Rail Crew Resource Management Pilot Course

Participant's Manual

Version 1.2 (T)
Transportation
2005

Railroad Crew Resource Management (CRM) Training Course

Transportation 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?

Introduction

Class Schedule

Morning: Modules 1-3

Afternoon: Modules 4-6

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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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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 teams 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

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

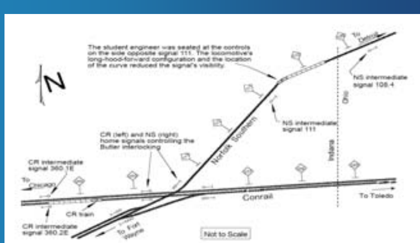
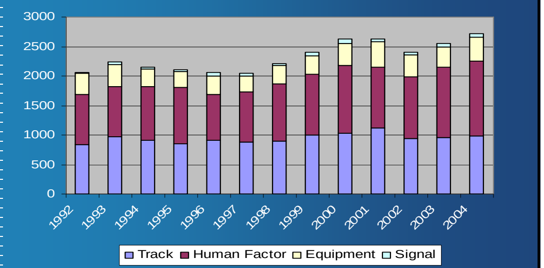


Figure 1 Conrail (CR) and Norfolk Southern (NS) signals in area of Butler interlocking

Introduction

Why CRM?



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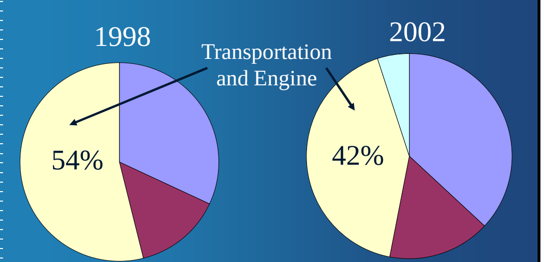
Introduction

Railroad Employee Fatalities by Craft



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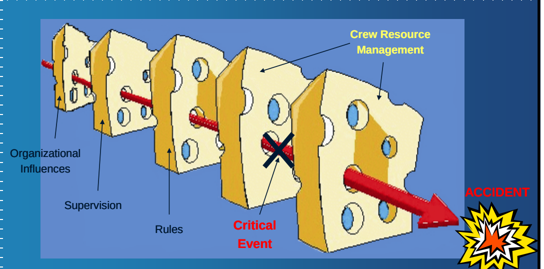
Introduction

Swiss Cheese Model



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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

Runaway Cars

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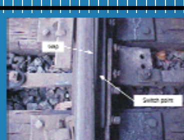
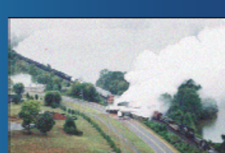
Introduction

Split Switch





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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

Unfamiliarity with Equipment Leads to Crash

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

Reality/Perception of Situation

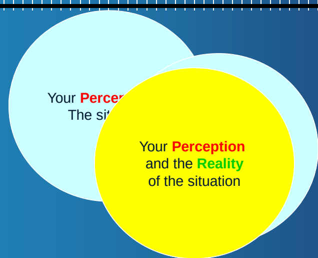
Reality of the Situation

Your **Perception of** the Situation

Too Many Cars

Situational Awareness

Accidents Caused by Loss of Situational Awareness



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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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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

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

Clarendon Head-On Collision

8876 E

0747–Dispatcher issues TW 15 authorizing the 8876 E to move from Restricted Limits Amarillo to the East Siding Switch at Malden and to hold the track.

0749–Dispatcher issues TW 16 authorizing the 8876 E to move from the East Siding Switch at Malden to the East Siding Switch at Ashtola **after the arrival of 9984 W** and hold the main track at Ashtola.

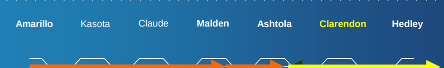
Clarendon Head-On Collision

8876 E

4385 W

0826–Dispatcher issues TW 19 authorizing the 4385 W to move from the West Siding Switch at Hedley to the East Siding Switch at Ashtola after the **arrival of the UP 5827 E** and to clear main track at Ashtola.

Clarendon Head-On Collision



8876 E

4385 W

0843–Dispatcher issues TW 22 authorizing the 8876 E to move from the East Siding Switch at Ashtola to the East Siding Switch at Hedley **after the arrival of the 4385 W** and to hold main track at Hedley.

Communication

Clarendon Head-On Collision

4 minutes later

0847–The 8876 E exceeded its movement authority by continuing on the main track past the East Siding Switch at Ashtola.

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Communication

Communications Breakdown: Clarendon Head-On Collision

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Communication

Oral Communication

Video Clip

- 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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Teamwork

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”

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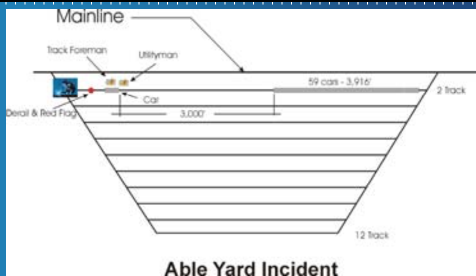
Teamwork

La Crosse, WI



Teamwork

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

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

Review of Each Module

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

Review

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

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

Review

Seventeen Mile Grade

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, about 35 °, 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.

