NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF RAILROAD, PIPELINE &
HAZARDOUS MATERIALS INVESTIGATIONS

Washington, D.C. 20594

DCA 11 FR 004

REAR END COLLISION OF CSXT Freight Trains
(TRAIN Q19423 with CSXT TRAIN Q61822)

On CSXT Transportation Monroe Subdivision
Mineral Springs, North Carolina

May 24, 2011

DRAFT FACTUAL REPORT

Prepared by: C. Wayne Workman, Investigator in Charge

Accident

Event: Collision between two CSXT freight trains
Date: May 24, 2011
Company: CSX Transportation (CSXT)
Location: Mineral Springs, North Carolina
Train: Train Q19423 (northbound--striking) with Train Q61822 (northbound)
Time: 3:35 a.m. EDT
NTSB No: DCA 11 FR 004

Synopsis

On May 24, 2011, at about 3:35 a.m., eastern daylight time, northbound CSX Transportation Monroe Subdivision train Q19423 struck the rear of northbound CSX Transportation train Q61822, which had stopped at milepost SG[1] 314.0. The accident occurred in Mineral Springs, North Carolina, approximately eight miles south of the CSXT Monroe Yard. The striking train Q19423 consisted of twelve intermodal cars and the struck train Q61822 consisted of nine general merchandise cars. Each train had two crewmembers, a train engineer and train conductor, both located at the front of the lead locomotive. The engineer and conductor of the striking train were killed; the conductor and engineer of the struck train incurred minor injuries. The accident resulted in a fire of the two Q19423 locomotives and also included an equipment fire of the striking train. There were no hazardous materials in either trains consist. Total monetary damages were estimated at about $1.6 million.

[1] CSXT uses 2 and 3 letter identifications to identify subdivisions across their system. The Monroe Subdivision is identified by SF and SG preceding a specific milepost location.

THE ACCIDENT

The crew (engineer and conductor) of train Q61822 went on duty in Greenwood, South Carolina at 10:30 p.m. Their departure was delayed about an hour. During this time the crew of train Q19423 had arrived at the train yard and both crews talked to one another. The crew of train Q61822 told investigators that the engineer and conductor of crew Q19423 seemed fit for duty and did not mention any concerns about working that night.[2] Crew Q61822 then received a job briefing and boarded their train. They departed Greenwood about 11:30 p.m. and operated their train northbound. They knew that train Q19423 was scheduled to depart and operate behind them, though they did not know their exact location during the trip.[3]

The crew of train Q61822 told investigators that they did not think the accident territory (Monroe Subdivision) was a difficult territory to operate. They had no problems seeing the signals that evening, and had not come across any dark signals. They also stated that during their trip, per CSX rules, they used their radio to call out the type of signals they observed, their train number, engine number, and the direction they were headed. They had also heard other trains communicating this information; however, at times their radio reception was poor. The conductor of Q61822 told investigators that crewmembers from other trains had communicated with them that the light on their end of train (EOT) device was illuminated.

When they reached McDowell, train Q61822 entered a siding where they waited for another train to clear the tracks. After departing that area they proceeded to Catawba where they waited for another train to depart. After leaving Catawba they continued north to around Van Wyck when they started to follow train Q61623 while receiving a series of approach signals.

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[2] The conductor of train Q61822 told investigators that the engineer of train Q19423 "was an excellent engineer" who knew his rules well and who he'd never seen him do anything wrong. He was not aware of any personal or family problems. He said that the engineer and conductor of train Q19423 were friends.

[3] The engineer of train Q61822 told investigators that he recalled hearing the crew of Q19423 call out a signal one time early in the trip; they believed that train Q19423 was around Fuller and Clinton, South Carolina.

About 3:24 a.m. the crew of train Q61822 arrived at Mineral Springs and stopped their train at a red signal at MP SG 313.7. They also communicated their status over the radio. Train Q61623 was already stopped ahead of them for a red signal at milepost SG 308.5.[4] The red signal at SG 308.5 was a result of trains being moved through Monroe at restricted speed which began around 01:10 a.m. due to a reported track light [5] between the southend of Marshville (SF 295.4) and Richardson Creek (SF 303.9) located immediately north of Monroe. The track light was reported to the Engineering Signal Specialist (ESS) in the Florence Division Operations Center by the FC[6] Dispatcher. The dispatcher made the report due to a previous train moving through the area. The ESS instructed the dispatcher to bring one more train through the location to see if the track light would clear after another train movement.

At about 1:24 a.m. train Q69621 (northbound) was given permission by the signal at Richardson Creek. Q69621 was required to move through the area at restricted speed due to the red signals and because the reason for the track light had not yet been determined. At about 2:32 a.m. Q69724 (southbound) took siding at Marshville to await the arrival of the Q69621. The congestion from this train traffic north of Monroe necessitated the stopping of Q61623 (northbound) which had not yet arrived at Monroe.

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[4] As a point of reference, the 3 trains discussed in this report went by the north end of Waxhaw (SG 318.4) at the following times: Train Q61623: 3:03:50 a.m.; train Q61822: 3:15:10 a.m.; and train Q19423: 3:26:54 a.m.

[5] Track occupancy light (also referred to a track light) is an indicator light on a dispatcher's display screen that represents the occupied/unoccupied status of a track circuit or track block that is generated by data received from the signal system in the field.

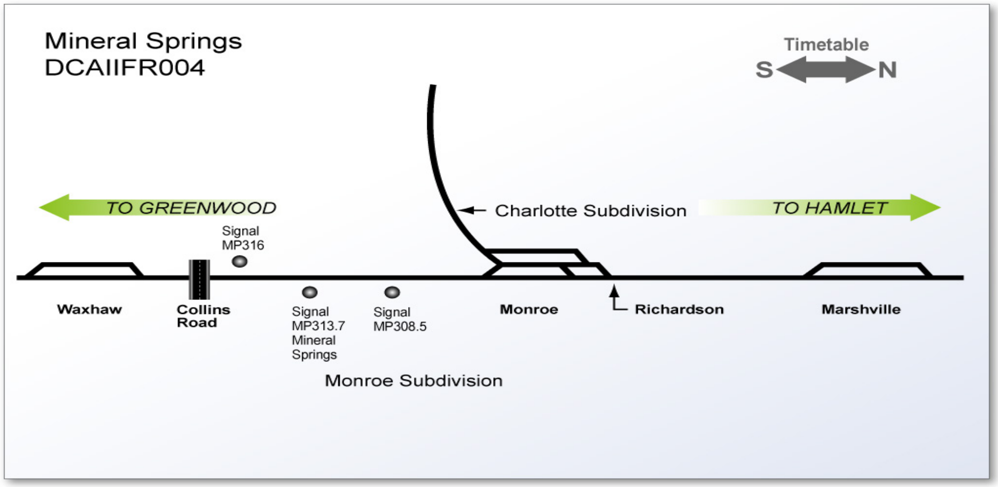
[6] FC is the name for the particular dispatcher desk responsible for the Monroe Subdivision

After being stopped at the signal for about 10 minutes (during which time the signal had changed from red to yellow), Q61623 began to move and at about 03:32 a.m. passed by the southend of Monroe (SF 306.2). Q61623 moved to the northend of Monroe (SF 305.3) to await the arrival of Q69721which was the next train to move south. The crew of train Q61822 heard the crew of train Q61623 call over the radio their clear [green] signal and their intentions to proceed north. Train Q61822 soon received a clear signal and before Q61822 could move northbound train Q19423 collided with the rear of Q61822 at about 3:35 a.m.

Post accident sight distance tests determined that about 3 minutes before the accident (about 964 feet from the signal and near Collins Road) the crew of train Q19423 would have been able to observe signal SG 316.1. However, due to a burned out light bulb, this signal was not displaying any signal aspect when it should have been displaying a red aspect. Moments after passing Collins Road (MP 316.2) the engineer manipulated the throttle from throttle position 8.[7] The speed of the train – due, in part, to the topography - continued to increase from about 31 mph and reached a maximum speed of 48 mph. Event recorder data indicates that during the 78 seconds before the accident the engineer made throttle control manipulations, applied the dynamic brakes,

[7] During the final minutes of the accident trip the engineer had manipulated the throttle from the T8 position to T6, T4, T2, idle..

and activated the bell and horn.[8] Event recorder data indicates that there was an emergency brake application after the collision had occurred.[9]



EMERGENCY RESPONSE

According to a computer-aided dispatch report, the first call to 911 was at 3:38 a.m. from a home on Springview Drive. The Mineral Springs Volunteer Fire and Rescue Department was dispatched at 3:39 a.m. They began arriving on scene at 3:46 a.m.

Mineral Springs Firefighter Interview

Summary

The first responding firefighter met the crew of train Q61822 at the intersection of Potter Road and Waxhaw Highway. He could see the train and the fire. The firefighter

[8] Event recorder data also shows similar control maneuvers, in addition to dynamic braking, during the last 15 minutes of the trip.

[9] According to post-accident sight-distance testing (discussed later in this report), a crewmember positioned at the engineers side of cab would have been able to first detect train’s Q61822 EOT device from a distance of 450 feet. Traveling at 48 mph, the crew of Q19423 would have had no more than 6 seconds to detect, identify and react to train Q61822.

asked the crew if there were any hazardous materials on the train, and the crew said that there were not hazardous materials on the Q61822. The firefighter then went into the accident site using Eubanks Street. When he arrived at the first locomotive of train Q19423, he saw the conductor sitting upright inside of the overturned locomotive. He tried to pull the conductor out, but could not because of a wedged electrical panel cover. After additional emergency responders arrived, the conductor was removed from the cab and flown to a hospital.

Train Q61822 Crew

Summary

The engineer said that he felt a hard knock in the rear of his train. The engineer and

conductor were both sitting down during the impact and were thrown from their seats. When the engineer looked to the rear of the train, he saw black smoke. The conductor said that he saw fire. After exiting the locomotive, the engineer called the CSX dispatcher, and the conductor called 911. The engineer and the conductor went to the intersection of Potter Road and Waxhaw Highway where they met the Mineral Springs firefighter. The crew told the firefighter that their train had 9 cars and 2 engines and did not have hazardous materials. The engineer and conductor then returned to the accident site.

