

SUMMARY FOR FE-35-03
SELECTED AND POSSIBLE CONTRIBUTING FACTORS

SELECTED FACTORS

Railroad: Union Pacific Railroad
Location: San Antonio, Texas
Region: 5

Month: December
Date: Dec. 7, 2003
Time: 12:12 a.m., CST

Data for Fatally Injured Employee(s)

Switch Foreman (Remote Control Locomotive)
37 years old
5 years, 9 months of service
Last rules training: Jan. 20, 2003
Last safety training: Jan. 20, 2003
Last physical: Feb. 7, 2003
Last related efficiency test: Dec. 6, 2003

Data for All Employees (Craft, Position, Activity)

Craft: Transportation and Engine

Positions:

YEY36R Switching Crew

Foreman (Lone Worker)

YEY26R Switching Crew

Foreman

Helper

Yard Master

Manager of Yard Operations

Manager of Train Operations

Activity: Switching with remote control locomotives

EVENT

A Switch Foreman (remote control locomotive operation) was fatally injured when struck by rail equipment during a switching move.

SUMMARY FOR FE-35-03 CONTINUED

POSSIBLE CONTRIBUTING FACTORS

PCF No. 1

The fatally injured employee failed to comply with railroad operating rules which required employees, when standing, walking, or working between or near tracks, to keep a careful lookout in both directions for trains, locomotives, cars, or other equipment, and expect movement at any time, on any track, in either direction.

PCF No. 2

The fatally injured employee failed to properly line both switches of the crossover for the intended route, prior to moving the locomotive.

PCF No. 3

Investigators concluded that at the east end, wheel yard cross-over, the switch may have malfunctioned (failed to remain in position) at the time of the accident, based on its performance as observed during a re-enactment. They attributed this malfunction to a defect of the switch machine which controlled the switch points at that location.

PCF No. 4

FRA investigators analyzed the carrier's operational testing data (and FRA's inspection findings) for the time period when remote control locomotive operations began to the date of the accident (February - December, 2003). They concluded that railroad management's oversight of the monitoring and enforcement of operating rules concerning switching operations at this location was deficient.

REPORT: FE-35-2003

RAILROAD: Union Pacific Railroad (UP)

LOCATION: San Antonio, Texas

DATE & TIME: Dec. 7, 2003; 12:12 a.m., CST

EVENT¹: A Switch Foreman (operating a remote control locomotive) was fatally injured when struck by rail equipment during a switching move.

EMPLOYEE:

Craft:	Transportation and Engine (T&E)
Activity:	Switching with Remote Control Locomotives
Occupation:	Switch Foreman (Remote Control Locomotive)
Age:	37
Length of Service	5 years, 9 months
Last Rules Training:	Jan. 20, 2003
Last Safety Training:	Jan. 20, 2003
Last Physical:	Feb. 7, 2003
Last Related Efficiency Test:	Dec. 6, 2003

CIRCUMSTANCES PRIOR TO THE ACCIDENT

The YEY36R Foreman reported for duty at the East Yard's west-end shanty at 11 p.m. on Dec. 6, 2003. Prior to contacting the Foreman, the Yard Master informed the YEY26R crew members (who had completed an afternoon job) that they would be held over to work overtime. The Yard Master instructed the YEY26R Foreman to put their locomotives in the stub track directly in front of the west-end shanty, short-term the locomotives, and step inside the shanty to talk with him about the continued work plan. Both the YEY36R and YEY26R crews performed remote control locomotive switcher jobs.

¹ "Event is defined as "occurrence that immediately precedes and directly results in the fatality." Possible contributing factors are identified in the following report and attached summary.

While the YEY26R crew members were in the shanty, they handed their remote control transmitter (RCT) belt packs to the YEY36R Foreman. The YEY26R crew completed a job briefing with the YEY36R Foreman to transfer use of their remote control power to his job.

According to the Yard Master, the YEY36R Foreman informed him that his Helper had not reported for duty. The Yard Master advised the Foreman that the extra board was exhausted and that no one was available to fill the Helper position. The Yard Master asked the YEY36R Foreman to work the job as a lone worker. The Yard Master instructed the Foreman to proceed to Track No. 003, handle his switch list (44 cars) in smaller cuts, about five moves, and then tie up, and go home.