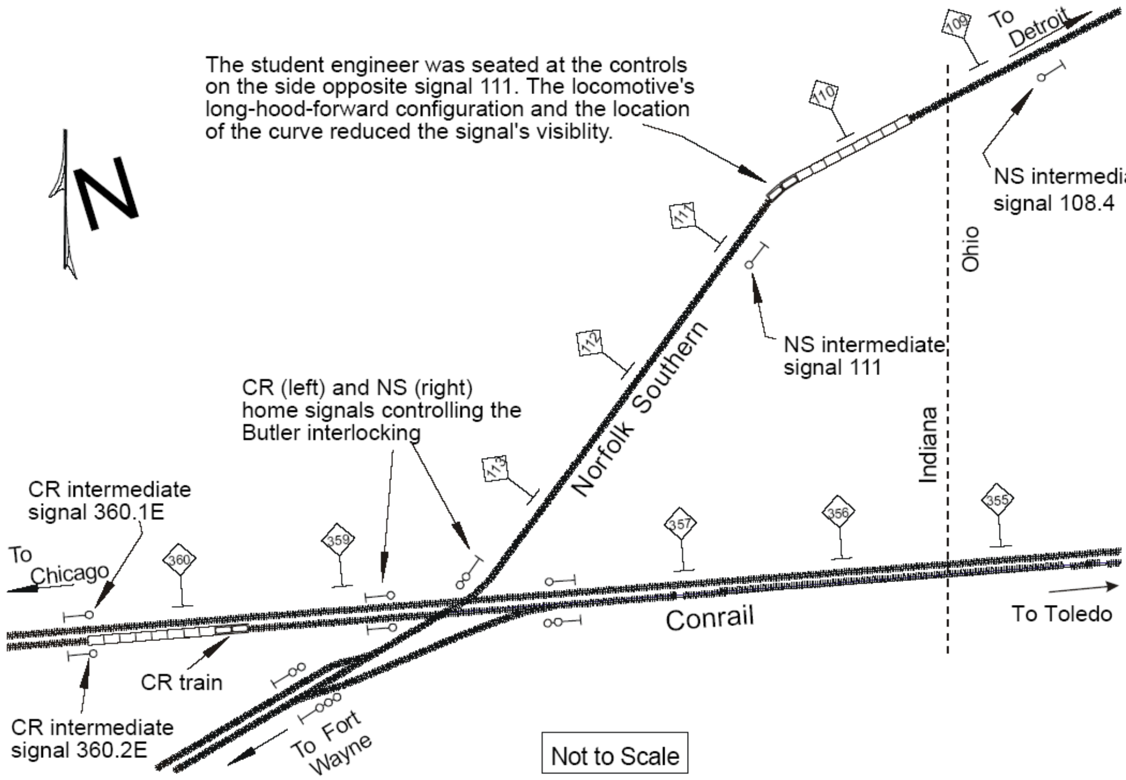


Figure 1 Conrail (CR) and Norfolk Southern (NS) signals in area of Butler interlocking

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 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?

Runaway Lumber Cars

Employees Involved in Accident:	• Inbound Crew Engineer • Inbound Crew Conductor • Switching Crew Engineer • Switching Crew Conductor • Trainman • Dispatcher • Chief Dispatcher • General Superintendent
Railroad:	Union Pacific Railroad
Train:	Inbound: QRVML-19 Switching: LOB32-20 31-car consist: 28 lumber cars, 2 paper cars, and 1 empty
Location:	City of Commerce, CA
Accident Date and Time:	June 20, 2003, 11:58 a.m., PCT
Type of Accident:	Derailment of runaway cars at approximately 95 mph
Fatalities/Injuries:	No fatalities, 13 injuries
Property Damage:	Total damages estimated at $2.4 million

The Incident

Phase 1

The crew for train QRVML-19, a mixed freight train with 3 locomotives and 69 cars, began their tour of duty in Long Beach, California, at 5:45 a.m. on the day of the accident. After a job briefing, they boarded their train, performed an air brake test, and departed the yard in East Los Angeles eastward toward Montclair Yard, about 31 miles away. The accident occurred on the Los Angeles Subdivision, which is controlled from UP's train dispatching office in San Bernardino, California. The main track(s) on this subdivision are centralized traffic control (CTC) and vary between one and three main tracks. The maximum timetable speed for trains on the Los Angeles Subdivision is 79 mph for passenger trains and 65 mph for freight trains.

After setting out 38 cars in UP's City of Industry Yard, the crew continued on to Montclair Yard with the 31 remaining cars. Of the 31 cars, all but one car were loaded. Twenty-eight cars (flatcars and boxcars) contained lumber or lumber products, and two cars contained paper. None of the cars contained hazardous materials. The 31 cars weighed 3,881 tons and had a total length of 2,281 feet. After delivering the 31 cars to Montclair Yard, the crew was to leave one locomotive on a storage track in the yard and continue eastward with the two remaining locomotives for about 20 miles to UP's West Colton Yard, where the crew was to go off duty.

As the inbound train approached Montclair Yard, the train dispatcher issued instructions to the conductor for the train to enter the siding and instructed him to communicate with road switch train (LOB32-20) for permission to jointly occupy the siding at Montclair. The conductor of the switching crew told the inbound train that they had permission and told them to "hi-ball" (to "disregard" or "skip") the brakes because "We're going to be coming up against the rear of your train." In this communication, the switching crew informed the crew of the inbound train not to set hand brakes on their train because the switching crew would couple their engine to the opposite end of the cars.

After the last car of the inbound train cleared the west switch into the siding at the west end of Montclair Yard, the conductor and brakeman of the switching crew were standing near the track and were preparing to assume responsibility for the train from the inbound crew. The switching crew engineer was with his locomotive in a yard track, making his way through several yard tracks to the west switch, preparing to enter the siding and approach the rear of the inbound train. Without setting handbrakes, the crew of the inbound train uncoupled their locomotives from the train. As intended, the separation of the cars from the locomotives caused the car's air brakes to apply in an emergency application. The crews were aware that the grade of the siding would cause cars without brakes to move downgrade. Both crews later told investigators that they expected the emergency application of the air brakes to hold the cars stationary and that because the switching crew's locomotive would quickly be attached to the opposite end of the cars, the cars would not be left standing for very long without a locomotive attached. Crews had done this before at this location, and UP supervisors acknowledged being aware of this method of exchanging cars from one crew to the other. However, UP's operating rules prohibit crews from relying on air brakes to secure cars when locomotives are detached. The rules require that a sufficient number of handbrakes be applied on the cars before detaching a locomotive. UP's *Air Brake and Train Handling Rules* also require that handbrakes be used to secure equipment.

After uncoupling the 3 locomotives and moving a short distance from the 31 cars, the inbound crew separated the lead locomotive from the other 2 locomotives, which remained on the siding a short distance from the cars of the inbound train. The crew then took the lead locomotive to the storage track, as instructed. After securing the locomotive on the storage track, the crew walked back to the two remaining locomotives as they prepared to depart the yard.

The conductor of the switching crew told investigators that he began bleeding the brakes on the cars, starting in the middle of the 31 cars and walking to the west, releasing the air brakes on each car as he walked by. As the trainman approached the middle of the train, the conductor said that he instructed the trainman to "start there [in the middle] and bleed the train eastward." When the conductor finished releasing the airbrakes of the cars on the west end, he returned to the yard to assist the engineer in bringing the locomotive from the yard track to the west end of the siding so that they could couple to the rear car and begin switching.

Meanwhile, the trainman completed his task of bleeding the cars and walked in the direction of the crew of the inbound train, who had placed the one locomotive on the storage track and were returning to their two remaining locomotives. As the trainman approached the other crew, the inbound crew noticed that the 31 cars were moving westward, downgrade, toward the switch at the west end of the siding.