INJURIES

The engineer and conductor of the struck train CSXT Q61822 sustained minor injuries and were transported to Carolina Medical Center. The engineer of the striking train Q19423 was killed in the impact. The conductor was life flighted to Carolina Medical Center, Charlotte, NC where he also died.

Injury Type	Q19423 Train Crew	Q61822 Train Crew
Minor	0	2
Fatality	2	0
Critical	0	0

Title 49 CFR 840.2 defines fatality as the death of a person either at the time an accident occurs or within 24 hours thereafter. Title 49 CFR 830.2 defines serious injury as "an injury which: (1) requires hospitalization for more than 48 hours, commencing within 7 days from the date the injury was received; (2) results in a fracture of any bone (except simple fractures of fingers, toes or nose); (3) causes severe hemorrhages, nerve, or tendon damage; (4) involves any internal organ; or (5) involves second or third-degree burns, or any burn affecting more than 5 percent of the body surface."

DAMAGES

CSXT locomotives (7783 and 8429) of striking train Q19423 sustained substantial damage during the collision and subsequent fire. CSXT estimated that damage to be approximately $950,000. Equipment damages to the 4 derailed cars from Q61822 and the 3 intermodal three pack (9 individual platforms) cars of Q19423 was estimated to be $623,000. Track structure damages were estimated at $43,000. Total damages not including lading, clean-up, property or environmental costs were $1,616,000.

PERSONNEL INFORMATION

Train Q61822

The engineer (36 years old) was hired on July 3, 2000 as a conductor. His promotional date to a locomotive engineer was March 28, 2004. His certification was revoked on March 5, 2005 to April 5, 2005 as a result of making a reverse move at 33 mph and not observing restricted speed. His next recertification date is 2012. His last rules examination was May 4, 2011 which he successfully passed. During the previous

6 months beginning December 1, 2010 he had been operational tested 8 times two of which were signal tests with no failures.

The conductor (49 years old) was hired and qualified as a conductor on September 4, 2005. He had been assigned to the extra board. On May 3, 2011, he received a score of 100% on his most recent T&E operating rules training. During the previous six months beginning December 1, 2010 he received 4 operational tests which included 3 failures.

Train Q19423

The engineer (35 years old) was hired on July 3, 2000 as a conductor and promoted to engineer on February 2, 2004. On March 1, 2011, he received a 98%.on his most recent T&E operating rules training. Since January 1, 2011, he had operated over the Monroe territory 44 times (which included 3 deadhead trips). During the previous 6 months beginning December 1, 2010 the engineer had been operational tested 13 times which included 1 authority for movement, 1 restricted speed banner test and 3 signal tests with no failures.

The conductor (33 years old) was hired and began training as a conductor on July 31, 2005. He had passed the 20, 40, and 55-day conductor trainee performance checklist. He became a qualified conductor in November 2005. He was then assigned to operate out of Greenville, S.C. where he had worked until the day of the accident. On March 1, 2011, he received a score of 86% on his most recent T&E operating rules training. During the previous 6 months beginning December 1, 2010 he received 30 operational tests which included 2 restricted speed banner tests and 9 signal tests with no failures. During the previous 8 months the conductor had made 25 trips over the Monroe subdivision.

Work Rest Cycles

Train Q19423[10]

The engineer went on duty on Monday May 23, 2011 at 9:45 p.m. and operated his train until the time of the accident at 3:35 a.m. on May 24, 2011. He had been on duty for 5 hrs. 50 min. and fully qualified under the hours of service rules. He had been off duty for 16 hrs 40 min since his last tour of duty. On Sunday, May 22, 2011 he had worked from 6:00 p.m. until 5:05 a.m. May 23, 2011. On Saturday May 21 he worked from 10:30 a.m. to 3:50 p.m. He was off duty on May 19 and May 20. On May 18 he worked from 0500 to 1410, after having been off duty for 10 hrs 25 minutes.

The conductor went on duty Monday, May 23, 2011 at 9:45 p.m. and worked until the time of the accident. He had been off duty for several days prior to that. He had worked on May 16, 2011 from 5:00 p.m. to 03:10 a.m. May 17, 2011.

Train Q61822

The engineer was contacted by CSX on Monday May 23, 2011 about 8:30 p.m. to report for work in 2 hours. He went on duty at 10:30 p.m., and operated his train until the time of the accident. He had been off duty for 14 hrs and 15 minutes. On May 23, 2011 he also worked from 1:30 a.m. to 8:15 a.m. after having been off duty for 18 hours

[10] The investigators were unable to collect detailed information about the off-duty activities of the engineer and conductor of train Q19423.

43 minutes. On Saturday May 21, he went on duty at 11:00 p.m. and worked until 6:47 a.m. May 22. On Friday May 20, he went on duty at 7:45 p.m. and went off duty at 2:40 a.m. on May 21.

The conductor was contacted by CSX on Monday May 23, 2011 about 8:30 p.m. to report for work in 2 hours. He went on duty at 10:30 p.m., and worked with the engineer until the time of the accident. He told investigators that he "felt fine" at the start of his shift. He had been off duty for 87 hrs and 17 min. He spent his off duty time with his family and resting. Prior to that, he had last worked on May 19, 2011 from 10:00 p.m. to 7:13 a.m. on May 20, 2011.

Work Rest Tables

Based on interviews and/or CSX work records, the following tables of the operating crewmembers' activities on the days prior to the accident were generated. All times in the tables are expressed in Eastern Daylight Time (CDT)

Train Q19423 Engineer Activities prior to the accident

Thursday, May 19, 2011

Time	Event
All day	Engineer off duty

Friday, May 20, 2011

Time	Event
All day	Engineer off duty

Saturday, May 21, 2011

Time	Event
10:30 a.m.	Engineer on duty
3:50 p.m.	Engineer off duty

Sunday, May 21, 2011

Time	Event
6:00 p.m.	Engineer on duty

Monday, May 23, 2011

Time	Event
5:05 a.m.	Engineer off duty
9:45 p.m.	Engineer on duty

Tuesday, May 24, 2011

Time	Event
3:35 a.m.	Accident Occurs

Q19423 Conductor Activities prior to the accident

Monday, May 16, 2011

Time	Event
5:00 p.m.	Conductor on duty

Tuesday, May 17, 2011

Time	Event
3:10 a.m.	Conductor off duty

Wednesday, May 18 – Sunday, May 22, 2011

Time	Event
All day	Conductor off duty

Monday, May 23, 2011

Time	Event
9:45 p.m.	Conductor on duty

Tuesday, May 24, 2011

Time	Event
3:35 a.m.	Accident Occurs

Train Q61822 Engineer Activities prior to the accident

Friday, May 20, 2011

Time	Event
7:45 p.m.	Engineer on duty

Saturday, May 21, 2011

Time	Event
2:40 a.m.	Engineer off duty
11:00 p.m.	Engineer on duty

Sunday, May 22, 2011

Time	Event
6:47 a.m.	Engineer off duty

Monday, May 23, 2011

Time	Event
1:30 a.m.	Engineer on duty
8:15 a.m.	Engineer off duty
8:30 p.m.	Engineer contacted by CSX to report for work in 2 hrs
10:30 p.m.	Engineer on duty

Tuesday, May 24, 2011

Time	Event
3:35 a.m.	Accident Occurs

Train Q61822 Engineer Activities prior to the accident

Thursday, May 19, 2011

Time	Event
10:00 p.m.	Conductor on duty

Friday, May 20, 2011

Time	Event
7:13 a.m.	Conductor off duty

Saturday, May 21 – Sunday May 23

Time	Event
All day	Conductor off duty

Monday, May 23, 2011

Time	Event
8:30 p.m.	Conductor contacted by CSX to report for work in 2 hrs
10:30 p.m.	Conductor on duty

Tuesday, May 24, 2011

Time	Event
3:35 a.m.	Accident Occurs

Medical Factors

Train Q19423

The CSX medical records for the engineer of train Q19423 indicated that his last hearing and vision tests were on May 22, 2009. The results indicated that his vision and hearing were normal. No medical conditions or medications were mentioned in these records.

The CSX medical records for the conductor of train Q19423 indicated that his last hearing and vision tests were on September 16, 2009. The results indicated that his vision and hearing were normal. No medical conditions or medications were mentioned in these records.

Train Q61822

The engineer and conductor on train Q61822 told investigators that they were in good health when they went on duty on the night of the accident. Neither had any medical conditions nor were they taking any prescription or non-prescription medications at the time of the accident.

Post accident toxicological tests

In accordance with Federal Regulations, following the accident train Q61822 engineer and conductor provided blood and urine specimens at a hospital in Monroe, North Carolina. Blood and urine specimens were also taken from the conductor and the engineer of train Q19423. The results for all the crewmembers were negative drugs and alcohol.[11]

Operational and Train Information

Method of Operation

The Monroe Subdivision method of operation is through a traffic control system operated from a central location with automatic signals between control points. These automatic signals convey to trains the occupancy and/or condition of the track ahead of them. Their purpose is to control the movement of trains in territory where the entrance to each block is governed by fixed signals. Under normal conditions train movements are authorized by these signals.

CSXT Operating Rules & Signal Aspect and Indications effective 12:01 a.m. January 1, 2010 and Florence Division timetable and special instructions effective 12:01 a.m. July 1, 2010 govern train operation on the Monroe Subdivision.

CSXT Monroe Subdivision is single track at milepost SG314. Trains are operated in either direction on a single main track by signal indication. Maximum authorized (timetable) speed for the subdivision is 60 mph with a permanent 50 mph speed restriction in the vicinity of the accident.

OPERATING RULES

CSXT operating department employees are governed by CSX Transportation

[11] Blood and urine specimens were collected in less than 8 hours, which is consistent with FRA regulations.

Operating Rules & Signal Aspects and Indications, effective January 1, 2010.