At approximately 12:15 a.m., the Yard Master monitored the afternoon job, as the crew completed its locomotive inspection and performed operational and safety checks, linking their remote control transmitters to the UP 797 locomotive consist.

At 12:30 a.m., the YEY26R Foreman (UP 797) requested to activate Remote Control Zone 2. At that time, the Yard Master looked at the west end jobs and observed that the YEY36R consist was stationary on the wheel yard lead. The Yard Master attempted to contact the YEY36R Foreman two or three times to see if he was ready to proceed to Track No. 3. The Yard Master stated there was no answer. The Yard Master then called the west end shanty, via telephone and intercom, and received no answer. Finally, the Yard Master radioed the YEY26R Foreman, asking if he had seen the YEY36R Foreman, and was told no. The Yard Master assumed the YEY36R Foreman was in the shanty restroom. At approximately 12:45 a.m., the Yard Master again looked at the west end jobs and observed the YEY36R consist in the same stationary position.

The Yard Master attempted to contact the Foreman several more times. He then called the Manager of Yard Operations (MYO), informing the officer that he could not establish communication with the YEY36R Foreman. The Yard Master and MYO agreed to jointly search for the Foreman. They began a ground search of the west end shanty area and finally the locomotive consist, where they found the YEY36R Foreman. The MYO immediately ran to his vehicle and called the Manager of Train Operations to report the accident. The MYO instructed the Yard Master to call 911 and report the emergency. The 911 dispatch center received the call at 1:02 a.m., assigning response officers who arrived at 1:10 a.m.

At the time of the accident, the temperature was 39° F. It was dry with a calm wind; the sky was clear, and there were no impediments to visibility.

THE ACCIDENT

The YEY36R Foreman began his work after releasing the hand brakes on his light engine consist and recovering full service brake application in four minutes, 53 seconds. The Foreman, utilizing UP709 and UP337, executed three light-engine moves, the third of which resulted in his fatal injury. The first was a 643-foot westward move from the stub track, stopping west of the west wheel yard lead cross-over switch (inner loop). Move 2 was an eastward 673-foot movement on the wheel yard cross-over, stopping just east of the east wheel yard cross-over switch, where he had intended to line the switch for movement through the cross-over to the

train yard lead, outer loop. The final move was westward for 286 feet on the same wheel yard cross-over, where he was struck and killed at approximately 12:12 a.m. The elapsed time from the first RCT control input to the final stop was seven minutes, 31 seconds.

POST-ACCIDENT INVESTIGATION

An Inspector-In-Charge (IIC) was assigned the investigation and arrived on scene at 9 a.m. that same day. Additional Inspectors were requested, including, from the Federal Railroad Administration (FRA), a Track Inspector and Motive Power & Equipment (MP&E) Inspector, and from the State of Texas, a Signal & Train Control Inspector. The National Transportation Safety Board (NTSB) responded by sending two investigators who arrived later that evening.

FRA's investigators inspected the remote control locomotive consists involved, UP 709 & UP 337. The MP&E inspector stated that there were several defects taken on each unit; however, the nature of the defects would neither cause nor contribute to the accident.

FRA's investigators inspected all track components of the switches in the accident area, in particular, the east end wheel yard's cross-over switch. The inspection revealed the track in the accident area complied with FRA Class 1 safety standards and did not cause or contribute to the accident.

Catron-Theimeg, the remote control system manufacturer, responded to the accident and completed analysis of the remote control systems involved in the accident. An FRA MP&E inspector participated in the inspection and testing, corroborating the process. The manufacturer provided documentation, verifying the remote control system had operated correctly.

FRA and State S&TC inspectors inspected the power switch machines and found problems in this area. According to the on-scene railroad representative, as soon as the scene was released by local law enforcement, the switch points were inspected and revealed no obstruction.

Arriving at the accident site, FRA investigators initially interviewed the on-scene railroad representative for an overview of the incident, following that up with numerous interviews at the scene. Both Yard Masters and crews had indicated the switches had failed on numerous occasions and stated that they had requested that the wheel yard cross-over switch be re-evaluated.

