NATIONAL TRANSPORTATION SAFETY BOARD

Office of Railroad, Pipeline and Hazardous Materials Investigations
Washington, DC

IIC Factual Report

DCA-12-MR-009

CSXT Transportation Derailment with
Non-Railroad Fatalities

CSX Train N0. U81318

Ellicott City, MD

August 20, 2012

James A. Southworth
Investigator In Charge

Accident

NTSB Accident Number:	DCA 12 MR 009
Date of Accident:	August 20, 2012
Time of Accident:	11:56 p.m. (EDT)
Type of Train and No:	Unit Coal Train U81318
Railroad Owner:	CSX Transportation (CSX)
Train Operator:	CSX
Crew Members:	1 Engineer, 1 Conductor, 1 Student Engineer
Location of Accident:	Ellicott City, MD

Synopsis

On August 20, 2012, at about 11:56 p.m. EDT, an eastbound CSX Transportation (CSX) coal train, (identification number U81318) with two locomotives and 80 cars derailed the lead 21 cars at milepost 12.9 on the Old Main Line (OML) Subdivision in Ellicott City, Maryland. The derailed cars included 21 cars full of coal, six of which fell into a public parking area positioned about 12 to 15 feet below the main line to the north of the tracks. Other coal cars involved in the derailment were overturned, spilling their content along the north side of the main line. As a result of the derailment and spillage of coal, there were two civilian fatalities. The two individuals were local citizens (not railroad employees) sitting on the north side of the railroad bridge that crosses above Main Street in downtown Ellicott City, MD. The two individuals were not authorized to access the railroad right-of-way or to sit on the railroad bridge overpass.

Parties to the investigation are the Federal Railroad Administration, CSXT Transportation, and the Brotherhood of Maintenance-of-Way Employes Division[1].

The weather at the time of the incident was cloudy skies with calm winds and a temperature of 65 ° F.

[1] ‘Employes’ is a spelling from the Old English language.

Damages

The damage estimates provided by CSX are $1.9 million, which includes environmental remediation and approximately $35,000 in track/structural repairs. The CSXT signal system did not sustain any damage to the signal equipment and appurtenances as a result of the train collision. Repair damages to track connections and bonding were necessary to restore track circuits.

Accident Description

On August 24, representatives from CSXT, Federal Railroad Administration and NTSB conducted interviews with the crew from the accident train. The interviews were recorded and a transcript was prepared. From the interviews, investigators learned that on Monday August 20, 2012, a CSXT train crew, consisting of an engineer, a student engineer and a conductor, reported for duty at Cumberland, Maryland at 4:00 p.m. After the crew took charge of train U81318, they departed Cumberland eastbound en route towards Baltimore, Maryland. The train consisted of two locomotives, (CSXT 4579 and CSXT 267) and 80 open top hopper cars loaded with coal. The train was 4,227 feet long and weighed about 9,873 trailing tons.

According to interviews with the train crew, the trip was uneventful and the engineer trainee operated from the lead locomotive the entire trip. All three crew members were in the lead locomotive. When approaching Ellicott City, the train was in dynamic braking. There were no slow orders in effect for the Ellicott City area and none of the three man crew saw anyone on the right-of-way. The train crew told investigators that the train was travelling at 24 mph, and at approximately milepost 12.8 the train went into emergency and stopped in about 3 car lengths. The crew notified the dispatcher that their train was in emergency braking and they were unsuccessful in their attempts to restore brake pipe pressure. The conductor got off the locomotive on the engineer side and saw people gathered in the street and approaching the train and right-of-way. As the conductor walked to the back of the second locomotive he realized the derailment and radioed the engineer to join him at the rear of the second locomotive. The engineer and conductor discussed the derailment and what they needed to do report the derailment. The crew stated that at this time emergency personnel began arriving and the crew provided the fire department with the consist list and advised that the entire train was loaded coal cars. The first 21 cars of the train derailed directly behind the locomotives spilling loads of coal beside the historic Ellicott City train depot/museum area, including the bridge over Main Street in Ellicott City, Maryland. Two citizens had been sitting on the north side of the bridge and they were fatally injured as a result of being engulfed in the spillage of coal.

Locomotive Event Recorders

The locomotive event recorders from both CSXT coal train U81318's lead locomotive 267 and CSXT coal train U81318's second locomotive 4579 were downloaded on-scene. The files were readout and evaluated by the National Transportation Safety Board's Vehicle Recorder Division.

In brief, the locomotive event recorder data from CSXT 267 indicated the following:

- At 11:55:10, the EAB BP was at 89 psi, the DB was at B2, the throttle was off, and the speed was 23 mph.
- At 11:55:11, the EAB BP reduced to 65 psi, the DB remained at B2, the throttle remained off, and the speed remained at 23 mph.
- At 11:55:12, the EAB BP reduced to 18 psi, DB changed to B3, the throttle remained off, and the speed reduced to 21 mph.
- At 11:55:13, the EAB BP reduced to 0 psi, DB changed to B8, the throttle remained off, and the speed reduced to 18 mph.
- Six seconds later at 11:55:19, the EAB BP remained at 0 psi, DB had changed to B3, the throttle remained off, and the speed reduced to 0 mph.
- At 11:55:20, the EAB BP remained at 0 psi, DB changed to off, and the throttle changed from Off to Idle.

Signals

The CSXT Baltimore Division, Old Main Line Subdivision runs in a timetable east-west direction between control point (CP) Saint Denis at milepost BAC-6.5 and milepost BAC-38.9. The maximum timetable[2] speed for trains operating in the vicinity of the derailment is 25 mph for freight trains.

Train movements on the CSXT Old Main Line Subdivision are governed by operating rules, timetable instructions and the signal indications of a traffic control signal (TCS) system.

[2] CSX, Baltimore Division Timetable No. 7, effective January 1, 2011.

The "BD" train dispatcher located at the CSXT Baltimore Division Operations Center in Halethorpe coordinates train movements with the signal system. Between CP East Davis at milepost BAC-20.0 and CP West Avalon at milepost BAC-9.8, the CSXT TCS system consists of an Invensys (Safe Tran) Geographic Signaling System (GEO), which is a vital microprocessor-controlled signal system with electronic coded track circuits and four-aspect color light type signals.

CSXT Operations Center Data Logs

Post-accident data was downloaded from the Ansaldo Computer Aided Dispatch (CAD) System logs at the CSXT Baltimore Division Operations Center. Table 2 summarizes signal and train control events recorded between CP East Davis and CP West Avalon on the data log.

Table 2 *Recorded events from CSXT Operations Center diagnostic log.*

Time[3]	**Location**	**Event**
Train B813-18		
23:16:44	East Davis	Signal requested by CAD system
23:16:54	East Davis	Signal indicates clear
23:27:51	West Davis	Track segment 003 indicates occupied
23:33:06	West Davis	OS indicates occupied (track segment 002) Signal indicates at stop
23:33:32	West Davis	Track segment 007 indicates occupied (between West & East Davis)
23:35:22	West Davis	Track segment 003 indicates unoccupied
23:35:44	West Davis	OS indicates unoccupied
23:37:44	East Davis	OS indicates occupied
23:38:04	East Davis	Track segment 001 indicates occupied
23:40:06	West Davis	Track segment 007 indicates unoccupied
23:40:15	East Davis	OS indicates unoccupied
23:43:45	East Davis	Track segment 013 indicates occupied (accident track segment)
23:45:18	East Davis	Track segment 001 indicates unoccupied

[3] Time based on CSX Baltimore Division Operations Center system clock which is synchronized to UTC.

CSXT Field Signal System Data Logs

Additional postaccident data was downloaded from signal equipment located in the field along the railroad right-of-way. Hot bearing and dragging equipment detector logs were downloaded from the two defect detectors that the accident train went by prior to the accident. Table 3 summarizes the information from the defect detector logs.

Table 3 *Defect detector log for Train B813-18.*

Time[4]	Location	Axle Count	Defects
22:55	Ridgeville - MP BAC-38.9	332 axles	No defects
22:16	Daniels - MP BAC-18.1	332 axles	No defects

Signal system data logs from the two CP locations and the three intermediate signal locations were downloaded. The data logs record track circuit codes transmitted and received between signal locations.

Postaccident Inspection/Testing of Signal System

On August 21, representatives from CSXT, the Federal Railroad Administration and NTSB began conducting a field inspection and investigation of the railroad signal system between CP East Davis and CP West Avalon. The postaccident inspection found the signal light units and the signal cases locked and secured with no indications of tampering or vandalism to any of the signal equipment at the two CP locations and the three intermediate signal locations.

All signal indications were found to be in accordance with the physical location of the accident train. The signal light units at the two CP locations were configured to be constantly lit and the three intermediate signals locations were configured to be approach lit for all train movements.

[4] Time based on defect detector clock and has not been synchronized with signal system clock.

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 eastbound signals between CP East Davis and CP West Avalon. Track circuits were verified and no failures were identified. Ground tests were performed.

Signal maintenance records for all signal locations between East Davis and West Avalon were provided to the Signal Group for review.

Verizon Network Operations Center Data

A Verizon cable located along the CSXT right-of-way was severed as a result of the derailment. The Verizon Network Operations Center (NOC) maintains an event log that records alarms affecting their system. The event log is time stamped and recorded. The time stamp is acquired from the NOC clock which is synchronized to Greenwich Mean Time (GMT). The NOC event log recorded a loss of signal alarm on August 21, 2012, at 03:56:13 GMT.

Emergency Response

At 11:55 p.m. the first 911 call was received by the Howard County Police Department. The caller reported that a train was derailed on a bridge over Main Street in Ellicott City. Three additional 911 calls followed. At 11:58 p.m., the initial police department units were dispatched. At 11:59 p.m., fire companies from the Howard County Department of Fire and Rescue Services were dispatched. At 11:59 p.m., Howard County dispatchers notified Baltimore County about the accident.[5] Police and fire personnel began arriving on scene at 12:02 a.m. A unified command system was established with fire and police department officials.

At 12:03 a.m., the police dispatchers established direct contact with CSXT. Also at 12:03 a.m., police officers began shutting down the roads in the area to secure the scene. At 12:07a.m., a fire department engine company located the train crew. The train crew provided the engine company any with the train consist. At 12:09 a.m., fire dispatchers contacted Baltimore Gas & Electric and requested electric personnel to respond to the scene. At 12:15 a.m., an engine company located two people who were injured fatally on the north side of the right-of-way on the bridge.

[5] At the accident location, the border between Howard County and Baltimore County parallels the railroad right-of-way.

Figure 1: The railroad right-of-way and bridge over Main Street in Ellicott City, Maryland. (Photo: Howard County Police)

The railroad bridge passes over Main Street in the historic district of Ellicott City. Coal spilled from the overturned cars onto the right-of-way, the street, a parking lot, and the bank of the river. The fire department searched cars in the parking lot and did not locate any victims at that location. An environmental response contractor for CSXT conducted water sampling to ensure that there was not any environmental release. The Maryland Department of the Environment monitored the environmental sampling.

At 1:23 a.m., the fire department safety officer confirmed with electric company personnel that power was shut down and secured. After the scene was confirmed safe, responders worked overnight to recover the victims. At about 7:00 a.m., the fire department commander began to release fire companies from the scene.

Medical and Pathological Information

Two 19 year old females sustained fatal injuries[6] as a result of the accident. According to the Maryland Office of the Chief Medical Examiner, the cause of death for both victims was compressional asphyxia.

Locomotive Video Recorders

The following video recorder evidence was obtained from CSXT Transportation, who secured the hard drives from the locomotives on August 21, 2013, at 3:00 a.m.

1. Forward Locomotive 267: hard drive Model #GE 17FM738B1, S/N 111430067.
2. Trailing locomotive 4579: hard drive Model #GE17FM738B1, S/N 11142073.

The recorder evidence was transferred on-scene at 3:45 p.m. to the custody of NTSB.

Cellular Telephones

Howard County Police Department, Criminal Investigation Division, transferred custody of two cell phones recovered from the victims at the accident scene. The phones were submitted to the NTSB for examination. One cell phone was recovered from the piled coal near the bodies. This phone was powered on to determine whether it would work, and then powered off. Examination of this device showed the last outgoing call was placed at 3:15 p.m. on August 20, 2012. The last outgoing text message was sent at 11:21 p.m. on August 20, 2012. Another cell phone was recovered from green electrical box on edge of bridge on right of way. Examination

[6] 49 Code of Federal Regulations 830.2 defines fatal injury as "any injury which results in death within 30 days of the accident."

of this device showed that the last outgoing call was placed at 10:48 p.m. on August 20, 2012. The last outgoing text message was sent at 11:40 p.m. on August 20, 2012.

Mechanical

Train Consist

U81318 consisted of two locomotives units at the head end and 80 loaded coal cars. The train weighed 9,873 tons and was 4,080 feet in length.

Railroad Equipment Involved in the Derailment

The lead locomotive, unit, CSXT 267, of the derailing train is a General Electric model CW44AC (GE AC4400 HP AC Traction Control) built in 1996. These steerable truck units are six-axle / two-truck, 4400 HP diesel-electric locomotive. They are equipped with a GE 7FDL™ engine, a medium-speed turbo-diesel engine. The locomotive units feature six alternating current (AC) traction motors (one fitted to each axle).

The locomotive unit measures approximately 73 ft. (length), by 10 ft. (width), by 15.5 ft. (height), and weighs (fully loaded with fuel, traction sand, etc.) about 416,000 lbs. A fuel tank, having a capacity of about 5,000 gallons, is located (suspended from the underside of the underframe) between a pair of three-axle power truck assemblies.

The second locomotive unit, CSXT 4579, of the derailing train is an Electro Motive Diesels Inc., model SD70AC built in 1998. This unit is a six-axle / two-truck, 4000 HP diesel-electric locomotive. The locomotive unit measures approximately 74 ft. (length), by 12 ft.

(width), by 16 ft. (height), and weighs (fully loaded with fuel, traction sand, etc.) about 425,000 lbs. A fuel tank, having a capacity of about 4800 gallons, is located (suspended from the underside of the underframe) between a pair of three-axle power truck assemblies.

The coal cars behind locomotive U81318 were open top gondola coal cars manufactured by Freight Car America, Inc., designed with a steel underframe, utility grade stainless steel and aluminum car body, and twin rounded bottom tubs.

The car design is based on a 286,000 pound gross rail load, AAR Plate "B" clearance diagram, and unit train single rotary dump service operating on track meeting the requirements of the Title 49 *Code of Federal Regulations*, Part 213. These cars are designed for a 238,000 pound payload and a max gross vehicle weight of 286,000 lbs. This car is approximately 51 feet long, 10 feet 7 inches wide and 12 feet 7 inches tall. The unloaded weight is approximately 48,000 lbs. Train list data reports the loaded weight of these cars on average to be 240,000 lbs.

Pre Accident Inspection

CSXT coal train U81318 originated in, Grafton, WV, destined for Baltimore’s Curtis Bay Coal Pier. A Class 1 brake test was completed by qualified inspectors with no exceptions recorded. The train was re-crewed in Cumberland. U81318 departed Cumberland heading for Baltimore at 5:11p.m. on August 20, 2012. The train derailed in Ellicott City, MD at milepost 12.9.

Wreckage Description

The locomotives did not derail. The first car behind the locomotive was pitched and rolled approximately 45-degrees to the north with all wheels off the track. The next nine cars were lying on their sides to the north of the track. Car number 11 was disconnected from car number 10 and cars 11 through 17 derailed and fell into a public parking lot located about 12-15 feet below the main to the north of the track. Cars 18 through 20 were on their side to the north side of the main. The last car to derail was car number 21. The leading two axles on this car were derailed and the trailing two were still on the rail. The leading end of the car was buried about 3-4 feet into the ballast. Additionally, the rail under the car was destroyed with several sections lying nearby. Some had indications of fresh overstress fractures, characterized by a shiny, granular appearance with sharp edges around the freshly exposed metal.

There were also sections of the broken rail in the area under the car that had the appearance of recent longitudinal loading at the exposed edge of the rail head, consistent with wheel tread impacts.

Equipment Post Accident Inspections

NTSB investigators formed a group of qualified inspectors to evaluate the mechanical condition of the equipment involved in this derailment.

On August 21, 2011, 59 cars from U81318 that were not derailed were given a Class 1 mechanical inspection near the point of rest by the Mechanical Group. The brakes on all 59 cars applied and released as designed. The original End of Train Device (EOT) from the train was used to complete the inspection on the 59 cars, serial number CSXE 44518. No exceptions were taken with this equipment.

On August 21, 2011, the two locomotives were given a Class 1 mechanical inspection at their point of rest by the Mechanical Group. The brakes on both units were applied and released as designed. The group observed very light witness marks on the wheels of the second locomotive that traveled over the north rail. The marks were located on the tread of the wheels perpendicular to the running surface.

Remove bullet number left of this message

Figure 2 - Photograph of Witness Mark on CSXT 4579, Wheel R1

On August 21, 2012, the first ten cars of the train that derailed were examined where they came to rest. With the cars lying on their sides, the group took no exceptions with the conditions of the brake rigging or the side bearing plates on the cars, all appeared to have indications of normal contact wear patterns, consistent with properly steering bogies. The side frames, bolsters, and wheels were examined and no abnormal conditions were observed.

Wheels from these cars that traveled over the north rail were observed to have witness marks in their tread, perpendicular to the running surface. Beginning at car numbers one through car ten, the witness marks became increasingly apparent in both size and depth.

Figure 3 - Photograph of Witness Mark on CSXT 398511, Wheel R4

On August 22, 2012, wheel and axle assemblies were recovered from cars 11 through 20 for examination. The group identified and documented all wheels by serial number with information from CSXT that allowed loose wheel sets to be matched up with the car they were installed on. No wheel defects were noted.

The group noted the presence of witness marks on many wheels examined, similar in appearance to those previously mentioned. The group located wheels from the twelfth car, CSXT 302724, and placed them in position oriented as they would have been when moving through the derailment area.

Figure 4 - Photograph of Wheel Sets from CSXT 302724

Upon close examination, the group observed several lateral strike marks in the wheel tread of the third set of wheels, specifically the wheel that moved over the north rail (R3). These series of marks were the first marks observed to have a pattern of successive impacts spaced approximately three-inches apart becoming more apparent in size and depth. These series of marks did not appear on the wheels on axles one and two.