Applicable Rules

The following rules are germane to this incident:

34. Communication of Signals and other Important Information

Employees must maintain a lookout for signals or conditions along track affecting the movement of their train.

34-A. Required Announcements

1. Within the locomotive cab employees in the operating cab of an engine must communicate the following information to each other, including the track name or number in multiple-track territory:

a. The name of each signal governing the movement of their train as soon as the signal aspect is clearly visible and again just before passing it.

b. The name of each sign displayed in connection with:

(1) Track Warrant Control (TWC) authority,

(2) Yard limits,

(3) Temporary speed restrictions, and

(4) Work forces limits

c. The observance of burning fusees.

2. By Radio

A crewmember in the operating cab of an engine must announce by radio the following conditions or occurrences:

a. The name and location of each block and controlled point signal.

b. Train entry into each TWC authority, from any location.

c. Train departure from each TWC authority, as soon as the authority is reported clear to the train dispatcher.

d. Passenger train arrival and departure at passenger stations.

e. The presence of cars loaded with pulpwood or poles in the train when approaching trains and equipment on adjacent tracks.

f. Train entrance into a passing siding.

g. When stopping, and each 15 minutes after being stopped, on a main track or passing siding. These announcements must include the train ID, engine number, and direction of travel. In multiple track territory, the track name or number must be included in the announcement. Crewmembers not in the operating cab must acknowledge signal and TWC announcements. If a crewmember fails to acknowledge a communication, the engineer must determine the reason at the next scheduled stop.

225. Movements Requiring Restricted Speed

A signal indication requiring Restricted Speed applies until the leading end of the train reaches the next governing signal. When a signal aspect requiring Restricted

Speed is displayed by a signal governing movements into non-signaled territory, it will apply:

1. To the movement of the entire train through turnouts and crossovers, and
2. Until the leading end of the train reaches the end of signaled territory

228. Absent or Imperfectly Displayed Signals

A signal imperfectly displayed must be regarded as the most restrictive indication that can be conveyed by that signal.

Exceptions

1. If only one indication is possible, this indication will govern.
2. When the arms of a semaphore signal can be seen, they will govern;
3. When one colored light is displayed in the cluster of lights of a color position light signal, it will mean the same as two lights in the cluster; or
4. When one or more lower units of a color light signal aspect is dark, the aspect will be observed as though the lights that should be displayed were displaying red. This does not apply to Rule C-1290

a. A signal imperfectly displayed must be reported promptly to the train dispatcher. If a fixed signal is absent from the place where it is usually shown, movement must be governed by the most restrictive indication that can be given by that signal. This absence must be reported to the train dispatcher immediately.

Restricted Speed

A speed that will permit stopping within one-half the range of vision, it will also permit stopping short of a train, a car, an obstruction, a stop signal, a derail or an improperly lined switch. It must permit looking out for broken rail. It will not exceed 15 MPH.

CSXT'S Program of Operational Rule Tests and Inspection

Each railroad, under 49CFR—217 Railroad Operating Rules must have a program of operational tests and inspections (efficiency tests). CSXT's formal program is in compliance with the regulation was effective on January 1, 2010. The program provided quotas and testing requirements. Tests were to be spread out and not confined to specific times and days of the month. The tests were to include CSXT and foreign line crews operating over the CSXT property. Testing methods should include visual observation, monitoring live and previously recorded radio and telephone transmission, scrutiny of locomotive event recorder data, and use of radar or other approved wayside speed monitoring devices. Provisions are made for shunt or shunting track barricades.

The Safety Board obtained test records that could be identified as related to stop signal, restricted speed, Main - track banner test from CSXT for the previous 12 months. These test records are maintained by the operating rules department and used

to ensure the operational status, as well as FRA operational testing requirements.

Those test records reflect the following,

Stop Signal Tests

- System – total 7132 failures 6[12]

[12] All stop signal, restricted speed and restricting signal violations are investigated thoroughly by CSXT.

- Florence Division – total 500 failures 0
- Monroe Subdivision – total 62 failures 0

Restricted Speed Tests

- System – total 2641 failures 4
- Florence Division – total 598 failures 2
- Monroe Subdivision – total 99 failures 0

Restricting Signal Tests

- System – total 5823 failures 6
- Florence Division – total 766 failures 2
- Monroe Subdivision – total 111 failures 0

Main Track Banner Tests

Shunting Track[13]

- System – total 3227 failures 12
- Florence Division – total 724 failures 2
- Monroe Subdivision – total 110 failures 0

Dispatcher Involvement

- System – total 1894 failures 6
- Florence Division – total 104 failures 0
- Monroe Subdivision – total 7 failures 0

Training

[13] Shunting track is the process of attaching cables to the rails causing the affected signal to display its most restrictive indication. Only signal department personnel or qualified managers may shunt tracks for the purpose of operational testing.

Face to Face Rules Training

Beginning in 2006, the CSX Safety Department and assistance from operating managers representing the ten operating divisions, developed a face-to-face classroom based interactive rules training plan where attendees would gain the benefit of learning from local managers. This learning method provided attendees the opportunity to interact with their peers as questions and scenarios were discussed. Additionally, this learning method provided the attendees the value of hearing answers from their local transportation manager facilitating the class and for managers to learn which topics were challenging for the employee. This classroom based interactive training was in addition to the already required multi-media training component that CSX had implemented in 2001.

Face to Face Rules Training Process

CSX Safety Department rules personnel and operating field managers participated annually to develop teaching materials on selected rule topics that provide field rule instructors a resource for educating CSX employees. The teaching topics and materials are validated by engaging a contingent of Senior Road Foremen of Engines and Manager-Safety and Operating Practices who participate in a closed book test exercise to determine if the subject matter achieves the goal of effecting knowledge transfer to the employee from the rules training. The Senior Road Foremen of Engines and Manager-Safety and Operating Practices become the subject matter experts for their respective division to facilitate rules training to other management trainers. These management trainers, in turn, become the rules trainers for the operating department employees. Each local leader will provide the same rules training and testing to their operating department employees. Since 2006, CSX has provided this face-to-face training with a majority of the training completed by the end of the first quarter of each calendar year.

Rules Education on Imperfectly Displayed Signals

The CSX commitment to provide annual employee education on the topic of imperfectly displayed signals and how to recognize and respond to them was made by CSX Vice President Safety on January 23, 2008 in a letter to the National Transportation Safety Board based on their recommendation No. 22RA116 following the January 18, 2006 Norfolk Southern freight train rear end collision that was deemed a result of the train crew failing to recognize an extra lighted V5 aspect as an imperfectly displayed signal. The NTSB responded on July 25, 2008 to Mr. Michael J. Ward, CSX Chairman and CEO, informing him that Safety Recommendation R-07-30 had been classified as “Closed-Acceptable Action”.

MECHANICAL INFORMATION

Equipment and Train History

At the time of the collision, standing Train Q61822 consisted of two locomotive units, Union Pacific 4220 and Union Pacific 3960, both SD70M[14], 8 loaded gondolas[15]

[14] SD70M refers to a special duty six axle class of locomotive.
[15] A gondola is a low sided rail car used to carry scrap and other bulk materials.

and 1 empty, non hazardous tank car[16]. Striking Train Q19423 consisted of two locomotive units pulling 12 loaded TOFC-COFC[17] cars. The train weight was 1,562 tons; train length was 1,977 feet.

Train Q19423 originated in Hulsey Yard in Atlanta, GA and was destined for Charlotte, NC. A crew change was made in Greenwood, SC at 2230.

According to statements received from the CSX Trainmaster located in Atlanta, GA Hulsey intermodal facility, a yard assignment performed the Class I[18] Initial Terminal Air Brake inspection on Train Q19423 at Hulsey Yard in Atlanta, GA. Locomotives CSXT 7783 and CSXT 8429 were taken from the fuel pad and placed on the train by a hostler crew who were instructed to attach the end-of-train device on the rear car, arm and test the EOT and perform a Class 3[19] continuity air brake test. The statement provided by the crews involved stated that the EOT tested good and that the flashing light was observed operating as intended.

Post-accident Mechanical Inspections

On May 25, 2011, party representative investigators lead by the FRA met at the CSX Monroe Yard located in Monroe, NC to inspect the 5 non-derailed cars off of standing train Q61822, which had been taken from the accident site and placed on track # 9 that morning. A two-unit locomotive (CSXT 7572, CSXT 8064) was coupled to the 5 cars

[16] A tanker car, used to carry non-HAZMAT materials, which was empty at the time of the collision.
[17] TOFC-COFC refers to “trailer on flat car” and “container on flat car”. These rail cars are designed to transport trailers with wheels. The type pulled by semi-trailer trucks and containers that are moved by ocean vessels and placed on specially designed equipment to be move by semi trailers.
[18] Class 1 Initial Terminal Air Brake inspection is required by the Federal Railroad Administration at the original train origin. The test requires all cars to be properly charged, a leakage test of the brake pipe performed and a visual inspection by a qualified employee to ensure all brakes apply and release properly.
[19] A class 3 brake test requires an observed brake application and release to ensure the brakes function properly.

and charged the air brake system while the carman monitored the handheld air gauge. The test was successfully completed at 10:14 a.m.

On the same day, party representative investigators met at the CSX Catawba Yard located in Catawba, SC to inspect the 10 available cars (9 non derailed, 1 derailed upright wheels only) of striking train Q19423, which had been taken from the accident site and placed on the “B” Track, a single locomotive (CSXT 6092) was coupled to the ten cars and charging the air brake system while the carman monitored the handheld air gauge. There were no exceptions taken to the Initial terminal air brake inspection.

TRACK INFORMATION

The inspection included a walking inspection of the CSX main track between MP SG 313.4 and MP SG 314.4, a review of geometry car reports, track inspection reports, ultra-sonic rail tests, and on the ground observations. Starting at the point of initial impact between trains, gage, superelevation, and curvature measurements were taken at stations spaced 15.5 foot apart using a 62 foot chord. The measurements were recorded and evaluated for any deviations or exceptions in gage, superelevation, and curvature. The team used the Vmax formula[20] with 3-inches of unbalance to determine if the track geometry allows a train speed of up to 57 mph. According to CSX Florence Division Timetable No. 6, the maximum operating speed at SG 314.2 is 50 mph, FRA Class 4. No geometry exceptions were discovered during this track inspection.

