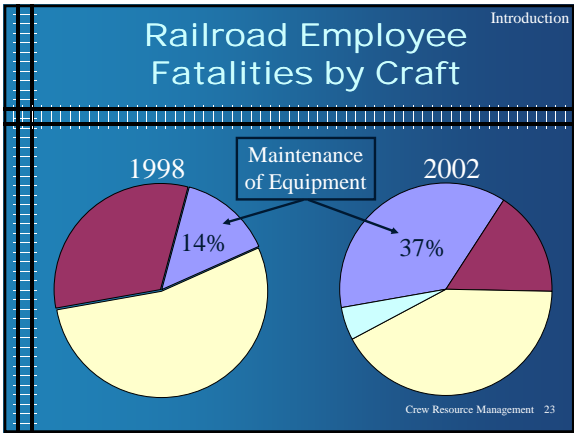
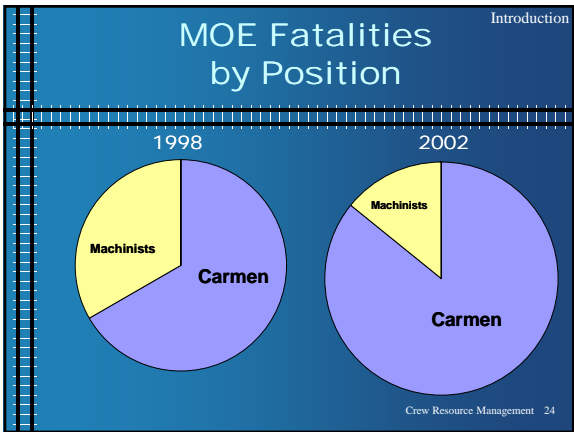


Figure 1 Conrail (CR) and Norfolk Southern (NS) signals in area of Butler interlocking







Introduction

Swiss Cheese Model

Organizational Influences
Supervision
Rules
Critical Event
Crew Resource Management
ACCIDENT

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Introduction

Benefits of CRM Practices

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

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Introduction

Car Inspector Parks on Hump Track

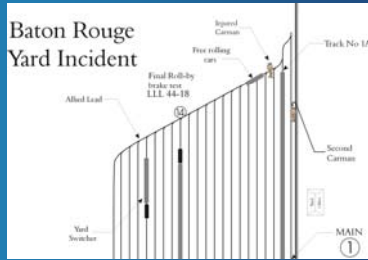
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In the Dark



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Carman Hit by Cars



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Main CRM Elements

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

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Introduction

Break

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Technical Proficiency

Module 2: Technical Proficiency

Learning objective:

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

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Technical Proficiency

Elements of Technical Proficiency

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

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Technical Proficiency



Technical Proficiency

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

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Technical Proficiency

Second Day Back



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Situational Awareness

Module 3: Situational Awareness

Learning objective:

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

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Situational Awareness

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

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Situational Awareness

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

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Situational Awareness

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

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Situational Awareness

Reality/Perception of Situation

Reality of the Situation

Your Perception of the Situation

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Situational Awareness

Dangerous Dumper

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Situational Awareness

Accidents Caused by Loss of Situational Awareness

Your Perception of the Situation

Your Perception and the Reality of the Situation

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Situational Awareness

Cues

- Environmental
 - Equipment
 - Crewmember
- Personal

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Situational Awareness

Are Cues Valid?

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

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Situational Awareness

Steps in Maintaining Situational Awareness

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

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Situational Awareness

Steps in Regaining Situational Awareness

- Communicate
- Resolve
- Monitor

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Situational Awareness

Maintaining and 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

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Situational Awareness

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?

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Situational Awareness

Lunch Break

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Situational Awareness

Module 4: Communication

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

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Communication

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

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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

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Communication

Outline of Module

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

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Communication

No Blue Flag Protection



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Communication

Oral Communication

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



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Communication

Two-Way Communication/ Active Listening

- Ask questions
- Restating or paraphrasing
- Recording information

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Communication

Other Modes of Communication

- Radio
- Written
- Hand signals

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Communication

New Technology

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

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Communication

Job Briefing Guidelines

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

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Communication

Active Participation (in job briefing)

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

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Teamwork

Module 5: Teamwork

- Understand that safety hinges on both individual and team actions

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Teamwork

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

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Teamwork

Teamwork

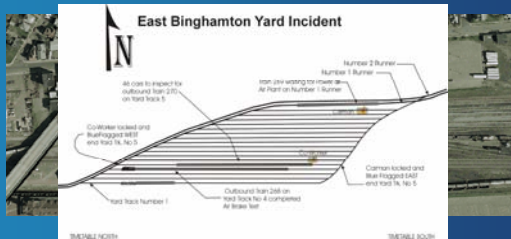
- Definition of a team-crew
- Team decisionmaking
- Conflict resolution

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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”

EOTD Application without Blue Flag Protection



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

Teamwork

Conflict Resolution

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

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Assertiveness

Module 6: Assertiveness

Objective: Understand the proper use of assertive communication

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Assertiveness

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

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Poor Support In Soft Yard



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

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

Caught by a Shoe



NS Student Engineer at Butler, Indiana

Employees Involved in Accident:	<ul style="list-style-type: none"> • 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 AM 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, about 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 (Norfolk Southern)² train 255L5, which was en route to Fort Wayne, Indiana, struck eastbound Consolidated Rail Corporation (Conrail) train TV 220, which was en route to Columbus, Ohio. The collision occurred where the Norfolk Southern Huntington District and the Conrail Chicago main lines cross at grade at the east end of the town of Butler, Indiana. Both locomotives and five cars from the Norfolk Southern train derailed, and three cars from the Conrail train, two with multiple, stacked platforms, derailed. The Norfolk Southern 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.

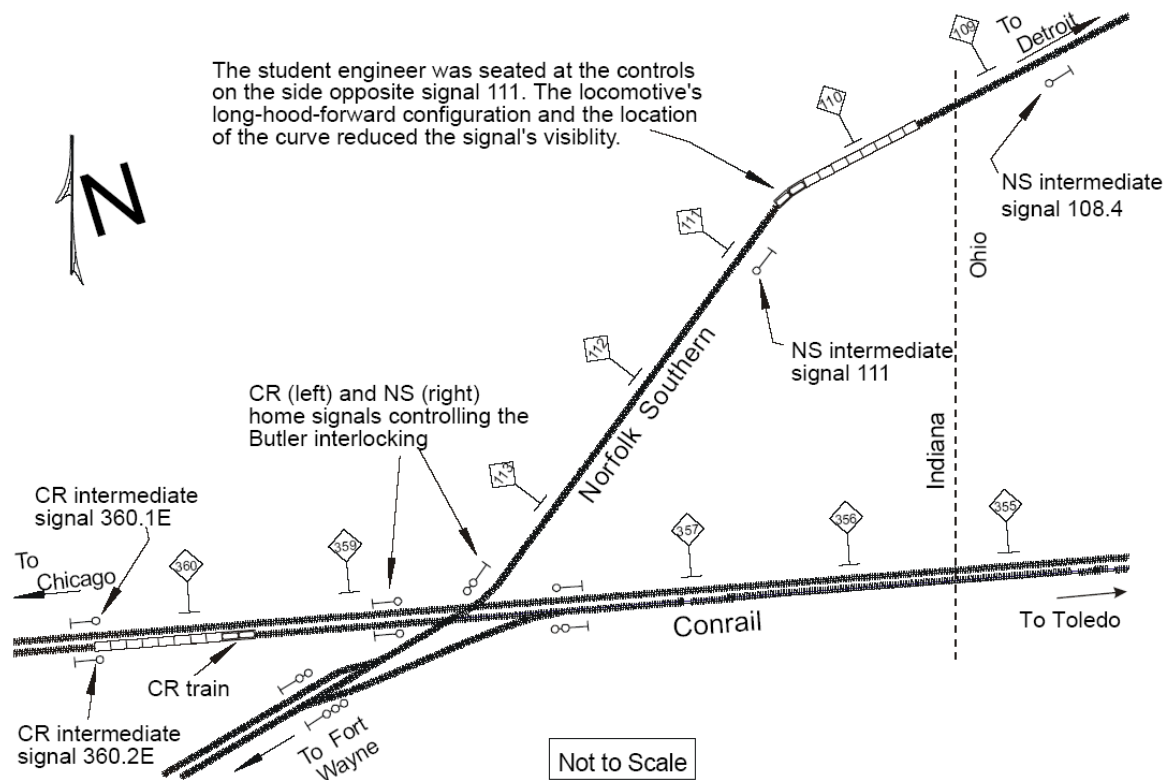


Figure 1. Conrail (CR) and NS signals in area of Butler interlocking.

Norfolk Southern

On an uneventful trip from Peru to Detroit, two 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 (a Norfolk Southern Rules violation, Rule 34 requires all signals to be clearly called.)