Additionally, a corresponding mark, or a mark on the adjacent wheel in the same horizontal plane of reference, was observed on the on the L3 wheel, located on the outside rim of the wheel.

Figure 5 2- Photograph of Witness Marks on Wheel R3 from CSXTT 302724

Figure 6 - Photograph of Corresponding Witness Mark on Wheel L3 from CSXT 302724

Wheel profiles from the wheel sets off of CSXT 302724 were collected at CSXT's, Mount Clair rail yard in Baltimore on Wednesday October 17, 2012, using a MiniProf® wheel profile measurement system. MiniProf® is a portable precision measurement tool designed for use in railroad environments and can be used during the on-scene phase of investigations. Wheel and rail profiles are independently captured with specialized measurement instruments that convert the measurement into an electronic format.

Recovered rail from the derailment footprint was assembled into a rail re-build on August 22, 2012. During the project, investigators measured the rail pieces, inventoried and documented each piece recovered. The rails were identified and oriented as they laid in the track as to whether they were north or south rails and laid out in a continuous “in track” positioning[7]. The profile from wheel R3 was overlaid against the profile section of one of the pieces of the high rail (N5)[3] in the area of the point of derailment. See figure 7.

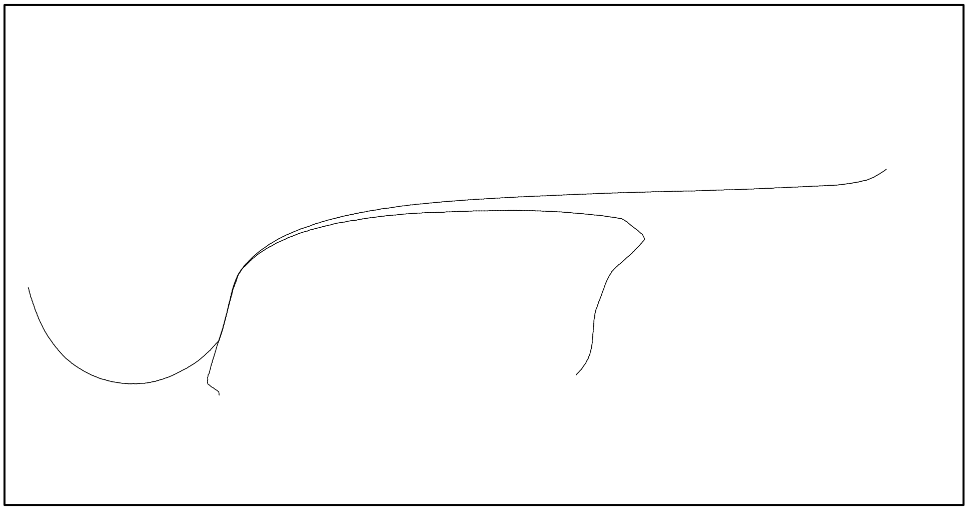


Figure 7 - CSXT 302724, Wheel R3 Profile Aligned with High Rail Profile at POD

The alignment represented reflects the wheel and rail interface expected during curving conditions when CSXT 302724 moved through milepost 12.9 on the Old Main Line in Ellicott City, MD.

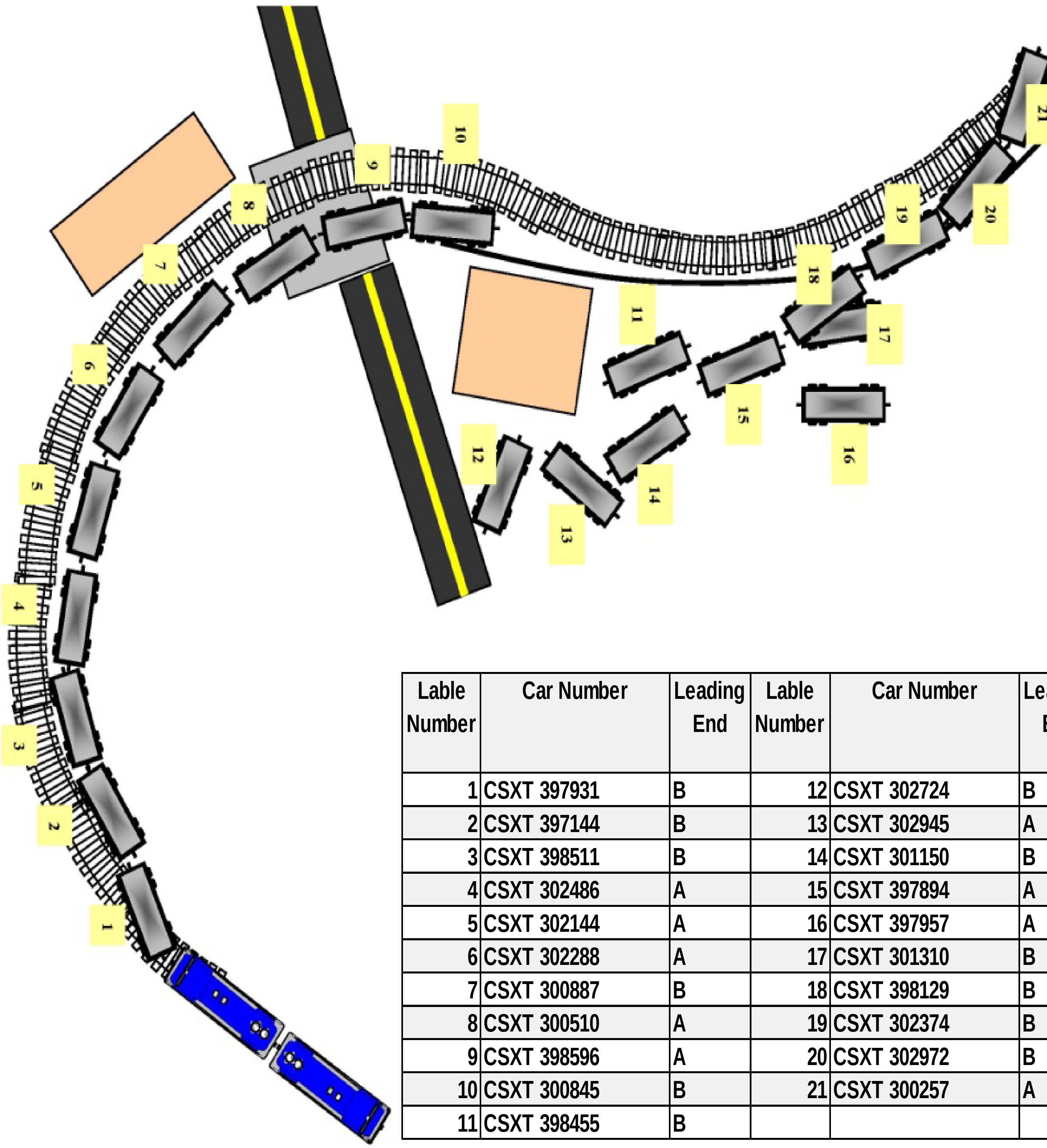
The mechanical coupler assemblies were examined on cars ten through twelve. The mechanical coupler knuckle on the B-end of the twelfth car, CSXT 302724, was observed to have been severely loaded and fractured in the upper portion of the face. The fracture surfaces were sharp and showed indications that the knuckle was twisted.

[7] See Track & Engineering Group Chairman Factual Report, DCA-12-MR-009, CSX Transportation Derailment with Non-Railroad Fatalities CSX Train No. U813-18, Ellicott City, MD August 20, 2012

Figure 8 3- Photograph of CSXT 302724 B-End Fractured Knuckle Assembly

Figure 9

Not to scale



Lable Number	Car Number	Leading End	Lable Number	Car Number	Lea
1	CSXT 397931	B	12	CSXT 302724	B
2	CSXT 397144	B	13	CSXT 302945	A
3	CSXT 398511	B	14	CSXT 301150	B
4	CSXT 302486	A	15	CSXT 397894	A
5	CSXT 302144	A	16	CSXT 397957	A
6	CSXT 302288	A	17	CSXT 301310	B
7	CSXT 300887	B	18	CSXT 398129	B
8	CSXT 300510	A	19	CSXT 302374	B
9	CSXT 398596	A	20	CSXT 302972	B
10	CSXT 300845	B	21	CSXT 300257	A
11	CSXT 398455	B			

Track

This portion of the CSXT Railroad was originally a double track main line system; however, the north main track was removed in 1959. This particular line is the oldest common carrier railroad in the United States (former Baltimore and Ohio Railroad). The track between milepost 9.7 and milepost 20.0 is now single main track. This subdivision operates an average of 10 trains daily, which amounts to about 33.70 MGT annually for the area in and around the derailment footprint.

According to CSXT's track profile data, for the eastward movement of the accident train, beginning at milepost 14.0, the train would have been on a slight descending grade to milepost 12.0. In terms of track alignment, beginning at milepost 14.0, train U81318 would have first traversed a 4^{o} 09' left curve with 1 ½ inches of super-elevation. Upon exiting that curve the train would have traversed about 3 tenths of a mile of straight track. Next, the train would have traversed a series of six consecutive curves to milepost 13.0 beginning with a 8^{o} 32' right curve, a 4^{o} 57' left curve, a 6^{o} 58' left curve, a 2^{o} 22' left curve, a 7^{o} 52' left curve and finally a 8^{o} 40' right curve. According to the profile information, the aforementioned curves had 2 ½", 1 ½", 2", 1", 2 ½" and 2 ½" of super-elevation, respectively. At milepost 13.0, the train would have continued on a slight descending grade and traversed a 10^{o} 30' right curve with 3" of super-elevation; followed by a 7^{o} 11' left curve, a 3^{o} 42' right curve and a 10^{o} 40' right curve (the aforementioned 3 curves had 2", 1" and 3" of super-elevation, respectively). The locomotives of the accident train came to rest in the 10 ^{o} 40' right curve located east of the depot.

CSXT inspects and maintains the single main track on this portion of the OML Subdivision (OML) to Federal Railroad Administration (FRA) Track Safety Standards (TSS) for Class 2 and 3 track in the vicinity of Ellicott City (milepost 18.0 to 12.7), which allows for a maximum operating speed of 25 to 40 mph. While the accident location was in a curve restricted to 25 mph, the authorized operating speed on either side of that curve was 30 mph.

Track Maintenance Work Prior to the Derailment

In the area of rail sections preceding the damaged track at the west end of the derailment footprint, investigators observed field welds and the location of recently installed rail plugs. During an engineering interview with the local roadmaster, he said that they had surfaced the track throughout the Ellicott City area in May of 2012.

Crossties, Anchors, Ballast and Continuous Welded Rail

The crossties measured 9-inches by 7-inches by 8-feet 6-inch long, spaced 20 inches on center (nominal). Investigators counted, at random locations, an average of 22 crossties per 39-foot length of rail. The crossties were box anchored[8] with rail anchors[9] every tie to restrain longitudinal movement of the continuous welded rail (CWR). The track was supported by a mixture of granite and limestone rock ballast. The ballast section was estimated by investigators

[8] "Box Anchored" is a railroad terminology that means that each rail is affixed with two rail anchors at a given crosstie location and that those anchors (4 per crosstie) would bear on the sides of a crosstie in order to restrict the potential longitudinal movement of the rail.

[9] "Rail anchor" means those devices, which are attached to the rail and bear against the side of the crosstie to control longitudinal movement. Certain types of rail fasteners also act as rail anchors and control rail movement by exerting a downward clamping force on the upper surface of the rail base.

at areas outside of the disturbance, on the average, a minimum of 8 to 12 inches of ballast underneath the crossties.

Investigators did not take exceptions to the anchoring patterns or rail restraint effectiveness of the anchors in the area of the derailment. Investigators observed that the track adjacent or outside of the disturbed area were box anchored every other crosstie. No rail movement was noted

Federal Railroad Administration Standards

FRA Track Safety Standards (TSS) address ballast regulations with the following language:

Part 213, Subpart D, under subsection 213.103, Ballast; general, states the following:

Unless it is otherwise structurally supported, all tracks shall be supported by material which will:

- Transmit and distribute the load of the track and railroad rolling equipment to the subgrade; Restrain the track laterally, longitudinally, and vertically under dynamic loads imposed by railroad rolling equipment and thermal stress exerted by the rails;
- Provide adequate drainage for the track; and
- Maintain proper track cross level, surface, and alignment.

Ballast and Continuous Welded Rail:

The following sections factually describe the specific individual components that comprised the track structure. Each section refers to the CSXT Standards and is followed by FRA's regulations relating to that track component or geometry requirement.

CSXT MWI No. 703-07, Rail Anchoring Policy, issued on July 28, 1997, and revised on August 10, 2011, details the uniform instructions for anchoring CSXT track structure; it states in part the following:

> Rail anchors are essential in achieving a stable track structure. They are designed to prevent longitudinal movement of the rail and work together with the other components of the track structure to prevent buckling.
>
> Rail anchors are required on both jointed and continuously welded rail tracks.
>
> All tracks, that are not in compliance with this rail anchoring policy, will be brought up to standard during the next System Team Rail Laying, Curve Patch, Timbering, and Surfacing.
>
> Relay rail anchors will not be used on main tracks or passing sidings. Rail anchors removed to perform spot maintenance activities may be reinstalled.

Continuous Welded Rail Territory

Continuous welded rail (CWR) will be box anchored on every other tie throughout the entire section of CWR and for 130 ties on jointed rail at each end of the CWR.

The figure below depicts CSXT's MWI diagram for anchoring welded rail on tangents, curves and ballast deck bridges. The derailment occurred on curved track.

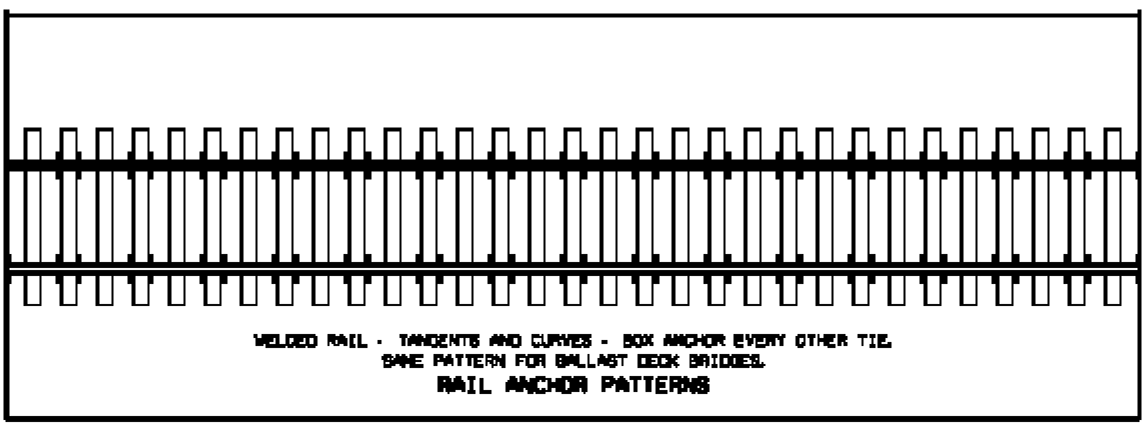


Figure No. 2. The above is a CSXT schematic showing anchor pattern for CWR.

FRA TSS states in 49 CFR 213, Subpart D, Subsection 213.119 Continuous welded rail (CWR); general, in part, the following:

(b) Rail anchoring or fastening requirements that will provide sufficient restraint to limit longitudinal rail and crosstie movement to the extent practical, and specifically addressing CWR rail anchoring or fastening patterns on bridges, bridge approaches, and at other locations where possible longitudinal rail and crosstie movement associated with normally expected train-induced forces, is restricted.

Investigators examined the anchoring patterns or rail restraint effectiveness of the anchors in the area of the derailment. Investigators observed that the track adjacent or outside of the disturbed area were box anchored every crosstie. No rail movement was noted.

CSXT MWI No. 301-04, Ballast and Sub-Ballast Specification, issued on December 16, 1996, and revised August 1, 2012, details the ballast standards for CSXT tangent main track preceding the derailment footprint

Figure No. 7. View of water and mud condition under derailed car.

Figure No. 8. View of a fouled ballast condition

Investigators noted that several locations prior to and at the point of derailment exhibited fouled ballast conditions or saturation of the subgrade. Investigators observed that the south ditch line was wet and there was evidence of water flow along the ditch line

CSXT MWI No. 2502, Rail Wear Limits

CSXT instructs their employees through their maintenance standard about the limits of rail wear whereby one determines rail replacement options. In CSXT 2502, Rail Wear Limits, issued in April 15, 1999, and revised in July 5, 2005, the table contained in the standard displays various rail dimensions for new rail design, as well as, maximum wear or minimum dimensions for rail top and side wear. For 136 pound rail, the standard denotes that the design rail height is 7 9/32 inches and a maximum top wear measurement of 5/8 of an inch and a minimum rail height of 6 21/32 inches. For 136 pound rail, the design rail head width is 2 15/16 inches and the table lists the maximum side wear at 5/8 of an inch and a minimum rail head width of 2 5/16 inches. In the notes section of the standard (No. 2502), it list the following: (in part)

1. Dimensions in the table are in inches.
2. Rail is to be scheduled for removal from the track when the side or top wear has reached the maximum for the rail section and usage given in the table.

Point of Derailment

Investigators identified the point-of-derailment (POD) as a place on a section of the south rail that exhibited markings that were documented during the post-accident rail rebuild project. The markings exhibited a break in the metal overflow on the gage side of the ball of the rail and corresponding marking on the rail base and other on-track materials (i.e. rail spikes and tie plates). Investigators formed a consensus that these markings indicated a POD located at about milepost 12.9. Investigators had the south rail cut west of the POD location at a point directly across from the middle of a rail joint location on the opposite north rail. Calculations for the rail re-build were measured from that rail cut location and the north rail joint location.

Derailed Cars

The head ten loaded coal hoppers rolled over to the north side of the track and did not significantly damage the track. The 11th through the 18th cars came to rest significantly farther from the center of the track. Several of the cars were found in a parking area adjacent to and below the right-of-way. The 19th to 21st cars were derailed north of the track towards the west end of the derailment footprint as shown in the diagram below.