The trainman ran after the cars in an attempt to climb aboard the moving cars and set handbrakes. However, the cars gained speed, and the trainman could not catch them. The conductor of the switching crew also noticed that the cars were moving, and he too began running toward the cars. The conductor also used his handheld radio to have the switching engineer alert the train dispatcher that the cars were rolling downgrade toward the main track. At other, similar, locations, a derail is in place to prevent equipment from entering the main track. At the time of this accident, no derail was in place at the end of Montclair Siding.

Phase 2

About 11:33 a.m., the switching engineer used his cell phone to contact the train dispatcher but was connected to voice mail. He then used the locomotive radio, selected "9" for an emergency radio contact with the dispatcher, and was immediately connected. The dispatcher determined that the cars were running away toward the main track. She said she immediately turned to the corridor manager to notify him of the runaway cars.

After rolling downgrade on the Montclair Siding, the 31 cars entered the main track at MP 35.1. The main track signal system recorded the runaway cars passing the west switch at Montclair and onto the main track of the Los Angeles Subdivision at 11:34 a.m. The main track was mostly on a descending grade ranging from 0.24 percent to 1.01 percent with short level sections between Montclair and Los Angeles. At the time of the initial notification about the runaway cars, personnel in the dispatcher's office were unaware of the grade of the main track. They also did not know the number of cars that were running away. Personnel in the dispatching office told investigators that they expected the cars to slowly come to a stop on the main track.

The engineer of the inbound train told investigators that he asked the dispatcher if he should take his locomotives and chase after the cars. The engineer moved his locomotives westward on the siding in pursuit of the cars but was stopped by a red signal at the west end of the siding.

Between 11:40 and 11:42 a.m. the corridor manager asked the chief dispatcher if he should send an engine after the cars. The chief dispatcher instructed him to wait for the cars to come to a stop. The chief dispatcher later told investigators he feared that an attempt to catch the cars could result in a collision. Unaware of the direction of the grade of the main track in this area, he instructed the corridor manager to re-line the Montclair Siding switch to prevent the cars from coming back into the yard and causing damage or injury. The train dispatcher contacted maintenance-of-way employees in the area and instructed them to clear the track.

During the next few minutes, a report of the movement of the runaway cars was received from the Pomona Police Department. The corridor manager notified the assistant general yard manager in the East Los Angeles Yard that the runaway cars were headed his way and for him to alert his crews and trains in the area to stop their trains and clear the main track. At this time, dispatching office personnel were uncertain if the cars would stop, reverse direction, or derail. Dispatching center supervisors told investigators that because of these uncertainties, they decided to continue evaluating the situation and gathering information; however, they did not notify local authorities about the runaway cars.

UP's mainline between Montclair Yard and City of Commerce varies between one and two main tracks. However, closer to Los Angeles there are three main tracks. The location of the derailment in City of Commerce was at a control point that contains switches that direct trains from one track to another in an area where the railroad changes from two main tracks to three. At this location, there is also a sidetrack named House Track No. 4. The entrance to House Track No. 4 was from a main track switch, which, like other main track switches in the area, was remotely controlled by the train dispatcher.

Allowing the cars to continue rolling on No. 1 main track beyond MP 7.1 would have directed the cars to roll toward Los Angeles and UP's Los Angeles Yard. UP managers were aware that a Metrolink passenger train was on this track beyond City of Commerce.
Four choices for diverting the runaway cars were available to the dispatchers:

- Divert them from the main track to a branch line that crosses two tracks of the Burlington Northern Santa Fe Railway over which high-speed freight trains and Amtrak and Metrolink passenger trains operate.

- Lining the switch from No. 1 main track to No. 2 main track which would have caused a head-on collision with a 93-car train carrying hazardous materials, including several cars of liquefied petroleum gas and chlorine residue.

- Lining the switch from No. 1 main track to No. 3 main track which would have caused a head-on collision with a UP switching crew. Had the switching crew not been occupying track 3, the runaway cars would have posed a risk to a fuel storage facility in Los Angeles near track 3.

- Lining the switch from No. 1 main track to House Track No. 4. Because the maximum speed of the turnout from the main track to House Track No. 4 was 15 mph, the managers knew that the speed of the cars would likely cause them to derail as they passed over the turnout.

At 11:47 a.m., the chief dispatcher inquired as to whether there were cars on House Track No. 4 and was informed that House Track No. 4 was clear of locomotives and cars. At 11:50 a.m., after considering all of the information that was available at the time, the chief dispatcher decided to have the dispatcher line the main track switch to direct the cars in the direction of House Track No. 4 because the tracks in the area presented a wide section of railroad right-of-way within which the cars could derail.

At 11:51 a.m., the chief dispatcher called the general superintendent of the territory and informed him of the situation. The superintendent, after being briefed by the chief dispatcher, agreed to route the cars toward House Track No. 4.

At 11:52 a.m., a maintenance-of-way employee who had been earlier instructed to clear the main track because of the runaway cars called the dispatcher's office and reported that the cars had been observed. When asked about the speed of the cars, the employee estimated that the cars were moving at "50 or 60" mph.

At 11:54 a.m., a voice radio transmission from a wayside defect detector at MP 14.8 broadcast the speed of the cars as 86 mph. (Based on time and distance measurements between control points, the runaway cars reached a calculated maximum speed of 95 mph.)

At 11:58 a.m., 28 of the 31 cars derailed due to excessive speed as they passed over the turnout into House Track No. 4. Cars 1 though 6 derailed but stayed on the right-of-way. Cars 7, 8, 11, and 13 departed the right-of-way and struck neighborhood residences. Cars 29, 30, and 31, the rearmost cars as the 31 cars rolled downgrade, did not derail. The runaway cars had traveled about 28 miles from Montclair Yard to the switch at House Track No. 4 in City of Commerce. Before derailing, the cars had traversed 25 highway rail crossings, 24 of which were equipped with active warning devices.

Tasks

1. What was the primary cause of the runaway cars in this scenario?

2. Once the cars exited the yard, what were some barriers to communication that prevented the dispatchers from realizing the potential for them to accelerate as quickly as they did?