On the night prior to the accident, at 11:35 p.m., the Norfolk Southern 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 about 114 miles northeast of the accident, the engineer turned over the train's operation 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 engineers 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, Indiana, to Detroit, Michigan, 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. Norfolk Southern 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 an 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 then placed the automatic brake valve handle in the emergency position.

The Accident

As the Norfolk Southern 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 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?

Car Inspector Parks on Hump Track

Employees Involved in Accident:	<ul style="list-style-type: none"> • Car Inspector (51 yrs old/29 yrs service) • Engineer of Yard Assignment Y33614 • Crew of Train No. Q5124 • Inbound Lead Car Inspector • Hump Yard Master • Hump Foreman
Railroad:	CSX Transportation, Incorporated
Employee Craft:	Maintenance of Equipment
Location:	Cincinnati, OH
Accident Date and Time:	November 15, 2002; 5:20 a.m., EST
Type of Accident:	(Example: Collision, Derailment)
Fatalities/Injuries:	Car Inspector Fatally Injured
Property Damage:	NA

The Incident

South Road and East Open Track

On Nov. 14, 2002, the Outbound Lead Car Inspector went on duty at 11 p.m. at CSX's Queensgate Yard, in Cincinnati, Ohio. On Nov. 15, 2002, the Lead Car Inspector received instructions to do a set-and-release air brake test on CSX Train No Q54115. He was informed Q54115 would be stopped on the east open track, where he could have access to the rear of the train. He drove his CSX pick-up truck south on the "south road" to a location where he could position himself for observation of the rear car of Q54115. The south road was a straight, 1-paved lane, oriented generally north and south. The east open track, where he would be doing his work, was immediately next to the east side of the south road, and receiving yard Track No. R8 was immediately to the west. The east open track and Track No. R8 were parallel to the south road in most of the yard.

When Train No. Q54115 stopped on the east open track, the rear car of the train was north of the Outbound Lead Car Inspector's position on the south road, thus the Outbound Lead Car Inspector has driven farther south than he needed to. He backed his truck north on the South road and backed onto the cart path crossing on Track No. R8. Thus, he was facing the east open track.

The engineer of Yard Assignment Y33614, another hump assignment working in the area, was moving Locomotives CSXT 2414 and CSXT 1054 from the hump crest to the car shop lead track, and then going to lunch. He observed the truck back onto the cart path crossing and remain there for about a minute. He did not see the truck leave the crossing, and left the immediate area before the accident occurred. It is not known how long the truck remained on the crossing.

Track No. R8

After reaching its destination, inbound Train No. Q51214, which was 4,829 feet long, was left standing on receiving yard Track No. R8, waiting to be humped. The crew of Train No. Q51214 had coupled two locomotives to the south end of the cars on Track No. R8, and was preparing to shove them north over the hump. An Auto Carrier, the car on the north end of train, was standing south about half the length of an auto carrier (47 feet) south of the cart path crossing that crossed Track No. R8 near the north end.

Lights mounted on towers illuminated the receiving yard. Visibility of a freight car was several hundred feet when viewed in open areas on a night with similar weather conditions. In areas with rail equipment nearby on both sides (between cars), visibility was reduced. At the time of the accident, it was dark and cloudy. The temperature was 46° F.

At about 5:19 a.m. on Nov. 15, 2002, the crew of Yard Assignment Y33514 received instructions from the Train Director to start shoving Track No. R8 toward the hump. The Engineer was operating Train No. Y33514's locomotives manually and the movement toward the hump was a blind shove. When the north car on Track No. R8, Auto Carrier TTGX 976118, reached the cart path crossing, it struck the Outbound Lead Car Inspector's truck on the passenger side and started shoving it north on Track No. R8. The event recorder download from Locomotive CSXT 2415 indicated it was moving at 4 mph at the time of the accident.

Radio broadcast transcripts indicated that at about 5:20 a.m., the Outbound Lead Car Inspector called on the Car Inspector's radio channel (20) to stop the movement on Track No. R8. This transmission was heard by the Inbound Lead Car Inspector, who phoned the Hump Yard Master. The Hump Yard Master monitored a different radio channel. The Hump Yard Master called the Hump Foreman and notified him to stop the movement on Track No. R8. At about 5:21 a.m., the Hump Foreman notified the Engineer on Train No. Y33514 to stop, and he took immediate action to do so.

Before the shoving movement came to a stop, the Car Inspector's truck was shoved about 360 feet north of the cart path crossing before coming to rest upside-down, underneath the north end of TTGX 976118, and was on fire. The Car Inspector was severely injured and ejected from the vehicle about 20 feet south of where it came to rest. The Cincinnati Fire Department, Cincinnati Police Department, and Hamilton County Coroner responded to the accident. At 9:45 a.m., the Coroner pronounced the Car Inspector dead and transported his body from the accident site.

Tasks

1. Was the car inspector aware of the situation?

In the Dark

Employees Involved in Accident:	<ul style="list-style-type: none"> • Carman (42 years old/16 years of experience) • Crew of Train G-25 • Crew of Train M-98 • Mechanical Department Supervisor
Railroad:	Norfolk Southern Railroad (NS)
Employee Craft:	Maintenance of Equipment
Location:	Macon, GA
Accident Date and Time:	January 19, 1997, 6:40 a.m., EST
Type of Accident:	Carman struck by train
Fatalities/Injuries:	One fatality
Property Damage:	Unknown

The Incident

Circumstances Prior to the Accident

The Carman reported for duty in the forwarding yard at 11:00 p.m., the evening prior to the accident, at NS's Brosnan Yard in Macon, Georgia. His regularly assigned shift was 7 a.m. to 3 p.m. He was working this shift in overtime status. The Mechanical Department Supervisor assigned him to the south end Blue Flag protection job and instructed him to go to the south end of the yard and leave the Blue Flag protection in place on Tracks Nos. 3 and 6 after the Train Crew of Train No. G-25 had completed its move on each of those two tracks. The tracks in the south yard extended northward and southward and were numbered one through nine, beginning from Thoroughfare No. 2. The yard lighting in the area of the accident consisted of a single pole light, east of the accident area, and located between Track No. 9 and the East Levy Road. The ambient temperature at the time of the accident was 28° F. No atmospheric condition limited visibility. The FRA report diagram of the accident location is shown on next page.

The Carman drove the company-owned truck southward on the East Levee Road to the south end of the forwarding yard, and upon arrival, parked the vehicle near a light pole. From the point at which he parked the truck, he had to cross Tracks Nos. 9, 8, and 7 to get to his Blue Flag assignment. Upon completing the Blue Flag requirements for Track No. 6, the Carman crossed over to the switch leading to Tracks Nos. 2 and 3. He stood beside the switch while he was waiting for the locomotives of Train No. G-25 to exit the south end of Track No. 3.

Train No. G-25 was a local freight train that originated in Savannah, Georgia at 7 p.m. on Jan. 18, 1997. The Crew comprised an Engineer and a Conductor who had completed their statutory off-duty periods prior to reporting for duty. This Train Crew performed local switching duties between Savannah and Macon, and arrived at Macon Junction at 3:55 a.m. on Jan. 19, 1997.