The on-scene railroad representative directed the Manager of Signal Maintenance (MSM) to test the wheel yard cross-over switch again. After 20-25 operations, the switch failed to function on four occasions. The switch points remained in their original position after the button was pushed, even though the switch machine's electric motor energized, pumping the hydraulic pump, and making sounds as though the switch points were being repositioned.

Tests were completed with a finding that the number 8 terminal on the Wago strip held a number 10 power supply wire, providing 220 volts. The MSM determined that the number 10 wire was intermittently corrupt, allowing the motor to lose power at any given time. When the wire was disturbed, it would occasionally cause a power interruption, which would prevent the mechanism from working as designed.

The loss of power caused the switch machine motor to fail to complete its design cycle, stopping after the switch points were positioned. The switch machine cycle could only be completed by initiating a second push-button response. The second push-button response caused the machine to perform a partial cycle which replicated the machine functions and sounds for repositioning the switch, but did not actually move the switch points to the desired position. The switch points remained in the position attained prior to the power interruption.

The MSM attempted to resolve the problem by removing the number 10 wire and re-sizing and re-installing it in the number 8 terminal. Additional tests were made with no further failures.

At approximately 2:30 p.m., the on-scene railroad representative was informed by other investigating officers that the same switch had failed again. FRA was informed and observed additional switch malfunctions. The on-scene railroad representative called the MSM back to further examine the switch. The MSM tested the switch again, finding the same malfunction.

After reviewing manufacturer installation and maintenance specifications, the MSM found that, instead of the number 10 wire, the specifications called for a smaller, number 14 wire to be installed in the number 8 terminal. The MSM believed that to be the problem and directed the switch machine to be removed from service immediately and replaced with a new one. FRA instructed the MSM to seal the removed switch machine, pending FRA inspection. The change-out was completed later that day with an alternative installation, utilizing a number 14 jumper wire connected to the number 8 terminal and finally connected to the existing number 10 wire, with a wire nut.

NTSB and FRA personnel observed the carrier's re-enactment of the remote control locomotive's movements, according to the event recorder information downloaded from the transmitter unit. There were four re-enactments which took place, two during the day and two at night. All were performed less than 24 hours after the incident had occurred.

After the second of the two night re-enactments, the FRA IIC observed the following event occur: The remote control consist was turned over to a yard crew. One crew member boarded the east end of the consist and moved it from the wheel yard lead through the cross-over to the train yard lead. The second crew member walked to Track No. 1's power switch, which was lined for reverse movement. The switch point indicator light progressed from green to red to yellow. Approximately 8-10 seconds later, just prior to the consist going over the switch, the switch lined back for the lead (a facing point move) and the switch point indicator lights progressed from yellow to red to green. The crew was able to stop the consist movement short of the switch. The second crew member lined Track No. 1's power switch and removed the electrical power from the switch to insure it would not line back. There was no obstruction in the points.

Analysis and Conclusions

Prior to moving the locomotive consist involved in the fatality, Union Pacific investigators measured and marked Locomotive UP 709's L-1 wheel (229'3" from the wheel yard cross-over switch point) and downloaded the event recorder. FRA established the wheel yard cross-over switch point as the bench mark for measurement analysis of factual information.

During the YEY36R Foreman's final remote move, the most logical sequence of action presumes the Foreman's intention was to line the power switch for movement through the cross-over to the train yard lead and walk to the west end train yard cross-over switch to line it for his next move: a routine event for west end jobs. However, when the deceased was discovered, the east end wheel yard switch was not lined for the cross-over. The switch was lined for the wheel yard lead.

Analysis of the event recorder's remote equipment "communication path" provides vital information correlating the events of this accident. Further, it provides circumstantial information as to when and where the RCT may have been separated from the deceased's body and finally lodged between the R-1 traction motor and wheel.