3. What could have prevented this accident?

4. Did the road and yard crew's realize the potential implications of their normal exchange of cars on the siding?

Split Switch Derailment

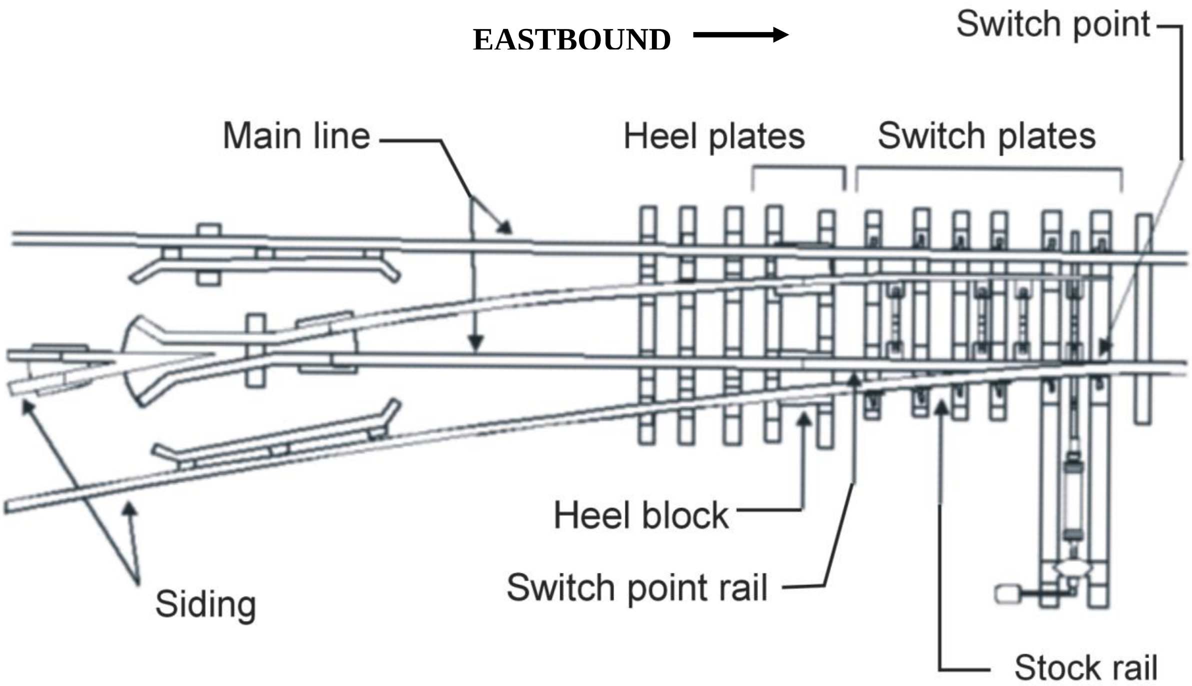
Employees Involved in Accident:	• Conductor • Engineer • Dispatcher • Signal Maintainer
Railroad:	Norfolk Southern Railway
Location:	Farragut, TN
Accident Date and Time:	September 15, 2002, 11:20 a.m., EST
Type of Accident:	Derailment
Fatalities/Injuries:	No fatalities or serious injuries
Property Damage: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

The Incident

At 8:30 a.m., eastbound NS train No. 721, en route to Knoxville, Tennessee, 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 about 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 a 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 about 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, about 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 first thing that went wrong?

3. What do you see as some errors after the initial error?

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.

Unfamiliarity with Equipment Leads to Crash

Employees Involved in Accident:	• Engineer • Conductor
Railroad:	National Railroad Passenger Corporation (Amtrak)
Train:	Amtrak train No. 90 "The Palmetto"
Location:	Baltimore, MD
Accident Date and Time:	June 17, 2002, about 5:42 p.m. EST
Type of Accident:	Collision/sideswipe and subsequent derailment
Fatalities/Injuries:	Six minor injuries—all treated and released
Property Damage:	$740,000

The Incident

The engineer of the Amtrak train was an extra-board employee based in New York City. On the day of the accident, the engineer had deadheaded from New York to Washington, D.C., to operate Amtrak Train No. 90 on a trip from Washington back to New York. When she arrived in Washington, she was surprised to learn that the train she was to operate was being pulled by two diesel-electric P-42 locomotives. She said she expected to operate electric equipment on this run, as she had on other occasions. She said her experience in operating P-42s was limited to training and operating in a yard environment and that she had never operated P-42s in revenue service. (Amtrak records stated that the engineer had operated a train with 2 P-42 locomotives on passenger run between Philadelphia and Washington under the observation of a designated supervisor of locomotive engineers about six months prior to the accident.)

Train No. 90 departed Union Station on time at 4:45 p.m. with the engineer as the only person in the locomotive cab. (Normal procedure for Amtrak trains as the conductor and other crewmembers are often busy taking care of passengers.) As the train proceeded out of the station and began to enter the main line, upon reaching 20 mph it experienced a penalty air brake application which stopped the train due to the territory switch being improperly positioned. The engineer stated that the electric locomotives she normally operated within the Northeast Corridor always had cab signals activated and thus did not require that the territory switch be repositioned. (The engineer had experienced a similar penalty brake application on an earlier occasion when locomotive cab signals of an electric Acela train set were not properly configured when she departed Washington, D.C., for New York City.) The engineer said that after she reported the penalty stop, as required, the trip north toward Baltimore was generally uneventful.

As the train approached the tunnel in Baltimore, the engineer received an approach medium signal indication, which required a speed reduction to 45 mph. The signal was followed by an approach signal indication, which authorized her to proceed through the tunnel at not more than 30 mph. The engineer said that while traversing the tunnel, she concentrated on maintaining a train speed of 30 mph. The engineer recalled that the brake system for train No. 90 was configured in the direct-release position, as opposed to the graduated-release air brake setup with which she said she was more familiar. She also said she normally engaged the dynamic brakes in electric locomotives but that she "…was not familiar with how to…control the train using the dynamic on those P-42s." Rather, she said she used the automatic brake to slow the train's speed through the tunnel. The engineer said that the track was on a descending grade as it approached the end of the tunnel and that as she traversed this section, her throttle was off and that the train pushed her along. She recalled that she initially used the independent brake (applying to the locomotives only) to slow the train but worried about causing flat spots on the locomotive wheels.

Locomotive event recorder data showed that after receiving the approach signal, the train received a restricting signal indication requiring that the train slow to below 20 mph and operate in a manner that would permit stopping within half the range of vision short of a stop signal. Although the engineer said she did not recall receiving the restricting signal indication, the event recorder showed that she acknowledged receipt of the signal and that she did slow the train below 20 mph.

The engineer said she continued to operate on an approach signal until she exited the tunnel, and that "…to my recollection, the only other signal, the only thing I had in the cab was an approach." She said she was not distracted while traversing the tunnel and that she was "just trying to control these two motors. My concentration was on keeping the speed down."

Two main tracks, track No. 2 to the east and track No. 3 to the west, are in the vicinity of the accident. The two main tracks diverge into the station tracks for Baltimore's Penn Station. Train No. 90 was operating on track No. 2 through the tunnel. Meanwhile, southbound MARC train No. 437 was operating on a permissive diverging aspect at the interlocking signal outside the station. The route lined through the Charles Interlocking was a crossover route from station platform track No. 5 to the No. 2 main track, continuing through the crossover to the No. 3 main track. While train No. 437 was traversing the interlocking, the signal governing the movement of train No. 90 on No. 2 main track was displaying a stop indication.