Locomotive Wheel Marks

At the beginning of the derailment investigation, members of the Mechanical Group met in Ellicott City to inspect and document the wheel condition of the locomotives of the accident train. Lateral lines were documented on the north wheels of the trailing locomotive starting at the axles of the second locomotive. No lateral markings were observed on the lead locomotive's wheels.

Rail Rebuild Project

Investigators recovered rail from a limited portion of the derailment footprint and assembled those rail pieces into a 'focused rail re-build' on August 22, 2012. Due to car wrecking operations that were limited by close clearances from the retaining wall on the north side of the track and bluff to the south, over the course of next two days, the rail from the immediate area of the POD was recovered and reassembled along the north side of the right-of-way to the west of POD. During the project, investigators measured and re-measured the rail pieces, inventoried and documented each piece recovered for the area of the focused rail re-build. The rails were identified and oriented as they laid in the track as to whether they were north or south rails and laid out in a continuous "in track" positioning.

The south rail was found unbroken and upright on the crossties for the vast majority of the derailment footprint. The only piece used in the rail re-build was a section of the south rail with marking indicating a loss of normal wheel/rail relationship that was directly opposite of the north rail re-build location. This section of the south rail was under the last car derailed (the 21st head car). A set of joint bars on the north rail under the same car and directly opposite the south rail was cut from that joint location to serve as a coordinated set of reference points for the rail re-build. Investigators examined, recovered and achieved total continuity of the south rail. In reconstructing the west portion of the north rail, investigators pieced together all of it, save for about 5 inches of rail missing from the west portion of a 17’ 1” section of rail. (See rail inventory photos and details in this report or NTSB’s Materials Laboratory Factual Report. Note: During the laboratory examination, investigators confirmed the 5 inch figure for the missing piece of rail).

Figure No. 5. View of rail re-build.

Figure No. 6. A view of a severe wheel
flange strike mark on piece No. “N 18”.

On August 23, 2012, investigators and a NTSB metallurgist examined the rail re-build layout and fracture faces on-scene. It was determined that six rail sections and several other smaller pieces would be shipped or transported to NTSB’s Materials Laboratory for further examinations, including a scheduled ultrasonic hand testing of the rail sections.

The rail pieces exhibited raised stencil marks on the gage side of the web of the rail which read “136-10 CC BETH STEELTON 1997 IIIIIII”, indicating that the rail size was 136 pound rail[10] manufactured in July, 1997. The stenciled marking was repeated along the length of the rail. The length of each piece that included a portion of the rail head was measured at the

[10] In the rail industry, rail size is referenced in pounds, which is the weight of a 3-foot length of rail.

running surface. Results of these measurements conducted in NTSB's Material's Laboratory are listed in table 1.

Rail Piece	Length (inches)
N1	88.75
Missing length*	5
N5	20.25
N15B	6.625
N16B	9.25
N17B	11.125
N18	40.75**
N19B (west end to break within joint bars)	25
Total of above pieces	206.75

Table 1. Length of Rail Pieces

*The missing length between N1 and N5 was determined based on the missing length within the identification stencil on pieces N1 and N5.

**Length includes missing material due to end batter at the west end as determined using the mating fracture on piece N17B.

The fracture between N1 and N5 occurred through the raised stencil markings. On piece N1, the east fracture occurred through the east vertical leg of the "N" in "STEELTON", and on piece N5, the fracture occurred approximately 0.44 inch east of the west tip of the "7" in "1997". On a different intact area of the rail where the stencil was repeated, the distance between the "N" and "7" measured 5.44 inches. As a result, it was estimated that approximately 5 inches were missing between N1 and N5 as listed in table 1.[11]

The total length of the rail between the cut end of piece N1 and the repaired[12] defect was compared to measurements taken from internal rail inspection data obtained from tests conducted in July, 2012, and August, 2012. Based on that data, it was estimated that the total length of rail from the west end of piece N1 to the location of the repaired defect in N19 was approximately 17 feet 1 inch (205 inches).[13] (See photographic layout of rail pieces are in the Materials Lab factual report.)

Damages Estimates

CSXT engineering personnel estimated total track and structural damages at $35,000.00. This figure includes costs for the installation of 8 track panels, associated ballast, track materials, and renewal of the CRW. This figure does not include additional costs associated with replacement of a retaining wall and/or environmental remediation efforts.

There were no utilities in the immediate area of the derailment; however, a secure network communication fiber optic line was damaged.

[11] Excerpt from the Materials Laboratory Factual Report.
[12] Joint bars applied to internal defect on 7 6/2013 (per FRA regulations).
[13] Excerpt from the Materials Laboratory Factual Report.

CSXT estimated the initial total damages for the accident at $2.1 million, which includes costs for the track structure mentioned above and all other derailment related costs typically compiled for FRA reporting purposes and those associated with environmental remediation.

Weather History – August 21, 2012:[14]

An NTSB metrological investigator provided the following weather data.

The National Weather Service (NWS) Surface Analysis Chart for the period depicted a low pressure system along a stationary front extending off the east coast into North and South Carolina, with a trough of low pressure extending over Maryland and located immediately east of the accident site. A weak pressure gradient existed over the area during the period resulting in calm to light winds over the region. The station models depicted in the immediate vicinity of the accident site depicted calm winds, mist, clear skies, with temperature of 65° Fahrenheit (F) and a dew point of 64° F.

Observations

The closest official NWS reporting site to the accident site was from Baltimore/Washington International Thurgood Marshall Airport (KBWI) located 8 nautical miles southeast of the derailment, at an elevation of 146 feet. The conditions at the time of the accident were as follows:

Baltimore/Washington (KBWI) weather at 2354 EDT August 20, 2012, wind calm, visibility 6 miles in mist, a few clouds at 1,000 feet above ground level (agl), scattered

[14] The weather data was provided by NTSB meteorologist investigator.

clouds at 14,000 feet, overcast at 25,000 feet, temperature and dew point 64° F (18° C), altimeter 29.96 inches of mercury.

72-hour Weather History

Thunderstorms and heavy rain were reported hours prior to the accident between 1910 and 2032 EDT on August 20, 2012, with 0.71 inches of rainfall being recorded at KBWI, with a few early morning rain showers reported during the morning hours between 0400 and 0800 EDT with no significant accumulation. During the previous 72 hours several periods of light to moderate rain showers and thunderstorms were reported with 0.29 inches, for a total rainfall from August 17-21 of 1.00 inch of precipitation.

Day	Max. Temperature (°F)	Min. Temperature (°F)	Significant Weather	Rainfall
August 20, 2012	80	64	Rain and mist	0.71”
August 19, 2012	76	61	Rain	0.03”
August 18, 2012	84	64	Rain and mist	0.08”
August 17, 2012	92	64	Rain and mist	0.18”

Table No. 2. Local weather data for days preceding the derailment.

Weather Radar

A review of the NWS radar images during the period depicted an intense line of thunderstorms over Ellicott City and in the immediate vicinity of the derailment site on August 20, 2012, between 1810 to 1850 EDT (2210Z-2250Z) with 50 dBZ. This was the area of weather that went through KBWI with heavy rain and resulted in 0.71” of rainfall. The intensity had decreased considerable however, compared to the period when the line was over the Ellicott City area.

Post-accident Inspection/Testing of Track:

On August 21 and 22, 2012, track measurements were taken at 15 locations (stations) on 15-foot 6-inch intervals beginning at about milepost 12.9 (near the last portion of undisturbed track at the west end of the derailment footprint) and extending westward (westward from Ellicott City) for about 232 feet. Two of the stations extended eastward into an area of disturbed track (from station 0 to station -2). The track inspection field notes noted:

- The maximum measurement allowed for gage in FRA Class 2 track, a maximum authorized speed of 25 mph, is 57 ¾ inches. Track notes determined that the widest gage was 57 1/4 inches (loaded); or ½ of an inch under the FRA maximum allowable limit.
- The maximum allowed deviation for alignment measured with a 62’ chord in FRA Class 2 track is 3 inches for both tangent and curved track. Track notes determined that the greatest alignment deviation was 5/16 of an inch; or 2 11/16 inches under the FRA maximum allowable limit.
- The maximum allowable deviation from zero crosslevel at any point on tangent or

reverse crosslevel elevation on curves may not be more than 2 inches for Class 2 track. Track notes determined there was no reverse crosslevel on the curve and that the maximum crosslevel was ¼ of an inch; or 1 ¾ inches under the FRA maximum allowable limit.

This is the last segment of track CSXT train No U81318 traveled over prior to the August 20, 2012, derailment. Investigator's post-accident inspection from the west end of the derailment walking west from the end of the undisturbed track toward the west found there were no visual exceptions to milepost 13.0. The investigators did observed locations of the track where fouled ballast was present.

CSXT Track Program Maintenance History

The most recent crosstie and out-of-face surfacing production work was completed in 2008 and subsequent out-of-face surfacing was completed over the portion of track through Ellicott City in 2012. CSXT contracted to have rail ground on the OML which was completed on July 6, 2012. In total, with regard to the rail grinding, the OML had 17.48 pass miles ground for an area of 6.91 total track miles, which was completed primarily at various curve locations. The rail in the area of the derailment (12.87—12.92) underwent a grinding program wherein that curve received five passes out-of-face (one for the high rail and five passes for the low rail).

Track Inspection Records

FRA regulations found in 49 CFR 213 require that a rail carrier's track inspection records be prepared and signed on the day of the inspection for frequency of compliance with the Federal

Railroad Administration Track Safety Standards (FRA/TSS). FRA track inspection records are required to reflect actual field conditions and deviations from the FRA/TSS. CSXT has elected to maintain the track in the vicinity of the curve where the derailment occurred to FRA Class 2 standards requiring CSXT personnel to inspect the main track at least once per calendar week. However, CSXT inspects all of its main line tracks a minimum of three times per week. The track on either side of the derailment area was maintained to FRA class 3 standards, which requires two inspections per calendar week.

Track inspection records for the CSXT OLM Subdivision were examined for the time period from August 19, 2012, through to March 1, 2012. The records show the frequency of inspections was in compliance with federal regulations.

The track in the area of the derailment was last inspected on August 19, 2012, by a FRA qualified CSXT track inspector (T/I). The T/I noted no defects within milepost 14.0 to 12.0, an area that includes the derailment footprint.

Regulatory Track Inspection History

On August 23, 2012, a FRA track safety inspector conducted a records inspection of the OML Subdivision from milepost 6.5 to milepost 65.0 that included the area through the derailment site. No exceptions were noted on that report for the records review (Report No. 149). On a previous routine inspection conducted by FRA on May 21, 2012, from milepost 21.7 to milepost 40.8, one deficiency was noted at milepost 21.9. FRA cited an exception to their TSS, 213.33.06, drainage or water carrying facility deteriorated to allow subgrade saturation. At this same location, FRA also noted an exception of deviation from uniform profile west of the switch. According to CSXT records, CSXT repaired those items on June 4, 2012, by removing mud from the track structure to allow better drainage.

CSXT Geometry Test Vehicle Data

On August 6, 2012, CSXT operated a geometry vehicle to measure the track. The data provided indicated that the test began at Point of Rocks, milepost 64.8, and the test continued eastward to St. Denis, milepost 7.0. The data recorded the footage (location of defects) in negative figures from each milepost in a descending manner. Below are the track or geometry conditions recorded by that test vehicle near the point of derailment:

- A warp condition in a curve at milepost 12.92 that measured 1.28 inches;
- A wide gauge condition in a curve at milepost 12.92 that measured 1.18 inches;
- A wide gauge condition in a curve at milepost 12.76 that measured 1.17 inches.

Geometry Tests

FRA operated their Automated Track Inspection Program (ATIP) geometry vehicle, T-217, over the OML Subdivision on July 17, 2012. The FRA data showed no defect recorded for that test and none in the vicinity of the derailment. The Track Group did not take exception to the data.

Personnel Information

CSXT maintains the tracks on the OLM Subdivision including the area within Ellicott City, MD utilizing the following available track forces: one Supervisor/Roadmaster and one assistant Roadmaster; five track inspectors, one trackman, 3 foreman, two vehicle operators, two machine operators and two welders. In addition, the Roadmaster indicated that he had an extra gang of four employees to aid in the maintenance, as well.

Four engineering personnel were interviewed on August 24th in Ellicott City, MD.

CSXT Track Inspector (T/I):

The track inspector stated he was hired on July 7, 2008, on the RFP Subdivision and worked as trackman, foreman and machine operator. He later was promoted to his current position as a T/I on August 21, 2011, headquartered at Point of Rocks, Maryland. He said his territory includes the OML Subdivision to Point of Rocks, and the Metropolitan Subdivision or roughly 100 main track route miles. He indicated he is responsible for inspecting switches on the main track on a monthly frequency, as well as, industry tracks on a three month frequency. He does not have any yard track inspections as part of his responsibilities. He said he normally patrols the main track by himself except on Wednesday, when he is accompanied by another inspector.

He stated his normal assigned work days were Sunday through Wednesday and Thursday through Saturday were his days off days, unless he gets called in. He indicated that he completes his track inspection records digitally, via CSXT's Integrated Track Inspection System (ITIS). The ITIS provides prompts in completing the daily records. He also said he feels comfortable with his duties.

He indicated he had attended 3 weeks of training in Atlanta, Georgia, which included a week long class consisting of FRA/CSXT track safety standards. He said he attends a CRW maintenance class, a FRA track standards and a Roadway Worker Protection class on an annual basis.

He said that when he observes something [a track deficiency] during a track inspection, he may put out a slow order [with the dispatcher] depending on the defect and location. He stated he also may take more drastic action depending on what he finds, such as take the track out of service. On those occasions, he reports the track out of service to the dispatcher and his supervisor. Most of the time, he fixes the smaller maintenance items by himself.

With regard to Sperry internal rail flaw detection operations, he said that he does not have a lot of involvement with the Sperry Car, but he may follow behind it to put up slow orders signs. He stated that, generally, the roadmaster [the title of his supervisor] is on the car.

When a geometry car tests the territory, he said he would stand by to correct any issues which have to be handled immediately. Other, smaller non-FRA defects may be noted and repaired when time allows. He stated that he works with a Sperry Car approximately once every 30 days and the geometry car a few times a year. When the Sperry Car or Geometry Car tests on his assigned territory, he gets the printed data indicating where track deficiencies [defective rails or geometry defects] are located and those defects are entered into the ITIS system which tracks the repair completion dates.

The track inspector said that on one occasion over the past year that he found a broken rail in a tunnel. He also said that he has found other defects, such as a chunk of the ball of the rail broken out. The track inspector did not recall if a broken rail occurring in Ellicott City area on or about April 19th (2012). He stated that he was not involved with that repair.

Investigators asked the track inspector what he thought about when he heard of the derailment at Ellicott City. He replied that he had just inspected the area on Sunday [the day before the derailment] and that he honestly did not know what would have caused it. However, he said he knew the area was scheduled for rail replacement.

When asked about recent weather, he stated that he was aware of some rainfall on Sunday (August 19th) in the Ellicott City area, and that there was more rain on Monday.

CSXT Track Supervisor[15]:

[15] Track Supervisor and Roadmaster are interchangeable terms.

The Track Supervisor stated he has been employed by CSXT for approximately 3 years and 1 month and has been a roadmaster for 1 year and 8 months [at the time of the interview], since January of 2011. Prior to becoming a roadmaster, he was an assistant roadmaster for one year. He said he was hired by CSXT as a management trainee in July 2009. He said he has a bachelor's degree in engineering and has worked on the Long Island Railroad prior to his employment with CSXT.

He indicated that his major duties are to handle the day to day maintenance projects and emergencies by making sure that maintenance forces have the proper materials. He also said he provides input for capital programs. He stated he works with local communities on grade crossing improvement issues and acts as a liaison between rail labor and senior CSXT managers.

He stated he has two subdivisions as part of his areas of responsibilities, the Metropolitan and OML Subdivisions, which account for approximately 157 miles of main line track. He has three headquarters for the 15 core maintenance personnel, but also has access to an additional extra gang consisting of four employees.

Regarding questions about rail wear limits, he stated there are rail wear limits under CSXT standards; however, there is not a "condemnable limit" for rail wear.

He stated he tries to get out on his territory often and hy-rails over the territory at least every 2 weeks and makes a documented report of those activities. As part of his duties, he stated that he reviews inspection work performed and checks on ongoing project work. If needed, he said that the "Change Order" process allows him to reallocate resources and prioritize work that needs to be done.

He said the Ellicott City area had several plug rails [installed] and the area was scheduled for rail replacement this August.   In a subsequent interview, the roadmaster said the replacement rail for the accident curve was to be completed with "self-help" rail released from other capital rail renewals in that area.

He stated the Sperry inspections are the most common automated inspections on the OML, which is on a 31 day rail test cycle, but that the sidings are tested every 60 days [every other test cycle]. He said he is advised ahead of time when the car will be on the territory and he generally tries to be on the car to take notes and that it [riding on the Sperry car] also gives him a good opportunity to see his territory and prioritize repair work. He said that, when the Sperry car finds a defective rail location, he takes measurements on rail wear [the rail height and rail head width] to facilitate a proper match for the repair rails. He stated that in his estimation that Sperry defects have decreased lately and that the last run he only had three or four rail defects---head defects. He said that FRA has a table for the initial and remedial actions to be taken for rail defects. In addition, there are CSXT remedial actions, which are more restrictive than the FRA TSS remedial actions. He said that the Sperry reports let him know of multiple defects in a single rail.

He said he feels that under normal conditions, he has enough people and equipment to safely maintain his territory. He stated that CSXT does have a rail wear standard, which he uses for head wear, “we try to stay ahead of the game, with the curves in my territory, this can be a challenge.” He indicated that he has seen an increase in tonnage lately on the OML Subdivision, “in the spring we ran numerous coal trains.”

He stated his territory is comprised of 90% curves and that he receives charts that indicate rail wear from the CSXT geometry car, which is later field verified. He said that he has rail wear gauges that he uses and calipers for the measurement of side wear. In a subsequent interview, he re-characterized the amount of curves on the territory to a lower percentage.

