NATIONAL TRANSPORTATION SAFETY BOARD

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

TRACK & ENGINEERING GROUP CHAIRMAN PRELIMINARY FACTUAL REPORT

DCA-14-FR-008

CSX Transportation Crude Oil Train Derailment with Hazardous Materials Release

Derailment of CSX Train No. K08227

In Lynchburg, VA

On April 30, 2014

Preliminary Factual Report Prepared by:
R. A. Hipskind,
Track and Engineering Group Chairman

Date: October 24, 2014

Accident:

NTSB Accident Number:	DCA 14 FR 008
Date of Accident:	April 30, 2014
Time of Accident:	1:54 p.m. (EDT)
Type of Train and No:	Train K08227
Railroad Owner:	CSX Transportation (CSX)
Train Operator:	CSX
Crew Members:	1 Engineer, 1 Conductor
Location of Accident:	Lynchburg, Virginia
Injuries:	2 non-fatal (breathing symptoms)

Synopsis:

On April 30, 2014, at about 1:54 p.m. eastern daylight time[1], an eastbound CSX Transportation (CSX) Bakken crude oil unit train, identification number K08227, with two locomotives, one buffer car, and 104 tank cars, derailed 17 tank cars at about milepost CAB 146.45 on the James River Subdivision in Lynchburg, VA. One of three tank cars that ended up partially submerged in the James River was breached spilling crude oil that caught fire and also released into the river. There were no injuries resulting from the derailment and fire.

Figure 1. This is a view looking east at tank car on fire in the James River.

1 All times in this report are eastern daylight time.

There was a local evacuation of about 6 city blocks in the area of the derailment effecting about 350 residents and about 20 businesses to the south of the derailment along the river front. The fire was extinguished at about 4:00 p.m. and the evacuation was lifted about 6 p.m. The train was travelling at 24 mph. The maximum speed through the derailment area is 25 mph.

Initial damage estimates provided by CSX are about $1,000,000, which includes environmental remediation. The weather at the time of the incident was cloudy skies with light rain and a temperature of 53°F.

Parties to the investigation include: Federal Railroad Administration, CSX Transportation, Brotherhood of Locomotive Engineers and Trainmen, United Transportation Union/SMART, and the Brotherhood of Maintenance of Way Employes Division[2].

Circumstances Prior to the Accident:

Train KO8827:

On Tuesday April 30, 2014, a CSX train crew, consisting of an engineer and a conductor, reported for duty at Clifton Forge, Virginia at 9:15 a.m. After the crew took charge of train KO8227, they departed Clifton Forge en route eastbound towards Richmond, Virginia with the final destination at Yorktown, Virginia. The train consisted of two locomotives, BNSF 7485 (lead) and BNSF 7658 (trailing) with 105 cars consisting of one buffer car and 104 loads of crude oil. The train was 6,426 feet long with 14,107 trailing tons.

The authorized speed for the James River Subdivision is 35 mph. There were no slow orders in effect for the Lynchburg area; however, at milepost (MP) 146.9 to MP 146.3, the timetable[3] lists the authorized speed of 25 mph for both main tracks. As the crew was operating on main track 2 at about 24 mph south (timetable east) of Washington Street (MP 146.07 DOT # 224557U), the train engineer described in his interview that the train went into emergency. As the crew looked back to the north (timetable west) they said they observed “a very large amount” of smoke on the north side of their train about 30 cars back, whereupon they announced “emergency” on the dispatcher’s radio channel and notified the Lynchburg yardmaster of the situation via radio, as well. Shortly thereafter, the two member train crew departed the locomotive concerned for their safety and walked to the nearest highway-rail grade crossing. At the grade crossing, a CSX Signal Maintainer who heard the emergency radio transmission; transported them to the CSX yard office approximately five tenths of a mile away.

2 ‘Employes’ is a spelling from the Old English language.
3 CSX Huntington Division East Timetable No. 31, effective Sunday, August 5, 2012 at 0001 hours CSX Standard Time Rules Conversion 1/1/2014.

Accident Narrative

Cars Derailed:

Investigators documented that the 35th through the 51st cars derailed—all loaded tank cars of crude oil. The investigation found that the 34th car from the head end was not derailed, but it exhibited a wheel flange strike mark on the L1 wheel (the trailing axel of the rear truck) and a wheel tread witness mark on the L2 wheel (the lead axel of the rear truck). The 35th car was derailed and it exhibited gusset burn marks on the underside of the side frame on the rear truck. The 36th car was derailed and it exhibited deeper gusset burn marks on the lead truck's underside of the side frame. The 38th through 51st cars were derailed, some rolled over on their side, three over the bank and partially submerged in the James River and some were found upright and in line.