The train No. 90 engineer said that as her train rounded a curve after leaving the tunnel, she saw the MARC train crossing over in front of her. She said that she "went for the brake" but that she could not recall if she "put it in emergency all the way or what." According to event recorder data, train No. 90 was traveling about 15 mph when the engineer put the train into emergency braking. The left leading corner of the lead Amtrak locomotive struck the 4th car from the head-end of the MARC train. The 5th and 6th cars on the MARC train derailed upright, and the lead truck of the Amtrak locomotive derailed. The collision occurred about 330 feet north of the red signal governing train No. 90's movement.

Tasks

1. What were the engineer's options when she arrived in Washington and realized that she was being assigned to equipment with which she was relatively unfamiliar?

2. What were some of the outside pressures that made her take the train anyway?

3. What were some of the clues that other crew members should have noticed, indicating that something was lacking in her technical proficiency to operate the train?

4. What was the primary error that caused the crash?

5. What could the engineer have done to prevent this accident?

Too Many Cars

Employees Involved in Accident:	• Clerk • Dispatcher • Engineer • Conductor
Railroad:	Union Pacific Railroad
Location:	Odem, TX
Accident Date and Time:	February 21, 1997, about 2:08 a.m., CST
Type of Accident:	Collision, derailment
Fatalities/Injuries:	2 crewmembers of striking train received non-life threatening injuries
Property Damage:	$31,000

The Incident

Train 1, a northbound Union Pacific freight train (BVFW-20), arrived at Kingsville, Texas to switch crews. The inbound crew informed the clerk at UP's National Customer Service Center (NCSC) that the train consisted of 136 cars. The clerk at the NCSC improperly entered in the computer that the train had only 64 cars. As a result, the outbound crew received an incorrect computer-generated car count. The crew departed Kingsville and arrived in Odem, Texas. It was early in the morning and foggy out when upon arrival, the train dispatcher (who had information that the train was carrying 136 cars) informed the crew that they had cars to set out. The train crew advised the train dispatcher that they only had 64 cars in their train and that they were all through cars. With this new (incorrect) information, the train dispatcher instructed the crew to pick up 30 cars destined for Fort Worth, Texas. At 1:28 a.m., the crew, thinking that they had 64 cars, reported to the train dispatcher that their train was clear of the yard limits at MP 153. The crew uncoupled the locomotives and the first 5 cars from the train and proceeded onto the yard track that had the 30 cars. After the crew of train BVFW-20 reported their train clear of the main track, the train dispatcher gave another train, Train 2 (EM-20) permission to proceed to MP 153.0. No one knew that the uncoupling of the 136 car BVFW-20, left the rear portion of their train approximately 2,100 feet south of the yard limit sign, which was located at MP 153.

Train 2 operating at 45 mph, approached the yard limits in Odem, Texas. The engineer made an initial brake pipe reduction with the train brakes in preparation for entering the yard limits. As the train proceeded, the crew observed the marker light flashing on the rear car of Train 1. The engineer placed the train into emergency braking 1,046 feet from the rear end of Train 1. The crew of Train 2 jumped from their train at approximately 20-25 mph. Train 2 collided into back of Train 1 on the mainline track just south of the Odem Yard. Both crewmembers who jumped from train 2 received non-life threatening injuries. The crew of train 1 was not injured.

Tasks

1. Determine who comprised the crew assigned to accomplish the task of safely moving into the yard.

2. Determine when the error chain began in this accident.

3. What was the crew of train #1's perception of the situation?

4. What was the reality of situation?

5. How was the team's incorrect perception of the situation developed?

6. If the key to team situational awareness is communication between team members, what should be done when there are discrepancies between team members' understanding of the situation?

Clarendon

Employees Involved in Accident:	• Engineer (Coal Train) • Conductor (Coal Train) • Engineer (Intermodal Train) • Conductor (Intermodal Train) • Dispatcher
Railroad:	Burlington Northern Santa Fe Railroad
Location:	Clarendon, TX
Accident Date and Time:	May 28, 2002, 8:43 a.m., CST
Type of Accident:	Collision, derailment
Fatalities/Injuries:	1 Fatality (Engineer of I.M. Train 4385)
Property Damage:	Equipment $6,401,192 Lading $427,000 Track $331,189 Environmental cleanup $202,765 Wreck clearing $763,506 Total $8,125,652

The Incident

The engineer and conductor of the intermodal train went on duty at 6:45 a.m. in Childress, Texas, about 60 miles east of the accident location. The engineer and conductor of the coal train went on duty at 6:00 a.m. in Amarillo, Texas, about 55 miles west of the accident location. The coal train, with 116 cars of coal and headed by lead locomotive BNSF 8876, departed Amarillo at 7:40 a.m. The train operated eastward, entering track warrant control (TWC) territory several miles east of the yard area. The coal train crew's first track warrant was quickly followed by a second one at 7:49 a.m. The second track warrant was an after-arrival warrant, stipulating that the coal train was to wait at Malden Siding for the arrival of a specified train before proceeding beyond that point. As was common BNSF practice when heavy coal trains were to meet other, lighter, trains on this portion of the railroad, the coal train was to remain on the main track while the lighter train was diverted onto the siding. The coal train met the opposing westbound train at Malden Siding, as required. At 8:05 a.m., the engineer of the coal train called a family member on his cell phone. The call was ended 23 minutes later at 8:28 a.m. The meet between the coal train and the specified train took place two minutes later at 8:30 and lasted till 8:35, after which, in accordance with its track warrant, the coal train proceeded toward the east end of Ashtola Siding.

Meanwhile, the westbound intermodal train (Engine BNSF 4385 West) was granted track warrant authority at 8:26 a.m. This track warrant was also an after-arrival warrant. The train was to proceed to Hedley Siding (see figure 2) where it was to await the arrival of Engine UP 5827 East. Once that train had passed on the adjacent track, the intermodal train's track warrant authorized it to move on the main track from Hedley Siding to Ashtola Siding. At Ashtola, the intermodal train was to divert onto the siding to allow the coal train to pass on the main track. As instructed by the track warrant, the intermodal train waited for the passage of Engine UP 5827 East, after which the requirement of the track warrant was complete, and the intermodal train began moving westward toward Ashtola.