According to Cattron-Theimeg's design engineers, the "communication path" between the remote transmitter and receiver is designed to interrogate one time per second. An example would be a control input via the transmitter, one second, and a command output via the receiver, the next second. "Active" indicates communication did occur between the transmitter and receiver and "Inactive" indicates communication did not occur between the transmitter and receiver. An interrogation will continue to occur, alternately, from the transmitter direct to the receiver and then indirectly to the repeater tower and receiver until communication is re-established by either path. In either case, control input and command output occur one second apart.

Before reading the event recorder sequence review, the East Yard video tape re-enactment for a visual perspective of the train movement, and a review of the East Yard video tape of the power switch operation (made after the replacement switch was installed) were conducted. While progressing through the time/distance sequence, consider the distance location is wheel L-1 and that the end plate of the locomotive is eight feet forward of the L-1 wheel.

This is the sequence of remote control transmitter (RCT) inputs, receiver outputs, system communication path, and event time/distance comparisons for this accident:

00:06:50-00:10:29 - The Foreman's RCT communicated with the receiver "Active" - "Direct" through the first move.

00:10:30-00:10:47 - Through the second move, the RCT communicated with the receiver "Active" - "Repeater."

00:10:48-00:12:14 - During the third and final move, the RCT communicated with the receiver "Active" - "Repeater." From the beginning of the Foreman's remote control operations, to this time, there were no breaks in the communication path.

00:11:54 - Beginning the final move westward, the Foreman selected 10 mph. The remote control receiver accelerated the engines to 12.8 mph. At this point, the computer was applying independent brake to decelerate the consist back to 10 + or - 0.5 mph.

00:12:12:70, (122'10") - The first disturbed ballast occurred between the tracks, on the wheel yard lead and probable location of the point of impact of the deceased. This location would place the Foreman on a straight line walking path, to the west-end train yard cross-over switch he intended to line next. The locomotive was traveling at 12.65 mph, (velocity, 18.55 ft/sec).

00:12:13:60, (135'8") - This was the probable location where the deceased body made contact with the ground after being propelled from the point of impact. From the location of the second disturbed ballast between the tracks, continuous drag marks were displayed to the paved crossing.

00:12:15 - The RCT attempted to communicate with the receiver "Not Active"- "Direct." First communication break.

00:12:16, (170'3") - The RCT communicates with the receiver "Active"- "Direct" with the command "Speed, Select, Stop." Transmitter and receiver re-establish a communication path.

UP 709's end-plate arrived at the east end of the cross walk traveling at 11.45 mph, (velocity, 16.79 ft/sec). It was 8 feet in front of wheel L-1).

The east end of a 10-foot wide paved crosswalk began at 165'6." It was paved slightly below level with the track rails and ended at 175'6." The cross walk clearance was 7.5" between the locomotive end plate and the pavement. Based on physical evidence and event recorder information, the east edge of the cross walk was the probable location where the remote control transmitter and safety vest were torn from the deceased's body at impact. Additionally, the time line and respective distance of the transmitter selections, receiver response commands, distances, and physical location strongly support that the stop command was selected when the RCT impacted with the paved cross walk. The Foreman was a large man, six feet tall, weighing 270 pounds at his last physical.

The Foreman's safety glasses, ear plugs, and remote light were located just east of the paved cross walk (163'10"). The Foreman's handheld radio and holster were located on the paved cross walk (166'4"). The radio and holster were torn from the safety vest.

The Foreman's body was discovered just beyond the west end of the paved crosswalk (183'4") between the tracks at the rear of the leading locomotive, in the opening between traction motor no. 4 and the locomotive end-plate.

00:12:17, (185'3") - The RCT communicated with the receiver: "Not Active" - "Repeater" and then a second communication break occurred.

At the same time, the receiver commanded the remote consist to initiate a stop based on the last input selected from the transmitter, which had occurred one second prior. This was the probable location where the remote control transmitter and safety vest was dragged prior to becoming lodged in the traction motor.

00:12:18-00:12:19, (198'3" and 210'3" respectively) - The RCT communicated with the receiver "Not Active"- "Direct" while still decelerating to a stop by the previous stop command, and third communication break. These were probable locations where the remote control transmitter and safety vest continued to be dragged just prior to becoming lodged in the traction motor.

