Federal Railroad Administration
Office of Railroad Safety
Accident and Analysis Branch

Accident Investigation Report
HQ-2018-1293

Norfolk Southern Railway Company (NS) Derailment
Pittsburgh, Pennsylvania
August 5, 2018

Note that 49 U.S.C. §20903 provides that no part of an accident or incident report, including this one, made by the Secretary of Transportation/Federal Railroad Administration under 49 U.S.C. §20902 may be used in a civil action for damages resulting from a matter mentioned in the report.

SYNOPSIS

On August 5, 2018, at 1:02 p.m., EDT, a Norfolk Southern Railway Company (NS) intermodal train 21QC105 (Train 1) derailed seven double-stack articulated intermodal cars with three wells each. Train 1 was traveling northbound in Pittsburgh, Pennsylvania, on the NS Pittsburgh Division, Mon Line on Main Track 1 at 18 mph, on clear signal indication with the lead locomotive approaching Milepost (MP) ML 5.6 when the derailment occurred.

There was no fire or injuries due to the derailment; however, there was significant damage to the Port Authority light rail system servicing Pittsburgh, including nearly a three-week service disruption and $1,800,000 in damage to infrastructure.

Estimated railroad damages were $314,952 to track and signal, and $773,275 to equipment.

At the time of the derailment, it was daylight with scattered clouds, 7 mph winds, and 80º F.

The Federal Railroad Administration (FRA) determined probable cause of the derailment was T207 – Broken rail – Detail fracture for shelling or head check.

Additionally, FRA determined a contributing factor in the accident of H993 – Human factor – track.

U.S. Department of Transportation
Federal Railroad Administration

FRA FACTUAL RAILROAD ACCIDENT REPORT

FRA File #HQ-2018-1293

TRAIN SUMMARY

1. Name of Railroad Operating Train #1	1a. Alphabetic Code	1b. Railroad Accident/Incident No.
Norfolk Southern Railway Company	NS	130464

GENERAL INFORMATION

1. Name of Railroad or Other Entity Responsible for Track Maintenance	1a. Alphabetic Code	1b. Railroad Accident/Incident No.
Norfolk Southern Railway Company	NS	130464

2. U.S. DOT Grade Crossing Identification Number	3. Date of Accident/Incident	4. Time of Accident/Incident
	8/5/2018	1:02 PM

5. Type of Accident/Incident
Derailment

6. Cars Carrying HAZMAT	7. HAZMAT Cars Damaged/Derailed	8. Cars Releasing HAZMAT	9. People Evacuated	10. Subdivision
8	0	0	0	NORFOLK SOUTHERN CORPC

11. Nearest City/Town	12. Milepost *(to nearest tenth)*	13. State Abbr.	14. County
Pittsburgh	ML5.95	PA	ALLEGHENY

15. Temperature (F)	16. Visibility	17. Weather	18. Type of Track
80 ˚F	Day	Clear	Main

19. Track Name/Number	20. FRA Track Class	21. Annual Track Density *(gross tons in millions)*	22. Time Table Direction
One	Freight Trains-25, Passenger Trains-30	19	North

23. PTC Preventable	24. Primary Cause Code	25. Contributing Cause Code(s)
No	[T207] Broken Rail - Detail fracture fr	H993

U.S. Department of Transportation
Federal Railroad Administration

FRA FACTUAL RAILROAD ACCIDENT REPORT

FRA File #HQ-2018-1293

OPERATING TRAIN #1

1. Type of Equipment Consist:	2. Was Equipment Attended?	3. Train Number/Symbol
Freight Train	Yes	21QC105

4. Speed (recorded speed, if available) R - Recorded E - Estimated	Code	5. Trailing Tons (gross excluding power units)	6a. Remotely Controlled Locomotive? 0 = Not a remotely controlled operation 1 = Remote control portable transmitter 2 = Remote control tower operation 3 = Remote control portable transmitter - more than one remote control transmitter	Code
18.0 MPH	R	7681		0

6. Type of Territory

Signalization:
Signaled

Method of Operation/Authority for Movement:
Signal Indication

Supplemental/Adjunct Codes:
D

7. Principal Car/Unit	a. Initial and Number	b. Position in Train	c. Loaded (yes/no)	8. If railroad employee(s) tested for drug/alcohol use, enter the number that were positive in the appropriate box	Alcohol	Drugs
(1) First Involved *(derailed, struck, etc.)*	DTTX 786313	13	yes		0	0
(2) Causing *(if mechanical, cause reported)*				9. Was this consist transporting passengers?		No