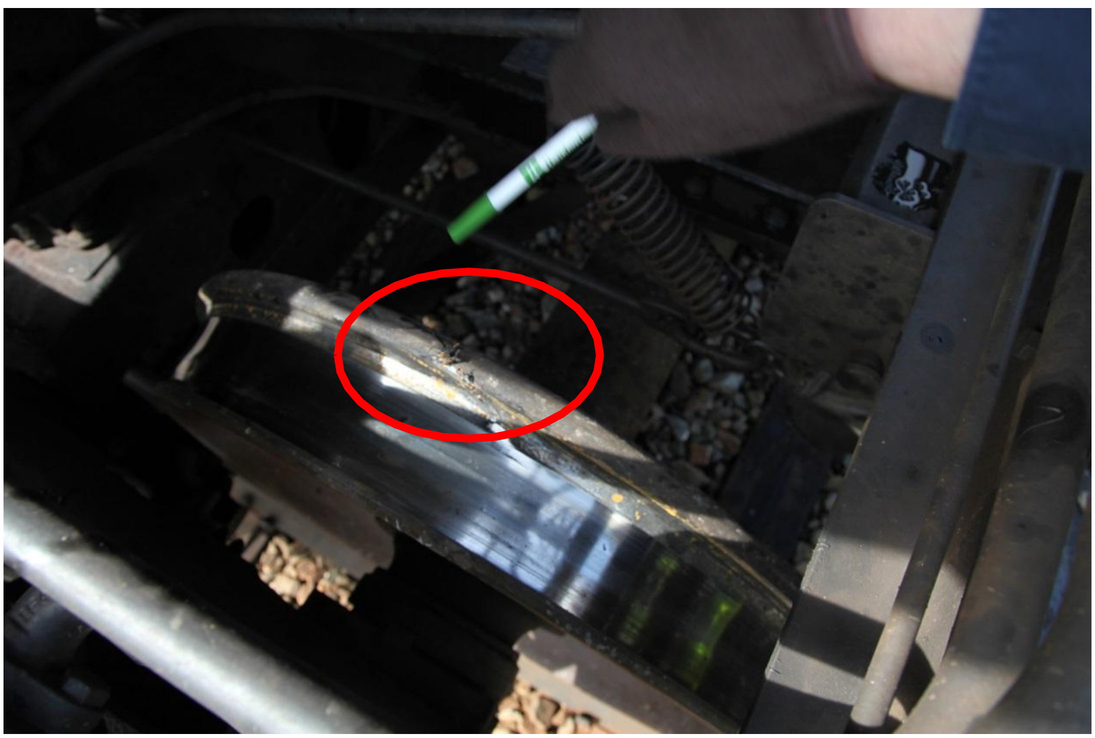


Figure 2. A close-up view of the wheel flange strike mark observed on the 34th car's rear truck, rear axle, the L1 wheel.

Track Description:

The train travel was moving in a descending milepost direction or eastward. According to CSX's track profile data, for the eastward movement of the accident train, beginning at milepost 147.4, the train would have been on a slight descending grade to MP 147.05 In terms of track alignment, beginning at MP 147.4, train K08227 would have first traversed a 3º 07' left curve[4] a short stretch of straight track leading into a 2º 00' right curve up to MP 147.1. Upon exiting that curve the train would have traversed about 3 tenths of a mile of straight track up to MP 146.8. At MP 146.8 the train entered a 3º 07' left curve with one inch of superelevation. Upon exiting that curve, the train traverse a short section of straight track and entered the next curve, a 6° 30' left curve with 1 ½ inches of superelevation followed by entering the accident curve, a 6° 53' right curve with 1 ½ inches of superelevation. In terms of grade, from MP 147.05 to MP 146.8, the grade is level. From MP 146.8 to MP 146.3, the grade is slightly ascending. The locomotives of the accident train came to rest at about 145.8 south of Washington Street crossing.

CSX inspects and maintains the single main track on this portion of the James River Subdivision to Federal Railroad Administration (FRA) Track Safety Standards (TSS) for Class 2 and 3 track in the vicinity of Lynchburg (milepost 146.5), which allows for a maximum operating speed of 25 mph. While the accident location was in a curve restricted to 25 mph, the authorized operating speed on either side of that curve restricted section of track was 35 mph.

Maintenance Work Prior to the Derailment:

A review of CSX track chart indicated that in the 147 to 146 mile, No. 2 main track received a program crosstie and surfacing program in 2011. During an engineering personnel interview with the local roadmaster, he said that the James River Subdivision had received an ultrasonic rail flaw detector test over the entire subdivision over the course of several days and through the accident area on April 29, 2014. The test data from the April 29th test noted a 20% transverse detail fracture in the high rail of the accident curve (MP 146.45), He indicated that he arranged for a 40 foot rail plug to be set out near that location to facilitate a rail repair he scheduled on May 1, 2014. In addition, the roadmaster indicated that a production rail gang was scheduled to install new rail in the accident curve in about three weeks.

4 This report uses the classification of "right" or "left" curve based upon the appearance of the curve layout in the direction of travel of the accident train.

Crossties, Anchors, Ballast and CRW:

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. In observing 44 consecutive crossties, investigators did not locate any defective crossties. The crossties were fastened and anchored with Pandrol elastic fasteners every tie to restrain longitudinal movement of the continuous welded rail (CWR). The double shoulder ties plates measured 16" by 7 ¾ " and were fastened to the crossties with a minimum of four spikes, hairpins or screw lags, in many instances, there were up to six fasteners to hold the tie plates. The track was supported by a mixture of granite and limestone rock ballast. The ballast section was estimated by investigators 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 track preceding the derailment footprint.

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 track 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 crosslevel, surface, and alinement.

Ballast and CRW:

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 did not take exception to the anchoring patterns or rail restraint effectiveness of the anchors in the area of the derailment. No rail movement was noted.

Point of Derailment:

Investigators identified the point-of-derailment (POD) as a point on a section of the north rail (high rail) that exhibited markings that were documented during the post-accident rail rebuild project. The markings exhibited a break in the rail head about 30 inches east from the rail end held in place within a set of joint bars. The joint bars were a remedial action taken by the railroad to repair a service rail failure found in January of 2014. Investigators observed and documented markings on the inside or gage side of the rail joint bar that was found broken. The outside rail joint bar was bent but not broken. On the low rail opposite the rail joint bar location, investigators observed several marks trailing down from the gage corner (inside portion of the rail towards the center of the track) of the rail head and marks on the base and inner edge of the base of the rail in the vicinity of the aforementioned rail break located on the north rail.

The rail break immediately east of the joint bar location exhibited slight rail end batter on the trailing fracture edge and slight rail end batter on the receiving rail fracture edge. Several rail pieces from this area of rail were tagged and marked as evidence and sent to NTSB Materials Laboratory in Washington DC.

The rolling stock derailed to the high side of the curve towards No. 1 main track. Several hundred feet of No. 1 main was destroyed. Three cars eventually went over the embankment into the James River. Investigators formed a consensus that the marked rail, the damage at the rail joint and the path of the derailed equipment indicated a POD located at milepost 146.45.

Rail Rebuild Project:

Investigators had the south and north rails cut west of the POD location at a point directly across from one another (squared off to accommodate installation of track panels). These saw cuts formed the zero foot location for measurements of the rail re-build project. Sperry[5] data and calculations for the rail re-build were measured from that rail cut location. Investigators recovered rail from a limited portion of the derailment footprint and assembled those rail pieces into a 'focused rail re-build' on May 3--4, 2014. In conjunction with car wrecking operations and recovery efforts of hazardous materials over the course of three days, the rail from the immediate area of the POD was recovered and reassembled along the south side of the right-of-way to the south of POD. During the project, investigators measured and re-measured the rail pieces, inventoried[6] and documented each piece recovered for the area of the focused rail re-build. The rails were identified with a north or south rail identification based upon the rail wear and oriented as they laid in the track in a continuous "in track" positioning.