He stated they have experienced issues with broken rails at Ellicott City. As such, he said he keeps a closer eye on it compared with other parts of his territory. He stated that he has had some curve patch work [rail replacement] scheduled for this area, “to stay ahead of the game.” He said that it can be a challenge to get the work done, with the increase in train traffic, but that prior to this accident, he had been doing some curve work with his local forces. And he also said that rail was scheduled to be placed in Ellicott City area this week [the interview was conducted on August 24th] for installation.

He stated that in the last three years in Ellicott City area about 500 feet of rail was replaced near the station [located east of the derailment area]. He said that in his opinion transverse detail defects (DF) are not usually isolated, “we find this rail will continue to get them.”

He indicated he receives geometry cars tests on his territory every three to four months and the defects [data from the geometry car] are broken down into three categories, FRA defect, almost FRA defect and minor. He stated a lot of geometry defects on the OML Subdivision are corrected with crosstie replacement. He said that about 3 or 4 months ago they re-surfaced the Ellicott City area.

He stated CSXT's ITIS is used to document defect repair work completed, defect locations and that they [CSXT, he and his personnel] have access to that data when records are downloaded at least every 24 hours. The same applies for the Sperry defects data and tracking. When asked by investigators, the T/S said that he reviews his inspector's reports and approves them to make sure there are no outstanding major defects. He said that non-class specific exceptions like loose brace plates or fouled ballast, etc., are reported and tracked in ITIS, as well.

He said that in severe weather, he talks to the inspectors about when and where to go for those inspections, but, for heat, they pretty much know what to do and when.

He indicated he is satisfied with the training he has received. Most of it has been via OJT and that he believes this type of work is best done this way. He said that he tries to ride a train over his territory once per month, usually on MARC[16]. He finds it beneficial to ride trains to see how the track rides and also to talk to the crews.

CSXT Engineer Rail Services:

The Engineer Rail Services (ERS) stated he has been with CSXT since 1999, but started on Conrail in 1993, as an electrician in a locomotive shop. In January 1994, he was promoted to a position of Track Geometry Engineer and subsequently to Manager of Track Geometry Cars

[16] MARC stands for Maryland Rail Commuter service.

until his promotion currently as Engineer Rail Test. He said he has a total of 19 years of experience.

As an ERS, he manages CSXT's rail testing with outside contractors that include one Nordco truck and 16 Sperry trucks, which are mobile and can set on and off of railroad tracks to conduct testing. Part of his duties is to schedule the 20,107 miles of main line track CSXT routinely tests. His duties include making sure the reporting and test quality is conducted at established [both CSXT and regulatory] frequencies. Normally when the testing is over for the day, two reports are made, a movement report, and a defect report. The data is distributed to the division engineer (DE) and division personnel daily and the defect report information is entered into CSXT's ITIS.

When asked about the last rail flaw inspection, the ERS replied that on August 3, 2012, the OML Subdivision was tested by a Sperry truck test vehicle. He said that the Sperry trucks have the latest technology, a 1900 system with induction and ultrasonic equipment systems including the latest Cross Fire® technology. The ERS stated the Sperry chief operator of the test truck was a very experienced operator and that he has been over this specific territory many times over the past four years, and is very familiar with the OML territory. He indicated that CSXT made a decision to test the OML every 31 days, and use a risk-based assessment model to schedule the testing. In a follow-up e-mail, the ERS wrote that CSXT was using a 62 day frequency to test the OLM subdivision in July of 2010; however, they changed to a 31 day test cycle around August of 2010 and have been at that frequency of rail testing since that time. He said that Harsco, formerly Zeta-Tech, established the risk-based testing frequency as a recommendation to CSXT, which CSXT adopted.

The ERS said he had reviewed the screen shots[17] from the data of the August 3, 2012, test and he did not find anything unusual, except for an alignment issue [the vehicle's test carriage—not the track]. He stated the rail wear would [likely] indicate a positive zero [due to the aforementioned alignment issue]. He also stated adverse track conditions such as mud, etc. will sometime affect the test. He said it uses basic recognition software, which records the location and other rail information. He stated the test system on the truck "blocks and identifies" things for the operator's attention. He went on to say that according to CSXT requirements and Sperry procedures that verified rail defects are to be clearly marked and numbered on the rail. He added that the markings are very difficult to miss. The CSXT track forces then locate the markings and take the necessary corrective action. CSXT requires that the remedial action taken is to be input on the nightly report. He said that he cannot compare rail bound equipment versus a truck for quality, they are both comparable.

The ERS stated that Sperry archives all the testing data and keeps years' and years' worth, but he was unsure for how many years. He said during the Sperry rail tests, the operator can use icons to populate the charts to indicate various rail surface conditions. He stated the presence of heavy grease on the rail could affect the quality of the testing. The ERS said, "From time-to-time, if we note heavy grease, from locomotives, or wherever, we [CSXT engineering department] ask the operating department to shut it [the lubrication] off, but it has to be real

[17] Screen shots refer to the archived images available for review of each section of data captured during the original rail test. A screen shot thus is a depiction of the color coded data as it appeared to the rail test operator.

heavy." The ERS said that if extended periods [linear rail distance] of non-test occur, their policy is to re-test. Certain tests set off an alarm in the truck which prompts the operator to notice it.

The ERS stated for clarification, the top surface refers to top of rail and not the track surface [or track geometry]. The ERS said that when a rail defect is identified, testing personnel draw a crow's foot symbol on the web of the rail for a TDD and the marking is clearly obvious for follow up repair identification [by maintenance forces]. The ERS said that when he reviewed the test data screen shots that he did not see any areas where the test truck backed up in the Ellicott City area for the August test.

With regard to the rail testing frequency, the ERS stated the 31 days cycle is the most frequency that we have and that he did not know of anywhere that does testing more often, except perhaps the Powder River Basin [a heavy tonnage coal hauling route on the BNSF]. The ERS said that CSXT does not have the technology to test the base of the rail nor is he aware that any rail testing service that does.

CSXT Division Engineer (DE):

The DE stated he began his railroad career in 1981 on the Baltimore and Ohio Railroad, which later became the Chessie System Railroad. He worked initially as a trackman and later held the following positions: equipment operator, track foreman, production supervisor, assistant roadmaster and roadmaster. In 1998 he received a promotion to the positions of staff engineer and then regional staff engineer and in 2004 to engineer of track. In 2007 he became the engineer of track at Connellsville, PA. In 2011 he was promoted to the position of division engineer at Baltimore.

He said he is responsible for all maintenance of way on the Baltimore Division, but that he does not do the planning for rail testing. The rail testing contractor has developed frequency recommendations, which he reviews. He said that the 31 day test cycle is a challenge to execute; however, he thought they had done a very good job of handling it.

He stated CSXT gets rail wear data from their inspection vehicles and he or his personnel also take physical measurements as a method of field verification. He said all of that data is then used to project rail replacement; however, rail wear and rail defects are the primary drivers for rail replacement. He stated the next step in the rail replacement planning process is to predict how long the railroad can use the rail before it needs to be replaced. CSXT has a set of guidelines that provides instruction when to plan rail replacement. The DE said CSXT plans for about a year's lead time before completing or executing a capital project. He added that tonnage and passenger traffic weigh heavily in determining rail replacement plans. The DE said that on main line heavy tonnage areas, they typically get new rail to replace worn rail. He indicated the system's rail force is at Jessup, MD this week [the time frame of the interview] and was scheduled to move to Ellicott City area the following week. He thought the roadmasters on his division were very good at following the CSXT guidelines.

In terms of answering questions about investigators field observation concerning drainage, the DE said that they do have a drainage issue in Ellicott City, where it needs to drain away from the station. He stated that they planned on improving the drainage during the rail replacement. He said it was his opinion that rail does last longer in dry, tight securement areas. He said he understood that the track was recently surfaced in the derailment area, but was not cribbed[18] and that left several muddy spots. There were long term sub-grade saturated areas that were worsened by the recent rains. He said this [the long term sub-grade saturation] is one reason why equipment was scheduled to work there next week.

The DE stated the training provided at CSXT's Railroad Education and Development Institute (REDI) is more important than ever, considering the large number of new people employed and that this is why the REDI center was created. He indicated that all crafts of the railroad are trained there.

The DE said he instructs the roadmasters to get over their territories at least once every two weeks and they [the roadmasters] should also spend time with their track inspectors. The DE stated that the service rail failure data is a part of the ITIS system and that the system is equipped with a drop down box for the employees to make the correct selection. He added that rail defect identification is a normal part of all CSXT training [engineering department].

The DE stated the OML is considered to be a heavy tonnage main track. As a rough estimate, he thought that a good estimate would be 30 million gross ton annually [CSXT provided more exact figures that appear later in this report]. He said that over the last year the coal traffic has increased, although the last month it has dropped off a little.

[18] Cribbed is a term that refers to the process of removing, generally muddy fouled ballast, and material from between the crossties, both between two consecutive crossties and along the outside edges in the shoulder ballast area.

The DE said automated rail flaw detection defect numbers fluctuate up and down and do not seem to be consistent or have a pattern [see a graphic later in the report depicting the annual numbers and trends]. He said CSXT purchases certified rail plugs from a manufacturer, who test and certify the rail plugs, and that when using relay rail, CSXT hires a contractor to certify those replacement rails. The two rail weights in the derailment area are 136 RE and 141 RE. They are used together.

The DE stated the roadmasters have the ultimate responsibility to monitor the track inspection records.

The DE commented on the term “self-help” by explaining that CSXT has a program system that creates capital improvements, “so, a lot of the work that we do, the major work, laying rail, installing ties, is -- that is programmed now for next year, and they will have large gangs come and do that work”. But he went on to add that to be truly successful, [what one has to address] is that middle work that is not included in the stuff that the big gangs do or the just daily maintenance (i.e. it is laying a curve that is not going to be done by the big gangs). He referred to some examples on the OML, where they laid about 800 feet near milepost 11; and at milepost 16.6, they laid 800 feet; milepost 17, 450 feet; and at 21 -- or 22, they were in the process of getting ready to lay that along with the road crossing repair. The DE agreed that those opportunities to relay rail in a ‘self-help’ manner were derived from the management of some released materials and cascading of rail from maybe one place to another, but he clarified that the previous examples were all new rail installations.

In terms of how the track personnel on the division are instructed on a trespasser policy, the DE stated CSXT considers their property, "their property, and anyone on it, other than an employee, is trespassing." The standard is that CSXT employees are told to inform the trespassers to leave. CSXT has an 800 number to call if police are required. In Ellicott City area, including the park, it is not uncommon for employees to see trespassers and to ask them to leave the property.

CSXT Director of Engineering Training (DET):

The DET recalled he had been in the railroad industry for about 37 years beginning with a series of engineering jobs in the early 70's for about 15 years before going into a management position in 1990. He said he went to the Atlanta Division as an assistant roadmaster before going to the Nashville Division in 2002 as an assistant regional engineer. He stated he transferred back to the Atlanta Division in 2003 with the same title and responsibilities before being promoted in 2007 to his current position as Director of Engineering Training at CSXT's REDI Center in Atlanta.

The DER described his duties and responsibilities are to manage the engineering training at the REDI Center[19]. He informed investigators he has served as a classroom instructor and added that the REDI Center covers just about every discipline that the rail industry has and most every position comes to the training center to start their career, with the exception of a couple of positions. He said that when the REDI Center first began training it really only had 'new hire' track worker training and FRA track safety standards training and it [the training curriculum] has

[19] REDI stands for Railroad Education and Development Institute.

grown to cover track welding, bridge training (to cover steel structure, timber structure or concrete). He further added that each one of those areas has its subject matter expert whose career was along those lines and it [his responsibilities] is really just overseeing the instruction, the scheduling, the growth, and managing the constant improvement of what we deliver to the CSXT employees, you know, in meeting the needs of the field.

The DER stated that when employees hire out (i.e. a track worker) their first 3 weeks of employment is going to be 'in training' at the training center before they ever show up at the location that they were hired for. He said, usually the supervisors, will go in and put all the information we need for a person they want to come to that specific training. He said one of the reasons for the training is CSXT has got many inexperienced people coming to the rail industry and CSXT has got to have a mechanism that helps prepare them as they go to the field. He added that the biggest thing about the REDI Center is that it works hard on the safety mindset, the attitude of the employee and the way that they approach their job, right along with the technical training that the person gets to prepare them to the field and not just to be successful in what they do as an engineering employee, but to get out there and do it safely throughout their entire career. The DER pointed out the training is a 40%--60% ratio, 40% classroom with 60% hands-on.

The DER stated the training on track safety standards includes the [Part] 213 track safety standards training which is built off of the FRA [Part] 213 regulations, but they [the students] have right alongside with them in the training the CSXT field manual, which we do refer to when we have something corresponding that we are covering in the FRA 213 standards, something that is a little more stringent. With regard to non-class specific defects like drainage or fouled ballast and the training, the DER said CSXT talks about the standard as it is written and it relates to drainage and that drainage is the key, but from a non-class-specific standpoint, it is something that has got to be addressed. He added that if you have a mud hole and you have fouled ballast, "you got to get out," it is not going to heal itself. He further explained so what you have to determine is, is whether or not, under load, the track structure itself, based on what you are seeing as a drainage problem, if you have got a geometry problem that is starting to occur along with that [drainage condition]. He said that in the training CSXT instructed the inspectors to get out and look at that [areas of mud] because as an inspector you want to know what is happening under load.

The DER stated CSXT's training includes use of FRA's compliance manual, when students ask specific questions about FRA defects or conditions. In some instances the DER said he has even gotten an FRA officer on the phone to make sure that the answer we were giving are right with what the original intent of the regulation was.

The DER said an initial training for new hires was a 3 week course, but that the training for those attending the FRA track safety standards class was a 5-day course. The DER replied that anyone can apply to attend FRA training in Atlanta, but those students are required to pass a test.

The DER said local supervision also makes assessments about the employees and they determine if an employee needs additional training. The DER clarified a point about informal communication about an employee’s performance and said he provides informal communication to the field and receives informal communication from the field about the results of the training.

FRA Track Safety Inspector (TSI):

The FRA Inspector began his railroad career in 1974 on the Penn Central and worked various positions of progressive responsibility for Penn Central (which later became Conrail) until 1999 when CSXT took over a portion of Conrail and he was transferred to the Baltimore area. In 2004, he retired from CSXT and began work at FRA later that year until present or about eight years. Currently, he works for FRA in the Baltimore area.

The FRA Inspector reflected upon the change in track standards over the years since he began railroading to say that eventually the Conrail standards became “stiffer or higher standard than the FRA regulations” at that time. He also reflected upon his early days at Penn Central, the bankruptcy, lack of money for maintenance, the initial struggles at Conrail and that things eventually got better—more money meant a more mature and improved training program and greater track maintenance—“everybody got up to speed.”

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With regard to how he addressed fouled ballast during his time in the industry, he commented that in his early years the railroad “didn’t even fool with it” unless there was a geometry defect associated with it. However, he went on to state that Conrail began addressing track conditions that were causing derailments and eventually fouled ballast conditions. He added having good drainage is---the number one key of railroading is having proper drainage--and that's not only in the ditch lines, but it's also within the track structure. When asked how

FRA addressed fouled ballast, he said that the FRA said fouled ballast was fouled ballast. He added, “I think you would find, even though the FRA spells out what fouled ballast is, each person, each inspector in the field looks at that a little differently, I believe.”

He said that when he went to work for CSXT that he found it difficult, because it was a little bit of déjà vu all over again. However, he also said that since he left CSXT and has been with FRA that within the 5 – “last 5 years they've been pouring I don't know how many hundreds of millions of dollars into the railroad; it's like a completely different railroad now from when I was working for them.” He said his current assigned territory at FRA includes CSXT and the Baltimore area.

He said that since he began working at FRA that he goes to training every year; you go over everything that's in the Track Safety Standard Compliance Manual (TSS—CM) and it's quite detailed.

He was asked to read a portion from the TSS—CM about Scope of Part, to which he entered the following into the interview record:

> 213.1 Scope of part: (a) This part prescribes the minimum safety requirements for railroad track that is part of the general railroad system of transportation. The requirements prescribed in this part apply to specific track conditions existing in isolation. Therefore, a combination of track conditions, none of which individually amounts to a deviation from the requirements in this part, may require remedial action to

provide for safe operations over that track. This part does not restrict a railroad from adopting and enforcing additional or more stringent requirements not inconsistent with this part.

Paragraph (b). Subparts A through F applies to track Classes 1 through 5. Subpart G and 213.2, 213.3, and 213.15 apply to track over which trains are operated at speeds in excess of those permitted over Class 5 track.

He agreed that one aspect of the FRA's Scope of Part was that defects 'in combination' may cause some problems. However, the TSI said there was no defect code for the Scope of Part regulation.

He was asked to read a portion of FRA's TSS—CM that addresses guidance on Scope of Part: (under the paragraph of Guidance, which is directly underneath 213.1 Scope of Part) it states,

It is important to note that the TSS-- that's Track Safety Standards – are minimum safety requirements and are not appropriate for track maintenance purposes. This section also notes that while the TSS address specific track conditions that exist in isolation, there can sometimes be a combination of track conditions, none of which individually amounts to a deviation of the TSS that require remedial action to provide for safe operations over the track. Experience has shown that such an event occurs only rarely, but if an inspector should encounter such a condition, the inspector should immediately bring the condition to the attention of the accompanying railroad official, explain the hazard of such a condition, and encourage its rapid removal. Where the inspector is not able to convince the railroad to initiate some action, the inspector should refer to the regional track specialist for assistance.