10. Locomotive Units (Exclude EMU, DMU, and Cab Car Locomotives.)	a. Head End	Mid Train b. Manual	Mid Train c. Remote	Rear End d. Manual	Rear End e. Remote	11. Cars (Include EMU, DMU, and Cab Car Locomotives.)	Loaded a. Freight	Loaded b. Pass.	Empty c. Freight	Empty d. Pass.	e. Caboose
(1) Total in Train	3	0	0	0	0	(1) Total in Equipment Consist	57	0	0	0	0
(2) Total Derailed	0	0	0	0	0	(2) Total Derailed	7	0	0	0	0

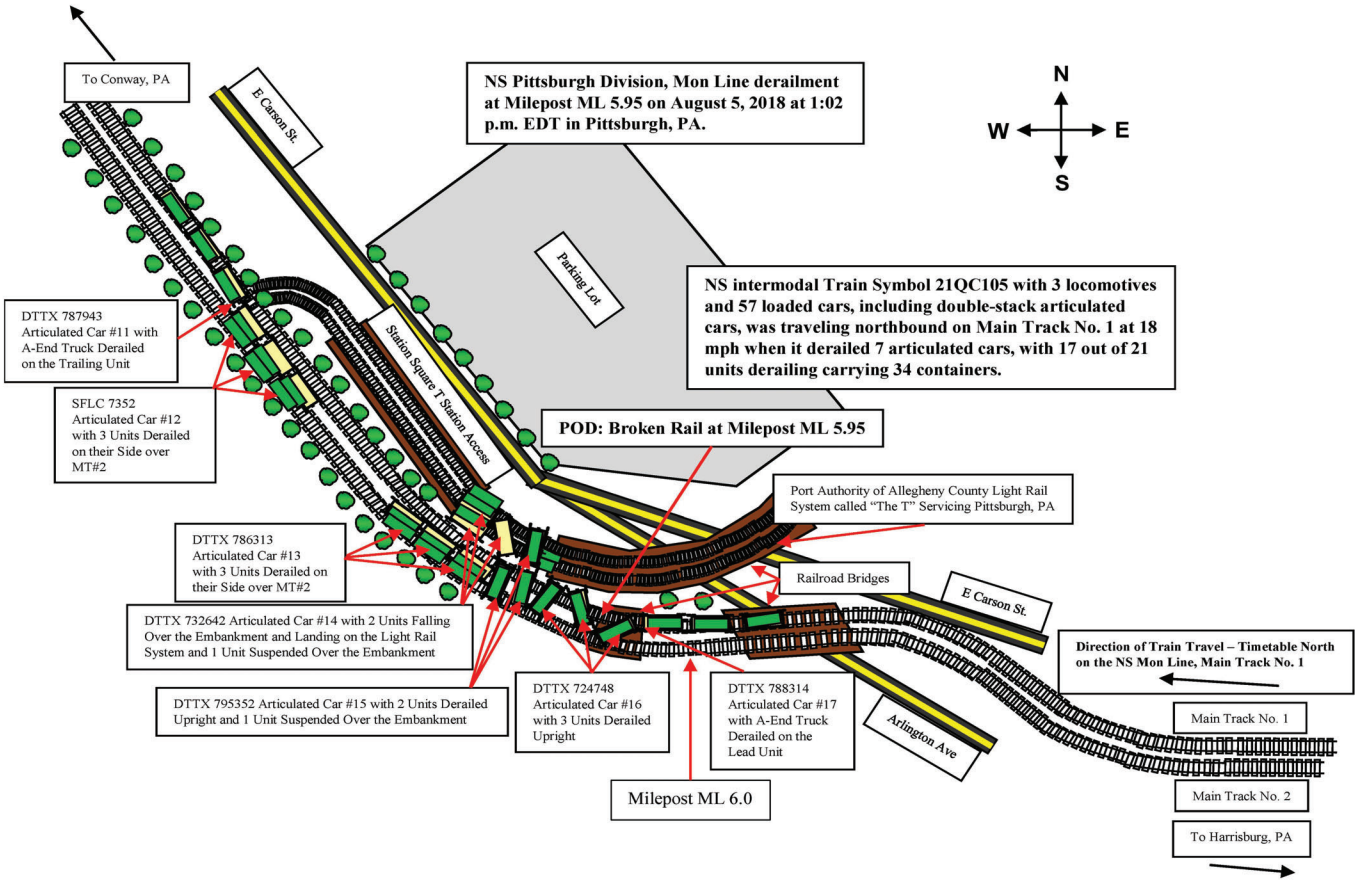
12. Equipment Damage This Consist	13. Track, Signal, Way & Structure Damage
773275	314952

Number of Crew Members				Length of Time on Duty	
14. Engineers/Operators	15. Firemen	16. Conductors	17. Brakemen	18. Engineer/Operator	19. Conductor
1	0	1	0	Hrs: 11 Mins: 2	Hrs: 11 Mins: 2
Casualties to:	20. Railroad Employees	21. Train Passengers	22. Others	23. EOT Device? Yes	24. Was EOT Device Properly Armed? Yes
Fatal	0	0	0	25. Caboose Occupied by Crew?	N/A
Nonfatal	0	0	0		