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[20] Vmax formula is an engineering formula that incorporates the amount of cross level and unbalanced track and computes the amount of superelevation in a curve based on track speed and degree of curvature..

The walking track inspection included analysis of crosstie, rail, ballast, fastener, rail anchor, and vegetation conditions. The tangent track from MP SG 314.4 was constructed with 132 lb. of continuous welded rail (CWR), wood crossties, 15 inch tie plates, track spikes used for fasteners, box anchored on every other crosstie, and a clean, full ballast section. The rail was held in place with two track spikes on the gage side and one spike on the field side. The full body of the curve is constructed with 136 lb. CWR rail, wood crossties, 18 inch tie plates, track spikes, box anchored every crosstie. The rail was held in place with two track spikes on the gage side, one spike on the field side, and one hold down spike on the field side. The drainage ditches on either side of the track is free of obstruction. Vegetation was present on both sides of the track but is not within the track envelope, or brushing the side of rolling stock. No track structure exceptions were discovered during the track inspection.

The FRA DOTX 217 Geometry Car operated on the Monroe Subdivision on January 14, 2011. The DOTX 217 did not record any exceptions to geometry conditions within 10 miles either direction of the collision location. The curve analysis from the DOTX 217 reported the geometry of the curve would allow a maximum train speed of 57 mph. The CSX Geometry Car operated on the Monroe Subdivision on March 16, 2011. The CSX Geometry Car did not record any exceptions to geometry conditions within 10 miles either direction of the collision location.

Sperry Rail Services Ultra-Sonic Rail tests dated August 10, 2010, and March 11, 2011, recorded three rail defects within one mile of SG 314.2. All three defects were oxygen/acetylene welds with internal anomalies. CSX rail records reflect these defects and the replacement of defective welds on August 11, 2011. All three of the rail defects were in tangent track south of the collision location.

CSX Track Inspection records between April 25, 2011 and May 23, 2011, apply to the section of track between SG 306.3 and SG 317.1 inspected by CSX track inspectors 10 times during the one month period. No defects are recorded within two miles of the collision location. Rail defects generated by the accident were discovered within the collision location.

SIGNAL INFORMATION

DETAILS OF THE INVESTIGATION

Description of Railroad Signal System

The CSX Florence Division, Monroe Subdivision runs in a timetable north-south direction between north end of Pee Dee at milepost SF 264.9 in Pee Dee, NC and south end of Abbeville at MP SG 441.9 in Abbeville, SC. The maximum timetable[21] authorized speed for trains operating in the vicinity of the accident is 50 mph for freight trains.

Train movements on the CSX Monroe Subdivision are governed by operating rules, timetable instructions and the signal indications of a traffic control signal (TCS) system. The “FC” train dispatcher located at the CSX Florence Division Operations Center coordinates train movements with the signal system on the CSX Monroe

[21] CSX, Florence Division Timetable No. 6, effective Thursday July 1, 2010

Subdivision. Between control point (CP) North End of Waxhaw and CP South End of Monroe, the CSX TCS system utilizes coded track circuits and colored-light signals (approximately 12.2 miles).

The NTSB investigative team inspecting the dark signal SG 316.0.
The G plate attached to the signal mast represents that this signal may be passed at restricted speed when conditions require

CSX Operations Center Logs

Post accident data was downloaded from the Ansaldo Computer Aided Dispatch (CAD) system logs at the CSX Florence Division Operations Center. Table 1 summarizes signal and train control events recorded between Control Point (CP) North End of Waxhaw and CP South End of Monroe on the data log.

Table 1 *Recorded events from CSX Operations Center logs.*

Time[22]	**Location**	**Event**
2:06:42	NE Waxhaw	Dispatcher requests signal clear
2:08:33	NE Waxhaw	Signal indicates clear indication
2:58:01	SE Monroe	Dispatcher requests switch normal Switch indicates normal indication
2:58:03	SE Monroe	Dispatcher requests signal clear Signal indicates clear indication
2:58:04	SE Monroe	Switch indicates out-of-correspondence
2:58:19	SE Monroe	Switch indicates normal indication System requests signal clear (stacked request)
2:58:24	SE Monroe	Signal indicates clear indication OS track circuit indicates occupied
3:00:11	SE Monroe	OS track circuit indicates unoccupied
3:03:35	NE Waxhaw	OS track circuit indicates occupied by northbound Train Q61623 Signal indicates stop indication
3:03:50	NE Waxhaw	OS track circuit indicates unoccupied by Train Q61623 Block between SE Monroe and NE Waxhaw indicates occupied by Train Q61623
3:07:48	NE Waxhaw	Dispatcher requests signal clear (follow-up move)
3:13:23	NE Waxhaw	Signal indicates clear indication
3:15:10	NE Waxhaw	OS track circuit indicates occupied by northbound Train Q61822 Signal indicates stop indication
3:15:49	NE Waxhaw	OS track circuit indicates unoccupied by Train Q61822 Block between SE Monroe and NE Waxhaw indicates occupied by Train Q61822
3:15:54	NE Waxhaw	Dispatcher requests signal clear
3:20:25	NE Waxhaw	Signal indicates clear indication
3:26:54	NE Waxhaw	OS track circuit indicates occupied by Train Q19423 Signal indicates stop indication
3:28:20	NE Waxhaw	OS track circuit indicates unoccupied by Train Q19423 Block between SE Monroe and NE Waxhaw indicates occupied by Train Q19423
3:31:57	SE Monroe	OS track circuit indicates occupied by Train Q61623

[22] Time based on CSXT Florence Division Operations Center system clock.

		Signal indicates stop indication
3:32:05	SE Monroe	OS track circuit indicates unoccupied by Train Q61623 Block between SE Monroe and NE Monroe indicates occupied by Train Q61623

Recorded radio logs from the CSX Florence Division Operations Center and field personnel were reviewed. Table 2 summarizes events recorded on the radio logs.

Table 2 *CSX Operations Center radio communication log.*

Time[23]	Event
3:19	Train Q69724 stopped at Marshville waiting for arrival of Train Q696-21.
3:35	Train Q69724 given permission to advance past signal at SE Marshville into block between Marshville and Richardson Creek.
3:40	Smoke and fire at rear of train reported by Train Q618-22

Postaccident Inspection/Testing of Signal System

On May 24, 2011, representatives from CSX and the Federal Railroad Administration began conducting a field inspection and investigation of the railroad signal system and the SG 316.0 automatic signal location. The post accident inspection found all signal units, switches, and the signal cases, at the intermediate signals, SE Monroe and at NE Waxhaw, locked and secured with no indications of tampering or vandalism to the signal equipment. Observation of the SG 316.0 red aspect revealed that it was dark. Further testing discovered that the signal cable from the case to the 316.0 red aspect was energized. This indicated that the signal lamp bulb for the red aspect was burnt out.

[23] Time based on CSXT Florence Division Operations Center system clock.

On May 25, 2011, representatives from CSX, Federal Railroad Administration, Brotherhood of Railroad Signalmen, North Carolina Department of Transportation and NTSB began conducting a field inspection and investigation of the railroad signal system. All relay positions were found to be in accordance with the physical location of the accident trains and with the displayed signal aspects. Ground tests were performed and all track circuits were verified as working properly. On the CSX Monroe Subdivision, 10 volt, 18 watt lamps are installed in the signal heads. The colored light signals were inspected and lamp operating voltages were measured. Table 3 contains the lamp voltage readings for the SG 316.0 signal. The lamps were found to illuminate properly with the exception of the automatic signal 316.0 red aspect which was dark. Signal 316.0 was configured to be constantly lit for northbound train movements and Signal 316.1 was approach lit for southbound train movements.

Table 3. *Signal SG 316.0 lamp voltages.*

Signal Aspect	**Voltage**[24]
Red	13.05 V (dark signal)
Yellow	11.4 V
Green	11.3 V

Track connections and insulated joints were inspected and no exceptions were noted. No terrain or physical structures were found to impede the preview to the northbound home signals at NE of Waxhaw or at automatic signal SG 316.0. A complete operational test was conducted for a northward train movement with following moves up to and including the SG 313.7 automatic signal. Insulation resistance tests

[24] Voltage measurements were taken at the junction box located at the base of the signal mast.

for all cable at the NE of Waxhaw, the SG 316.0/316.1 signals and the SG 313.7/313.8 signals were conducted. All relays at the NE of Waxhaw, the SG 316.0/316.1 signals and the SG 313.7/313.8 signals, were tested for operating specifications and no exceptions were noted.

On May 27, 2011, the cable for the SG 316.0 signal lighting circuit was tested for insulation resistance. All case wiring for the SG 316.0 signal lighting circuit were verified as working properly. All involved relays contact and mounting blocks in the lighting circuit of the SG 316.0 were tested and verified as working properly. Flex wire from the SG 316.0 signal base into the mast and up to the signal lamps was removed, inspected and replaced with new flex wire. No exceptions were noted with the condition of the flex wire.

The investigation determined that the circuit plans at the SG 313.7/313.8 signal case were incorrect and did not include all signal equipment that was installed at that location.

CSXT Train Control Incident Reports

Signal incident reports logged by CSX Electronic Signal Specialists (ESS) located at the CSX Florence Division Operations Center were reviewed by the signal investigation group. Table 4 summarizes the train control incident reports logged between control point NE of Waxhaw and control point SE of Monroe for one year period prior to the accident.