Regarding fouled ballast as a defective condition, he stated TSS address fouled ballast, but he added he believed their [FRA's] new standards have some new codes that spell out a little bit more in detail what fouled ballast, saturated subgrades, what those defects are. The FRA Inspector in describing fouled ballast said, "fouled ballast -- when you look at, what ballast can consist of, it can consist of dirt, in the book -- cinders, dirt, anything that will support the track structure and provide drainage, so if he went along and he saw fouled ballast that was dry and there was no track geometry of any there, he did not write a defect." And he agreed with an earlier characterization {from a previous interviewee] of fouled ballast as one that said that was mud and was saturated subgrade and that one of the attributes was that the condition would hold water, the ends of the ties created pockets because it was pumping. However, he went on to say, so when he found fouled ballast, he wrote it if it was causing geometry, a geometry defect. And he clarified that it could have been a class of track, specific defect of Class 2, 3, 4, or 5, whatever class of track he was inspecting, but it could have been it did not meet the threshold [geometry] of that class of track, but he wanted it taken care of so he wrote a defect on what he measured. He explained, if it measured more than half of what that defect was allowed -- if it measured 3 [inches] -- if a defect was 3 inches and he could get an inch and a half or an inch and three-quarters, he wrote it as a defect even though it didn't meet the threshold, because he wanted it taken care of.

He affirmed that geometry is a class specific defect and that fouled ballast is a non-class specific type defect. In terms of defining class or track and operating speed limits, he read the following from FRA TSS 213.9 paragraph (b)(1) Failure to restore other than excepted track to compliance with Class 1 standards.

> 213.9 Classes of track: operating speed limits. (a) Except as provided in paragraph (b) of this section and 213.57(b), 213.59(a), 213.113(a), and 213.137(b) and (c), the following maximum allowable operating speeds apply.

> Paragraph (b). If a segment of track does not meet all of the requirements for its intended class, it is reclassified to the next lowest class of track for which it does meet all of the requirements of this part. However, if the segment of track does not at least meet the requirements for Class 1 track, operating may continue at Class 1 speeds for a period of not more than 30 days without bringing the track into compliance, under the authority of a person designated under 213.7(a) who has at least one year of supervisory experience in railroad track maintenance, after that person determines that operations may safely continue and subject to any limiting conditions specified by such person.

Additionally, he was asked to read a portion of FRA's TSS---CM that addresses the guidance for FRA safety inspector with regard to Part 213.9 (b), it states, in part:

Guidance. A track segment must meet all the requirements for its designated class of track -- or class. Where a track segment does not meet all the requirements, railroads can reclassify the segment for the next lowest class with which it complies. For example, on a Class 3 track, where the alignment measurement of a 62-foot chord in a tangent is 2 inches, the railroad can elect to reduce the speed equivalent to Class 2 track.

Trains may continue to operate over a non-complying condition under 213.9(b). However, the 30-day limit for any given condition cannot be exceeded. The 30-day period commences when:

(1) An FRA inspector notifies the carrier or issues notice with a F 6180.96 form;

(2) A person designated under 213.7 records the defect on an owner's record of inspection;

(3) Notices of substandard conditions are received from third parties; and

(4) The track owner is deemed to have a constructive knowledge if the defects were discoverable through properly performed track inspections required by the TSS even if the defects are not reported on the owner's record of inspection.

The FRA Inspector was asked whether or not the regulatory language in Part 213.9 (b) applied to both class specific and no-class specific defects, to which he agreed that they do apply. However, he went on to say that if you are not meeting the class of track, then you drop it down into the next class that it will meet for that type of defect that you found and the measurement that you got--those are specific defects. For a non-class specific defect -- a frog, he said, “if you have a broken frog it spells out in the book that that broken frog, which is not class specific, will be 10 mile an hour passing over it." Regarding how to think about fouled ballast as a non-class specific defect, he said, but there is nothing per what he has been told, that if they [the railroad] fail to put a speed restriction on it that he can write them up for it. He added, so to answer your question, when he has a non-class specific defects that does not have a remedial action provided to him by the FRA, it does not really exist as far as speed goes.

With regard to whether or not the FRA Inspector felt he had the tools to get repairs made with 213.9(b), the combination of 213.9(b) and non-class specific defects, to all conditions you find out there that need to be repaired, the TSI responded that he felt he certainly did have those tools [regulatory options] available to him.

He agreed the time limit to bring a track back into compliance was 30 days.

He indicated he sometimes rides with the railroad assigned inspector of the territory, when he conducts his inspection; however he had not hy-railed with the assigned inspector for the OLM Subdivision. He normally is accompanied by either the track supervisor or engineer of track for that territory when he has made inspections. He agreed there would be value to have the railroad track inspector accompany him during the FRA inspection and he agreed that he could get a feel for what their challenges are and what their deficiencies are and what is on their mind. He also added they would get more insight --from the FRA on how we interpret and look at the track and what is a defect, what is not a defect to continue with their education. However, he noted it is CSXT policy as to who goes with him on an inspection. Regarding how the FRA

Inspector might answer questions about non-class specific or fouled ballast, he said from what he sees in his territory now from CXS's production that they put in capital work, the local maintenance can now maintain their fouled ballast locations. He added they [CSXT] are on prioritized lists that the roadmaster has and a lot of times they will say to me they got the two or three behind me that you wrote up the last time, they are getting it done and they recognize what they got to do and it just takes time.

Regarding fouled ballast locations being wet or dry and how tonnage affects those conditions; he agreed that tonnage was another aspect to consider in terms of track degradation.

He was asked about 213.9(b) as it applies to non-class specific defects and what expectations he had with regard to what the railroad would do, he said when he writes a non-class specific defect and it hits the report, he expects it [the non-class specific defect] to be repaired when he go back and look [a re-inspection]. He also said at the end of the day when he is done with the inspector or assistant roadmaster or whoever the person is representing the company, at the end of the day, he has a list of his defects, class specific and non-class specific and he will ask the railroad representative at the end of the day what have done to protect the track for X, Y, Z class specific defects. He stated they respond to him: I slow ordered it; I repaired it, whatever their response is before he leaves. When asked how long the railroad has to fix a class specific or non-class specific defect if the railroad uses 213 (b), he said it would be 30 days for either type of defect. He estimated he has written fouled ballast as a condition on his reports about 20—30 times in the last six months.

FRA Rail Flaw Detection Regulations

The Federal Railroad Administration defines in the Code of Federal Regulations the frequency and applicable classes of track for which internal rail flaw detection is conducted. The following language represents FRA's requirements for rail flaw detection:

§ 213.237 Inspection of rail

*237(a) In addition to the track inspections required by §213.233, a continuous search for internal defects shall be made of all rail in Classes 4 through 5 track, and Class 3 track over which passenger trains operate, at least once every 40 million gross tons (mgt) or once a year, whichever interval is shorter. On Class 3 track over which passenger trains do not operate such a search shall be made at least once every 30 mgt or once a year, whichever interval is longer. ** [This paragraph (a) is effective January 1, 1999.]*

Based upon the annual tonnage figures for the OLM subdivision, CSXT was required to test the rail once a year. However, the records and data provided by CSXT documents that they were testing 11-12 times a year beginning in August of 2010.

CSXT Rail Test Policy:

NTSB requested from CSXT a description of their rail test policy and received the following:

CSXT Rail Test Policy

CSXT Transportation performs a continuous test for internal defects in accordance with Code of Regulations Title 49, Track Safety Standards Part 213, paragraph 213.237.

Frequency of test is determined using a risk-based model (where risk is defined as the number of rail service failures/mile) that is run by an outside entity. The model relies upon previous 12 month rail service failures, detected fatigue defects, and tonnage.

Based upon the results of this model, and CSXT standard test periodicity, test frequencies are then determined.

The determined test frequency for the OLM subdivision was determined to be 31 days based on this analysis.

CSXT and Zeta-Tech

As written in CSXT's Rail Test Policy in the previous section, the CSXT policy states that the frequency of their rail test is determined using a risk-based model that is run [calculated and/or managed] by an outside entity. NTSB inquired about that relationship and was provided the following answers to a set of questions:

Q. When did CSXT reach out to Zeta-Tech (ZT) pertaining to the OLM and what was asked of ZT in that regard?

A. CSXT contracts Harsco's Zeta-Tech Business Unit (ZT) on an annual basis, which is usually in early spring to calculate our rail test frequencies on a system level based on a fatigue analysis. ZT uses a risk based frequency analysis model, that they call "Rail Test". The OLM Sub is part of the system calculation and is divided into two segments for review.

Q. As with our request for contract information with Sperry, are there similar documents with ZT like the "Playbook" or "Customer File" that go into more detail about the expectations or performance parameters for the work that ZT did for CSXT? If so, can NTSB receive a copy of those documents?

A. We have a contract with ZT for the annual review. Also, we receive a final report with a summary and Rail Test results and recommendations. We do not have a customer file or playbook.

Q. What data, in general, was asked for by ZT and were those requests fulfilled?

A. ZT requires the following to run the "Rail Test" model,

- Annual Tonnage for route segments

- Master Track file listing all CSXT main line track locations and boundaries
- Annual Rail defect history- detected and service failures
- Signaled and Non-Signaled route information
- Passenger routes for route segments
- Priority Hazardous Material routes for route segments
- Speed of track for route segments
- Rail in-track inventory of route segments

This was pulled in March of 2012 and sent to ZT.

Q. Please characterize CSXT's experience with ZT—how does it work—what are the intervals of communication and data exchange?

A. CSXT evaluates their route system based on a year that begins on March 1 and runs to February 28. In early spring, CSXT starts to pull the data that is required for the "Rail Test" analysis, as listed earlier. We send this data electronically to ZT. ZT formats the data and runs the analysis. The resulting information is electronically sent to CSXT in the form of an Excel spreadsheet. CSXT's track testing team evaluates the data by reviewing every segment and current traffic trends. We divide the spreadsheet into 3 spreadsheets that have increased frequency, reduced frequency, or frequencies that have remained the same that are based on ZT recommendations.

We divide the spreadsheet by divisions, in which we have eleven, and we send this for their review. We have scheduled conference calls with each division for approval of frequencies after their review. We reach agreement with every segment on the spreadsheet. Frequencies are adjusted based on the division's feedback.

We send for final approval to Chief Engineers Maintenance of Way. When we receive back concurrence, we send to ZT that the process is final and they print and mail copies of the final report.

Q. Did ZT offer recommendations based on their analysis of CSXT and Sperry rail defect data (among other inputs)? If so, can you share ZT's recommendations and when they were provided?

A. ZT did offer recommendations based on their analysis. Recommendations for the OLM SG BAC 6.5-61.93were a "Bound CSXT Interval" of 31 days, which was unchanged from last year.

Q. Did Sperry transfer or provide data to ZT directly or was the data routed specifically through CSXT?

A. CSXT provided all data to ZT directly.

Q. If a CSXT program for rail testing on CSXT's OML was enhanced (improved—recommendations adopted), what future changes are forecast in terms of rail testing frequency?

A. This is unknown until we see recommendations that are offered.

Q. Is ZT still engaged in providing recommendations?

A. ZT is still engaged in providing recommended frequencies to CSXT on an annual basis.

Q. Has the ZT experience (inputs) aided CSXT in rail risk management on the OML? Other areas of CSXT?

A. Yes, ZT experience has aided CSXT in risk management. The calculated risk has trended favorably through 2012 on both the OLM sub and overall system.

Q. Do you anticipate ZT "tweaking" their analysis or recommendations? If so, when is the next review planned?

A. We are currently in the process of collecting 2012 data for the ZT "Rail Test" model analysis. We would expect changes in recommended frequencies based on past experiences.

Internal Rail Tests Data

Sperry reports review

On August 3, 2012, ultrasonic testing was conducted from milepost BAC 21.7 to BAC 6.5 for a total of 15.20 miles tested. This test took 2 hours and 45 minutes. Sperry vehicle SRS919 conducted this inspection. No defects were recorded in the vicinity of the derailment. The closest defect was a 40% TDD located at milepost BAC 9.908.

On July 6, 2012, ultrasonic testing was conducted from milepost BAC 20.1 to BAC 10.9 for a total of 9.2 miles tested. This test took 2 hours. Sperry vehicle SRS919 conducted this inspection. Two defects were recorded in the area of the derailment. These defects were a 100% TDD at milepost BAC 12.903 and a 40% TDD at 12.395. Also a spall, shell or corrugation (SSC) at milepost12.303 was recorded.

On June 5, 2012, ultrasonic testing was conducted from milepost BAC 21.8 to BAC 6.60 for a total of 15.20 miles tested. This test took 3 hours and 15 minutes. Sperry vehicle SRS919 conducted this inspection. One defect was recorded in the area of the derailment. A SSC was recorded at 12.299 and the next closest defect was a 90% TDD at milepost11.034.

Investigators reviewed the ultrasonic internal rail test data conducted on the OLM Subdivision for the most recent three tests beginning on August 3rd, the most recent test, and the two tests prior to that. During the last internal rail flaw inspection there were no defective rails marked near the derailment area. However, the nearest rail defect east of the derailment was located at milepost 9.908 (coded as a TDD) and the nearest rail defect or condition recorded west was located at milepost 14.749 (coded SSC). Investigators did not take exception to the data.

Post-accident Investigation

Post-accident Sperry Defect Data

Investigators requested and received rail defect data and service rail failure report data from CSXT. The following table reflects a breakdown of that data for each year starting with 2008 up to the last test prior to the derailment. A test cycle is representative of multiple test dates to cover the OML Subdivision. The total numbers of transverse detail fracture (TDD) type defects for the OML are listed in the fourth column, followed by the number of TDD's located in curves. The last two columns record the number of service rail failures that occurred and were reported on the OML and Baltimore Division respectively.

CSXT provided the following annual tonnage figures that they provided to Zeta-Tech for calculating the rail inspection frequencies.

Year	Test Cycles	OML Total Defects	TDD on OML	TDD in curves	SRF on OML	SRF on Balt. Division	Annual Tonnage
2007							44.34
2008	6	106	57	28	18	137	51.91
2009	7	124	86	48	12	87	58.36
2010	6	95	67	44	3	77	47.00
2011	11	145	86	51	14	55	36.23
2012	8	91	44	21	6	32	31.02

Table 3. Sperry Rail flaw Detection Data and Annual Tonnage.

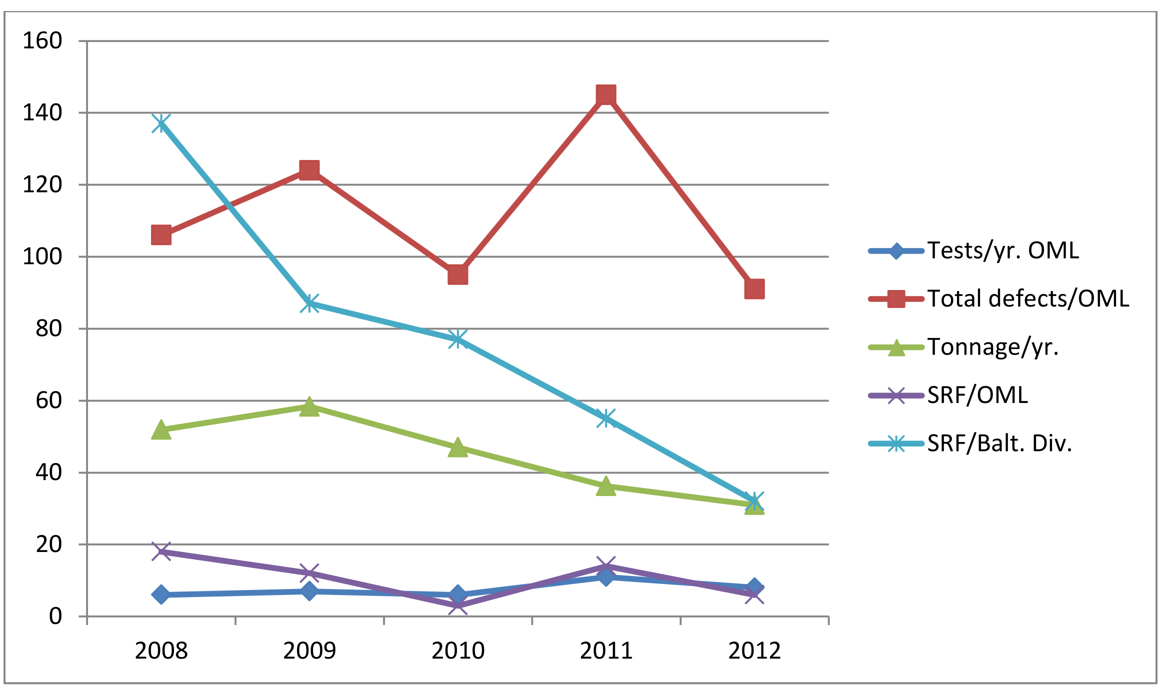

Figure 9. Graph of OML annual tonnage data, internal rail flaw detection tests, defect numbers and service rail failures (SRF) for OML and Baltimore Division.

Volpe Research

The Volpe National Transportation Systems Center produced a final report entitled "Estimation of Rail Wear Limits Based on Rail Strength Investigations[20]". The report provided technical information regarding rail-wear limits developed on the basis of engineering analyses. The report described the analysis performed to estimate limits on rail wear based on strength investigations wherein two different failure modes were considered: (1) permanent plastic bending, and (2) rail fracture. In part, the report examined two different wear patterns: (1) vertical rail head height loss, and (2) gage-face wear from the side of the rail (referred to as gage-face side wear).

In the aforementioned report, Volpe cited that rail-wear limits have traditionally been based on strength to ensure that the rail can adequately support revenue service traffic without failure.

According to the Volpe report, it [the research] revealed that rail-wear limits estimated with the fracture mechanics approach are more restrictive (i.e., conservative) than those based on the plastic-bending approach. And in the executive summary of the report, the report concluded, therefore, for safe operations on railroad tracks, allowable rail-wear limits should be estimated on the basis of fracture strength. And further concluded that for all but the lightest rail sections considered, the limits for allowable wear were estimated as 0.5 inch head height loss or 0.6 inch

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gage-face loss, under the assumption that the rail is inspected for internal defects every 20 million gross tons (MGT).