As the coal train neared Ashtola, at 8:43 a.m., the final track warrant, Track Warrant 22, was issued. At the exact time Track Warrant 22 was issued, and 16 minutes since getting off the phone earlier, the engineer used his cell phone to call his family again. As the engineer was controlling the train and talking on his cell phone, the after-arrival track warrant that covered the coal train's movement between Ashtola Siding and Hedley Siding, about 25 miles away was being repeated by the conductor. This track warrant specified that the coal train was to hold short of the east end of Ashtola Siding until the arrival in the siding of Engine BNSF 4385 West (the intermodal train). The track warrant would become effective at that point. A review of the audiotapes of the dispatcher's radio communications confirmed the content of the track warrant, which the conductor read back accurately to the dispatcher, including the stipulation that the track warrant was not in effect until after the arrival of Engine BNSF 4385 West at Ashtola. At the time this warrant was issued, the coal train was approximately 3.2 miles from the point at which it was to stop and wait and was traveling, according to event recorder data, about 48 mph.

The engineer was still on this call several minutes later as his train passed the east end of Ashtola Siding. The train should have stopped at this point to await the arrival of the intermodal train, in accordance with the train's track warrant. Event recorder data indicated that the train was traveling about 48 mph at that time. After the coal train had traveled for about 9 1/2 minutes after passing the east end of the siding, the train's conductor saw and alerted the engineer to the oncoming train as the intermodal train rounded the curve ahead. The engineer exited the rear door of the locomotive, followed by the conductor, and jumped from the rear steps. The conductor and engineer of the intermodal train also exited their locomotive and jumped from the walkway.

Event recorder information indicates that both trains' brakes were placed in emergency before the collision. At the time the coal train was placed in emergency, it was moving at 49 mph. The intermodal train was placed in emergency as it was moving at 42 mph with the throttle in the 8th notch (maximum power). An engineering survey commissioned by the BNSF indicates that the coal train went into emergency 1,093 feet before the collision point and that the intermodal train went into emergency 1,064 feet before the collision point. At the point of the collision, the coal train had traveled for almost 10 minutes and about 7.8 miles from the point where it should have waited for the arrival of the intermodal train.

The coal train engineer received critical injuries. The conductor of the coal train was struck by the debris of the derailing equipment of his train and partially buried in coal. He received critical injuries and required extensive hospitalization and rehabilitation. Although the intermodal train conductor received minor injuries, the engineer of the intermodal train was fatally injured when he was struck by the derailing equipment.

Tasks

1. Determine who comprised the crew assigned to accomplish the task of moving the two trains.

2. What was the first error?

3. What were some of the breakdowns in communication?

4. Were there any distractions to communication?

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, 12:50 p.m. EST
Type of Accident:	Run over red flag, yard derailment
Fatalities/Injuries:	None
Property Damage:	Unknown

The Incident

At approximately 0745, 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, there was no communication 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 1201 on February 6, 200 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 feet long train consisted of 59 cars, 43 loads, 16 empties weighing 5359 tons, with approximately 90.8 tons per operative brake. The train was sitting at the east end of Track 2.

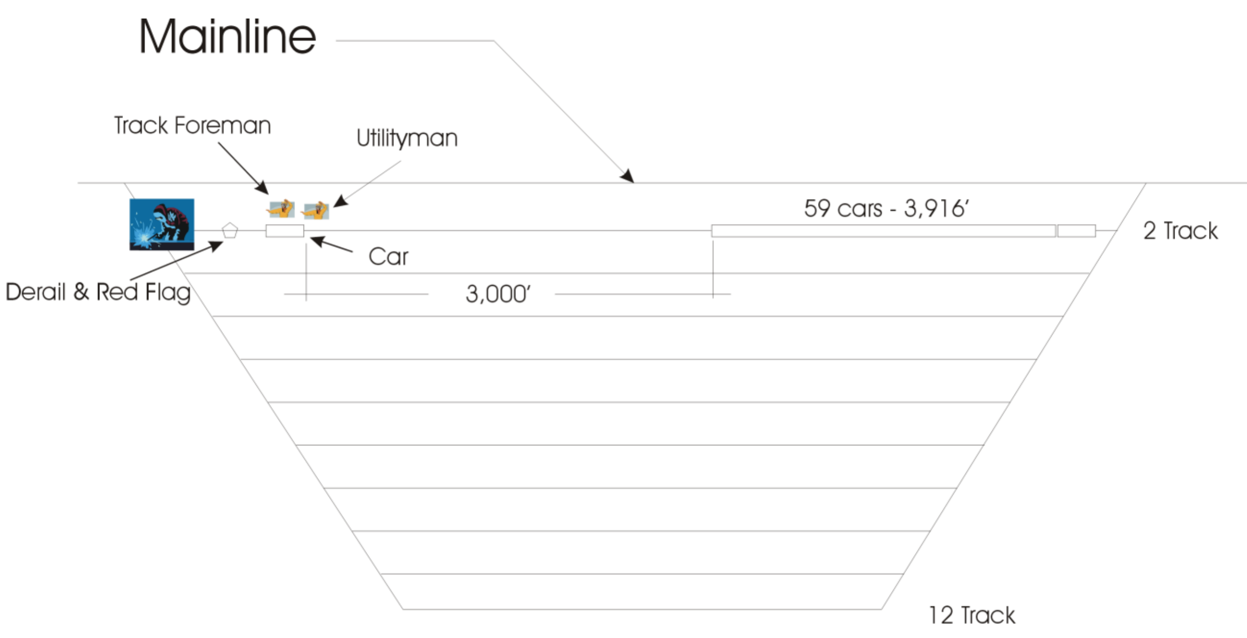
Before departing Able Yard the crew was instructed by the Yardmaster to pick up an additional car that was sitting at the west end of Track 2. The Yardmaster also informed the crew that a utility man would be assigned to their crew to facilitate the pick up.

A safety briefing was conducted between the conductor and the utility man concerning the pick up. The facts 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 there were more than 40 car lengths 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," "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 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 maintenance of way work area at approximately 1250. There were no injuries.



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

Seventeen Mile Grade

Employees Involved in Accident:	• Engineer • Conductor • Trainman Trainee • Helper Engineer • Dispatcher • Crew Callers • Road Foreman
Railroad:	CSX Transportation
Train:	Coal Train V986-26
Location:	Bloomington, MD
Accident Date and Time:	January 30, 2000, about 7:00 a.m., EST
Type of Accident:	Derailment on long descending grade in mountainous territory
Fatalities/Injuries:	1 fatality–15-yr old boy in house destroyed by derailed cars; 3 other residents were injured–1 seriously; crew escaped without injury
Property Damage:	Total damages in excess of $3.2 million

The Incident

Crew background

Engineer:

The locomotive engineer assigned to this train was considered one of the most senior and experienced engineers in the Grafton area. He had qualified as an engineer in 1976 and stated that he had taken trains from Grafton to Cumberland "thousands of times;" however, he had recently been in yard service for 4 years and returned to road service on January 9, approximately three weeks prior to the accident.