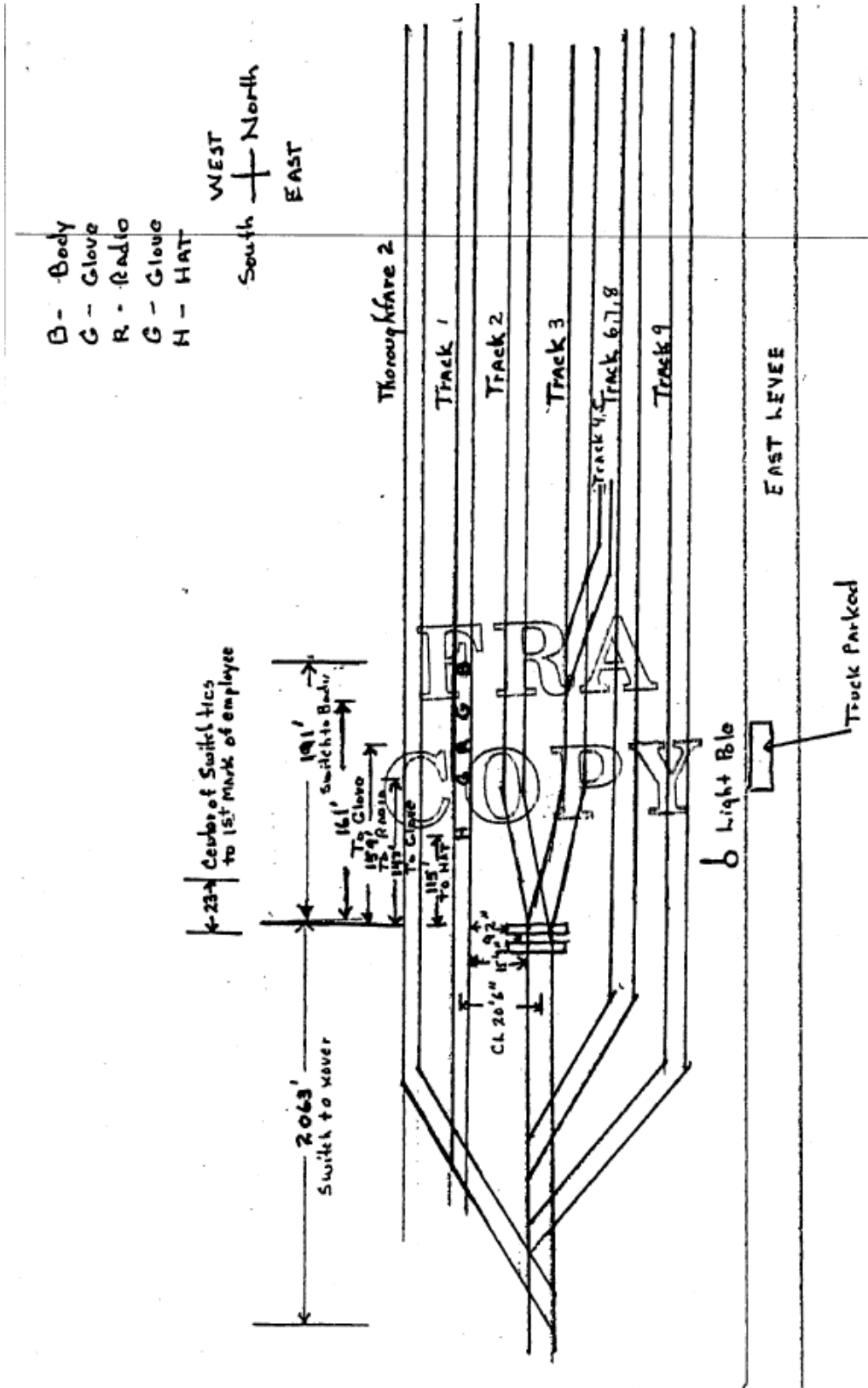
This train remained at Macon Junction until 5:50 a.m. when the Yardmaster in the North Tower at Brosnan Yard instructed his Crew to pull through Track No. 6, make a cut, and shove the remainder of the train onto Track No. 3.

The locomotives for Train No. M-98 were being backed onto Track No. 1, to couple to the train simultaneously as the Crew of Train No. G-25 was moving its train onto Track No. 3.

The Carman was last observed by the Conductor of Train No. G-25 standing west of the switch for Tracks Nos. 2 and 3, as the Conductor uncoupled the locomotives from the cars that remained on Track No. 3. The Carman and Conductor waved to each other at this time, and according to the Conductor, everything appeared to be normal. The locomotives for Train No. M-98 were moving northward on Track No. 1 during the time of the Conductor's observation.

Train No. M-98 was a southbound freight train originating at Macon on the day of the accident. The Crew of this train comprised an Engineer and a Conductor who had completed their statutory off-duty periods prior to reporting for duty. They went on duty at the engine terminal at 6 a.m. on Jan. 19, 1997. The Crew of this train received instructions to depart the engine terminal at 6:25 a.m. They proceeded southward on Thoroughfare No. 2 to the switch for the south crossover to the forwarding yard.

When the locomotives arrived at the south end of the forwarding yard lead, the Yardmaster in the North Tower instructed the Crew to back onto Track No. 1 and couple its three locomotive consist to its train. This Crew was backing northward with the three light locomotives onto Track No. 1.



The Accident

As the Carman was standing near the switch between Tracks Nos. 2 and 3, waiting for the locomotives of Train No. G-25 to pull southward out of the track, the locomotives of Train No. M-98 were passing him, moving northward on Track No. 1. For an undetermined reason, the Carman apparently fouled Track No. 1 and was struck by the locomotives of Train No. M-98 as they moved northward. The body of the Carman was discovered by the Crewmembers of Train No. G-09 as the train pulled southward out of Track No. 2 at approximately 6:55 a.m., and they notified the Main Tower of their discovery via radio. There were no eye witnesses to the accident.

The Bibb County Medical Center Emergency Medical Service (EMS) arrived at the accident site, and an EMS paramedic pronounced the Carman dead at 7:16 a.m. The cause of death was multiple blunt and crush injuries with the trunk of the body transected. The Bibb County Coroner declared the manner of death as an accident.

Post-Accident Investigation

The company truck assigned to the Carman for this tour of duty was found parked near the switches leading to the forwarding yard. The Carman had left his hard hat, safety glasses, and hand-held, battery-powered light on the seat of the truck. He was apparently attempting to perform his assigned duties while utilizing illumination supplied by the pole-mounted light in the yard near his location.

Re-enactment of the circumstances surrounding this accident revealed that it was dark when the accident occurred, and the Carman would have been dependent on the lighting generated from the pole-mounted light since he did not have his hand-held light with him. The re-enactment also demonstrated that if both train's locomotive consists were passing the switch to Tracks Nos. 2 and 3 at the same time, illumination from the pole-mounted light would have been diminished to the point that a person standing near the switch would have been in almost total darkness. The noise from both locomotive consists may have made it impossible to hear the audible warning (bell) from Train No. M-98.

The Carman was wearing layered clothing with a stocking-type cap and a hooded sweatshirt at the time of the accident. His outer clothing was dark in color. It is unknown if the stocking cap and hooded sweatshirt he was wearing at the time had reduced his ability to hear. He also had gloves and a radio with him. His gloves and radio were found in the gage of the track north of the point of impact. His transected body was found approximately 191 feet north of the switch to Tracks Nos. 2 and 3. His upper torso was found in the gage of Track No. 1, while his lower portion was found outside the gage of the east rail.

Evidence observed on Locomotive NW 6143 of Train No. M-98 indicated that it had passed over the Carman's body. The Engineer was operating from the control stand from the west side of the south unit (NW 8067). The locomotive consist was moving northward onto Track No. 1 to couple to its train. The Conductor was controlling the northward movement of the locomotives from the cab of Locomotive NW 6143; he was seated on the west side. The

Conductor's view of the track in the direction of movement was hampered by the long hood end of Locomotive NW 6143.

There is conflicting information over whether the headlight was illuminated in the direction of movement. The Engineer of Train No. M-98 stated that he usually turned on the headlight at each end of the locomotive consist prior to departing the engine terminal. During an interview, he recalled not having to turn on the headlights because they were already illuminated. However, the Engineer and Conductor of Train No. G-25 stated that they did not observe an illuminated headlight on Train No. M-98's rear unit, nor did they hear the bell being sounded as they passed it. The investigation revealed that the Engineer on Train No. M-98 had been cited during a Safety Audit performed on Dec. 30, 1996 at Brosnan Yard for not having his locomotive headlight illuminated as required by Operating Rule No. 17.

Analysis of the speed/event recorder data removed from the locomotives indicated that Train No. M-98's locomotives made the reverse move onto Track No. 1 at approximately 6:40 a.m.

According to those with whom the deceased had worked during the night, the shift had been a routine tour until the Carman was given his last assigned flagging duty for the night. The majority of the mechanical force agreed that the Yardmasters in the towers habitually had attempted to notify all affected parties of yard movements whenever possible; however, no one could recall hearing a notification of this movement.

Additionally, the Carman was standing in darkness and did not have a hand-held light with him. Nor was he wearing any reflective equipment that would have enabled the Crew of Train M-98 to be aware of his presence. The sound from the locomotives of Train No. G-25 in close proximity to the Carman may have masked the sound of the approaching locomotives of Train M-98, leaving him unaware of their approach to his location.

Tasks

1. What were some factors that contributed to this incident?

2. Who made up the crew (interactive team) that needed to work together to ensure that these moves were completed safely?

3. What are some actions that the carman could have taken to protect himself?
4. What are some actions that the train crews could have taken to potentially prevent this accident?
5. What role could fatigue have played in this accident?

Carman Hit by Cars

Employees Involved in Accident:	<ul style="list-style-type: none"> • Carman (56 yrs. old / 31 yrs service) • Engineer of Yard Assignment Y33614 • Crew of Train No. Q5124 • Inbound Lead Car Inspector • Hump Yard Master • Hump Foreman
Railroad:	Illinois Central Railroad Company (IC)
Employee Craft:	Maintenance of Equipment
Location:	Baton Rouge, LA
Accident Date and Time:	November 18, 1998, 12:15 p.m., CST
Type of Accident:	Carman hit by cars in yard
Fatalities/Injuries:	Carman fatally injured
Property Damage:	N/A

The Incident

On Nov. 18, 1998, the Carman reported for a scheduled 8-hour shift at the Baton Rouge Yard. This work shift was scheduled for 7 a.m. - 3 p.m., his regular shift. The Carman had performed an outbound inspection and initial terminal train air brake test on LLL 44-18, a local Union Pacific train to be operated to Livonia, Louisiana. He had conducted the initial terminal train air brake test on Tracks Nos. 5 and 14. The UP Crew had doubled the train from Track No. 5 to Track No. 14. Then the Carman performed an end-of train device (EOT) test.