In a previously published final report, dated, October 1988, a Volpe report entitled, “Crack Propagation Life of Detail Fractures in Rails”, Volpe cited the following contributing factors effecting detail fracture growth:[21] (See diagram on subsequent page)

- Temperature differential, rail residual stress and track curvature have strong effects on detail fracture growth life;
- Rail section, track foundation quality (modulus), center of contact (wheel and rail profile) and average axle load all have moderate effects on detail fracture growth life;
- Vehicle dynamics and flaw center location in the rail head have only small effects on detail fracture growth life

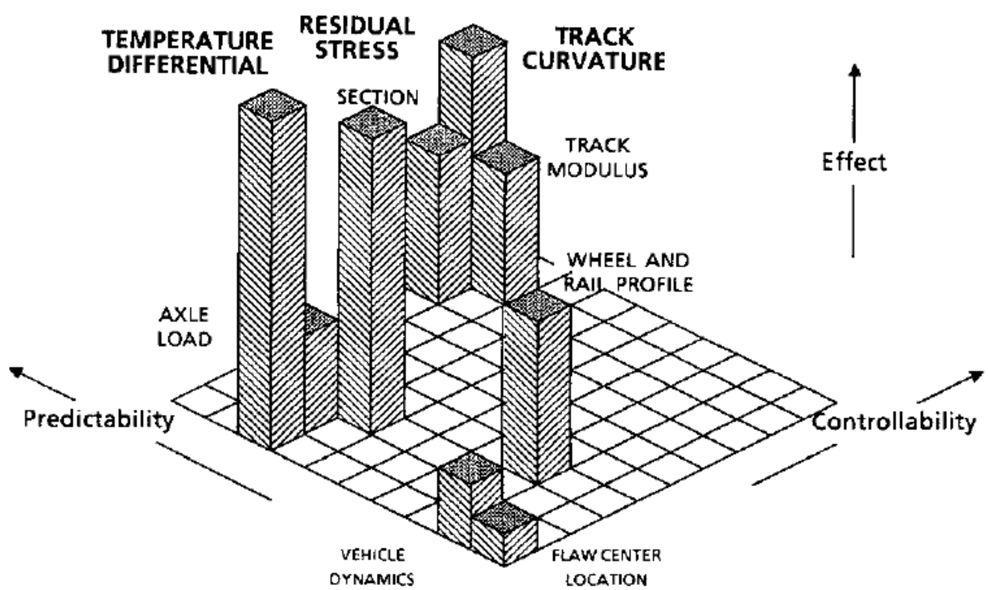

Figure 10. Effects and Attributes of Environment Factors[22]

[21] Volpe Report No. PB90—113044 entitled, “Crack Propagation Life of Detail Fractures in Rails”, page 111.
[22] Volpe Report No. PB90—113044 entitled, “Crack Propagation Life of Detail Fractures in Rails”, page 111.

Sperry Interviews

On February 21, 2013, investigators were assembled to participate in rail examinations at NTSB's Materials Laboratory in Washington DC. As part of those activities, representatives of Sperry Corporation attended and consented to a panel interview to elaborate on Sperry's services for CSXT and their knowledge of the rail testing data relative to the accident investigation. Sperry was represented by their General Manager (GM), the Operations Manager (OM), the Director of RFD (DRFD) and the Quality Manager (QM).

The GM opened his remarks by stating that Sperry is the leading, by size, rail flaw detection company, the founder of the industry, from 1928. And that they do work around the world, primarily providing service in all of North America, much of Europe, and selling our system technology for use in Asia, predominantly China.

The GM stated that Sperry's business for CSXT is primarily centered on providing equipment and personnel working under specific procedures to conduct rail flaw detection in the railroad industry. And he added that for CSXT specifically, and per a long-term contract of several years and a long history of work, Sperry provides vehicles, people, their proprietary technology, to the railroad on a per day fee basis where CSXT instructs them to work.

When asked why Sperry performs its services, its mission, for the railroad, the GM answered that from Sperry's perspective, it is all about railroad safety, and that their mission and sole purpose of their business is to increase the safety of the railroad by finding internal flaws and defects that are not visible by the naked eye or other means of detection. And in terms of risk management, he added that obviously brings in the variables of how much risk is to be accepted, what other means, such as rail replacement, are better methodologies or different methodologies to reduce risk but those become both economic and business decisions based on the infrastructure owner's management process.

The GM was not sure of the exact number of years that they had provided services for CSXT but he said it has been a decades long partnership and that CSXT and Sperry work collaboratively on a daily basis with a periodic, for the most part, quarterly management meeting -- management meetings organized to make sure that Sperry and CSXT are doing all they can together to maximize the rail flaw detection. He stated that CSXT has the requirement for testing of the railroad track; they determine the frequencies, the locations of such testing and Sperry provides the assets, the technology, the people, the process and conduct the work. He also said that when Sperry conducts the rail flaw detection inspection work, Sperry has the responsibility and contractual obligation of providing every day, at the end of the day, to CSXT Transportation the locations that Sperry had tested and any defects that Sperry had identified by their vehicle scanning the railroad and seeing that there -- scanning the rail track and seeing there's a potential defect, and eventually Sperry's chief operator going outside of the vehicle and with hand test equipment identify and verifying that the defect exists. In terms of how Sperry communicates the data, the GM stated that once they complete the daily work, they provide to the railroad our car movement report, which accounts for our time and location of testing that we have completed, as well as our defect rail report which identifies the defects that have been detected, furthermore, Sperry houses all that data in their our proprietary data management system and make that available to the railroad should they want to look at historical data, aggregate data, trend data, or any of those type of items.

The GM said that there are two governing documents: the first is the customer file, the customer being CSXT, the customer file is the contract from a high level in terms of terms and conditions, commercial terms and conditions, especially; and then secondly, Sperry operates to a playbook using our procedures, equipment, and processes that are well understood and trained into our workforce to follow through, but then the next most narrow part of the instruction is this customer file specific for CSXT Transportation, which we will keep on file and have on every vehicle and operate to while on their property.

With regard to how Sperry tests the track, the OM said they use about 18 hy-rail test vehicles and are given a weekly schedule from CSXT Transportation. The GM said that in terms of taking the data and archiving the data that there are three key pieces of data, one is the test system data itself where Sperry records the ultrasonic signals rendered on the B-scan to the customer, the second is the vision system or the pictures that are taken from the cameras on the vehicle at any time there's an ultrasonic indication, and the third is the logistical data of car movement report, where the vehicle has been by GPS location, where it stops and operates. He added that in every case that data is retained on the vehicle and is provided in a report which contains the car movement report and the defect rail report to provide the railroad the information they need to address any defects found by the rail inspector vehicle. The GM elaborated by saying that subsequent to the above archiving of data that Sperry takes the test data and electronically transfer to Sperry’s headquarter location in Danbury, Connecticut. We take the vision systems, they are burned onto a CD by the operator and those are also returned to Danbury, Connecticut, so that data will then be housed in their servers, both the vision system in terms of CDs and computer servers with the test data, for numbers of years, certainly more than 5 years of data. The GM said that Sperry performs the same process for car movement report and the defect rail report that allows Sperry and CSXT a database to look through data to aggregate, to trend, as a management tool.

The GM confirmed that at some point Sperry's responsibilities end and that CSXT responsibility picks up and Sperry does not get involved in that next stage of the repairs of the rails. The GM did clarify that Sperry use of the term ultrasonic testing includes also includes the use of induction.

Sperry was asked to describe the type of equipment used to test CSXT's OLM Subdivision for the past several years and the OM replied that on the OLM, from 2009 through 2012, CSXT has employed what we consider a full technology vehicle, which is equipped with ultrasonic devices, including the crossfire technology, induction and division based and that these vehicles have been operating on the OLM for longer than these 3 years and the CSXT has recently put the new vehicle, on this most recent test in 2012, which is one of our newest vehicles added to their CSXT fleet. The DRFD explained that the term "x-fire" or the crossfire technique was developed to do two things: one was to not get rid of surface conditions, but be less affected by surface conditions; and, secondarily, to be able to look under shells. The DRFD was asked to describe the term shell and if a shell is a surface condition that may help mask an underlying rail flaw, to which he replied that it is basically a cap on top of the rail that is made of steel that has – it is like a lamination and you can't penetrate ultrasonically through it and that the same is somewhat true of when you have the head checking. He added that the rail testing maybe can penetrate through some of it, but it creates a lot of interference and that those two conditions [shells and head checking] do not allow the gauge side to be easily inspected in some cases. He added that the crossfire feature basically uses reflection off the bottom of the fillet area, which allows it to get down under the gauge-side surface conditions and is more sensitive to odd angle transverse defects, in other words, ones that are not actually across the rail, but may be oriented at some angle to it. The DRFD clarified that the crossfire examines specifically the gauge side of the rail section and that Sperry has had the technology for about 4 to 5 years and uses it in all of their test vehicles. The DRFD was asked if Sperry has gained more data of what Sperry has learned from the use of the crossfire technology. The DRFD said that the initial results were that we had a 50 percent increase in DF, detail fractures, in gauge side and then it leveled out and it ran around 30 percent for a long time, but it is a significant improvement, not a minor one, but a significant improvement in transverse defect detection. The GM added that Sperry did track very closely the defect count when the crossfire was implemented and the amount of additional defects that Sperry determined through crossfire technology started at 40 percent when Sperry implemented that technology, and over time is now closer to 20, 25 percent, primarily for the reason of detecting defects through the crossfire and then repairing them so that they [the rail defects] were not there again. He clarified by stating that Sperry is finding 20 to 25 percent of their defects with the crossfire technology, which is an ultrasonic technology (UT) incorporating crossfire. The GM described the crossfire technology as similar to a bank shot playing basketball, if you can't -- if the defensive team has a blocker and you're not going to go right over him--you can bank it off the rim and put it in.

Investigators asked Sperry to describe the array of transducers used by their equipment and learned from the DRFD that the configurations of a standard truck that's used on CSXT has 30 channels. The DRFD went on to say there are 15 different transducers per rail oriented at various angles and that there is a set of transducers that specifically have full-head coverage, aside from the crossfire, that look for transverse defects. The DRFD added that there is an array of actually six transducers: three forward looking, three reverse looking for the head area and there is what is called a 37-degree transducer, which looks all the way down to the base and it's primarily for finding web defects and blow hole defects, although it aids sometime in finding rail defects. The DRFD also said then there is a zero degree transducer, which is -- aims straight down--it looks for horizontal defects and it is a control channel for all other channels that actually finds the surface of the rail and then controls all the other channels to say, start all your information from this point. He stated the purpose of the arrays is to attempt to get every part of the rail that can be obtained from the top of the head of the rail.

The OM provided comment on the induction part of the rail testing by saying that Sperry, with the induction system, the numbers that Sperry has calculated, accounts for between 17 to 20 percent of the defects that are marked on CSXT are induction assisted. Investigators inquired if induction could find defects on its own and the GM answered that, yes, a very small percentage, in the range of 3 to 5 percent, of defects are detected by induction only. The OM added that the induction technology is not as influenced by surface conditions as the ultrasonic systems can be. However, when asked if Sperry had any data on whether or not detail fracture derailments had decreased, the GM informed investigators that Sperry does not keep that type of data.

Investigators reviewed the condition of rail pieces sent to NTSB's Materials Laboratory and a review of the Sperry screen shots from the June, July and August rail for the area of the derailment on the day preceding the interview. Sperry was asked what rail condition could have possibly caused the positive zero or the LER (loss of expected response) requiring the operator of the test vehicle to back up three times during the August rail test. The GM reminded investigators that those being interviewed were not present during the actual rail tests and that the decision to back-up was the responsibility of the operator of the test vehicle. The QM said that the wear on the gauge face of the rail would have allowed the wheel [test wheel] to be off center a little bit for the wheel to be directly—for the zero to be directly in line with the web of the rail. He added, so, therefore, a little bit of adjustment had to be made at that point to keep continuity throughout the specimen at that time, so, that is really the cause. The QM continued to answer that the alignment of the equipment does not take away anything from the all these transducers, it influences them depending on the characteristics of the rail. When asked, the QM clarified that by characteristics he meant surface-related conditions, such as contaminants or wear can influence the detection. The GM also responded by indicating that the process of re-running and going over the same area often, as you think common sense, is done at a slower pace and done with the focus of detecting a particular issue.

Sperry was asked to define the terms SSC, LOS (loss of bottom/signal) and LER [loss of expected response] that are used by CSXT when those are marked and if they indicated a non-test. However, a CSXT representative and a participant in the investigation offered that CSXT treats them as a non-testable section, but the codes are actually assigned defect codes, but CSXT does not consider them defects, SSCs or LERs. He also stated that CSXT considers them [areas identified with a SSC or LER) as a non-testable area and the reason that CSXT assigns two different codes to them, SSC and LER, is CSXT wanted to actually pull out what was important for the rail grinder and to kind of say, hey, we're having some issues here, we would like to remove this -- it might be something we want to remove with our rail grinder. He finished his explanation by stating that it does mean that there is a loss of bottom, but there are times when that's not necessarily the only criteria. Sperry was asked if the test vehicle operator had the latitude to identify an invalid test by placing an icon into the data. The OM said that the operator does have that latitude and that is what the SSC designation and the LER designation is for and those are both CSXT terms in the CSXT customer file that we do follow and that is similar to the NT, non-testable, locations to the FRA regulations that were implemented [in 1998]. The GM added that all of those types of locations are reported to CSXT. The GM added so in layman's term, what Sperry is saying is not that there is a defect there, we do not know or did not detect a defect, but that it is not a complete test that has been accomplished at that location.

Sperry was asked to explain “gates and gains” as terms used in ultrasonic rail testing and whether or not those features can be adjusted by the operator. The DRFD answered they can be adjusted via operator, but we have fixed sets of values for specific railways, and then the system keeps them at that those values. When asked what would be the purpose of adjusting the gains, the DRFD responded that a gain is equivalent to turning your volume up on your radio; it is an amplifier. He added that the most reasonable reasons [to adjust the gain] is if when you have some sort of surface contaminant, and the biggest one is grease, would require some adjustment in gain, but the other one, which maybe a lot of people don't think about, is temperature, because of the materials Sperry uses in front of the transducer, the wheel fluid and the membrane itself, especially when it gets colder, it becomes more attenuated and so they need to adjust for that. He continued saying that you could have a 30, 40-degree temperature change and so you are not constantly adjusting this gain—usually, maybe two times a day that they [the operator] may adjust a gain. The DRFD said that adjusting the gain simply amplifies the signal.

Sperry was asked to describe the term “pattern recognition”. The DRFD referred to the review of the B-scan [screen shots] and said that those images actually have a little bit more processing before it gets there. He stated they use something called a spatial transformation, when Sperry gets information [from the testing process], it is just – it is a time measurement that Sperry converts into a distance for presentation on the B-Scan.

The DRFD elaborated by adding that Sperry has a module called a recognizer that if you look at those B-Scans you will see a certain pattern (i.e. a local pattern looks like an "A", it has 37 on each side, front and rear, and it has the zeroes in the middle, so it looks just like an "A"). He also added with [the] knowledge of that pattern -- and it varies a lot, but it actually is quite “loosey-goosey” in a sense that some of those things are not quite there, but we have a module that actually goes in and looks for that pattern and identifies that as a bolt hole. He further explained that the reason you do not see boxes [defect identification] around every one of those as a defect is that it has been recognized and processed and it is not shown to the operator because it detracts away from a real defect.

The DRFD continued the explanation by saying that the pattern recognition goes through with knowledge of all these different conditions and actually does a recognition and says -- classifies it even as the type of defect it thinks it is, a horizontal, a vertical type defect, or a transverse defect and the software by population of icon on the screen also tell you how many channels hit, for example, for the transverse defect, so its cues -- not only does the number indications that he [the operator] sees on the B-Scan, but that little icon also tells him the extent of how much, for specifically a transverse defect, that is going across the rail. The GM offered that the layman should take that term pattern recognition and look at it the other way around, that the system is recognizing the ultrasonic indications and seeing patterns so that it advances the science and reduces the operator dependency, so that the system, through routinely and reliably and repeatedly seeing the same patterns, is able to make the judgment or the assessment of what that particular indication is.

The GM indicated that of the 18 hy-rail vehicles used on CSXT property, the same vehicle and same operator are applied to the same territory for two or three pragmatic reasons: 1) logistically, it's the least expensive way to accomplish the work, including the opportunity to get chief operators close to home so that they have less hotel expenses; 2) pragmatically, it develops the relationship of our workforce with CSXT on that property to understand the layout and how to most effectively get the work done. The GM added that he would expect similar performance regardless of what vehicle was used to conduct the testing and that they are interchangeable.

Regarding how an operator can verify if a valid test has been made with a loss of bottom indication, the OM replied that there are other means to validate a test. He explained that if you [the operator] have a known track feature in the immediate area where you are receiving this loss of bottom, they [the loss of bottom indications] are going to reflect – you are not going to get your A's on your bolt holes and you are not going to see your rail-end responses. He added that Sperry has the induction method that is not affected the same as the ultrasonics, so you take all your methods and all the tools that you have available to you to make a decision on if you could perform a valid test. The OM said that ultimately it is the judgment of the operator if a valid test was conducted.

With regard to scheduling, the GM said it is a process that you would naturally expect from a field service organization but primarily, CSXT provides Sperry advanced notice of the areas to test to give us time to get the vehicles and operators to the right location—it is a routine process. He added that Sperry does not have a challenge in having the amount of assets ready for CSXT to do the work. However, he said that one variable is when a car has a mechanical problem or an operator illness, which he thought occurs about 2 percent of the time.

A CSXT representative said that if for some reason a test is deemed invalid (i.e. coded with an SSC condition), CSXT defaults to the FRA minimum of 40 mgt or schedules a rail grinder to correct or remove the SSC condition before the next test.

In terms of assessing the influence of rail wear or the rail profile with good alignment of the zero degree transducer with the web, the DRFD stated that it would be some influence, but minor. The OM added that the rail surface conditions and contaminants influence the rail testing more so than rail wear and rail profile. With regard to whether or not the rail pieces examined by the investigative group previously [the rail pieces sent to NTSB from the accident scene] would have presented challenges with the detectability of defects with the new equipment based on the rail conditions or rail wear, the DRFD said that the spalling on the gauge face was not far enough over to affect the crossfire. The OM added that a review of the screen data showed the induction responded very well to that defect that was detected in the rail. The DRFD commented that the ultrasonics did too [responded well].