Upon returning to road service, he had requested several trips accompanied by a pilot to re-familiarize himself with the route and any new or special procedures that had been put in place. The road foreman stated that he could have 2 round-trip pilot runs, but, due to scheduling, he had only received one pilot run in the direction opposite the accident run. He had completed a total of 20 trips along the accident route, 12 westbound and 8 eastbound in the three weeks he had been back on road service. Upon being assigned to this run, he reminded the crew callers that he still was "due" for more pilot runs but the crew callers said that they would decide if he needed one and, if so, there would be one there. Upon reporting there was not one there. The engineer knew that the road foreman was out of town and unavailable.

Conductor:

The conductor had been well rested upon reporting. He had been off duty for 11 hours and 30 minutes. He was qualified and experienced on this route.

Trainman trainee:

Trainman trainee had been on the railroad for about a month, most of which had been spent in initial classroom training. At the time of the accident, he was sitting in the second locomotive cab because the engineer was smoking in the lead locomotive and he did not like the smell.

Consist Information

CSXT train V986-26 originated at the CSXT Grafton Yard in Grafton, West Virginia, and was destined for the Potomac Electric Power Company's Bennings power plant in Washington, D.C. The 80 loaded coal cars of the accident train were coupled with a three-locomotive consist with a former Conrail locomotive as the lead unit at about 11:30 p.m. on January 29 by a yard crew under the direction of the dispatcher. All applicable brake tests were conducted and passed. The yard crewmembers were instructed to move the accident train down track No. 3 to the scale house, where they secured the train and were relieved at about midnight.

Route before the Incident

The accident train crewmembers (an engineer, a conductor, and a trainman trainee) arrived at Grafton about 2 hours later, at 2:00 a.m. on January 30. After receiving their orders and conducting a job briefing, the accident train crewmembers went to the train. The Federal Railroad Administration (FRA) air brakes test was completed by the engineer and a utility employee. The train line pressure was set for 90 psi, and according to both the engineer and the utility employee, the EOT indicated a pressure of 81 psi at the rear of the train. The engineer and the utility employee also successfully tested the EOT emergency brake application feature. The crew then checked that the locomotive hand brakes were off and that the control console of each trailing locomotive unit was set up in the proper configuration. About 2:30 a.m., the train, upon receiving the signal from the dispatcher, departed Grafton Yard. The utility employee said that he observed the last 30 to 35 cars of the train as it departed and that he noted no problems.

When the train reached Newburg at MP 267.2, it stopped so a helper locomotive could be added. The engineer later said that up to that point, he had not needed to use either the air brakes or the dynamic brakes to control the train. When the helper arrived and was coupled onto the rear of the coal train, the helper flagman (brakeman) disconnected the train line from the coal train EOT and connected it to the helper. The helper engineer told the train engineer that there were 82 pounds of pressure and asked him to do a set-and-release brake test. After successful completion of the test, the train proceeded east with a clear signal. From then on, except at Blaser (MP 258.9), until the helper was uncoupled at Terra Alta, the train engineer did not communicate with the helper engineer except to call signals. When the train reached the top of the hill at Blaser, the helper engineer radioed the train crew that the air on the rear of the train was adequate to go down the hill. The train proceeded down the hill at the authorized speed of 25 mph; however, the helper engineer thought something was unusual:

> "I think we used 17 pounds of air coming down the first hill. Which was kind of [unusual]. Generally, 10 to 11 [pounds of] air will hold a train off there. But [the coal train engineer] controlled the train at the speed limit."

The helper engineer said later that he did not say anything to the train engineer about the heavier air brake application, even though he thought it was unusual, because the train was under control and not exceeding the authorized speed. The train reached the bottom of the grade at Rowlesburg and began the uphill climb to Terra Alta. The train reached the top of the grade at Terra Alta without difficulty, where it stopped to cut off the helper.

As the train draped the crest of the grade at Terra Alta, the helper was uncoupled. The helper brakeman reconnected the flashing EOT to the train line, but the EOT would not register train line pressure. The helper brakeman replaced the EOT with a spare unit carried aboard the helper, and he and the train engineer were then able to establish telemetry and successfully performed an air test and an EOT emergency feature test. About 5:43 a.m., the train continued east, and the helper returned to Rowlesburg.

The portion of railroad from Terra Alta to Altamont was undulating over 18.6 miles, and the maximum authorized speed for coal trains was 30 mph. The eastbound route had a brief down grade, from Terra Alta to Snowy Creek, during which the engineer maintained a speed of 28 to 29 mph by using dynamic braking and a short and limited application of the air brakes. The engineer then went to full throttle (throttle control in the 8th notch) and ascended the grade to Edgewood, east of the Maryland State line. Then he descended the shallow down grade to Skipnish Fill, while he again made a short, 1-minute, minimum 8-pound application of the air brakes, supplemented by dynamic braking. (The engineer was unaware that the lead locomotive was the only unit on which dynamic braking was actually being applied because of a defective multiple-unit cable connecting the lead locomotive with the first trailing unit.)

After that, the grade dropped off rather sharply down into the Youghcogheny River Valley through Macking's Hollow, just west of Oakland, Maryland. The engineer used a brief minimum brake application of 10 pounds for about a minute and a half while continuously using heavy dynamic braking. The railroad was relatively level through Oakland and then gently ascended to Mountain Lake Park, where the grade increased and the railroad climbed up through Deer Park, Maryland, about 2.8 miles from the grade at Altamont. When the train reached Oakland, the engineer came out of dynamic braking and increased the throttle, eventually accelerating to 40 mph in order to build enough momentum to ascend to Altamont. He maintained maximum throttle (notch 8) on the climb to Altamont, but the speed slowly dropped to 15 mph as the lead locomotive unit crossed the summit, about 6:22 a.m. About a minute later, the speed dropped to 13 mph, and the engineer made a minimum brake application while in throttle notch 7. He proceeded to drag the train over the crest of the Altamont summit while progressively reducing the throttle as more of the train crested and began the descent. During this time, the train's speed dropped to 9 mph and then climbed to 13 mph.

<u>Descent of 17-Mile Grade</u>

As it began its descent at Altamont, down 17-mile grade, the train had been running for more than 4 hours and had traveled about 58 miles. Until the train had reached Newburg, where the helper was added, the engineer had not used either the air brakes or dynamic brakes. Between Newburg and Altamont (about 25 miles), the engineer made four applications of the air brakes, totaling 43 minutes and 18 miles. One of the four applications was the 17-pound reduction at Blaser that was noted by the helper engineer.