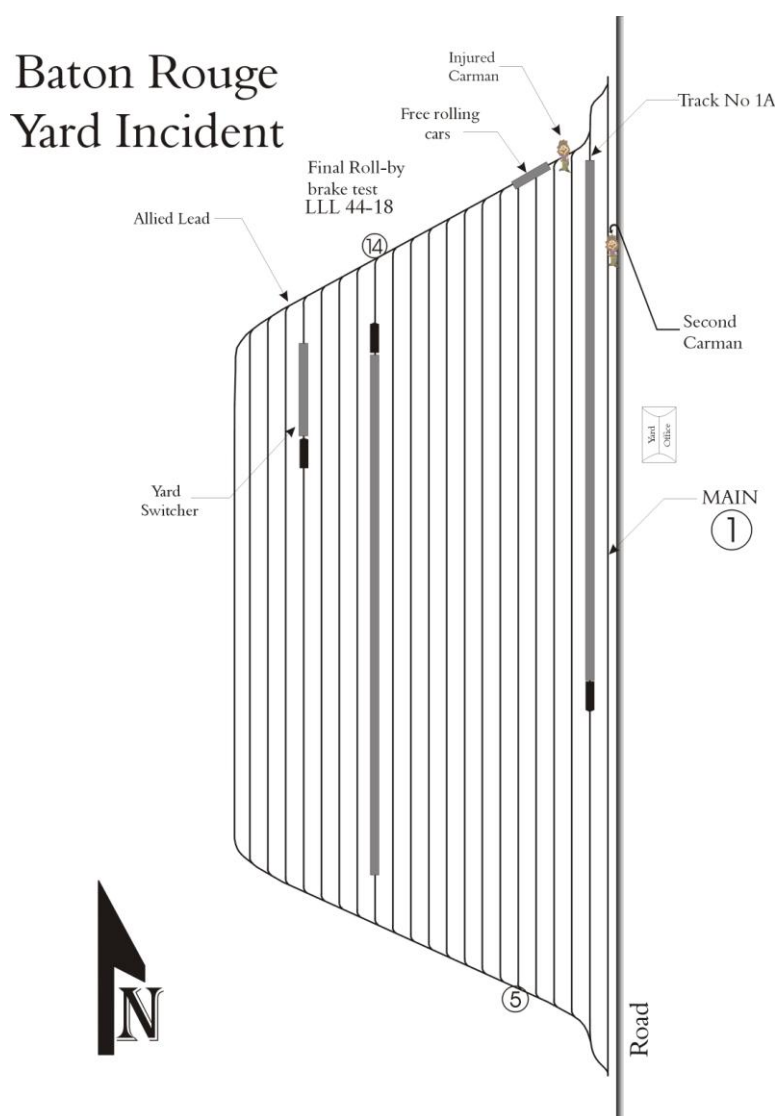
The EOT was armed, and the Carman was en route to the north end of the yard to perform a roll-by inspection of the train air brake release. He and the other Carman working with him in the yard were to board auto transportation, provided by the Yardmaster, to the north end of the yard. The Carman was proceeding on foot in a generally east-northeast direction across the yard to meet the other Carman and board their transportation. During this time, the other Carman, who was performing a roll-by inspection of the train air brake release for outbound train LBRGE (Local Baton Rouge to Geisner, Louisiana), was standing between the main track and the road, north of the Yard Office and south of the Allied lead. Train LBRGE was proceeding southbound on Track No. 1A.

A Yard Crew was switching cars from the switching lead onto various tracks as dictated by its switch list. This was a south-to-north movement with approximately six cars remaining to be switched. The Carman was walking perpendicular to their switching movements and could clearly observe the Crew's activity. The weather at the time of the accident was fair, with a temperature in the low 80's.

The Carman stepped into the gage of the lead track, between switches for Tracks Nos. 2 and 3, was struck by two rail cars rolling free on the lead track on his right rear side, and was

knocked face down between the rails. His left arm and shoulder apparently were positioned on the rail as the first of two loaded covered hopper cars struck him and the L4 wheel ran over his body, severing his left arm and shoulder. The force of the impact caused his hard hat to land on the end deck of the car, beneath the slope sheet. The Carman stood up and walked approximately 40 feet southward after the accident and then collapsed. The Yard Conductor saw him at this location as he fell down. The Conductor and Brakeman attempted to aid the Carman and summoned help using their radio. There were no witnesses to the actual impact and amputation.

A call was made to 911 at approximately 12:15 p.m., and emergency medical services arrived at the scene a short time later. The Carman was transported by ambulance to Baton Rouge General Hospital where he was pronounced dead at 1 p.m.



Baton Rouge Yard Accident Depiction (Not to scale)
Source: TTI-developed diagram based on FRA Report

Tasks

1. Was the carman aware of the hazards of working in the yard?
2. How many times had the carman probably crossed the tracks in this manner in his career?
3. Was the carman aware of this particular situation?
4. What was the carman's perception of the situation?
5. What are some of the problems with doing things so often that they become second nature?

Second Day Back

Employees Involved in Accident:	<ul style="list-style-type: none"> • Carman (55 years old/2 years, 9 months of experience) • Foreman • Yardmaster • Another Carman
Railroad:	Consolidated Rail Corporation (Conrail)
Employee Craft:	Maintenance of Equipment
Location:	Newark, NJ
Accident Date and Time:	March 21, 1997, 7:15 p.m., EST
Type of Accident:	Carman struck and killed by train
Fatalities/Injuries:	One fatality
Property Damage:	Unknown

The Incident

Circumstances Prior to the Accident

At 3 p.m., on Friday, March 21, 1997, a Conrail (CR) employee (deceased) reported for his regularly assigned duties as a Car Inspector (Carman) on the 3 p.m. to 11 p.m. shift at the railroad's Oak Island Yard in Newark, New Jersey. The Carman had returned to work the previous day (Thursday, March 20) following an extended absence from work due to an on-the-job shoulder injury he had sustained on July 17, 1995. Including this extended absence from work, his total experience with CR was two years, nine months. The Car Inspector had previously been employed as a Brakeman by the New Jersey Transit Rail Operations (passenger trains only) from Jan. 10, 1994 through Sept. 16, 1994. Following a routine job briefing conducted by the Carman's Supervisor (Foreman), he began his normal work activities. Please see the attached diagram of the Oak Island Yard to better visualize the accident scene and the chain of events that led up to the accident.

At approximately 6:30 p.m., the Carman and a co-worker were assigned to inspect 72 cars for outbound Train OIAL-7, located on Track No. 7 in the receiving yard. The receiving yard was a clear, open area with tracks running in an east/west timetable direction. There was an access road parallel to Track No. 7 to the south side and an adjacent track (Track No. 8) to the north. As instructed, the two Carman proceeded to the receiving yard by truck and, after applying Blue Signal protection to both ends of Track No. 7, began walking the cars from opposite ends of the track and on opposite sides of the cars. The Carman began walking eastbound between Tracks Nos. 7 and 8 while his co-worker walked westbound along the access road. At approximately the mid-way point of the 72-car train, the two Carman met one another and, following a brief conversation, continued their inspection. At some point after the two Carman resumed their inspection, the co-worker heard a locomotive pass his location traveling eastward on Track No. 8.

On the day of the accident, the Crew for Switch Job YPOI-31 at Conrail's Oak Island Yard reported for duty at 3:45 p.m. The Crew comprised an Engineer, Conductor, and Brakeman. At approximately 6:45 p.m., the Switch Crew received instructions from the Yardmaster to couple onto four cars located near the west end of Track No. 8 and shove them to a coupling with a tank car located near the east end of the track. The Conductor proceeded on foot to the east end of Track No. 8 to position himself at the tank car, while the Brakeman stayed with the locomotive to couple the four cars at the west end of the track. After coupling to the four cars and releasing the handbrakes, the Brakeman returned to the locomotive and positioned himself in the Fireman's seat opposite the Engineer (south side). The Engineer contacted the Conductor by radio and informed him that they were shoving the four cars eastward toward him. The locomotive headlight was on dim, and the bell was ringing. The shoving movement was made at an estimated speed of between 5 and 10 mph. The weather at the time of the accident was clear and cold with a temperature of 40° F. It was dark at the time of the accident (7:15 p.m.). There was no artificial lighting in the area.