00:12:20-00:12:24 - The RCT communicated continuously with the receiver "Active" - "Direct." The transmitter and receiver established and maintained a communication path until the removal and testing of the transmitter, during the investigation. This was the probable location where the remote control transmitter and safety vest became lodged and remained between the traction motor and wheel. The RCT was found, in an upright position, between the traction motor and R-1 wheel at a slight angle of approximately 20 to 30 degrees.

00:12:24, 229'3" - This is where wheel L-1 and thus the locomotive consist stopped.

Close examination of the RCT, after it's removal from the traction motor, revealed deep scratches, gouges, and abrasions on the controls with pavement imbedded in the control box. The position of the remote control transmitter levers were recorded upon removal: Independent Override - Release Position, Automatic Override - Release Position, Reverser - Neutral, Speed Selector - Stop.

The family of the deceased declined to provide information regarding a circadian rhythms schedule or any history about possible over-the-counter or prescription drug use. Mandatory Federal drug and alcohol testing was performed on the deceased. Test results were positive.

FRA's experts in Forensic Toxicology carefully reviewed the test results and determined that drug or alcohol impairment was not a factor in this accident. The blood test indicated the deceased was positive for the carboxyl metabolite of marijuana (THCA) at 5.5 ng/ml with no apparent drug, hydroxy metabolite (THC), present at detectable levels. No urine was available for testing.

The cause of the fatality was failure to comply with Carrier operating rule 81.1.1, Walking On or Near Tracks.... When standing, walking, or working between or near tracks, keep a careful lookout in both directions for trains, locomotives, cars, or other equipment, and expect movement at any time, on any track, in either direction. Do not rely on hearing the approach of a train or equipment. Since remote operations began on this Service Unit, this rule was tested in 209 events with 1 failure (0.5% failure rate).

The primary factor contributing to the fatality was failure to comply with Carrier operating rule 8.2, Position of Switches... requiring that a crew member ...must make sure the switches and

derails are properly lined for the intended route... Since remote operations began on this Service Unit, this rule was tested during 250 events with one failure and one hearing (0.4% failure rate).

An additional contributing factor was failure to comply with Carrier operating rules 81.1.2, Precautions near Passing Trains or Equipment...When near passing trains...stand clear of all tracks when trains are approaching or passing in either direction. Do not stand on one track while trains are passing on an adjacent track...

FRA investigators analyzed the carrier's operational testing data for the time period when remote control locomotive operations began to the date of the accident, February-December, 2003. Eleven months of information was analyzed and provided the following findings:

- The deceased was tested as a licensed Remote Control Operator (RCO) in 28 events with no failures.
- The Service Unit tested 627 RCO events, with seven failures and one hearing (1.3% failure rate). The RCO failures were recorded during the first month after the first RCO class was licensed and functioning in that role. No other failures occurred from March 12, 2003, to the date of the accident.
- The Service Unit tested 6,417 combined events, RCO and conventional with 233 failures and 8 hearings, (3.6% failure rate).
- The Service Unit tested 250 events for rule 8.2, Position of Switches, with 1 failure and 1 hearing (0.4% failure rate).
- FRA inspections for this Service unit, during the same time period, found 144 defects out of 504 units (28.7% failure rate). Specifically, FRA performed 87 inspections with eight failures (9.1% failure rate). The failures were non-Federal, Railroad Safety Rules defects, in the S330 series, handling switches.

These findings lead to the conclusion that management oversight regarding monitoring and enforcement of operating rules involved with yard switching operations at this location was deficient.

Investigators concluded that the east end, wheel yard cross-over switch may have malfunctioned (failed to remain in position) at the time of the incident, based on its performance as observed during the investigation. This condition occurred during the inspection and testing of the switches involved in, and installed around, the immediate area of the fatality.

During a re-enactment of the incident, a failure of the switch machine which controls the switch points at the east end, wheel yard cross-over did occur. After the button, which activates the switch machine, was pushed, the machine made movements and sounds as though it were moving the switch points from the normal (straight track) to the reverse (cross-over) position, but the switch points did not move and remained lined for the straight track.