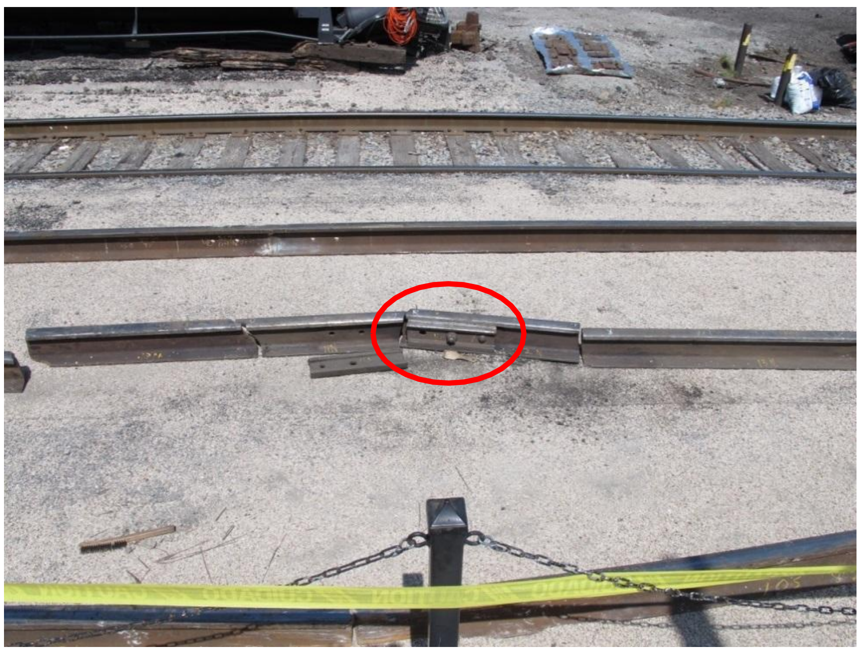


Figure 3. A view looking east at the rail service failure repair—rail joint bars and broken rail to the right of the intact one half joint bar. The defect, tested on April 29th, is located about three feet from the rail end in the rail joint.

On May 4, 2014, investigators and a NTSB metallurgist examined the rail re-build layout and fracture faces on-scene. It was determined that six rail sections would be shipped to NTSB's Materials Laboratory for further examinations, including a scheduled ultrasonic hand testing of the rail sections.

5 See Appendix A for a description of an exemplar truck used for rail flaw detection testing and a brief explanation of how ultrasonic and induction methods of testing function.

6 The full rail inventory can be reviewed in Appendix C of this report.

Figure 4. A view looking east at portions of the rail re-build project. The high rail is on the left and the low rail on the right.

The following bullets describe elements of the rail re-build effort pending additional Sperry data for confirmation:

- James River Subdivision POD at CAB 146.45 No. 2 track;
- Rail rebuild began and ended on 5/1/2014 – 5/4/2014;
- 1990 132 RE Nippon rail;
- In the focus area, investigators pieced together 353’ of rail on the low side and 222’ on the high side;
- Investigators determined there was about 1’ missing on the high side 6’ west of barred service failure;
- Investigators determined there was about 3’ missing on the low side ;approximately 25’ east of the barred service failure;
- The barred rail service failure on the high side of the curve at or near POD;

- Marked 20% transverse detail defect (a fracture coded as TDD) by Sperry SRS931 rail test car was 3' east of barred service failure. The paint and mark was not present;
- A <5% reverse TDD fracture[7] was found where we expected the 20% TDD was marked;
- A 20% defective field weld was discovered in the weld 8'10" from the barred service failure.

Damages Estimates:

CSX engineering personnel estimated total track and structural damages at $150,000.00. This figure includes costs for the installation of 44 track panels, associated ballast, track materials, and renewal of the CRW. This figure does not include additional costs associated with wrecking of the equipment or environmental remediation.

There were no underground utilities damaged in the immediate area of the derailment.

CSX estimated the initial total damages for the accident at $1,000,000, which includes costs for the track structure mentioned above and all other derailment related costs typically compiled for FRA reporting purposes but not those associated with environmental remediation.

Post-accident Inspection/Measurement of Track:

On April 30, 2014, track measurements were taken by investigators at 15 locations (stations) on 15-foot 6-inch intervals beginning at about MP 146.5 (near the last portion of undisturbed track at the west end of the derailment footprint) and extending westward (westward from Lynchburg) for about 232 feet.

7 A reverse TDD is a transverse detail defect and is defined as such by its location on the rail head profile—they are located on the bottom of the gauge face side of the rail head.

Figure 5. A view looking east at the last car derailed in the background while investigators are taking measurements of the track geometry.

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 56 7/8 inches; or 7/8 of an inch under the FRA maximum allowable.

- 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 ½ of an inch on the tangent track between the two curves; or 1 ½ inches under the FRA maximum allowable limit.

- The difference in crosslevel between any two points less than 62 feet apart may not be more than 2 ¼ inches for Class 2 track. Investigators determined from the track notes measurements that the crosslevel measurements in the curve spirals did not exceed the maximum limit as defined in the FRA regulations [the increase in elevation for the spirals did not deviate from design].

The track notes measurement area is the last segment of track CSX train KO8227 traveled over prior to the April 29, 2014, 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 two visual exception at milepost 146.5 and 146.6, both fouled ballast locations, one on the east side of the Blackwater Creek bridge and on the east end of Griffin Pipe road crossing. Both conditions were repaired prior to the resumption of train traffic. There were no fouled ballast conditions in and around the point of derailment.

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. CSX has elected to maintain the track in the vicinity of the curve where the derailment occurred to FRA Class 2. Due to the tonnage operated on this line, FRA track inspection frequency standards require CSX personnel to inspect the main track at least twice per calendar week. The track on either side of the derailment area was maintained to FRA class 3 standards.

A preliminary track inspection records review for the James River Subdivision was conducted for the time period from January 2014, through to April 2014. The records show the frequency of inspections was in compliance with federal regulations. The preliminary review did disclose deviations from FRA reporting requirements.

The track in the area of the derailment was last inspected on April 28, 2014, by a FRA qualified CSX track inspector (T/I). The T/I noted no defects within milepost CAB 145 to CAB 148, an area that includes the derailment footprint.