Table 4. *Train control incident reports.*

Date	Report Description	Identified Condition
6/13/10	Track occupancy light (TOL) between SE Monroe and NE Waxhaw	Issue cleared before cause identified, unable to duplicate
6/14/10	TOL left behind train Q675-13	Track circuit cleared
7/8/10	FC Dispatcher reported TOL	RTR relay replaced at MP SG 313.7
7/12/10	TOL left by train Q614-09	Shorted lightning arrestors replaced at 311 signal and 313.7 signal
7/12/10	Dispatcher reports TOL which dropped signal on northbound train Q194-11	Issue cleared before cause identified, unable to duplicate
7/27/10	Dispatcher had 2 southbound trains report red signal at Mineral Springs	Issue cleared before cause identified, unable to duplicate
8/19/10	Dispatcher reports TOL left behind northbound train	Maintainer replaced damaged trans-orb at signal 313.7
8/22/10	TOL between Monroe and Waxhaw	#2 contact bad in LTR relay, maintainer replaced RTR and LTR relays
8/30/10	Train Q675-30 reports signal SG 313.8 dark at Mineral Springs	Maintainer reports bulb adaptor not properly seated in socket, repaired
9/3/10	Southbound train Q699-03 reported signal MP SG308.6 cycling from green to yellow to red	Insulated joint end post replaced at SG 313.7 east rail
9/27/10	Dispatcher reported TOL between Monroe and Waxhaw	Bad contact on RCTPR relay at SG 313.7
12/3/10	Dispatcher reports TOL between Monroe and Waxhaw	Maintainer released RTR relay at MP SG 313.7
12/5/10	TOL left after train Q616-04 between Waxhaw and Monroe	RTR relay at signal 313 replaced due to burned/stuck contacts

12/15/10	Train F761-15 reports SG 313 signal cycling and signal SG 316 all red	Replaced bad insulated joint at MP 316
1/1/11	Dispatcher reports TOL behind northbound train Q614-30	Maintainer changed out RTR relay at MP 313.8
1/19/11	TOL on by itself between Monroe and Waxhaw	Dispatcher informed that trainmaster was doing tests on trains
1/23/11	Track circuit pumped ahead of train Q667-23 with a restricted proceed at MP 308.5	Issue cleared while testing
1/30/11	Southbound signal at SE Monroe dropped on train	Maintainer changed out RTR relay at SG 308 signal due to high resistance contact.
2/16/11	TOL on and off between Monroe and Waxhaw	LTR relay at SG 318 signal had #4 contact burned, and RCTPR relay at signal 316 no seated
4/23/11	TOL left behind Q194-24, train crew reports intermediate dark at SG 316.0	Maintainer replaced RTR relay at 313.7
5/19/11	TOL	Circuit cleared before arrival
5/20/11	Dispatcher reports northbound train F762-20 had a red at SG313.5 and a dark at SG 316	Maintainer reported the circuits cleared on arrival, track circuit was adjusted at 313.7 and watched a northbound train

Further investigation into the two reported dark signal incidents at SG 316.0 (4/23/11 and 5/20/11) determined that on both incidents, a signal maintainer was called out for the reported signal condition that consisted of the SG 313.7 signal displaying a red aspect and the SG 316.0 signal being dark. Voice tapes of the telephone calls between the ESS and the signal maintainers regarding the two incidents were reviewed.

On both occasions, the ESS informed the maintainers about the red signal at 313.7 and the dark signal at 316.0. During post accident discussions with the two maintainers neither could recall whether he was informed about the dark signal at 316.0. The train control incident reports regarding the two signal conditions indicated that the reported track occupancy light was resolved and trains were observed operating through the area to verify the repairs, but did not contain any information about either maintainer addressing the dark signal reported at signal SG 316.0.

METEOROLOGICAL INFORMATION

The weather at the time of the accident was dark, clear skies, light winds of 5 to 6 knots, and a temperature of 68° F. Visibility was 10 miles. This information was recorded by the National Weather Service official weather reporting location was from Charlotte-Monroe Executive Airport (KEQY), Monroe, NC, located approximately 4 miles northeast of Mineral Springs, NC.

TESTS AND RESEARCH

Cellular/Wireless Device Recordings

According to cellular phone records and NTSB analysis, neither crewmember of the train Q19423 had talked on his cellular phone during the accident trip. But the NTSB analysis did determine that the conductor had sent 8 text messages and received 8 text messages during this trip; the last outgoing text message was sent at 2:36 a.m., and the last incoming text message was received at 3:02 a.m.

SIGHT DISTANCE TEST DATA

On May 26, 2011, the NTSB Operations and Human Performance group met to develop and review a protocol for conducting sight distance tests. The group convened after performing a hi-rail trip along with the CSX track and engineering representatives along the accident route from the Northward Absolute signal at Waxhaw, NC and the estimated collision point on the Monroe Subdivision milepost SG314.2. The sight distance test began at approximately 4:50 a.m. on May 27, 2011. After detailed job briefing, signal maintainers were instructed to darken signal SG316.0 while the investigative team boarded the test locomotives at the North end of Waxhaw, NC and other group investigators positioned themselves at Collins Road appropriately 1000 feet in advance of signal SG316 to assist in identifying the first location the dark signal at SG316 could be seen from the locomotive. Other investigators positioned themselves at the estimated point of impact with a simulated EOT device to represent the position of Q61822 ahead of Q19423.

The weather at the start of the tests was overcast and dark with temperatures in the 70's as observed by the investigators.

CSXT provided two locomotives of the same class (CW40-8) that were operated in the lead of train Q19423 for the tests. An NTSB investigator, and representatives from the FRA, BLET and the locomotive engineer and train conductor were on the leading locomotive to perform the visual tests described below.

Signal SG 316.0

Time 05:15 a.m.

General concurrence of the ability to observe dark signal SG316.0 - 964 feet

Simulated End of Train Device at the estimated point of impact

Time 05:35 a.m.

1. Engineer observed the simulated EOT device and reflection on light on the track – 450 feet
2. Conductor observed the reflection of light on the track – 419 feet
3. Conductor observed simulated EOT device – 364 feet.

Radio Tests

On October 13, 2011, the NTSB, along with the parties to the investigation (CSX Transportation, Brotherhood of Locomotive Engineers and Trainmen, United Transportation Union) conducted radio tests near the accident site. The purpose of these tests was to simulate the radio announcement made by the crew of train Q61623 as it observed and announced the absolute signal at south Monroe, SG 306.2 to determine if the crew of train Q19423 could have received and understood the broadcast as they approached the final signal minutes before the collision.

Previously conducted interviews with the crew of train Q61623 determined the estimated time that the radio communication was made. These times were then matched with event recorder data from train Q19423 to determine the location of that train when the radio communication occurred. From this information, investigators determined that the crew of train Q19423 would likely have been traveling between MP 318.0 and 317.0 when the radio broadcast was made.

During the re-creation, radio announcements (similar to what was actually broadcasted by the crew of train Q61623) were made for each test by a UTU investigator on train Q61623. Each radio broadcast said: ("*Radio test. Radio test*. .." Insert script here). Investigators from the NTSB and BLET stationed on train Q19423 evaluated each radio broadcast based on its quality: good, fair, poor, or no audio received.

The radio testing began at 4:45 a.m. and ended at 6:22 a.m. The weather at the time of the radio tests was misty, with fog present during the latter part of the tests as determined by the investigative team. The temperature was in the upper 50s .

The first radio test was conducted with train Q19423 stopped at MP 318.5. After that test was completed, train Q18412 was moved to MP 318.0. From MP 318.5 to MP 317.5, train Q19423 was moved and stopped every one-tenth mile. Identical radio announcements were made from train Q61623 while investigators on train Q19423 evaluated and recorded the reception quality of each radio broadcast. Additional radio tests occurred with train Q19423 positioned at the Collins Road crossing (MP 316.2), and lastly at the signal at MP 316.0. A total of 19 radio communication measurements were conducted.

The results of radio tests are found in the table below. The investigators agreed that each radio communication had some static, but in only one case (MP 316.7) did it interfere with the auditory recognition of the listeners.

TEST #	MILE POST	QUALITY OF RADIO RECEPTION			
		Good	**Fair**	**Poor**	**No Audio Detected**
1	318.5				X
2	318.0				X
3	317.9				X
4	317.8	X			
5	317.7	X			
6	317.6	X			
7	317.5	X			
8	317.4	X			
9	317.3	X			
10	317.2	X			
11	317.1	X			
12	317.0	X			
13	316.9	X			
14	316.8	X			
15	316.7		X		
16	316.6				X
17	316.5	X			
18	Collins Road MP 316.2				X
19	316.0 (signal)	X			

Event Recorder Data

DETAILS OF RECORDER INVESTIGATION

On-scene investigators downloaded the event recorder from CSX Transportation train Q19423's lead locomotive 7783[25] and on May 25, 2011 sent the file to the National

[25] CSX Transportation train Q19423's lead locomotive 7783 will be referred to as CSXT 7783 for the rest of the report.

Transportation Safety Board's Vehicle Recorder Division for readout and evaluation. Table 1 has the information about CSXT 7783 and its event recorder as provided by on-scene investigators:

Table 1. CSX Train Q19423 event recorder information.

Locomotive	Event Recorder Information	Serial Number	Wheel Size
GE[26] CSXT 7783	GE Recorder Model: FE-133-CSX	FL00030380	37.62 inches

Recording Description and Wheel Size

For most event recorders, the actual speed and distance values are not recorded but rather the number of drive wheel rotations (or fraction thereof) is stored in memory. At the time the data is extracted, a wheel size is entered manually into the readout station or computer. Wheel size, number of rotations, and time are then used by the program to calculate distance traveled, where the computed distance traveled does not account for wheel skidding or slippage. Then the calculated distance traveled and time data are used to calculate speed.

Using the wheel size of 37.62 inches as provided by on-scene investigators, CSXT 7783's event recorder data were extracted using the program Wabtec Railway Electronics Event Recorder Data Analysis Software. Only data relevant to the investigation are provided in this report. The data exported from the Wabtec Railway Electronics Event Recorder Data Analysis Software with a sampling rate of one second. Therefore, the data has an accuracy of +/- 1 second.

[26] GE stands for General Electric

Event Recorder Timing and Timing Correlation

The recorded time from CSXT 7783's event recorder data file is time stamped and, consequently, the times may not reflect the actual time of day. To correlate the time between CSXT 7783's event recorder and CSXT 7783's on-board video recorder, the video recorder time was used as the base time. An offset of +1,314 seconds was provided by the video recorder specialist as found in the On-Board Video Recording Factual Report. Therefore, for the rest of this report, all times are referenced as Video Recorder Time.