The train started down 17-mile grade (an average grade of 2.4 percent) at 13 mph in throttle notch 7 with a 6-pound reduction of the train line. The maximum authorized speed from

Altamont to Swanton Flats was 30 mph. Over the next 3 minutes, as more of the train crested the summit and began to descend, the engineer increased the train line reduction to 10 psi, which increased the brake application. During this time, he also went from pulling (throttle) to dynamic braking, which he increased to the near maximum according to the event recorder on the lead locomotive unit. For the next 7 minutes, he maintained heavy dynamic braking (which was affecting only the lead locomotive because of the defective cable) and continued to increase air braking by making incremental 1-pound reductions in train line pressure about every 30 seconds until he had a 17-pound reduction.

About 10 minutes down the grade from Altamont, near “Swanton Flats,” the engineer deactivated dynamic braking and began to apply traction power while still maintaining a 17-pound reduction in train line pressure. The maximum authorized speed from Swanton Flats to Bloomington was 25 mph. The engineer then powered against the train brakes for about the next 2 miles (5 minutes) while keeping the speed between 21 and 24 mph. When asked later if the reason he powered against the brakes was that he was afraid of stalling out at Swanton Flats, the engineer stated that it was and that he knew if a stall occurred it could take up to two and one half hours or more to reset the brakes and continue down the hill. CSXT *Train Handling Rules*

> When necessary to apply power descending long heavy grades, trains must not be pulled for a distance greater than 2 miles if the brake pipe reduction is 18 pounds [psi] or greater.

According to FRA inspectors who have ridden trains down 17-mile grade and to CSXT operating officers and CSXT engineers who regularly operate trains through the accident area, it is possible to control a loaded coal train headed by three modern locomotive units with a 12-pound or less brake pipe reduction and light throttle or dynamic brake modulation. The accident engineer stated several times that he attributed his use of more air brake than usual to the wet snow and icy rail.

About 16 minutes down 17-mile grade, the engineer went from power to heavy dynamic braking with the 17-pound reduction still applied. The train was moving at 24 mph. Several minutes after reaching full or near-full dynamic braking (on the lead unit only), the train’s speed reached 28 mph, and the engineer increased the train line reduction to 18 pounds. Over the next 2 minutes, he steadily increased the train line reduction to 26 pounds, or “full service,” in response to the train’s steadily increasing speed.

The train failed to slow, and about 30 seconds later, while moving at 34 mph, the engineer put the train brakes in “emergency” which eliminated any effect from the dynamic braking. The train briefly slowed to 30 mph and then began to accelerate. Despite the emergency application of the air brakes, the train’s speed steadily increased over the next 6 minutes to 59 mph. When the engineer placed the train in emergency, he used the automatic brake valve handle. He did not use the switch in the cab that would have activated an emergency application from the two-way EOT on the rear of the train. He said that he noted the EOT was indicating a train line pressure of 0 psi about a minute and a half after he had made the emergency application and that he therefore felt no need to activate the switch. He said that he was taught to activate the switch only if the emergency application did not apply on the rear. The conductor said that he noted on his display screen that the train line had depleted to 0 psi and that he, therefore, knew that the emergency brake application had propagated all the way to the end of the train.

When it became apparent that the train was uncontrollable, the engineer attempted to radio the dispatcher on the locomotive radio but was unable to do so. According to the engineer:

> I could not contact the dispatcher. I tried the emergency button, the code 9 and applied on channel 14, but [this was] a Conrail radio, and evidently they're not compatible with ours [CSXT].

The conductor said:

> We tried to contact the dispatcher with the engine radio, but the engine radio is a Conrail radio, and it will not contact our dispatchers, the equipment is not compatible. Radios are locked-in and not changeable by crews.

The trainman trainee was in the second locomotive unit cab. He said:

> The first suspicion I had that anything was amiss was that the brake shoes were burning and there was acrid smoke coming into the cabin of the second locomotive. I opened the window, and it was even worse. I shut it quickly. Five minutes later, the engineer came on the radio, and said, "Go to channel 14 and get the dispatcher on the radio." He said there was a button that I should press, number 5. Well, the second radio is different from what he had, and I didn't know how to operate it, so I went to channel 14, but I was still on channel 8. I broadcast the emergency, but I was unable to get the dispatcher.

During post accident interviews, the trainman trainee was asked if he had been trained in making an emergency radio transmission. He said:

> Yes, but getting the dispatcher on the radio here is something different. You have to press certain buttons and I wasn't still sure he gave me some instructions over the radio, but the second radio was different from his, and it had no key pad, so I did not know how to operate the second radio.

The trainman trainee stated that he had seen as many as five different styles of radios on various locomotives but that the instructions he had been given on their use were generic and were not specific to any particular type of radio.

Near Bond, MP 212.6, the trainman trainee inadvertently contacted the operator at West Keyser. The operator responded and said that the train was "lit up," or cleared for continued movement. The conductor told the operator that the train was going through Big Curve at 50 mph and was in "real trouble." The conductor told the engineer that he did not believe the train would get to the bottom of the hill at all. The conductor said that he and the engineer discussed jumping but .figured we were going to land in a ditch someplace with the engine on top of us. I figured our chance of survival was about zero.

The train ultimately reached a speed of 59 mph. The train broke apart and derailed at curves in three separate segments, starting from the rear end. At MP 210.6, the first group of 20 cars separated, and 17 of the 20 cars derailed. At MP 209.8, another 18 cars separated and derailed. Finally, at MP 208.2, the remaining 42 cars separated, and 41 of the 42 derailed in a general pileup. Some of the 41 derailed cars struck a nearby occupied residence, destroying the house and killing a 15-year-old boy and seriously injuring his mother. Three other occupants of the house escaped with minor or no injuries. Some of the 41 cars also broke a gas pipeline inside a transfer building near the track; as a result, about 101 customers of Columbia Gas of Maryland temporarily lost natural gas service.

The three locomotive units finally came to rest more than 2 miles down the track, at MP 206.5, just west of Piedmont Road Crossing, where the crew was subsequently picked up and taken to Cumberland for toxicology testing and interviews.

Damages

Damages to railroad equipment totaled about $1.8 million (67 of the 76 cars that derailed had to be scrapped). Other damages included: Lading of coal: $182,753; Track and signal: $275,000; Private property: $288,963; and Clean up: $14,297. Total damages were in excess of $3.2 million.

Figure 1. Accident location.

Tasks

Since this scenario is generally 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 assertiveness?

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