Regulatory Track Inspection History

FRA inspection reports indicate that from January 2014 to April 2014, FRA track safety inspectors have conducted nine inspections and identified 53 defective conditions on the James River Subdivision. These conditions include; three defective frog conditions, 26 fouled ballast locations, four defective switch components, eight rail fastener defects, four bolt defects, 1 gage defect, four locations with defective crossties, one joint condition, one drainage facility obstructed, and one object between tie plate and rail base.

CSX Geometry Test Vehicle Data:

On April 3, 2014, CSX conducted a geometry car test on the Huntington Division, James River Subdivision from MP 229.44 eastward to MP 120.0. The data provided indicated that the test found one wide gauge measurement in the near vicinity of the derailment on No. 2 main track. The data recorded the footage (location of defects) in negative figures from each milepost in a descending manner. Below is the one track or geometry condition recorded by that test vehicle near the point of derailment:

- A wide gage condition in a curve at milepost 146.7 that measured 1.24 inches; [Note: the wide gage condition was not found by maintenance forces on April 7, 2014].

CSX Curve Analysis Data:

From the same CSX geometry test, noted above, the curve analysis data from that test showed the accident curve (MP 146.45) measured 6 degrees and 51 minutes of curvature with 1.24 inches of superelevation. The data listed the limiting speed for the curve at 30 mph.

FRA Geometry Tests

FRA operated their Automated Track Inspection Program (ATIP) geometry vehicle, DOT-218 over the James River Subdivision on November 4, 2013 (Survey No. 1405). The FRA data showed the presence of a wide gauge defect at MP 146.7. Repair forces inspected the track and verified that the wide gauge deficiency was not present.

Curve Analysis Data:

From the same test, as noted above, the FRA curve analysis data showed the accident curve measured 340 feet in length with an average curvature of 6 degrees and 28 minutes with an average superelevation of 1.19 inches. The data lists the posted operating speed at 25 and the limiting speed at 30.

Personnel Information:

CSX maintains the tracks on the James River Subdivision including the area within Lynchburg, VA utilizing the following available track forces: one Supervisor/Roadmaster, two track inspectors, one trackman, two foreman, two vehicle operators, one lubricator maintainer, one machine operators and two welders. .

Synopsis of Interviews:

Three engineering personnel were interviewed on May 2, 2014, in Lynchburg, VA.

CSX Material Truck Operator: (MTO)

The MTO said that he was hired on June 25, 1975, and has worked as trackman, foreman, and machine operator. He said he has been working on the grapple truck for the last 14 years.

The MTO was asked to describe the work he had conducted on Monday (04/28/2014) and Tuesday (04/29/2014). MTO stated that on Monday he had worked in conjunction with the local track gangs near Reusens VA. His primary function was to sort and place track material for the upcoming scheduled CSX production that was scheduled for the James River Subdivision.

The MTO said that on Tuesday (April 29th) he had returned to Reusens. During the course of the day it came to his attention that a rail defect had been identified near milepost CAB 146.5. He worked under the local section foreman's work authority (track and time) and set on the track around 1330 hours. The MTO said that he occupied the track in the Reusens siding and proceeded east toward the defect location. He traveled from the siding, to the main track, to

No.2 track. When he arrived at the previously marked Sperry defect he noted yellow paint on the north rail of No. 2 track. The MTO recalled that he looked at the area and determined that the plug that he had on his truck which was forty feet in length was long enough to remove the identified defect, two field welds and a barred rail service failure. He recalled that the entire span of rail from the east field weld to the west field weld was approximately 15 feet. He also noticed there were two field welds with a rail joint in between the two welds. MTO noticed fairly new bolts in the joint bars. He then measured the rail in the track and found the height to be 6 ¾ inches tall and the ball was 2 ¾ inches wide. The rail he placed down, the height was 7 inches tall and 3 inches wide on the ball. MTO noticed that the TD was 2-3 feet from the joint that was in the track on the east end.

When asked about the track quality in the subject location MTO said that the forty foot hi-rail truck that he operates is very prone to shifting and allows you to feel track conditions. He said that No. 2 track approaching the derailment location and beyond rode well. MTO said that he felt that he was empowered to protect track if he thought there was a concern based on his extensive railroad experience.

CSX Roadmaster: (RDM)

The RDM said he has been with CSX for 33 years and has been a supervisor for 14 years and Roadmaster for five years. The RDM stated that his territory is from Clifton Forge VA, to Gladstone VA, 110 miles. He stated that he is the supervisor of 11 men.

The RDM commented that in the curve where the derailment occurred the rail was to be relayed in about three weeks when the CSX System Production Teams would arrive. He said CSX personnel at CSX headquarters had input the curve to have new rail because of the history of defects. The Sperry rail test car ran on Friday (4/25/14), Monday (4/28/14), and Tuesday (4/29/14). On Tuesday the Sperry Car found 13 defects, which was higher than normal. He stated they have been having trouble with defects in close proximity of field welds. His section team had been repairing a 30% defect close to a field weld by changing the rail, and then worked on a 40% and 50% TDD by drilling the rail and applying joint bars. He stated he fixed the "worst first."

The RDM said that he was not on the Sperry Car on April 29th, when it was operated through the subject location. He was with his supervisor, conducting a planning trip for upcoming production. The production was to begin in three weeks, and last a total of six weeks. In the production plan were two large scale ties forces and two large scale rail forces. The work these teams were planning was in various locations across the James River. The subject curve was scheduled to receive renewal rail due to the number of defects and service failures that were occurring in the curve. RDM was unable to say with certainty the number of defects, but said there were a lot of defects.

Investigators became aware that a rail joint was likely present in the accident curve and asked the RDM if he knew anything about when a repair might have been made. The RDM did not remember when the rail service failure occurred, and when the joint bars had been applied. The RDM did not hi-rail through the accident location the day before the accident; the required track inspection was performed by the track inspector.