The Accident

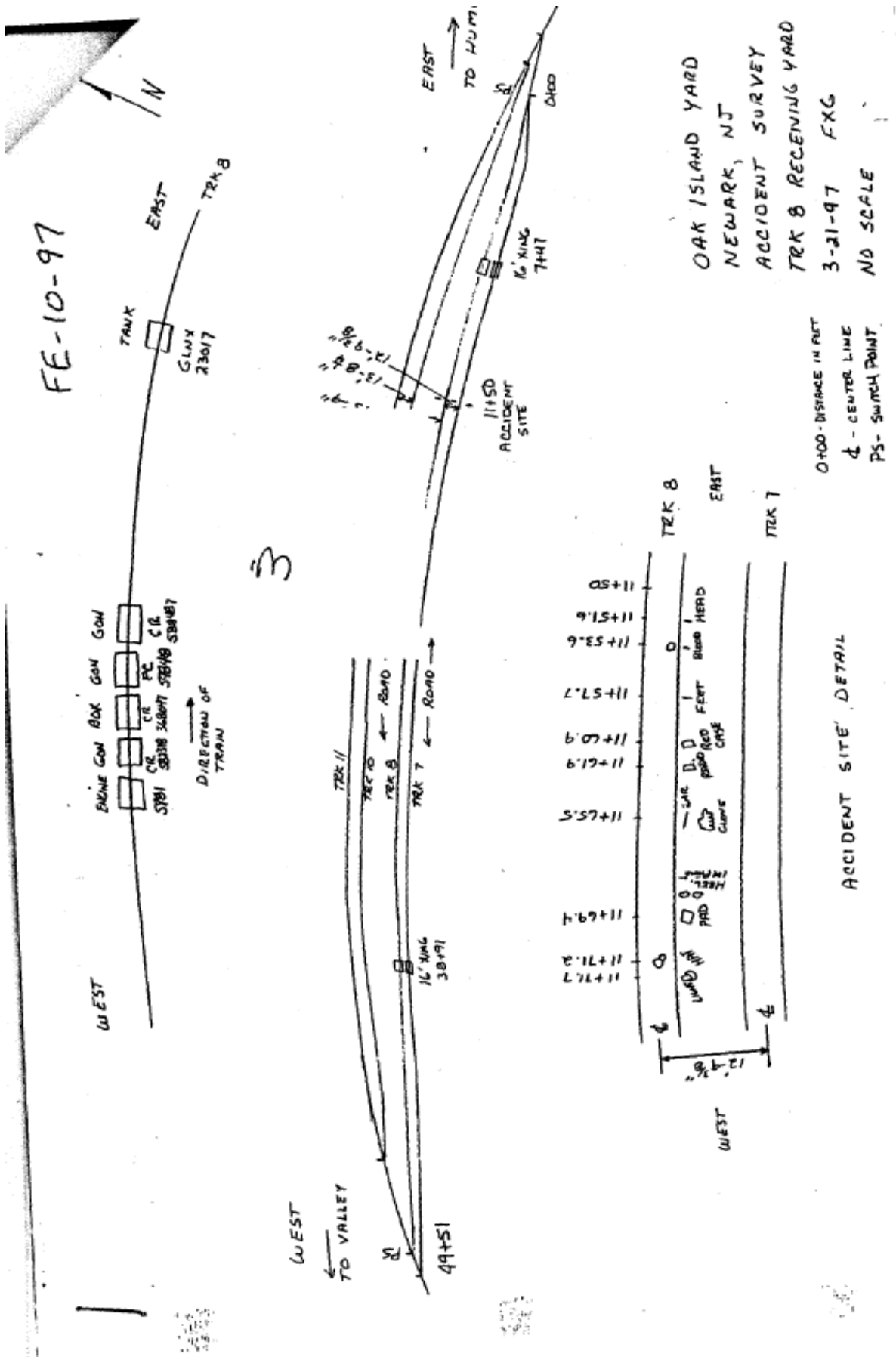
There were no eye-witnesses to the accident. Upon reaching the west end of the 72 cars on Track No. 7, the co-worker attempted several times to contact the Carman by radio. Receiving no answer, he began walking eastward toward the opposite end of the track in search of the Carman. At some point, he radioed the Foreman to inform him of the missing employee. The Foreman notified the Yardmaster to stop all train movements in the yard, and he and another Carman proceeded to the receiving yard to assist in the search.

At approximately 8:00 p.m., the Carman was found fatally injured lying between Tracks Nos. 7 and 8. Evidence indicates that the Carman was struck in the back and left shoulder by the moving equipment traveling east on Track No. 8. His right arm was severed above the elbow by the wheels of the passing equipment. While awaiting the arrival of the emergency responders from University Hospital in Newark, NJ, the Foreman performed CPR to no avail.

Post-Accident Investigation

Federal Railroad Administration (FRA) investigators inspected the equipment involved and found no defective conditions that would have contributed to the cause of the accident. There were no lading or other protruding parts of the cars which could have struck the deceased. No exceptions were taken to the condition of the locomotive. A re-enactment of the shoving movement was conducted the following day to determine at what point an individual located on the ground between Tracks Nos. 7 and 8 could be seen from the locomotive cab. Due to the right-hand curvature of Tracks Nos. 7 and 8, the end of the leading car could not be seen from either side of the locomotive cab during the backward shoving move.

Post-accident interviews revealed that the Engineer and the Brakeman were unaware that the equipment had struck the Carman. The Conductor, who was positioned at the west end of the tank car awaiting the arrival of the shoving movement, did not see the accident either.



Tasks

1. What were some factors that contributed to this incident?
2. Who made up the crew (interactive team) that needed to work together to ensure that these moves were completed safely?
3. What are some actions that the carman could have taken to protect himself?
4. What are some actions the train crews could have taken to potentially prevent this accident?
5. What are some elements of technical proficiency that could have played a role in this incident?

Dangerous Dumper

Employees Involved in Accident:	<ul style="list-style-type: none"> • Carman A • Carman B
Railroad:	Illinois Central Railroad, a subsidiary of Canadian National Railroad (CN)
Employee Craft:	Maintenance of Equipment
Location:	Stevens Point, WI
Accident Date and Time:	September 19, 2002; 10:55 p.m., CST
Type of Accident:	Explosion
Fatalities/Injuries:	Carman A fatally injured
Property Damage:	Unknown

The Incident

Circumstances Prior to the Accident

For the purpose of the identification in this report, Carman A was fatally injured, and Carman B was seriously injured.

On Sept. 19, 2002, two Carmen reported for duty at approximately 6:30 a.m. at CN's Wisconsin Central Division, Stevens Point, Wisconsin car shop. The two Carmen were assigned to work on Track No. 5 in the car shop. Their shift began at 7 a.m., at which time a 10-minute safety briefing was conducted with the reading of the safety rule of the day. The two Carmen then went to work.

The Accident

After repairing a couple of freight cars, the Carmen spotted air-actuated, side dump car No. CN 56034 for repair. One of the air dump cylinders had to be removed from the car to repair broken bolts in the cylinder head. The connection lug that attached the cylinder to the side of the car sat on top of the cylinder and was held in place by four ½-inch by 2-inch bolts. While Carman B removed the bolts that secured the air dump cylinder to the car, Carman A obtained a fork lift to safely handle the air cylinder. The cylinder was lifted away from the car with the fork lift and moved to a location between Tracks Nos. 4 and 5 inside the car shop.

The Carmen placed the cylinder on blocks to avoid damage to the air pipe on its bottom. They discovered that three of the four bolts that attached the small cylinder head to the car were broken and the other one was missing. In order to remove the broken bolts from the cylinder the Carmen would weld a nut onto the remaining portion of the broken bolt in the cylinder so that a wrench could be used to turn the bolt. The Carmen were attempting for the second time to weld a nut to the broken portion of one of the three broken bolts because the nut had come off the broken bolt on their first attempt.

Carman A was leaning over the cylinder holding the nut with a pair of pliers, and Carman B was attempting to weld the nut in place. As Carman B started to weld the nut, an explosion occurred within the cylinder, causing the large portion of the 2-stage cylinder to rapidly move upward. Carman A was struck in the upper chest and head with the large portion of the cylinder. The impact threw him against dump car; he bounced off the car and came to rest between Tracks Nos. 4 and 5 next to a building support beam and large floor fan. Carman B was struck in the face and was found hunched near the west truck of the dump car with facial bleeding. The first responder to the accident scene was the Stevens Point Police, followed shortly by the Stevens Point Fire Department EMT team. Carman A was transported to Saint Michael's Hospital where he was pronounced dead at 11:15 a.m. by the Portage County Coroner.