The GM confirmed that about 25 percent of the defects are found with crossfire assisted and not just crossfire. The QM also confirmed that 17 to 20 percent of defects found were by induction assisted and not by induction alone. The OM and QM both agreed that the a positive zero or loss of bottom was not an indication of not getting a valid test; it was only an indication that your alignment is off and that usually the positive zero that you are getting is mostly from beam spread because you are -- if you don't lose your bottom, you are still reaching bottom and not having a loss of bottom at the same time. Both the OM and QM agreed that when the test car backs to rerun an area, it is not because of a false positive, but mostly because of a loss of bottom and thus it is usually only an indication for them [the operator] to start thinking about changing their alignment. The QM agreed that the August test data did not have a loss of bottom. The DRFD agreed with a clarification about a point referring to the gains and the adjustment to say that you adjust the gains not to amplify something larger, you amplify it to keep it consistent at the same amplitude. And to clarify a point about pattern recognition and the potential estimate of the number of indications one could see in an average test day of 19 miles, the OM said that depending on locations, you could see upwards of 2,000 indications with pattern recognition. The OM and QM also commented that each pattern recognition indication has a vision photo number from the indication. In answering a question about the four reruns [in the area of the derailment] conducted during the July test, the GM said that the operator was working to the procedure and was completely diligent in doing so.

When asked to describe an operator's training to become a rail test operator for Sperry, the GM provided the following comments:

> ….it was a process of going to the field and learning from an experienced chief operator, assimilating and imitating and learning themselves how to become a chief operator. Several years ago now, near 10 years ago, Sperry determined, though, while that had been proficient, a better methodology was to conduct and develop its own Sperry school of rail testing, which we have done, which is organized and run under the professional mentorship and leadership of a gentleman named George Quinn, who is our Level III ultrasonic inspector, who had been previously a professional and paid trainer for a company called Hellier Inspection, which our company now owns. And under George Quinn's guidance, all chief operators come to Danbury, Connecticut to achieve their Level II ultrasonic testing certification.

Backing up from that, let me just give you a very simple road map for how someone becomes a chief operator today. We hire people and we put them in the field and we start them as a driver or a driver mechanic on our vehicles. We identify those people that have the aptitude and the attitude to become chief operators, a very significant and important job in railroad safety. Those people are identified by not only their chief operator, but also the field manager level of supervision that will qualify, will also look into these people's opportunity to advance.

Once we've identified a candidate as a potential chief operator, we start to engage with them to provide the content, give them a little bit of instruction. We let the chief operator know that they will be -- they've been elected and chosen to come to our 10-week class in Danbury, Connecticut. And in that 10 weeks, they are taught virtually, though much more, everything that we discussed today, from gates to gains to pattern recognition, ultrasonic induction, crossfire, vision, how to create the CMR[23] or the DRR[24], you know, a number of items. And upon completion of that course, there is a practical exam that is very difficult and lengthy to accomplish. If we were looking at the content on these tables in front of us, we would see three binders each of three or four inches thick that has that content.

Once those people achieve that -- completion of that curriculum and the testing that is accompanied with that, they go back to the field as a chief operator candidate. And there they are, for the most part, made or put on the vehicle to be the third person,

[23] CMR stands for Car Movement Report.
[24] DRR stands for Defect Rail Report.

someone to just shadow the chief operator, somewhat similarly to what I said years ago was the primary way to go. And we've elected chief operators who are proficient in their operation, but also proficient in training to mentor those individuals. At that point, they will be on the radar of not just the OM, who's running the operation, or the QM, who manages the qualification, certification, and the routine eye exams of all of our chief operators. And upon achieving time in the field that proves to us that they are able to do so and become a chief operator, we will certify them, they will go into our records. Today we have near 100 chief operators in the U.S., certified and qualified in that way.

We follow the ASNT, American Society of Nondestructive Testing, curriculum in regards to ultrasonic testing and the testing for those, which is how they become UT, ultrasonic test -- ASNT, UT, ultrasonic testing, Level II. So that's the process that these people will go through to become a chief operator.

The GM was asked to comment on how Sperry achieves its internal oversight of the entire operation and he replied with the following:

Sure. And I think really that I'll take you down two quality paths, one routine and then one by exception. So in the routine quality path, once that chief operator is in place and doing his job, the QM is here today, has a staff of near a half dozen tape auditors that will randomly, though systematically, audit, I believe it is 10 percent, the QM, of the chief operators' work every week. And so we will take those B-Scans the same that we looked at yesterday, and bring them in to review by people qualified to review a second time to make sure that the chief operators' indications, the dispatching, the disbursing of any pattern recognition is done to the best of our ability given the vision system and the B-Scan as opposed to being on the property. So that routine process happens every day, every week.

We score our chief operators relative to any suspect indications we might see. We prorate all (ph.) them to make sure that we are focusing on anybody that needs any type of work to increase their level of competency. Again, the science is for the most part the same throughout -- certainly keeping this with CSXT, CSXT runs the same technology. But we're really looking to advance. We're not looking to use that process to get people up to being a qualified chief operator, but continue to get them to be better. So that happens under Terry's watch and he is in direct contact then with the field management, where we will go and meet with any chief operator on their vehicle should there be any issues we see from that standpoint.

The second element of our quality control, as you would expect, is by exception. If there are any service failures, and all service failures are rail breaks that occur on CSXT, that data is provided to Sperry. We investigate every single one of those service failures or rail breaks by doing what we did yesterday, pulling up the tape, pulling up the vision system, and making sure there were no misinterpretations, our system or operator errors. So between those two, first routine and second by exception, processes, we are able to feel confident that everyday those 18 to 20 people out on CSXT property, or those 90 people out in North America, are able to do the job. And I think that's evidenced in what we saw yesterday with that type of discipline. And we will certainly evaluate the tapes for that type of discipline and follow-up.

The DRFD was asked about pattern recognition and whether or not there was an alarm associated with that system. The DRFD confirmed that the pattern recognition program is designed to bring the operator's attention to the screen for every time recognition (audible alarm) goes off. He added that if the recognition sees 2,000 events the alarm is audible 2,000 times. Both the QM and the DRFD commented that acknowledgement software provides an indication based upon a specific size [of defect] that requires the operator to physically annotate that indication. The OM commented that the first level of alarming is an audible ding [like a car horn] that goes off and then there's a second level, which is called the acknowledgment, the acknowledgment goes off when an indication meets a certain criteria or a certain ultrasonic or an induction response in the system. The GM also added that before the B-scan can advance, the operator must acknowledge the alarm as a fail- safe.

In reviewing the testing data dates the point was confirmed by the QM that sometime in 2011, Sperry began testing the OLM on a 31-day cycle or approximately 12 times a year.

Sperry was asked to comment on whether from the review of their data and experience if they believed that detail fractures exhibited different growth rates—one slow or predictable and a second type whose growth was more unpredictable or grew more quickly. The GM said that Sperry had some experience with rail testing in Australia on a coal line where they could see defects propagate within 7 days under great tonnage. He added that absolutely the issue for the industry is those defects that grow rapidly and to the best of our ability right now, Sperry, or as what the industry brings, frequency [of testing] is our number one tool to address that. He went on to say we are looking and looking to look at with the industry how can we get to a more predictive process and that may be a combination of statistical analysis, looking at clustering of defects, factoring in an advanced model beyond what's available today, with tonnage, climate, rail weight, many different applications. In terms of challenges that Sperry sees, the GM said that one of the big challenges at Sperry is to be able to test faster and more frequently to less disruption of the railroad to enable frequency of testing to be a tool to be used. The OM commented that there have been some studies that have been done on defect growth, and pretty much what he has read in the studies is it all hinges on tonnage, weather, track conditions, top grade.

Sperry Rail Detection Screen Shots

On February 20, 2013, investigators meet at NTSB headquarters and developed the following observations and bullets from their rail exam and Sperry data review:

- The July test was conducted by a “relief” operator.
- Each of the three test were conducted going the same direction—from the west going east or descending mileposts;
- The length of the “rail plug” was validated as 17’1” (plus or minus 3/16”);
- The July test identified a rail defect at milepost 9.908, north rail, defect number 593 (screen shot file requested);

- Rail identification labeled from perspective of test truck moving forward—eastbound, thus left rail is north rail, right is south rail.

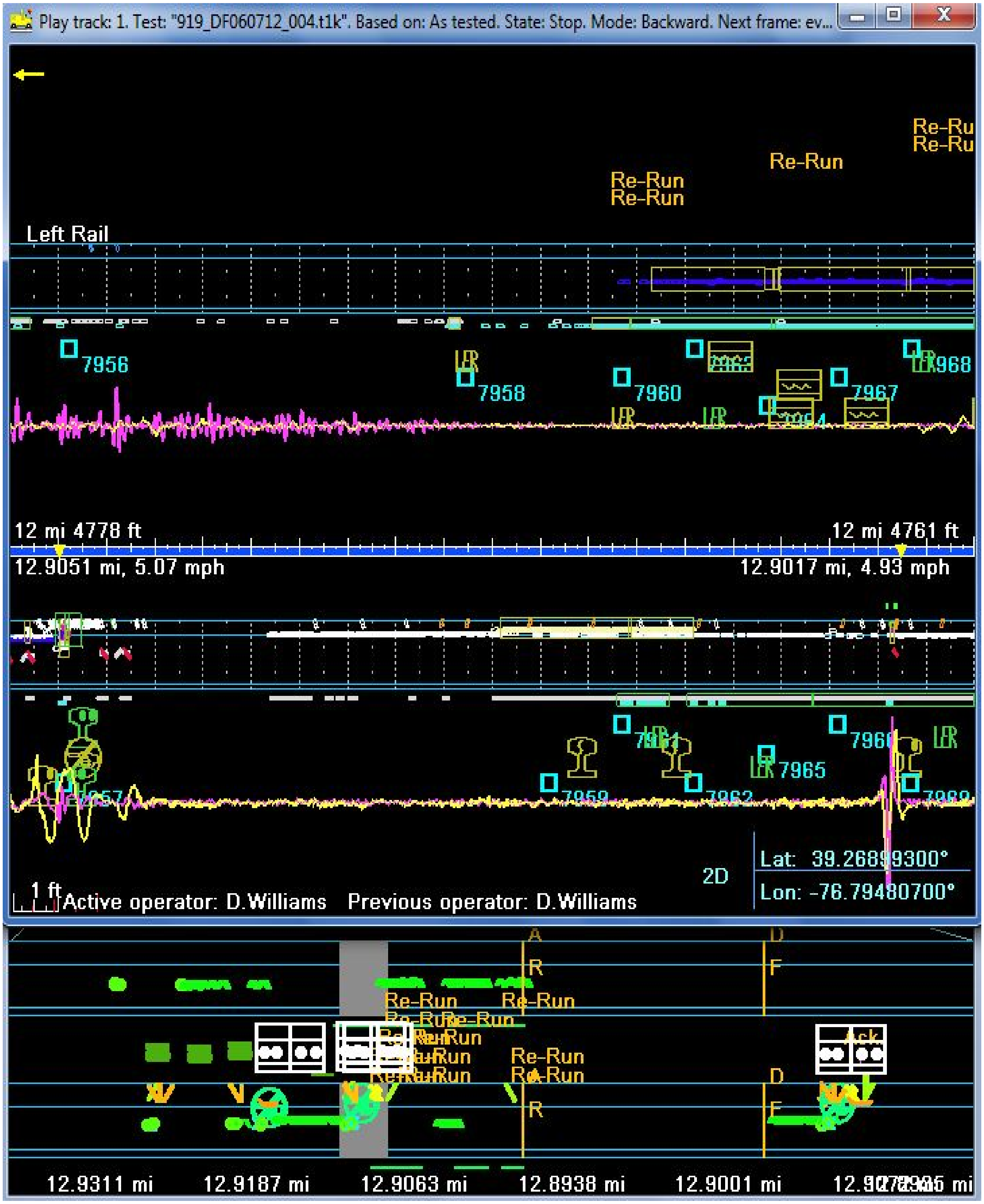

Figure No. 11. Sperry Rail Flaw Test July 6, 2012, Screen Shot of milepost 12.9311 to 12.9001.

Multiple Runs (see the following screen shot):

- The screen shot data in the lower limits of the data indicates a stop after a TDD was identified; an AR (ascending milepost location/ reverse) to a west location followed by a DF (descending milepost location/forward) to a stop point after a "re-run" over the "rail plug". The data indicates this process was repeated once again, the third run—original and two repeats. The data also indicates a final fourth run that continued beyond the location of the previous three stop indications—a total of four runs.
- The final run was the valid test for that area—each run indicated the presence of the TDD, first identified during the first run;
- The final run had no loss of bottom[25] indication but did contain "intermittent positive zero (head of rail).

[25] The term "a loss of bottom" (or "lack of expected response") can be caused by surface conditions on the rail such as center spalling.

1

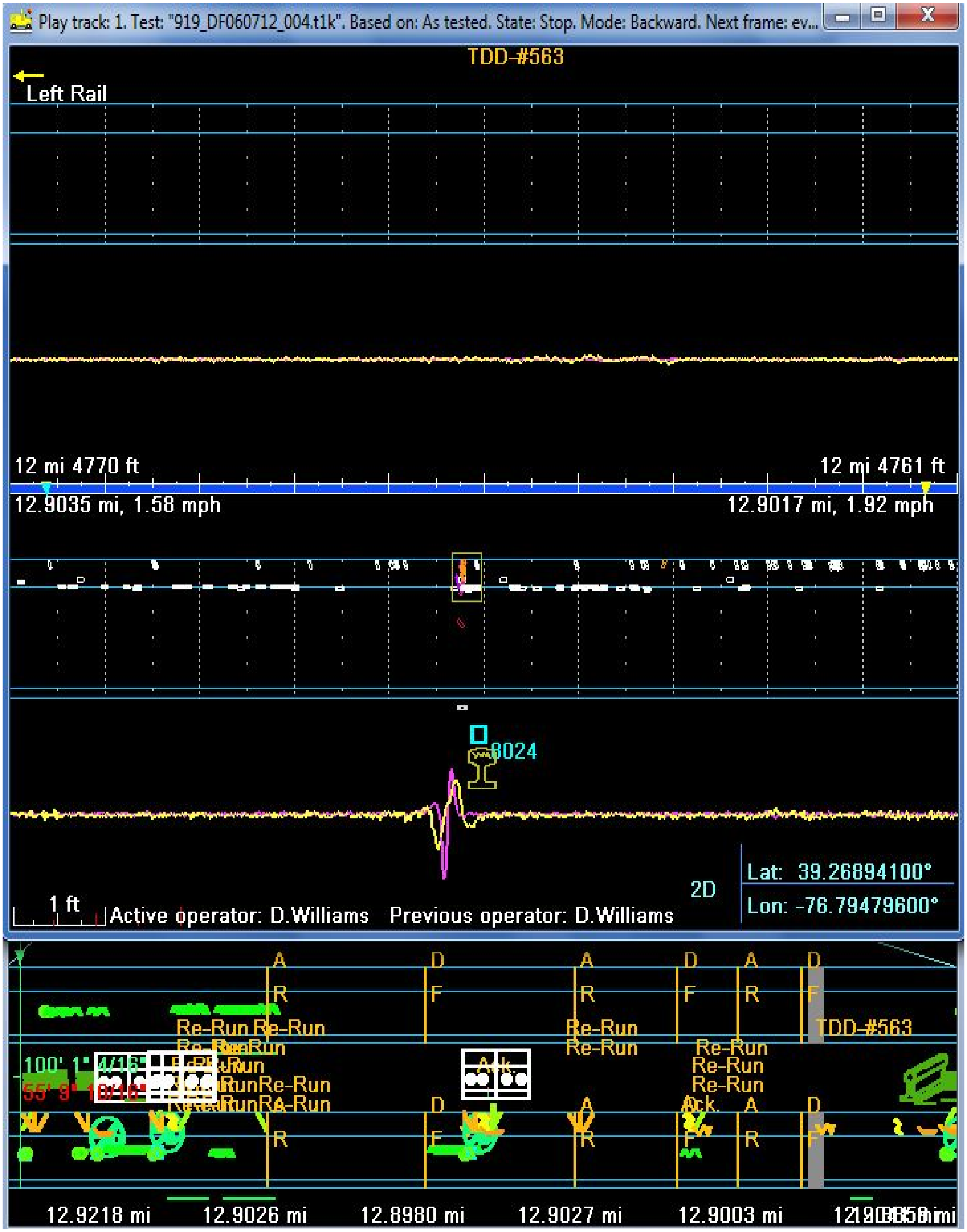

Figure No. 12. July Test Car Re-runs and defect location.