When asked who was in charge of the decision for remedial action when a defect was found, he stated he was 100% in charge. He said he had selected a trackman to pilot the test car because he had to be in another location but would call him (the RDM) when a defect was found. The trackman would let the RDM know what the defect was and the RDM would tell him what remedial action to take. If a defect was 20% [of the cross-section of the rail head] CSX standards are that you have five days to change the rail or drill and bar the rail. In the location of the derailment the speed is 25MPH. The plans for correcting the defect at milepost 146.45 were to send maintenance personnel to the location and replace the rail on Thursday May 1, 2014. Since the operating speed for that area was 25 mph the rail defect did not need a speed restriction to be placed for that location. When asked how long did it usually take for the test car to test all the track, RDM said about 3-5 days. When asked how frequently the test car operates over the subdivision, he answered, it tests every 30 days. Traffic on the No. 2 track is predominately eastward direction. The RDM estimated the annual gross million tonnage at 55-60 million for the area of his responsibility.

CSX Engineer of Track—Rail Services, CSX System (ETRS)

The ETRS said that he hired on the old Conrail System in January 1993 and has been a manager for 21 years in track testing. . His current duties are to schedule 22 test cars and track the progress and data from their operation. His also has the responsibility to determine when and where the trucks are to test, and the frequency in which the rail is tested.

He indicated that on February 25, 2014, FRA implemented a new regulation on how internal rail flaw detection is required to test for Class 3 and above. The regulation requires testing at 30 mgt minimum. CSX has established their own criteria that targets service rail failure rate that are more restrictive than the language in FRA's regulation with respect to target rail defect rates. Investigators have requested and received tonnage figures for the James River Subdivision for the past five years.

The ETRS stated that CSX uses a vendor who applies a predictive model or automated system to help determine when and where and how often to test the rail. CSX uses HARSCO (former Zeta Tech) to determine the frequency using tonnage, passenger service, hazmat, and speed as some of the factors in the modeling. He said that testing is done on 31, 62, 92, 123, 183, 365 day intervals. The James River Subdivision main and No.2 tracks are on a 31 day test cycle and every 123 days on No. 1 main track. CSX establishes a target rate (more stringent than FRA) and frequencies are increased if the rates are not being met. CSX has been applying this predictive modeling for the past ten years. The plan tailors frequency to each route (subdivision) to put testing resources where there are potentially greater risks.

The ETRS stated that the approach the Roadmaster was taking to manage the high number of defects was proper. CSX has a written policy that the Roadmaster or his designee will accompany the rail test cars. The ETRS recently did a review of data that showed on the Huntington Division in 2013 the ratio was 55% managers and 45% labor.

In discussing Sperry qualifications, the ETRS stated that the operator who conducted Tuesday's test was very qualified; this operator had conducted the last three test of the James River. He further stated that determining the size of an internal defect is an estimate. The percentage assigned to the defect is based on the compromised section of the existing rail head. He stated that a rail service failure behind a previously marked Sperry defect was very rare.

The ETRS had an opportunity to make a limited review of the B-Scan data [Sperry screen shot]. During this review he was able to determine that the identified defect existed three feet from the barred service failure on the north rail (high rail) in the curve. ETRS stated that the rail pedigree in the curve was 1990, Nippon, 132 lb. rail.

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 James River Subdivision, CSX was required to test the rail twice a year. However, the records and data provided by CSX documents that they were tested 15 times[8] from January of 2013 to April 29, 2014.

CSX Rail Test Policy:

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

CSX Rail Test Policy:

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

8 The specific tests dates are as follows: 1/25/13; 2/1/13; 3/19/13; 5/8/13; 7/2/13; 8/1/13; 8/30/13; 9/24/13; 10/30/13; 11/22/13; 12/12/13; 1/21/14; 2/24/14; 3/31/14 and 4/29/14.

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 a risk-based model, and CSX's standard test periodicity, test frequencies are then determined. The test frequency for the James River Subdivision was determined to be 31 days based on the above modeling and analysis.

NTSB requested rail service failure data from 2009--2014 up to April 30th for the Huntington (C&O) Division; rail service failure data for the same time period for the James River Subdivision; a breakdown of types of rail defects and the annual million gross tons (MGT or tonnage figures) for 2009—2013 for the James River Subdivision. The following are the three graphs and MGT chart data provided to NTSB.

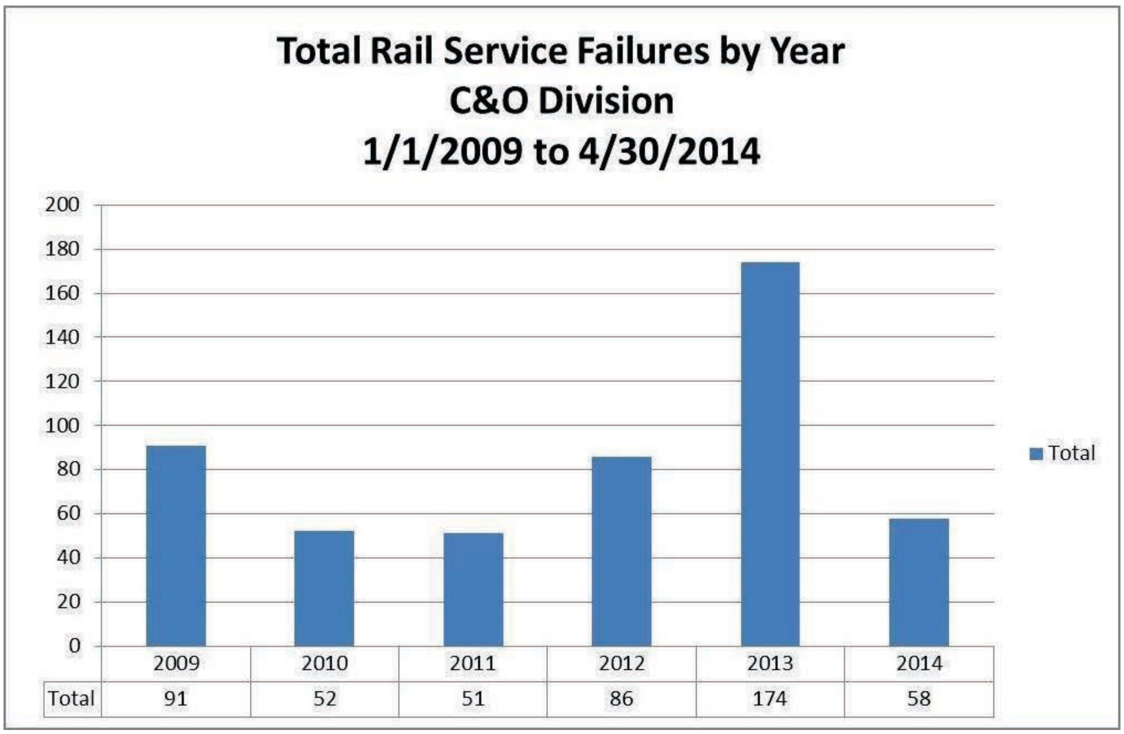


Figure 6. Rail service failure data by year for CSX's C&O Division—1/1/09 to 4/30/14.