Post-Accident Investigation

The car had been bad-ordered for a broken connection lug assembly on the top of one of the pistons used to tilt the car to dump the load. CN 56034 was equipped with four 2-stage, air dump cylinders, two on each side near the ends of the car. The 2-stage air dump cylinders comprised a housing approximately 39 inches tall by 32 inches in diameter. Inside the cylinder were two pistons, a large one and a smaller one. As air pressure was introduced into the cylinder housing, the larger piston deployed first to a height of two feet. Then the smaller piston deployed also to a height of two feet, to complete the dumping cycle of the car. The connection lug that attached the cylinder to the side of the car sat on top of the small piston and was held in place by four ½-inch by 2-inch bolts. On this particular cylinder, three of the four retaining bolts were broken and the fourth bolt was missing.

According to statements of employees in the vicinity, the first attempt at welding on the broken bolt failed, so the two Carmen attempted to re-weld another bolt or nut to the broken portion. At this time, an explosion occurred. According to the other employees in the area, the explosion sounded like a shotgun blast, and one employee working on the next track thought that a freight car had fallen off its jacks.

During an investigation of the accident site, investigators found an aerosol spray can of carburetor and fuel injector cleaner (Penray Gum-solve) on the brake step of the side dump car. On September 25, FRA viewed the air cylinder and accident site. Close examination of the connection lug cap revealed an accumulation of grease and oil on the bottom side that attached to the small piston head. They examined the top of the small piston which was found to be completely grease and oil free. This indicated the piston head had been wiped clean with rags and some sort of solvent.

During the interviews, a Carman who was working on adjacent Track No. 4 stated that he smelled something like paint or paint thinner. He said he was going to complain because he was very sensitive to these type of vapors. If indeed the solvent was used to clean the piston head, the one missing open bolt hole would have allowed the excess solvent to enter the cylinder chamber. Thus, the vapors would have had an enclosed area in which to accumulate and create a hazardous situation. In this case, when the second attempt was made to weld on the piston head, a spark would have entered the cylinder chamber through the open bolt hole and caused an explosion to force the large piston upwards.

All the rags in the area, the two Carmen's clothing, and the cylinder along with the mate cylinder on the same side of the car were examined by an independent laboratory for contaminants that could have caused the explosion.

The initial Portage County Coroner's report stated that along with blunt trauma injuries to Carman A, there were first and second degree burns to his head along with singed hair. This would indicate that an explosion had occurred.

On Dec. 20, 2002, the results of the tests were reviewed. The MIG welder and argon tank that was used for welding the nut on the broken bolt had been analyzed and found to be

normal. The contents of the Penray Gum-solve (Gum-solve) cans were analyzed, along with the rags and clothing found at the accident site. The contents of both the suspect can of Gum-solve found on the car's crossover platform and an exemplar can of Gum-solve. The major ingredients of Gum-solve are Acetone, Toluene, and Xylene.

The findings of the comparison analysis of the failed cylinder and the exemplar cylinder were that residue in the failed cylinder had 300 times the level of Toluene compared to the exemplar cylinder. The failed cylinder had nine times the Acetone levels and 200,000 times the level of Xylene. The failed cylinder also had 60,000 times the level of Ethyl-benzene, and the exemplar cylinder had none. In addition, the rags and clothing from the site were also found to have the same ingredients from the Gum-solve on them.

In conclusion, the use of Penray Gum-solve on the side dump air cylinder resulted in the solvent entering the enclosed cylinder where it began vaporizing. The welding process on the cylinder's piston provided the source of ignition which caused the vaporized Gum-solve to combust, and the cylinder to extend rapidly, causing the fatality and injury to the Carman. This also would be consistent with the statement of the Carman working on the adjacent track that he smelled something which caused him irritation. The vapors from the Gum-solve are heavier than air. The Carman was working in a pit on the next track near the location where the two Carman had placed the air cylinder. The vapors hugged the ground and caused him to experience irritation. In interviews, Carman B consistently denied that he used or saw Carman A use the Gum-solve.

The toxicological tests on Carman A were negative.

Tasks

1. What was the critical error?
2. What did the two carmen think the situation was regarding the use of Gum-solve to the task they were working on?
3. What conditions were present that led the carmen to develop their perception of the situation to be safe to use the Gum-solve?

4. What cues existed that the carmen could have used to alter their perception of the situation?

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

<i>CRM PRINCIPLES</i>

No Blue Flag Protection

Employees Involved in Accident:	Car Inspector
Railroad:	Delaware and Hudson Railway Company (subsidiary of the Canadian Pacific Railroad)
Employee Craft:	Maintenance of Equipment (MOE)
Location:	Binghamton, NY
Accident Date and Time:	April 9, 2002, 8:15 p.m., EST
Type of Accident:	(Example: Collision, Derailment)
Fatalities/Injuries:	Car inspector fatally injured by rolling car
Property Damage:	NA

The Incident

The fatally injured Car Inspector reported to work at 1 p.m., following 16 hours off duty, the injured Car Inspector reported for duty at 3 p.m., following 16 hours off duty and the Yard Master reported for duty at 3 p.m., following 16 hours off duty. The yard crew (Locomotive Engineer, Conductor, and Brakeman) reported for duty at 3:59 p.m. The Locomotive Engineer had 10 hours, 20 minutes off duty after working 12 hours; the Conductor stated he had received the proper rest; and the Brakeman had been off duty for 16 hours.

At approximately 7:50 p.m., the Conductor of the yard crew received instructions from the yard Master (via the switch list) to switch 35 cars located on the No. 2 Runner Track. After switching 25 cars on Yard Tracks Nos. 2 through 15, which are used for switching freight cars and classifying outbound trains, the crew determined that the 26th car (CTX 14344) was a “bad order” car which was to go to track No. 16, which was used for storing “bad order” cars destined for the car repair facility and to perform minor repairs.

At approximately 8 p.m., the Yard Master telephoned the fatally injured Car Inspector, who was performing inbound and outbound inspections, and instructed him to replace a coupler knuckle on car SAN 505, located on Track No. 16. A short time later, the fatally injured Car Inspector departed the trailer en route to Track No. 16. The injured Car Inspector, who was also performing inbound and outbound inspections, arrived to assist the fatally injured Car Inspector. When working on equipment, Car Inspectors are to provide themselves with blue flag protection as specified by DH Operating Rules and 49 CFR, Part 218, Subpart B. However, neither of the Carman put up blue flag protection or assured that each remotely and/or manually controlled switch was lined against movement to the track on which they were working and locked with an effective locking device.

The area on Track No. 1, around car SAN 505 (the car they were to replace a couple knuckle) was dimly lit. Weather conditions at the time of the accident were overcast, with scattered rain showers. The temperature was 46° F.

At approximately 8:20 p.m., the yard crew shoved and released Tank Car CITX 14344 south en route to Track No. 16. The car was released at 4 to 5 mph, approximately 359 feet from the switch controlling access to Track No. 16. When rolling freely down Track No. 16, the black tank car could not be heard. At the time the Tank Car CITX 14344 was released, the fatally injured Car Inspector was replacing the coupler knuckle on the south end of car SAN 505, and the injured Car Inspector was holding the coupling lever.

The free rolling car impacted the north end of standing Car SAN 505, causing it to roll south. The impact knocked the fatally injured car inspector to the ground, and the car rolled over him severing both legs. The injured Car Inspector was knocked clear, but sustained injuries to his face, shoulder, and back.

The injured Car Inspector contacted the Yard Master via radio to report the accident and requested medical assistance. Emergency responders arrived at the scene at approximately 8:30 p.m., but were unable to save the life of the fatally injured Car Inspector.

Tasks

1. What was the critical event or error?
2. What type of miscommunication contributed to this accident?
3. In this scenario, what is the relationship between communication and situational awareness?
4. Where there any more missed opportunities for communication by anyone in this scenario?

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

<i>CRM PRINCIPLES</i>

EOTD Application without Blue Flag Protection

Employees Involved in Accident:	<ul style="list-style-type: none"> • Carman (53 years old/29 years, 7 months of experience) • Another Carman (Co-Worker) • Yardmaster • Two Train Crews
Railroad:	St. Lawrence & Hudson Railway (A subsidiary of Canadian Pacific and formerly known as the Delaware and Hudson)
Employee Craft:	MOE
Location:	Binghamton, NY
Accident Date and Time:	July 24, 1997, 3:50 a.m., EST
Type of Accident:	Carman struck and killed by train
Fatalities/Injuries:	One fatality
Property Damage:	Unknown

The Incident

Circumstances Prior to the Accident

On Wednesday, July 23, 1997, a St. Lawrence & Hudson Car Inspector (Carman) reported for his regularly assigned duties working the 10 p.m. to 8 a.m. shift (10-hour shift) at the railroad's East Binghamton Yard in Binghamton. The yard's 17 tracks were geographically aligned east/west and were south of the railroad's two freight main lines which were designated from north to south as No. 2 Runner and No. 1 Runner, respectively. The railroad's timetable direction was north/south with timetable north being the west end of the yard and timetable south being the east end of the yard.