Parameters

Appendix A list the parameters from CSXT 7783's event recorder that were verified and provided in this report.

Distance Traveled

The default output for the distance traveled is the distance decreasing in time. Therefore, the distance traveled began with a very large value and continually decreased to 0 feet.

CSX 7783 Plots and Corresponding Tabular Data

Figures 1 and 2 contain CSXT 7783's event recorder parameters listed in table A-1 during the May 24, 2011 event. Figure 1 covers the last 15 minutes and 32 seconds of data from 03:19:00 to 3:34:32 (the x-axis ends at 03:35:00). Figure 2 has the same parameters as figure 1 except miles traveled was replaced by feet traveled. Figure 2 has an expanded scale covering the last 77 seconds of data from 03:33:15 to 03:34:32 (the x-axis ends at 03:34:35).

In summary, CSXT 7783's event recorder data indicated the following:

- At 03:34:27, the load was 496 amps while in dynamic braking and the speed was 48 mph, the brake brake pressure was 87 psi. "idle".
- At 03:34:28, the load increased to 600 amps while the brake pipe pressure, speed and dynamic braking remained the same.
- At 03:34:29, the load decreased to 264 amps, the brake pipe pressure decreased to 6 psi, the speed decreased to 47 mph, and the throttle transitioned from dynamic braking" to "Idle".

Note: possible magnified (exploded view) of the times listed below. Talk to Cassy Johnson for a different format.

All of the corresponding tabular data used to create figures 1 and 2 are provided electronic (*.csv[27]) format as attachment 1 to this factual report.

This describes the parameters provided and verified in this report. Table A-1 lists the parameters and table A-2 describes the unit abbreviations.

Table A-1 Verified and provided event recorder parameters.

Parameter Name	Parameter Description
1. Auto Brake Press (psi)	Automatic Brake Pressure
2. Bell (discrete)	Bell

[27] Comma Separated Value format.

Parameter Name	Parameter Description
3. Dyn Brake (discrete)	Dynamic Brake Pressure
4. Feet (ft)	Feet Traveled
5. Horn (discrete)	Horn
6. Indep Brake Press (psi)	Independent Brake Pressure
7. Load (amps)	Load
8. Miles Traveled (miles)	Miles Traveled
9. Speed (mph)	Speed
10. Throttle Notch (discrete)	Throttle Notch

Table A-2 Unit abbreviations.

Units Abbreviation	Description
amps	amps
ft	feet
miles	miles
mph	miles per hour
psi	pounds per square inch

NOTE: For parameters with a unit description of discrete, a discrete is typically a 1-bit parameter that is either a 0 state or a 1 state where each state is uniquely defined for each parameter.

Figure: 1. Last 15 minutes and 32 seconds of CSXT 7783 event recorder data.

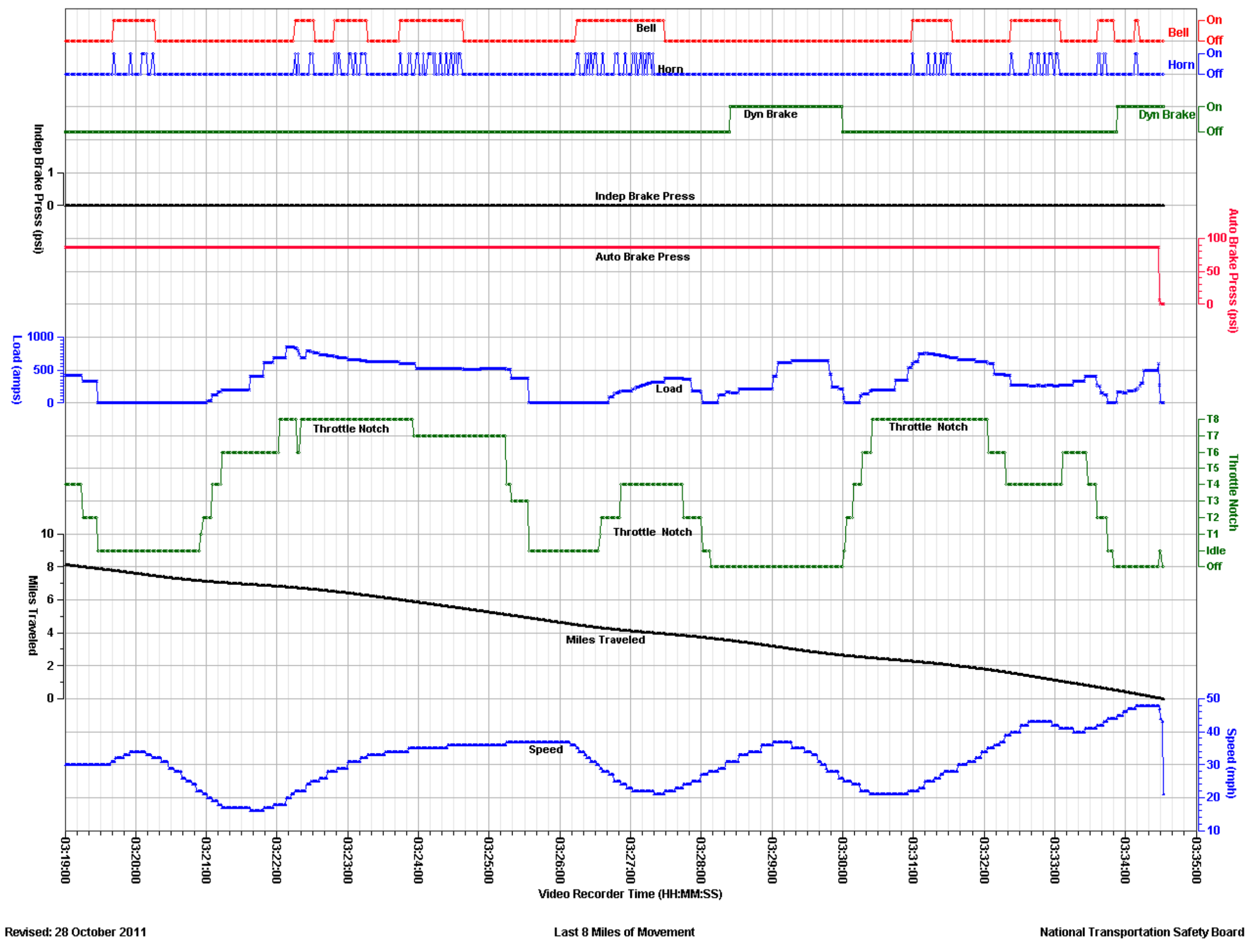
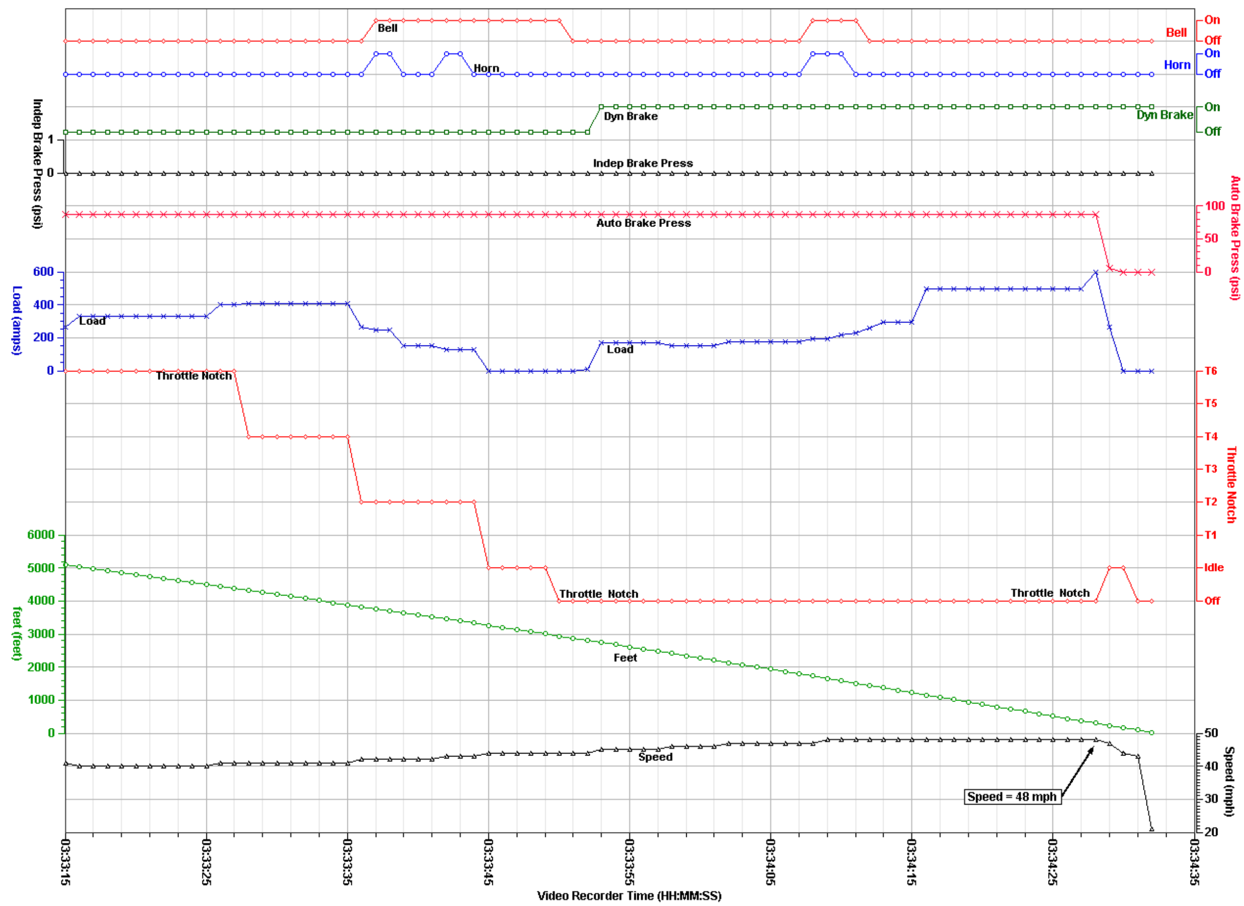


Figure: 2. Last 77 seconds of CSXT 7783 event recorder data.