Figure 7. Rail service failure data by the year from 2009 to April 30, 2014.

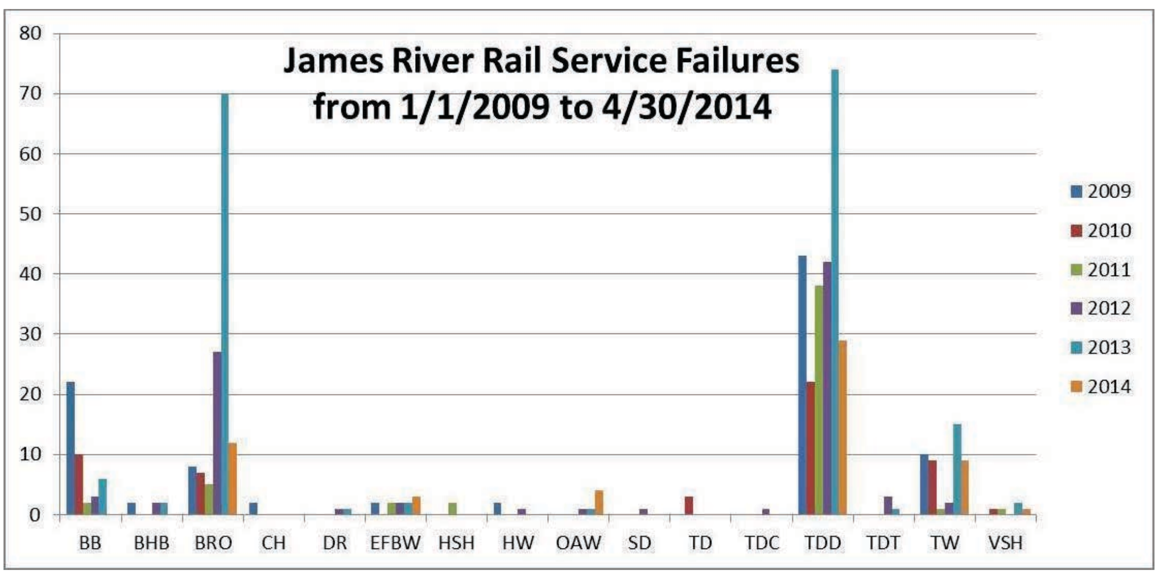


Figure 8. James River Subdivision rail service failure data from 2009 to April 30, 2014. The TDD coding represents the number of transverse detail fractures.

The GMT for the James River Subdivision increased for main track 2 from 35.05 MGT in 2009 to a peak of 44.79 MGT in 2012. In 2013 the MGT decreased to 41.86. The year-to-date tonnage for 2014 was 9.34.

Tonnages for James River Sub by year.

Year	SG MGT	Trk 1 MGT	Trk 2 MGT
2009	81.37	46.32	35.05
2010	85.15	57.96	27.19
2011	95.66	59.44	36.22
2012	97.06	52.27	44.79
2013	74.27	32.41	41.86
2014 YTD	19.10	9.75	9.34

Figure 9. Tonnage table for James River Subdivision

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; however, the authorized timetable speed for the track either side of the speed restricted curve area is 30—35 mph or Class 3. CSX does not operate any passenger trains on this section of track.

CSX MWI No. 2502, Rail Wear Limits:

CSX instructs their employees through their maintenance standard about the limits of rail wear whereby one determines rail replacement options. In CSX's Maintenance of Way Instruction (MWI) 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 132 pound rail, the standard denotes that the design rail height is 7 1/8 inches and a maximum top wear measurement of 7/16 of an inch and a minimum rail height of 6 11/16 inches. For 132 pound rail, the design rail head width is 3 inches and the table lists the maximum side wear at 5/8 of an inch and a minimum rail head width of 2 3/8 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.

Post Accident Rail Examinations:

Investigators sent evidence rail pieces to NTSB to determine exact measurements of the rail head and side wear, as well to characterize the size and type of rail defects. NTSB conducted its formal examination of the rails at the POD on September 10th and 11th, 2014 in Washington, DC in NTSB's Materials Laboratory. Rail pieces were measured and photographed. NTSB measured 0.42 of an inch vertical wear and 0.28 of an inch side wear. During the rail examination, a CSX representative provided NTSB with rail measurements: 7/16 of an inch vertical wear and 5/16 of an inch side wear.

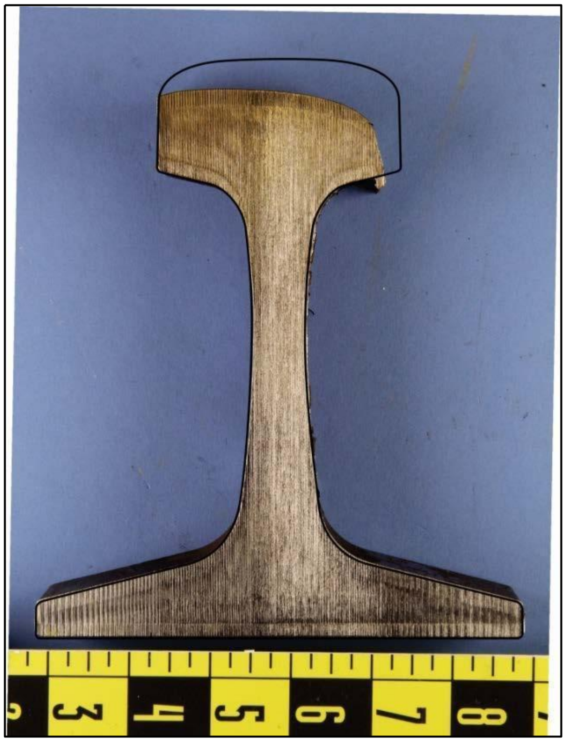


Figure 10. Photo of cross section of rail near 12N.
Outline shows loss (wear) of rail hear.