At approximately 3:15 a.m. on July 24, the Carman and a Co-Worker were informed by the on-duty Yardmaster that two tracks were ready to be used. Outbound Train 268 was waiting for an air brake test on Track No. 4, and 46 cars for outbound Train 270 were ready to be inspected on Track No. 5. After obtaining an additional end-of-train (EOT) device from the shop and placing it into the Carman's company vehicle (known as a "mule"), the two Carman proceeded to opposite ends of the yard. The Carman locked and flagged the east end of Track No. 5 while his Co-Worker did the same on the west end. After connecting the ground air to the end of the west car, the Co-Worker began walking eastward, inspecting the south side of the cars on Track No. 5 (Train 270) while the Carman performed the brake test on Train 268 on Track No. 4. After completing the brake test, the Carman was to join his Co-Worker and help finish inspecting the cars on Track No. 5.

At 3:35 a.m., the Co-Worker overheard the Carman's radio transmission informing the Crewmembers of Train 268 that the brake test was complete and that they were "OK to depart." He noted the time in his notebook. As Train 268 began pulling westward, its departure was temporarily interrupted by a cut of cars fouling the yard's Track No. 1 switch. Continuing his

inspection of Track No. 5, the Co-Worker reached the easternmost car and noticed the Carman's vehicle parked next to the No. 1 Runner.

On July 23, 1997, the Crew for East Binghamton Yard Switcher Job YBHS-66 (also known as 6R), reported for duty at 11:59 p.m. The 3-person Crew consisted of a Locomotive Engineer, Conductor, and Brakeman. At approximately 3 a.m. on July 24, the Crew received instructions to make up Train 269 on the No. 1 Runner. After performing several switching moves, during which they classified cars according to the switch list provided by the Yardmaster, the Crewmembers pulled 19 cars westward out of Yard Track No. 1, leaving 14 cars in the track and fouling the switch. They then shoved the cars eastward onto the No. 1 Runner and coupled to four cars they had previously left on the west end of the track. After coupling to the standing four cars, they shoved the entire cut of 23 cars eastward to spot them at the ground air plant. After stopping, the Brakeman instructed the Engineer to pull ahead (westward), believing that the head five were to go back to Yard Track No. 1. After pulling ahead, the Conductor radioed the Brakeman, informing him that all the cars were to remain on the No. 1 Runner. The Brakeman stopped the movement and instructed the Engineer to shove back (eastward) to the original position at the ground air plant. This completed the make up of Train 269, except for the outbound power, which was still at the engine house. The Crew uncoupled the locomotives and returned to Yard Track No. 1 where they shoved the cars they had left fouling the switch into the clear, allowing Train 268 to depart the yard off Track No. 4.

The Accident

There were no eyewitnesses to the accident. It is believed that the Carman attempted to apply the EOT device to the rear of the east end car (TTAX 554144) on the No. 1 Runner prior to the completion of the switching moves being made by YBHS-66. At some point during a shoving move eastward, the Carman was evidently knocked to the ground and rolled over by the wheels of the moving equipment.

After noticing the Carman's vehicle, the Co-Worker proceeded to the No. 1 Runner and discovered the fatally injured Carman beneath the wheels of the fifth car from the east end of the train. He contacted the Yardmaster by radio. The Yardmaster then called emergency responders at approximately 4:17 a.m. Emergency responders included the local sheriff's department, fire department, and EMS technicians. The local Coroner pronounced the victim dead at the scene and established the time of death as 3:50 a.m. The Coroner then ordered the body transported to a local hospital for autopsy.

(Please see the attached diagram of Binghamton Yard to better visualize the accident scene and chain of events that led up to the fatality.)

Post-Accident Investigation

Post-accident interviews were conducted with individuals having direct knowledge of the accident. The involved equipment was inspected for compliance with applicable safety regulations with no conditions noted which would cause or contribute to the cause of the accident. The EOT device was found positioned on the coupler of the east end car of the train

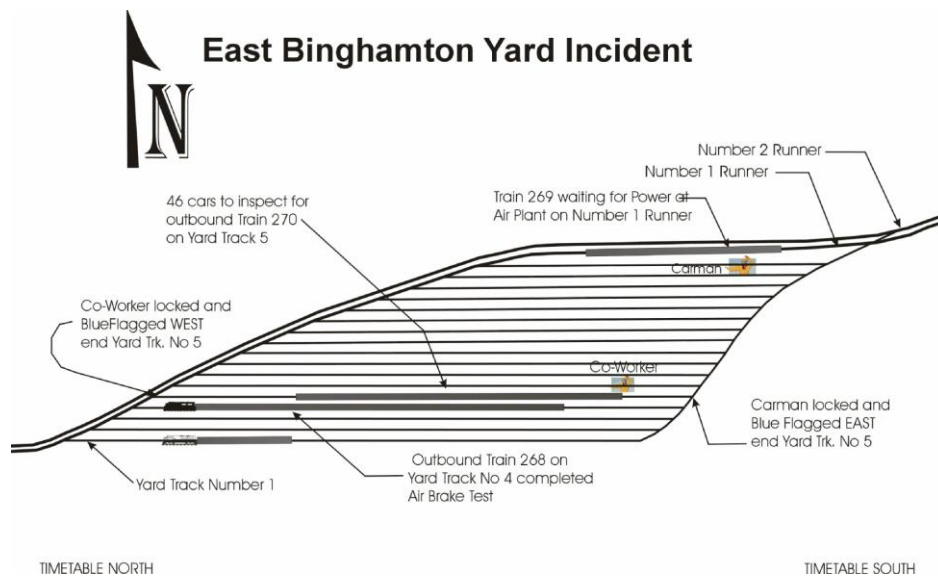
without the air hose connected. The investigation disclosed that no Blue Signals were displayed at either end of the cars on the No. 1 Runner.

Documentation indicated that the Carman had received training in the proper application of Blue Signal protection in March 1995 and March 1996; however, he had been disciplined in the past for not applying the Blue Flag rule. The Carman's portable radio and flashlight were found in the vehicle and were working as intended. The YBHS-66 Crew was unaware of the presence of the Carman working on the No. 1 Runner. Results of mandatory post-accident toxicology testing of the Carman's remains were negative. Cause of death as determined by autopsy was, "Compression injury of lower thorax with multiple internal injuries."



Satellite View of East Binghamton Yard

Source: <http://broomegis.co.broome.ny.us>



Schematic of East Binghamton Yard Accident (Not to Scale)

Source: TTI-developed graphic based upon FRA Report

Tasks

1. What critical event occurred that set up this accident?
2. The FRA report does not state that a formal job briefing between the two carmen was conducted; however, it does state that an understanding existed between them as to what actions each was going to take to get Trains 268 and 270 ready for movement. What action did the carman take that disrupted the expected pattern?
3. What actions could the carmen have taken to alert his co-worker and other team members of his actions?
4. What cue caused the co-worker to suspect that something had gone wrong with the carman?
5. Were any other CRM principles violated during this scenario?

Poor Support In Soft Yard

Employees Involved in Accident:	<ul style="list-style-type: none"> • Carman 1 • Carman 2 • Carman 3
Railroad:	Norfolk Southern Corporation
Employee Craft:	MOE
Location:	Frankfort, IN
Accident Date and Time:	March 6, 2002, 1:40 p.m., EST
Type of Accident:	(Example: Collision, Derailment)
Fatalities/Injuries:	Carman
Property Damage:	

The Incident

Circumstances Prior to the Accident

For the purpose of identifying the Carmen involved, Carman 1, 2, and 3 will be used. Carman 1 was fatally injured.

On March 6, 2002, Carmen 1 and 2 reported for duty at approximately 6:45 a.m., at NS's South Yard in Lafayette, Indiana. Carmen 3 reported for duty at approximately 6:30 a.m. After their morning stretching exercises, the Carmen reviewed the safety rule of the day and the incident report. The Lead Carman laid out their work assignments for the day. Carman 1 was to proceed to the east yard in Lafayette, Indiana to repair a locomotive. Carmen 2 and 3 would inspect and repair freight cars in the south yard. Carman 1's next assignment was to go to Frankfort, Indiana to repair defective freight cars with Carmen 2 and 3. The three Carmen loaded two pairs of wheels on the repair truck. Carman 1 drove the repair truck to Frankfort while Carmen 2 and 3 followed in a pick-up truck. They stopped en route for lunch about 11 a.m.

They arrived at Frankfort at approximately 11:40 a.m. Carman 1 proceeded to the west end of Track 14 to establish Blue Signal Protection. The other two Carmen took care of the Blue Signal Protection at the east end of Track 14. Carman 1 proceeded to repair a crossover platform on a boxcar. The two other Carmen repaired a covered hopper, and then helped Carman 1 finish repairing the box car.