The following landmarks or rail characteristics were identified from Sperry data of the July test:

- The left side of the screen is geographically west, the test car was moving from left to right, or eastward;
- A beginning point for the landmark locations is the “saw cut” rail joint or west end of “rail plug” examined in the accident investigation;
- First landmark to the west on the north rail as depicted in Sperry screen shot is located at a rail joint about 37’ 4 ½”;
- The second landmark is an additional 10’5” west of the previous landmark;
- The third landmark is a field weld located another 34’5/8” west of the previous landmark;
- The final landmark was located about 99’11 7/16” west of previous landmark that exhibited a two-hole drilling at a flash butt weld;

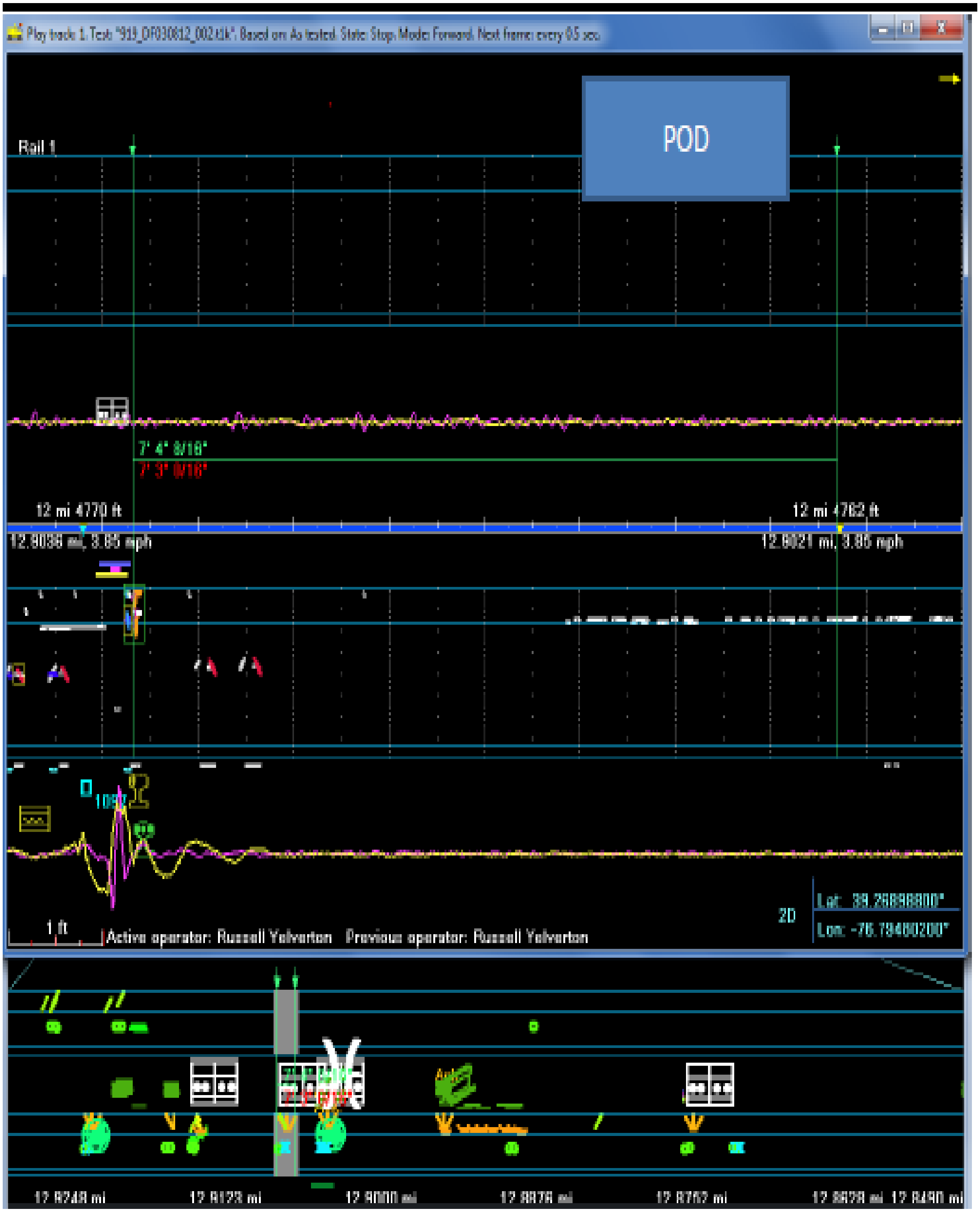

Figure 13. August 3, 2012, Sperry Screen Shot.

During the investigator's panel interview with Sperry, a Sperry representative provided the following observations about the August 3, 2012 screen provided to the investigation.

- Starting from the saw cut, we see evidence of the alarms on the bolt hole drillings where the angle bars were applied to the saw-cut end.

- There is a little bit of positive zero response through that area because of a transition, possibly a little bit of mismatch on the rail head area that caused that.

- From the saw cut to the angle-barred -- or the defect that was angle-barred in the August test, the measurement was about 17 feet. And when we look at the July run the measurements are exactly the same.

- Where a defect is noted, the software automatically takes a visual photo of that location.

NTSB Materials Laboratory

Investigators met in Washington D.C. on February 21 and 22, 2013, to review Sperry data and examine rail pieces from the derailment. Senior Materials Laboratory Metallurgist measured the transverse defects present in the fractures faces and developed the following table that compares the defect size of the remaining rail head to the original cross-sectional head area of a new rail profile. A view of the outline of a new rail profile overlaid on a photograph of piece NR can be seen in Appendix X of this report.

Sizing of Detail Fractures:[26]

In the rail industry, detail defects are sized relative to the head area of a new piece of rail. However, defects sizes reported earlier in this report were sized relative to the remaining head area. Based on measurements showing the remaining head area of piece N5 was 57 percent of the head area of new 136-pound rail, the defect sizes of the transverse detail fractures were calculated relative to the original head area, and results are listed in table 4.

Table 4. Summary of Defect Size Measurements

Fracture Surface	Defect Size Relative to Remaining Head Area (percent)	Defect Size Relative to Original Head Area (percent)
N1 east end	9	5
N5 west end	24[27]	14
N5 east end	10	6
N15 east end/N16 west end	2	1
N16 east end/N17 west end	<1	<1
N18 east end/N19 west end	1	<1
N19 east end/N20 west end	15	9

[26] This section of the Materials Laboratory Report appears in Report No. 13-018 page 6 in NTSB's docket for this accident.

[27] In contrast to the above TDD figure, CSX engineering personnel met with NTSB in Washington, DC in July of 2013 and reviewed data and images associated with the 24% TDD and did not agree to a defect size of a 24 percent TDD on fracture face of N5's west end. .CSX disagreed that one can definitively tell there was a TDD due to the rail end batter and the rubbing that occurred; therefore CSX contends that a size could not be determined.

FRA Regulatory Activity:

FRA initially presented to the full RSAC (Railroad Safety Advisory Committee) in September 27, 2012 the formation of a working group to discuss rail wear. The work of the group is on-going with a goal to complete its work and present their results to the full RSAC by March of 2014. Below are the group's areas or issues requiring specific review for their report to the RSAC.

- Determine whether current industry rail head wear management systems are adequate or should be standardized.
- Identify an approach to establish the state of understanding of issues related to rail performance utilizing known experts in the field of rail research. Determine methods to improve the effectiveness and efficiency of rail performance management and rail life extension, and provide recommendations as necessary.
- Specifically, determine whether, and if so how, rail life and performance management can be improve to reduce the rate of worn rail failures and related derailments.
- Determine whether new approaches to rail head wear limits should be developed and/or formalized.
- Evaluate whether methods of non-destructive rail inspections can be improved in terms of inspection effectiveness and efficiency.

Previous RSAC Working Group

Through FRA's ongoing efforts and commitment to internal rail flaw detection and rail testing cycles, and the RSAC Working Group's recommendations for proposed rule changes to the Track Safety Standards, which the NTSB is a member, below is NTSB comments to the NPRM published October 19, 2012. As part of the NPRM (Notice of Proposed Rule Making) process, NTSB provided comment to FRA about § 213.237 and §213.237(c) (2), Inspection of Rail. The following, in part, are sections of NTSB's response to FRA on that NPRM:

> As a result of the NTSB's investigation of the New Brighton, Pennsylvania[28] derailment the NTSB developed Safety Recommendation R-08-10, where the NTSB recommended that the FRA require railroads to develop rail inspection and maintenance programs based on damage-tolerance principles and demonstrate how those programs would identify and remove internal rail defects before the defects reach a critical size to cause catastrophic rail failures. Furthermore, the NTSB recommended each program should take into account, at a minimum, accumulated tonnage, track geometry, rail surface conditions, rail head wear, rail steel specifications, track support, residual stresses in the rail, rail defect growth rates, and temperature differentials. In a damage tolerance approach, a predicted time to failure is determined by predicting crack growth rates from a detectable size to a size that is expected to cause fast fracture (critical size), and actions are put in place to mitigate the risk of failure. A key principle of the damage tolerance approach is to

[28] *Derailment of Norfolk Southern Railway Company Train 68QB119 with Release of Hazardous Materials and Fire, October 20, 2006,* Railroad Accident Report NTSB/RAR-08-02 (Washington, D.C.: National Transportation Safety Board, 2008)

identify areas of high stress that are most likely to produce a future service failure and reduce risk of failure in the areas of high stress through timely inspections, repair, or replacement.

In §213.237(a) of the proposed rule, the FRA proposes a new performance-based measure for determining internal rail inspection frequencies. The track owner may use a method of their choice to schedule inspections provided that their service failure rates do not exceed a performance target for 2 consecutive years. The performance target is calculated as the number of service failures per year per mile of track across a segment of track. The segment length is determined by the track owner or railroad, and according to the rule, "is used to determine the milepost limits for the individual rail inspection frequency."

Given the variability in rail crack growth rates and critical crack sizes observed in industry due to a variety of factors, the performance-based risk management approach may be a reasonable alternative method that incorporates key aspects of damage tolerance principles to mitigate failure risk. Rail industry has adopted complex algorithms and methods to predict rail failure risk, and then actions are implemented to mitigate the risk of failure. However, methods used to assess the performance of this form of risk management is a critical aspect to determine if the performance-based approach sufficiently accounts for the many factors that can influence rail failure in a way that is consistent with key damage-tolerance principles.

The NTSB believes that in order to be consistent with damage-tolerance principles, the algorithms and methods used by the track owners should identify areas of high stress, and the program should include actions to reduce risk of failure in these areas through timely inspections, repair, or replacement of the track. Areas of high stress could include areas with worn rail, poor track support, rail with high accumulated tonnage, or rail with high residual stresses, which are features identified in NTSB Safety Recommendation R-08-10.

The key to understanding whether the performance-based approach is accomplishing the objective is through a performance assessment. The NTSB believes that the performance assessment should include an assessment of whether areas of high stress are being identified and risk of failure is being mitigated by the track owners in a timely manner. Because of the variability of track conditions and service conditions, an assessment that is conducted across a wide area may not be sufficiently focused to identify the areas of high stress. The track owners analyze the track at varying length scales to identify track in need of maintenance, and those length scales are not necessarily the same lengths used to schedule inspections. If the FRA assessment of track owner performance is only based on segment lengths used to determine inspection frequency, then track owner performance toward a critical aspect of the damage-tolerance principle of identifying and promptly addressing areas of high stress, such as local areas of worn rail, may not be adequately assessed.

The FRA recently issued Safety Advisory 2012-04 as a result of the Columbus, Ohio[29] derailment to remind track owners, railroads, and their track inspectors of the importance of complying with the applicable rail management programs and engineering procedures that address rail with severe rail head wear and rolling contact fatigue (RCF) conditions. Safety Advisory 2012-04 included recommendations to track owners to ensure that their employees and other entities performing track inspections comply with the requirements of the applicable engineering procedures that address critical rail head wear, particularly if the track under inspection exhibits significant RCF or a sudden increase in localized rail failure. In the accident investigation that prompted Safety Advisory 2012-04, the FRA noted five rail failures had occurred on various portions of the track subsequent to the last nondestructive rail inspection at this location.

The FRA also stated that this accelerated defect development was possibly influenced by the significant rail head wear, and could be attributed to the presence of the RCF. The NTSB has cited worn rail conditions in other accidents including; Superior, Wisconsin[30] and New Brighton, Pennsylvania. Besides what the FRA indicated about worn rail in the Safety Advisory 2012-04 for Columbus, Ohio; the NTSB is investigating the circumstances involved in the Ellicott City, Maryland[31] derailment. Many track owners are using an adaptive-scheduling approach to schedule internal rail inspections, yet accidents continue to occur in areas where rail shows substantial wear in areas that have shown previous service failures.

[29] The accident occurred on July 11, 2012, and is under investigation by the NTSB.
[30] *Derailment of Burlington Northern Freight Train No. 01-142-30 and Release of Hazardous Materials, June 30, 1992*, Hazardous Materials Accident Report NTSB/HZM-94-01(Washington, D.C.: National Transportation Safety Board, 1994)
[31] This accident occurred on August 20, 2012, and is under investigation by the NTSB.

The NTSB believes the FRA should be looking at rail service failure history in a way that can assess the effectiveness of the track owner's approach to identifying areas of weakness and the timeliness and effectiveness of the mitigating actions. Rail service failure history can be an indicator of an area of high stress that is at higher risk of future failure. The FRA suggests in the preamble of the proposed rule that the FRA can assess this performance in this way by looking at rail failure records and comparing milepost locations. However, there is no reporting requirement for presenting this data in the proposed regulation, and there is no systematic approach to how the FRA would use this data to ensure acceptable performance.

The track owners have databases that record rail service failures. An expectation that this information is available to the track owners is implied in §213.237(d)(1) of the proposed rule where it is stated "If the performance target rate is not met for two consecutive years, then for the area where the greatest number of service failures is occurring," perform one of two actions. The NTSB believes that the track owners should be required to regularly report rail service failure information to the FRA which should minimally include failure location (milepost) and time of discovery. The NTSB also believes that the FRA should review service failure data on a regular basis across entire segments to assess overall performance of the track owner as proposed in this rule, but also in shorter lengths of track to assess track owner performance in timely identification and remediation of areas that are at higher risk of future failure.

The NTSB believes that there are problems with relating the segment length to the "milepost limits for the individual rail inspection frequency" in §213.237(b) of the proposed rule. Track owners may need to adjust inspection frequency on portions of a segment, and the areas that require adjustment could vary from year to year. As written, the rule limits the flexibility to conduct additional inspections on portions of a segment, since that would change the inspection frequency for that portion of the segment. The track owner would have to inspect the entire segment at that same frequency or file with the FRA to establish new smaller segments with different inspection frequencies. In either case, this could provide a negative incentive to conduct targeted inspections of problematic areas.

The NTSB believes that there is a problem with the following proposed remedial action.

If a track owner does not meet their performance target for two consecutive years, the track owner must do one of two actions:

(i) The inspection tonnage interval between tests must be reduced to 10 mgt; or

(ii) The class of track must be reduced to Class 2 until the target service failure rate is achieved.

The NTSB believes that there may be cases where the performance target is not achieved, and the track owner may be inspecting at or near a 10 mgt tonnage interval. In order to account for all potential cases, the tonnage between inspections for the penalty in (i) should be a fraction (such as half) of the average of the last two years or 10 mgt, whichever is less.

§213.237(c) (2), Inspection of Rail

As a result of the NTSB's investigation of the Nodaway, Iowa[32] accident, the NTSB issued recommendation (R-02-5) to the FRA: "Require railroads to conduct ultrasonic or other appropriate inspections to ensure that rail used to replace defective segments of existing rail is free from internal defects." The NTSB determined that the probable cause of the derailment of Amtrak train No. 5-17 was the failure of the rail beneath the train, due to undetected internal defects. Contributing to the accident was the Burlington Northern and Santa Fe Railway's lack of a comprehensive method for ensuring that replacement rail was free from internal defects.

This section of the proposed rule is inconsistent with industry good practice as described in the FRA's Safety Advisory (SA) 2006-02 issued on March 8, 2006 with their recommended industry guidelines for "plug rail"[33]. The SA recommended that the entire length of any rail that is removed from track and stored for reuse should be retested for internal flaws. The FRA also recognized that some railroads do not have the equipment to test second-hand rail in accordance with the recommendation, and railroads were encouraged to develop a classification program intended to decrease the likelihood that a railroad will install second-hand rail containing defects back into active track. In addition,

[32] *Derailment of Amtrak Train No. 5-17 on Burlington Northern and Santa Fe Railway Track, March 17, 2001,* Railroad Accident Brief NTSB/RAB-02-01 (Washington, D.C.: National Transportation Safety Board, 2002)
[33] FRA proposes a definition for "plug rail" to mean a length of rail that has been removed from one track location and stored for future use as a replacement rail at another location.

the FRA recommended that a highly visible permanent marking system be developed and used to mark defective rails that railroads removed from track after identifying internal defects in those rails.

Instead of incorporating the SA recommended practice into the NPRM for rulemaking, the FRA has proposed the following:

(2) The track owner must be able to verify that the plug rail has not accumulated more than a total of 30 mgt in previous and new locations since its last internal rail flaw test, before the next test on the rail required by this section is performed.

The NTSB has consistently said during the RSAC meetings that this is too high. During the RSAC process, railroads had proposed the 10 mgt threshold. The railroads have said that it is impractical to remove the rail from service before any traffic has traveled on it after an in-track inspection, and they need the 10 mgt for scheduling purposes. They have also said that in-track inspections are much more effective at detecting internal rail defects than using a portable device for inspections of the removed rail; although no data has been presented to support this position. The NTSB had proposed a threshold of 10 percent of the inspection interval. That would be a maximum of 3 mgt at an inspection interval of 30 mgt.

In light of the New Brighton investigation, it has become clear that as rail wear increases; cracks will grow faster and will cause rail fractures at smaller crack sizes, regardless of rail profile. Plug rail, by its very nature of being second hand rail, has some degree of wear so it can be placed into the track so there is a smooth matching rail head transition between the other two rail ends. Appropriate rail grinding can reduce residual stresses and decrease stress concentrations by maintaining an appropriate rail head profile, but quantifying that effect is difficult. In addition, used rail history is not always known, including the accumulated amount of fatigue and tonnage. Volpe crack growth models have shown that in some cases, cracks can grow from undetectable to failure in less than 10 mgt, which is one of the reasons we do not consider the 30 mgt threshold to be appropriate for all conditions.

The NTSB believes that this NPRM which allows an accumulation of 30 mgt is unacceptable and not in line with (R-02-5). In addition, the NTSB did not agree with the FRA's second part of the SA that recognized that some railroads do not have the equipment to test second-hand rail in accordance with the recommendation. No matter what railroad own the track, a rail defect can grow appreciably in 30 mgt or even sustain a rail service failure before it is tested in accordance with this NPRM. Therefore, the NTSB believes that recommendation (R-02-5) needs to be incorporated in this NPRM in its entirety.

CSXT Rail Testing Policy

CSXT Transportation performs a continuous test for internal defects in accordance with Code of Regulations Title 49, Track Safety Standards Part 213.237.

Frequency of test is determined using a risk-based model that is run by an outside entity. The model relies upon previous 12 month rail service failures, detected fatigue defects, and tonnage. Based upon the results of this model, and CSXT standard test periodicity, test frequencies are then determined. The test frequency for the OML subdivision was determined to be 31 days based on this analysis.

The CSXT tests the area where the derailment occurred about every 31 days. The FRA TSS Part 213 Subpart F 213.237 does not require railroads to perform a continuous search for internal rail defects in Class 2 track, regardless of the annual tonnage or commodities hauled. The section of track where the derailment occurred is designated as Class 2 with 32--34 mgt freight per year and CSXT does not operate any passenger trains on this section of track. Using last year freight tonnage rate, approximately 2.5 to 3 mgt would have traveled over the derailment area since the last rail flaw test was performed on August 3, 2012