Figure 11. Reverse detail fracture at east end of piece 12N.

On June 26, 2014, investigators met with Sperry representatives to discuss the previous test data beginning in December 0f 2013 through to the last rail flaw detection test prior to the accident. Below is a screen view (shot of screen as captured electronically from test data) of what the test operator saw on April 29, 2014 at MP 146.46, where the rail joint was located on the high rail of the curve. The red circle identifies the location of the rail joint; the green circle the location of the field weld. [Additional screen shot images, those from December 2013 to March 2014 can be seen in Appendix B]

Figure 12. Screen image of the rail test data for MP 146.45.

From the April 29th test, the above image is 10 foot track section screen shot including the rail joint area at MP 146.45. The screen shot data notes a marked defect No. 151, the GPS data for a barred service failure, and the multiple channels responses for two separate defects: 1) about three feet east of joint bar (in the image to the right of the joint bar) and 2) a second defect at a field weld about eight feet east (to the right) of the joint bar location.

FRA Rail Defect Remedial Actions Regulations:

FRA does not require Class 2 tracks to be tested for internal rail flaws. FRA does require the following for Class 3 tracks in Code of Federal Regulations (CFR) Part 213. Inspection of Rail, paragraph 237 (a), which states in part:

> 237(a) In addition to the track inspections required by §213.233, a continuous search for internal defects shall be made..... 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. ** [Effective January 1, 1999.]

FRA requires owners of railroads to provide for remedial actions based upon the type and size of rail defect in question. For a detail fracture rail defect identified in Class 2 track that is between 5—25% of the rail head cross-sectional area weakened by the defect, the remedial action table prescribes action "C", if the defective rail is not replaced. FRA's remedial action C is found in CFR Part 213.113, Defective Rails, and states, in part, the following:

> Remedial Action C. Apply joint bars bolted only through the outermost holes to defect within 20 days after it is determined to continue the track in use.

As noted in the interview section of this report, maintenance personnel stated they were aware of the rail defect location, size and type—a 20% TDD at MP 146.45. However, according to FRA regulation, the rail did not need a slow order (speed restriction for trains) nor was it a requirement to replace the rail immediately or place joint bars on the defect before 20 days. A forty foot rail was placed for repairs to eliminate the existing rail joint, the rail defect and other field welds in the immediate area of repair.

Post Accident Actions:

CSX provided investigators with a revised Maintenance of Way Instructions (MWI) that modified CSX's instructions for remedial actions for defective rails. Specifically, the modification issued on July 1, 2014, instructs that a detail fracture must have a ten mile an hour speed restriction placed at those locations until rail joint bars are applied to the defect location.

###

Parties to the Investigation - Acknowledgment Signatures

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

____

__________//s//_______________________ Date___10/31/14______
Richard A. Hipskind, NTSB

__________//s//_______________________ Date___10/31/14______
Robert J. Gordon, FRA

__________//s//_______________________ Date___10/31/14______
Jimmy Grupposo, CSX

__________//s//_______________________ Date___11/07/14______
Brad Spencer, CSX

__________//s//_______________________ Date___11/1/14_______
Russell Farmer, BMWED

Appendix A

Ultrasonic Rail Test Equipment:

Ultrasonics is briefly described as sound waves, or vibrations, that are propagating at a frequency that is above the range of human hearing, normally above a range of 20,000 Hz, or cycles per second. The range normally utilized during current flaw detection operations is 2.25 MHz (million cycles per second) to 5.0 MHz.

The ultrasonic test method of rail testing is described briefly as follows:

1) Ultrasound is generated onto the rail at various angles by piezo-electric transducers that are manufactured from ceramic materials. The transducers are contained in a wheel assembly, or sled device, which rides on top of the rail head. The ultrasound is produced by applying a voltage to the transducer, itself.

2) The wheel/sled containing the transducers is commonly referred to as the search unit.

3) The transducers are positioned at several different angles. The ultrasound produced by these transducers normally covers the rail from the top of the rail head through the web to bottom of rail and the entire width of the rail head. The base portion off center of the rail is currently not covered by current test systems.

4) Ultrasound is generated into the rail at all angles associated with the system at test speeds up to 100 km/h.

5) If a condition is encountered of sufficient size and orientation that would offer a reflector to the ultrasound that is transferred into the rail, the ultrasound is then reflected back to the respective transducer. These conditions would include rail head surface conditions, internal or visible rail flaws, weld upset/finish, or known reflectors within the rail geometry such as drillings or rail ends.

6) The information reflected back to the transducer is then processed by the test system and is recorded in the permanent test data on the coinciding display for that ultrasonic channel.

A view of an exemplar rail test vehicle used on CSX.

In effect the ultrasound produced from the transducer travels through the rail specimen from the top of rail head. If the sound path is uninterrupted no reflected signal is returned to the transducer. If a condition exists such as a rail head surface irregularity, rail geometry reflector (Bolt Hole Drilling, Weld Upset/Finish, Rail End, etc.) or internal rail flaw, the ultrasound produced will reflect back to the transducer and an equipment response is presented to the operator for interpretation. The information processed by the test system is maintained on a permanent record of test. Test systems that are utilized by heavy haul lines normally use a minimum of 24 ultrasonic test channels, 12 on each rail. However, recently systems that can accommodate more than 24 channels and additional wheel/sled angled test probes have been developed.

Induction:

The induction testing technique requires the injection, or transfer, of a direct current into the rail. The current is generally around 3600A however, it can vary by rail weight and test speed. The injection of the current takes place through the application of two sets of brushes that are placed on the rail head. The spacing between the brush sets is approximately four feet. The current flows into the rail through the leading brush set and out through the trailing brush set. The rail thus becomes part of an electrical circuit. Once motion is introduced, a magnetic field associated with the current flow in the rail is induced. The magnetic field is the means by which information about the condition of the rail is transferred to the sensor unit. The sensor unit is located between the two sets of brushes. The sensor unit is set up to maintain a constant pre-set distance between the underside of the unit and the surface of the rail head. If this clearance is not maintained through the test continuity, excessive data can be recorded and data interpretation will be very difficult.