The Carmen separated a tank car (GATX 1367), which carried a load of coconut oil, from the rest of the cut of cars by using the power winch on the repair truck. Once they had separated the tank car, the Carmen positioned wood blocking on the ballast on the east end of the car and placed chock blocks under the wheels on the west end. They placed hydraulic jacks on the blocks, lifted the tank car by the jacks, and removed the freight car's truck to change the truck's wheels. The car was lowered to rest on the jacks. The truck was disassembled. At this time,

Carman 3 took the pick-up truck to obtain parts to repair the truck. After Carman 3 returned, Carman 2 took the pick-up truck to retrieve another part. The new truck components were applied to the truck. After reassembling the truck, the car was again lifted. As the truck was being placed under the car, Carman 1 noticed a broken truck bolster side-bearing cage on the b-end right side of the truck. Carman 1 told Carman 2 and 3 to stop the truck with the No. 2 wheel axle positioned under the coupler of the car. He stated that this was to protect the car if it dropped. The side-bearing cage was removed and, while in process of replacing the bolts, Carman 1 positioned himself between the truck bolster and the No. 2 wheel axle toward the north side of the truck side. The reason was they had problems holding the bolt in the truck bolster in order to secure the side-bearing cage.

The temperature was 51° F.

The Accident

After securing the side-bearing cage, Carman 1 attempted to move from between the axle and the truck bolster. Carman 3 saw the car start to move and shouted to Carman 1, "LOOK OUT!" Before Carman 1 could move, the tank car shifted, crushing him against the right No. 2 wheel. Both Carman called to Carman 1, but received no response. Carman 3 called to the Yard Clerk on the radio and requested an ambulance and then left in the pick-up truck to guide the ambulance to the accident site. The Frankfort Fire Department EMT unit was the first to arrive on the scene. Carman 1 was pronounced dead at the scene by the Clinton County Coroner.

Post-Accident Investigation

A re-enactment of the incident revealed that Carman 1 was in an unsafe position between a jacked freight car and the partially removed freight car truck.

Prior to the incident, the blocking under the jack, on the north side of the tank car, was pressed into ballast (stones) and soil. Extreme temperature fluctuations (from 4° F on March 3 through March 5 to 40° F on the afternoon of March 6 when the incident occurred) caused the ground to thaw from a frozen state and allowed the blocking to sink into the ballast. Subsequently, the jacks and car shifted, crushing the Carman.

Following the accident/incident, the deceased was tested for drugs and alcohol. The tests were negative.

Tasks

1. Who was in charge of this work team?

2. What was the critical event in this incident?

3. What could have been done by the team members to prevent the critical event from occurring?

4. What was the team leader's level of technical performance in this incident? Did he know and follow all the rules applicable to safely carry out this job?

5. What other CRM principles were violated in this scenario?

CRM PRINCIPLES

Caught by a Shoe

Employees Involved in Accident:	<ul style="list-style-type: none"> • Fatally Injured Machinist • Machinist Co-Worker
Railroad:	Metro-North Commuter Railroad Company (MNCR)
Employee Craft:	MOE
Location:	New Haven, CT
Accident Date and Time:	March 5, 2002, 6:30 p.m., EST
Type of Accident:	Crushing accident between machinery and work piece
Fatalities/Injuries:	New machinist
Property Damage:	Unknown

The Incident

Circumstances Prior to the Accident

On March 5, 2002, at 3:55 p.m., the MNCR Machinist reported for his regularly assigned shift (4 p.m. to midnight) at the railroad's equipment maintenance facility in New Haven, Connecticut. His assignment was to work with a co-worker (another Machinist) on the wheel true machine housed in Building No. 2 (a.k.a. "wheel mill"). The co-worker was working overtime after having completed his regular 8 a.m. to 4 p.m. shift. The two Machinists were assigned to reprofile (a.k.a. "true") the No. 1 wheels on MU Locomotive No. 8820 and the No. 2 and No. 3 wheels of MU Locomotive No. 8821. Building No. 2, located west of the railroad's main maintenance shop, was a permanent metal building with a single track running east/west through it. The wheel true machine was housed in a concrete pit area located in the center of the building. The pit had plywood windscreens at the east and west ends of translucent lexan windscreens on the north and south sides.

The routine procedure for Machinists assigned to the wheel true machine was to reposition locomotives onto, and off of, the wheel true machine as needed. The workers used two devices to reposition the equipment on the wheel true machine: 1) a capstan and rope, and 2) a winch and cable. The capstan was a rotation cylindrical device which was operated electrically and moved by connecting a rope with a hook attached to one end of the equipment and wrapping the rope around the rotating capstan, thereby moving the equipment into proper position on the wheel true machine. The electrically operated winch could be utilized similarly. When either device was used, visual and audible warning devices were activated to warn workers of the movement. These warning devices were located both inside and outside of the building.

At the time of the accident the Machinist had completed their work on the Locomotive No. 8820, and were in the process of repositioning the No. 3 wheels of Locomotive No. 8821 onto the truing machine. The weather at the time of the accident was cold and clear. The outside temperature was 28° F.

The Accident

Prior to the accident, the fatally injured Machinist was participating in the movement of the equipment, and as was the customary practice, was to place a wooden chock on the rail to stop the equipment when the No. 3 wheel was properly positioned on the machine. He was positioned on the north side of the equipment in the wheel true pit near the control panel. The other Machinist was positioned at the electrically driven capstan approximately 55 feet from the control panel area. From this position, he was unable to see the Machinist at the control panel due to the plywood wind screen.

As the equipment began to roll, the Machinist operating the capstan shouted "free roll" to warn the Machinist in the pit. He released the tension on the rope and dropped it. As the locomotive moved onto the machine's idler rollers, the Machinist heard the idler rollers sliding into place as the equipment stopped moving. At this time, he heard moaning sounds from his co-worker in the pit. He looked between the side of the locomotive and plywood windscreen and observed the injured Machinist who was pinned between the wheel true machine's axle centers and the locomotive's third rail shoe. The Machinist immediately telephoned the Shop Foreman and told him to call "911." He then attempted to move the locomotive to free the pinned Machinist. When the equipment moved off the injured Machinist, he fell to the floor. He was alert and responsive, but complained of breathing difficulty.

The first person to arrive on the scene, an MNCW employee trained in emergency response, administered first aid. EMS personnel from American Medical Response and personnel from the New Haven Fire Department responded. The injured employee was transported by ambulance to Yale New Haven Hospital where he succumbed to his injuries at 7:25 p.m.

Post-Accident Investigation

FRA's investigation included the following: an inspection of the equipment and work area; interviews with co-workers and supervisors; and review of employee qualifications, training, and method of operation. The track inside the wheel true building was inspected by FRA. The track met or exceeded the requirements of Federal Track Safety Standards for "Class 1" track, 49 CFR Subpart C, Track Geometry, Section 213.63. The north rail had a 1-inch profile (depression) about 19 feet west of the wheel milling machine, and a 1 3/4-inch profile (rise) in the north rail at the center of the wheel milling machine.

FRA investigators concluded that the movement had been conducted in compliance with Federal regulations concerning blue signal requirements (49 CFR, Part 218.29). They also concluded, however, that the fatally injured railroad employee had failed to remain clear of moving equipment and had placed himself in an unsafe position during the movement of equipment.

The fatally injured employee, who had just five months experience working in the wheel true shop, had received no formal training other than "on-the-job" training provided by co-workers. FRA found no written standard procedures available to employees regarding proper

procedures to be followed in repositioning equipment in the building. The employee and his co-worker had not worked together often and were unfamiliar with one another's work habits.

Investigators found that the plywood windscreens on the ends of the pit area prohibited employees from observing each other during the moves, inconsistent with MNCW Safety Rule No. 9176. The location of the "idler roller control valve" required employees to foul equipment in order to operate the valve. Indications are that the fatally injured employee activated the valve while the equipment was still rolling and just prior to being pinned.

The railroad took the following remedial actions:

- Removal of the east and west end plywood windscreens;
- Removal of the capstan and winch from service;
- Placement in service of a shuttle wagon (remote control car mover);
- Implementation of a formal wheel true training program in May 2002;
- Development of formal training program for movement equipment; and
- Redesign (including relocation) of the wheel true's idler roller control valve, to allow employees to operate the wheel true without fouling the equipment.

Toxicology testing was conducted by Chief Medical Examiner's office of the State Of Connecticut. All test results were negative.

Tasks

1. What CRM principles could have been better applied in this incident?

2. List examples of technical proficiency that could have helped to avoid this incident.

3. List examples of situational awareness that could have helped to avoid this incident.

4. List examples of communications that could have helped to avoid this incident.

5. List examples of teamwork that could have helped to avoid this incident.

6. List examples of assertiveness that could have helped to avoid this incident.