Revised: 28 October 2011 Last 77 Seconds National Transportation Safety Board

On Board Video Recordings

Download and Recorder Details

The contents of the disk drive were downloaded using a GE readout station appropriate for this particular model of recorder. This process extracts proprietary files from the drive, which can then be viewed using a GE supplied viewer program. The system captures data to a series of individual files, each containing 12 seconds of audio, video, and data. These files are loaded into the viewer which can play back these

3 types of information synchronously. The images recorded from the camera were approximately 600 x 380 pixels in Size, and were recorded at a frame rate of approximately 15 frames per second.

The system also captured Global Positioning System (GPS) time of day, and location (latitude and longitude) at 1 second intervals.

Recording Timing

The LocoCAM recorder captured GPS time of day, which was synchronized to the event recorder data by comparing the sound of the horn as heard on the LocoCAM recording, to the parametric data for the horn operation captured on the event recorder.

The following relationship was established:

- Event Recorder Time + 1314 seconds = Video Recorder Time

Recording Duration

- Start of Recording: May 18, 2001 15:07:26 Eastern Daylight Time
- End of Recording: May 24,2011 17:07:48 Eastern Daylight Time

The recording is not continuous over this period. Most notably, the recording stops approximately 26 seconds (about 1840 feet) before the collision, based on the time synchronization with the event recorder. The recording then resumes about 1 hour and 4 minutes later. At the time the video resumes, the locomotive is on its side, and emergency responders can be seen walking in front of the locomotive.

With the exception of this interruption, the recording is continuous from 23:07:35 on May 23, 2011, until to the end of recording. Prior to this time, there are several interruptions in the recording ranging in length from about 1 hour, to 32 hours.

Description of Recording Contents

The video portion of the recording system captured a view through the windshield of the locomotive. The area in front of the locomotive could be seen, as illuminated by the locomotive headlight. Wayside signals and grade crossing equipment were visible. The audio included sounds from the locomotive's engines, pneumatic systems, as well as the horn and bell.

The video Group made the following observations from the recording:

- The north end Waxhaw Approach signal was displaying a yellow aspect. The train passed this signal at video time 3:26:43.
- Approximately 50 seconds before passing the intermediate signal at milepost (MP) 316, the train began accelerating from 21 miles per hour (MPH). About 20 seconds prior to the signal, as the train approached the Collins Road grade crossing, the silver signal box (bungalow) was visible in the video. The signal was not illuminated. The train had reached approximately 31 MPH as it passed the signal at MP316 at video time 03:31:49.
- Acceleration continued up to about 46 mph, when the video recording was interrupted at video time 3:34:01.
- Based on the synchronization with the locomotive event recorder data the video recording ends about 26 seconds (about 1840 feet) prior to the collision.

Additional Information

Figures 2 and 3 depict selected observations from the video recording as well as sight distance test information, overlaid onto the charts of event recorder data. These include:

- Location of yellow signal at North Waxhaw (MP318)
- Sight distance to the signal mast at MP316 (964 feet prior to mast)
- Signal mast at MP316
- Engineer sight distance to the point of collision (450 feet)
- "Reflection sight distance" -Location where a reflection of the End of Train device light can be seen on the rails, from conductor's side of the locomotive(419 feet)
- Conductor sight distance to the point of collision (364 feet)

The sight distance overlays were calculated based on the distance and references provided by the Operations Group, and comparing them to the distance travelled data from the locomotive event recorder. However, the event recorder data did not explicitly indicate when or where the collision occurred within the dataset. A review of the data indicated that the collision most likely occurred between 3:34:27 and 3:34:28, (video recorder time) based on a rise in traction motor current during this interval, and the subsequent loss of pressure in the automatic brake system. Using this timeframe as the point of collision, a reference for the sight distance lengths could be calculated using the event recorder distance

travelled values. It should be noted that at the locomotive's speed of 48 MPH, the one second of uncertainty in the time of the collision equates to about 71 feet travelled. The sight distance overlays shown in Figures 2 and 3 have this same uncertainty.

The video observation overlays were located using the time values from the video recording. For example, the locomotive passed the signal at MP318 at 3:26:43

video recorder time, as observed in the video recording. This overlay was placed on the charts in Figures 2 and 3, using that time value.