The mechanism by which rail condition is determined starts with the current. In general for modern rail weights, only the head and the top part of the web is “saturated” with current. In the past with smaller rail sections, the whole rail section has been saturated with current. As the current flows through the rail, if any features such as a defect block the current path, the current will take the shortest possible route to get around the obstruction. This distortion of the current flow will also lead to a distortion of the associated magnetic field. It is this distortion of the magnetic field that is detected by the sensor or search unit.

The search unit houses multiple coils or Hall Effect devices. The arrangement is differential in nature to help keep the number of false indications down. By differential we mean that there are two identical sensors located next to each other across the rail head that are wired together. The result of doing this is that when one sensor sees a disturbance and the other doesn’t, a signal will be sent to the test system. For example, a rail end is essentially a gross transverse defect. Both sensors will see the rail end and no signal will be sent to the test system. A transverse defect will generally only be seen by one sensor, so the asymmetrical disturbance will send a signal to the test system. Multiple sensors, arranged in various planes in relation to the rail head, are used to allow the detection of all the components of the magnetic field disturbances.

Taking into consideration that the current flow through the rail is longitudinal, current distortion will not occur as a result of the longitudinal features in the rail. The features that will produce the most current disturbance are those that are transverse in the rail head. Unlike the ultrasonic technique, the induction technique does not have trouble with inspecting right to the top surface of the rail head. The nature of the current flow is such that detection at the very center of the rail head is likely to be jeopardized if the system is unable to fill the rail head with energy.

The signals sent to the system are generally observed and measured to determine if they exceed a set threshold. If they do, a count is started. The number of counts that exceed the predetermined threshold determines whether the data is presented to the operator for interpretation as a potential defect or not. The data can be presented in many different formats. Most often it is a combination of processed (Counted/Digital) data and raw analog data side by side. The processed data is the mechanism that indicates the problem area and is kept as the record of test. Then the more defined features of the indication can be interpreted utilizing the analog waveform.

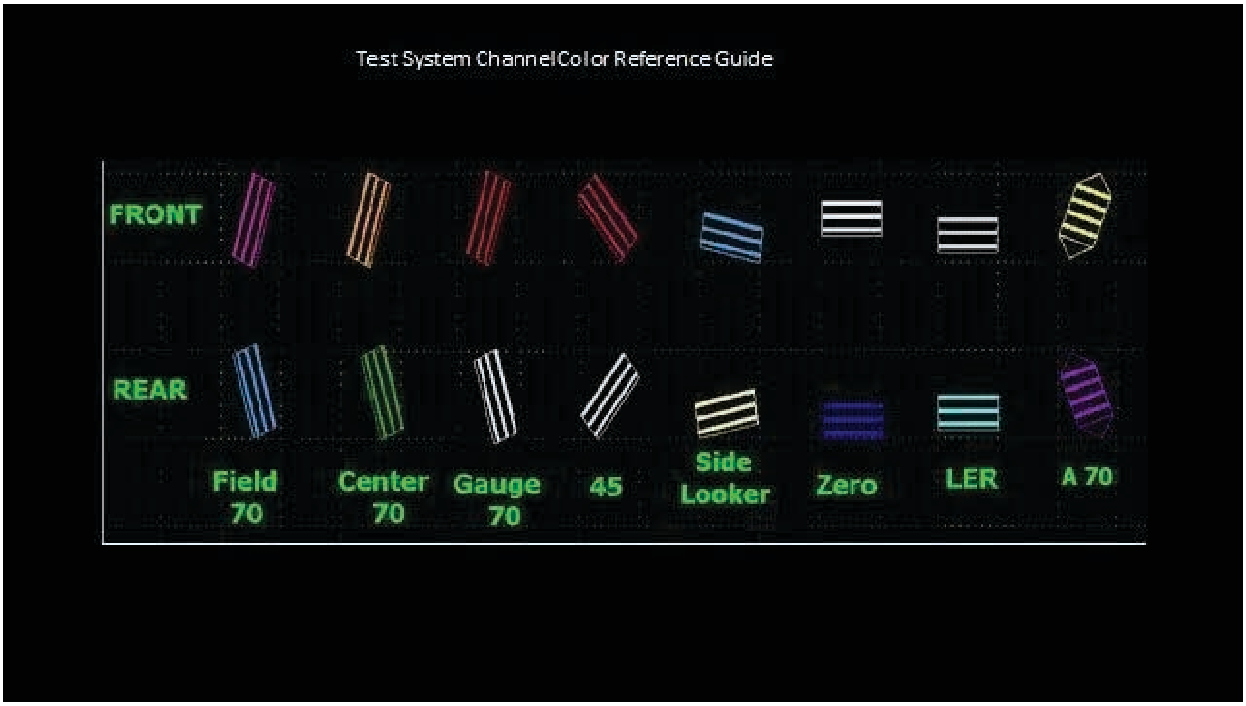
Appendix B

December rail test—10 foot screen shot, no presence of a rail joint bar at MP 146.45.

January rail test—10 foot screen shot, shows presence of a rail joint bar at MP 146.45. CSX maintenance personnel described a service rail failure that was repaired in early January of 2014.

February rail test—10 foot screen shot, rail joint bar at MP 146.46, no rail defects.

March rail test---10 foot screen shot, rail joint bar location at MP 146.45. No rail defects.



Test system channel color reference guide.

Appendix C

The following list is the rail re-build inventory by numbered pieces and measurements of each piece.

High Side Rail Inventory:

3N – 34'9"	4N – Base 3'10"	5N – Head 1' 11"	6N – 14'17"
7N – 23'2"	8N – 4'9"	10N – 42 ½"	11N – 31 ½"
12N – 34 3/8"	13N – 75 ¾"	14N– 194½"	15N – 39 5/8"
16N – 144 ¾"	17N – 188 ¾"	18N – 71 1/8"	19N – 131 ¼"
20N – 59 5/8"	21N – 298 ½"	22N – 37'5"	

Low Side Rail Inventory:

0S – 53'10"
1S – 39'6"
2S – 8'5"
3S – 3'7"
4S – 26'2"
5S – 14'7"
6S – 8'4"
7S – 9'3"
8S – 7'1"
9S – 7'3"
10S – 8'2"
11S – 19'10"
12S – 15'11"
13S – 11'2"
14SA – 1'
14S – 4'
15S – 7'9"
16S – 44'8"
17S – 5'4"
18S – 16'3"
19S – 42'4"