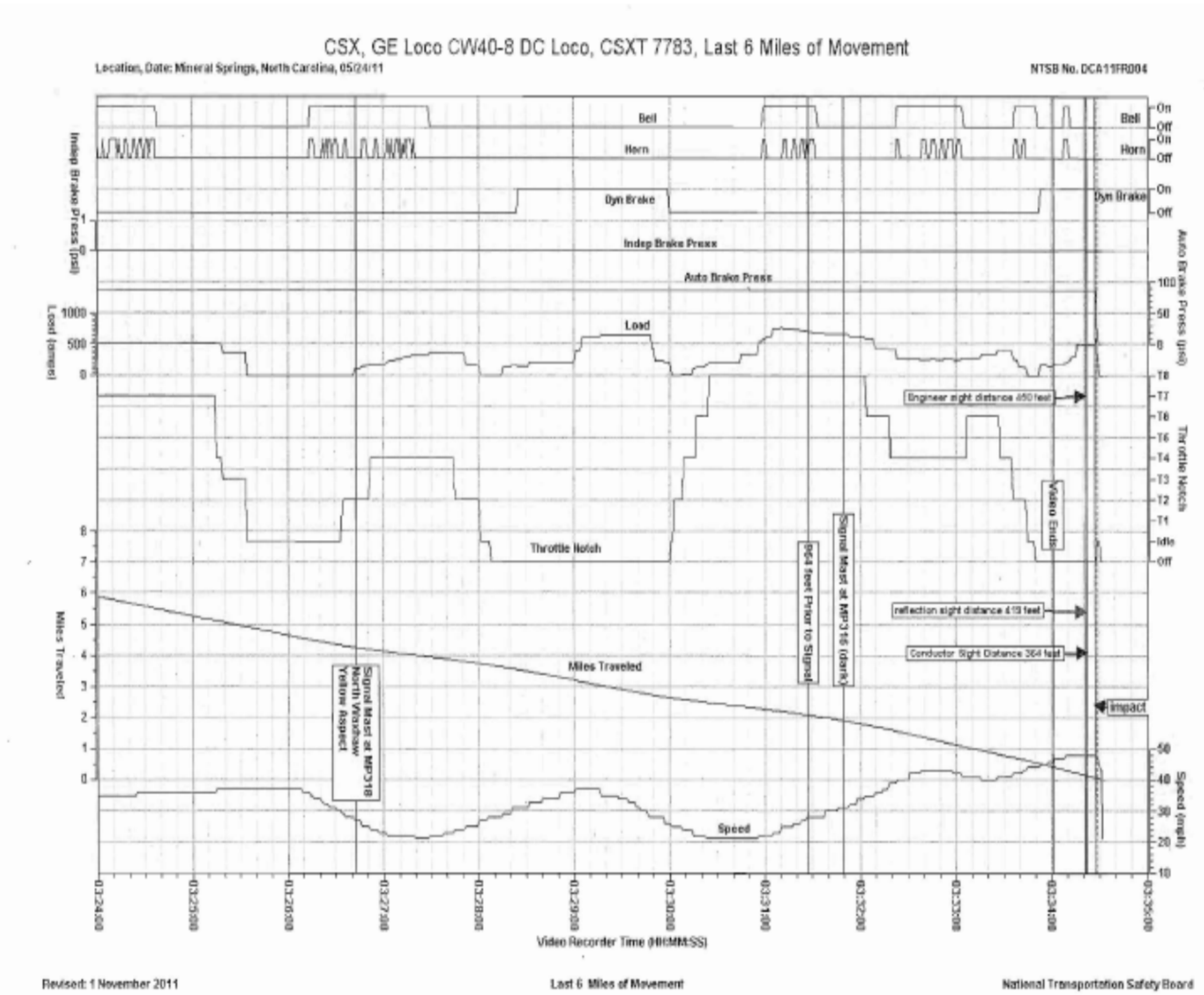


Figure 2 - Event Recorder Data with Overlays - Last 6 Miles

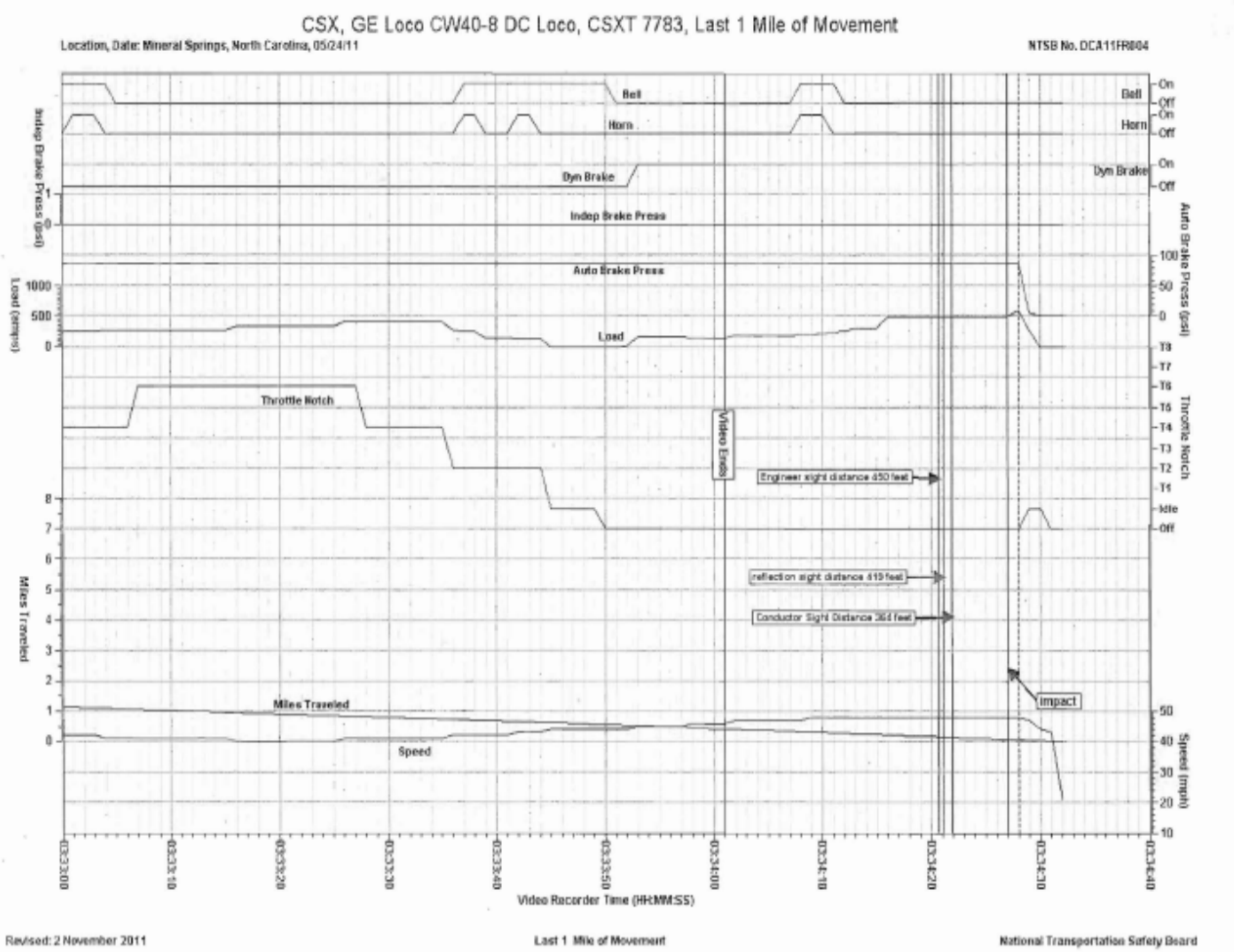


Figure 3 - Event Recorder Data with Overlays - Last 1 Mile

Stopping Distance Tests

Equipment

New York Air Brake Track Train Dynamics Analyzer

Verified measurements

- Q618-22 EOT/rear car location measured to be 782 feet south of MP SG 314.0

- Northbound intermediate signal with dark aspect at MP SG 316.1 measured 115 feet south of MP SG 316.0
- A lead-equipped locomotive approaching a signal displaying restricted speed must operate at a speed no greater than a speed of 15 MPH.

Simulated speeds/Braking actions/Results

The subdivision used was the Florence Division's Monroe SD from SG 306-442.

Train consist used is Q194-23 comprised the following:

Train Consist information

Q194-23 contained 12 loads, 0 empties, 1,562 tons and 1,977 feet in length.

Locomotive consist information

CSXT 7783 - model CW40-8 with a powered axle count of 6 and a dynamic brake axle count of 7(?footnote) (modified 1/26/97 for continuous dynamic braking following emergency braking).

CSXT 8429 - model SD40-2 with a powered axle count of 6 and dynamic brake axle count of 6. (modified 9/21/96 for continuous dynamic braking following emergency braking).

Simulation results

Legend:

Full Service brake application - FS
Engineer initiated brake application – EIE
DB – Mode is dynamic braking

Measured mile between SG 315 and SG 314 is 5,332 feet.

Scenario Count	Activity	Beginning Location	Train Speed	Braking Action FS / EIE & w / wo DB	Stopping Location / Distance (ft.)	Final Stopping Location	EOT location 314.146 Arrival Speed	Distance from EOT
1	Engineer observes EOT of Q618-22	314.2325	18.0	FS w DB @ 314.219	.087 mi or 463.88 ft.	314.140	6.3 mph	.006 mile or 31.99 ft. *past*
2	Engineer observes EOT of Q618-22	314.2325	18.0	EIE w DB @ 314.222	0.21 mile or 111.97 ft.	314.167	N/A	.021 mi. or 111.97 feet from EOT
3	Engineer observes EOT of Q618-22	314.2325	15.0	FS w DB @314.223	0.069 mile or 346.58 ft.	314.158	N/A	.012 mi. or 63.98 feet from EOT
4	Engineer observes EOT of Q618-22	314.2325	15.0	FS w/o DB @ 314.228	0.082 mile or 437 ft.	314.157	N/A	0.11 mi. or 58.65 ft from EOT
5	Engineer observes EOT of Q618-22	314.2325	15.0	EIE w DB@ 314.219	.041 mile or 218.61 ft.	314.178	N/A	.032 mi. or 170.62 ft.

6	Conductor sees EOT reflection on rail	314.2267	18.0	FS w DB @ 314.228	.077 mile or 410.56 ft.	314.157	6.7 MPH	.011 mi. or 58.65 ft. *past*
7	Conductor sees EOT reflection	314.2267	18.0	EIE w DB @ 314.218	.057 mile or 303.92 ft.	314.161	N/A	.015 mi. or 79.98 ft. from EOT
8	Conductor sees EOT reflection	314.2267	15.0	FS w DB @ 314.219	.066 mile or 351.91 ft.	314.153	N/A	.007 mi. or 37.32 ft. from EOT
9	Conductor sees EOT reflection	314.2267	15.0	EIE w DB @ 314.215	.04 mile or 213.2 ft.	314.175	N/A	.029 mi or 154.6 ft.
10	Conductor sees Train	314.2156	18.0	FS w DB @ 314.195	.077 mi. or 410 ft.	314.118	13.3 MPH	.028 mi. or 149.3 ft. *past* EOT.
11	Conductor sees Train	314.2156	18.0	EIE w DB @ 314.206	.06 mi. or 319.92 ft/	314.151	N/A	.005 mi. or 26.66 ft. from EOT.
12	Conductor sees Train	314.2156	15.0	FS w DB @ 314.207	.064 mi. or 341.2 ft.	314.143	4.2 MPH	.003 mi. or 15.99 ft. *past EOT.*
13	Conductor sees train	314.2156	15.0	EIE w DB @	.041 mi. or 218.61 ft.	314.167	N/A	.021 mi. or 111.97 ft from EOT.

If train Q194-23 after passing intermediate signal SG 316.1 had operated in compliance with restricted speed not exceeding 15 MPH while using sight distance for both engineer and conductor to the rear of train and initiating emergency brake application would have stopped approximately 112 feet short of the rear of the standing train Q61822.

Had Q19423 been operating at a speed up to 18 MPH using the engineer's sight distance, it would have stopped short of the rear of the standing Q61822 train prior to impact using the same brake application.

The simulations indicated that by operating at restricted speed not exceeding 15 MPH and applying a full service brake application using the engineer's sight distance of Q19423 would have stopped Q19423 movement prior to impact with the exception of simulation #12 which indicates an impact speed of 4.2 MPH and overrun of 15.9 feet.

Positive Train Control

CSXT intends to install Positive Train Control on the Monroe Subdivision during one of its later phases of implementation. Positive Train Control implementation would have responded to train movement as follows;

Q194-23 would have had an approach signal at NE Waxhaw (SG 318.4) and a restricted-proceed signal at the Intermediate signal at MP SG 316.1.

Approach Signal, requires a train exceeding 30 MPH to immediately begin a reduction to 30 MPH, as soon as the locomotive passes the approach signal. Restricted Proceed requires a train to operate at restricted speed (i.e. not exceed 15 MPH) and be prepared to stop within one-half the range of vision.

1. At NE Waxhaw, upon receiving an approach signal, the 0194-23 is required by CSX operating rules to begin slowing their train to 30 MPH, and be prepared to

stop at the intermediate signal SG 316.1 The PTC Onboard display would have indicated to the engineer that the next target is the intermediate signal at SG 316.1 for restricted speed (15 MPH). The PTC system does not enforce the approach signal by requiring a reduction to medium speed, but does provide for a "soft target" speed of 30 MPH.

2. Soft Target, in an approach block, once the locomotive engineer reduces the speed of the train to 30 MPH, the PTC on-board will enforce a 30 MPH limit, and warn the engineer when speed increases to 33 MPH and will stop the train if the speed reaches 35 MPH. The system does not enforce until the speed is reduced,
3. If the engineer maintains a speed above 30 MPH the system will not warn or enforce a stop.
4. At the intermediate signal at SG 316.1, the PTC on-board system would have set an enforceable target speed of restricted speed (15 MPH). Depending on the speed and the on-board brake algorithm's predicted speed, the engineer will receive a warning to slow the train. If the engineer's actions are not sufficient, the onboard system will stop the train.
5. Once past the intermediate signal at SG 316.1, the PTC on-board would enforce restricted speed's upper limit of 15 MPH.

The PTC Onboard system has no way of knowing where the rear end of a train ahead is, and does not enforce Restricted Speed's half the range of vision component, However, the system does enforce the 15 MPH cap on restricted speed. When the speed of the locomotive reaches 18 MPH the Onboard displays a warning prompt to the engineer of the over speed. If the speed reaches 20 MPH the Onboard system would stop the train.

Parties to the Investigation - Acknowledgment Signatures

The undersigned designated *Party to the Investigation* representatives attest that the information contained in this report is a factually accurate representation of the information collected during the investigation, to the extent of their best knowledge and contribution in this investigation.

_________________\\s____________________ Date ____3/20/12_____
C. Wayne Workman, NTSB

_________________\\s____________________Date ___3/20/12______

Joseph Corcoran, FRA

____________________\\s________________________Date ___3/20/12 ______
Bruce Rose, CSXT

____________________\\s________________________Date ____3/20/12______
James Herndon, UTU

____________________\\s________________________ Date ____3/20/12______
Mark Ciurej, BRS

____________________\\s________________________Date ____3/20/12______
Kimble Jackson, BLET