26. Latitude	27. Longitude
40.430689015	-80.001455997

SKETCHES

Sketch - Sketch1



NARRATIVE

Circumstances Prior to the Accident

The crew for Norfolk Southern Railway Company (NS) Train Symbol 21QC105 (Train 1) consisted of a locomotive engineer and a conductor. They reported for duty at 2 a.m., EDT, on August 5, 2018, at the NS Harrisburg Terminal, their away-from-home terminal, in Harrisburg, Pennsylvania. Their mission was to operate the intermodal train to NS Conway Terminal, their home terminal, in Conway, Pennsylvania. The crew members received more than the statutory off-duty rest period prior to reporting for duty. The engineer had been off-duty for 20 hours and 24 minutes, and the conductor had been off-duty for 20 hours and 26 minutes. Train 1 initially consisted of 3 head-end locomotives and 57 loaded intermodal articulated cars. The total length of the train was 8,857 feet with 7,681 trailing tons. At Harrisburg Terminal, on the morning of August 5, 2018, the train received a Class 1 air brake test at 1:35 a.m., EDT, and an end-of-train (EOT) device test at 3:01 a.m., EDT. Each locomotive's dynamic brakes were inspected by the Engineer for their operational status. The dynamic brakes were cut-out on the second locomotive in the consist but the Engineer could run all three locomotives on line.

Prior to departing Harrisburg, the Engineer and Conductor held a job briefing and checked the train's paperwork, noting that the train consisted of "high cars" because of the double-stack containers which restricted the clearance route to Conway Terminal. The "high cars" required Train 1 to travel via the NS Port Perry Branch and NS Mon Line to Conway Terminal. The only change to the train consist occurred en route on the Pittsburgh Line at Altoona, Pennsylvania, in which a locomotive "rear helper" helped push the train over the Appalachian Mountains' steep ascending grades. This was routine for an intermodal train along this route.

Train 1 departed Harrisburg in a westbound direction on the NS Harrisburg Line at 3:30 a.m., EDT, on August 5, 2018. The timetable direction is west until making the connection to the Mon Line and then the timetable direction becomes north. Immediately preceding the accident, the train was operating northbound on Main Track No. 1 with clear signal indication in Traffic Control System (TCS) territory. Timetable direction is used throughout this report.

As Train 1 approached the accident area, the train was operated by the Engineer who was seated at the controls on the right side of the cab facing forward. The Conductor was seated in the conductor's seat on the left side of the locomotive cab also facing forward.

The train traversed through a series of curves within two miles of the approach to the point of derailment (POD). The first curve at Milepost (MP) ML 8.0 was a right-hand 4.9-degree curve; then, at 1.6 miles from the POD was a right-hand 2-degree curve followed by tangent track for 0.6 miles. At 0.9 miles from the POD was a left-hand 4.3-degree curve; then, at 0.8 miles was a left-hand 1.3-degree curve followed by tangent track for another 0.6 miles. At approximately 0.2 miles from the POD, the train negotiated three consecutive 5-degree curves forming an "S" curve with the last left-hand curve as the POD at MP ML 5.95. The approach grade within 2 miles of the POD was ascending .27 percent; then, at 1.2 miles

the grade began to descend at 0.54 percent. The grade became generally flat at the POD for the next 4.4 miles.

The Accident

Train 1 was reducing its speed from 39 mph to 25 mph as it approached the "S" curves at MP ML 6.2. The maximum authorized speed changed from 40 mph to 25 mph at this location as designated in NS Pittsburgh Division, Northern Region, Timetable 1. The head end of the train was traveling at 25 mph when it traversed over the POD. At the time of the undesired emergency brake application, the train was traveling at a recorded 18 mph with its throttle in the idle position. The head end came to a stop near MP ML 5.6.

The Engineer immediately contacted the dispatcher to report the emergency brake application, and the brake pipe pressure did not restore. The Conductor began to walk back along the east side of the train to determine the cause of the emergency brake application. He found the 11th intermodal articulated car as the first derailed but still upright. The 12th and 13th intermodal articulated cars derailed to the west side towards Main Track 2 and turned over on their sides. The remaining cars derailed in an accordion fashion causing some cars to go over the embankment onto the light rail system on the east side of the track. A total of 7 cars derailed, positions 11 through 17 in the train consist, all of which were loaded double-stack intermodal articulated cars with three units each. The conductor told the engineer about the seriousness of the derailment via a hand-held radio, and the engineer immediately contacted the dispatcher again, using the 911 key function, to report it.

Local emergency responders arrived at the scene, and a Port Authority of Allegheny County police officer was the first to approach the head-end locomotive and asked to see the train consist and hazardous material paperwork.

No fire or injuries were due to the derailment; however, there was significant damage to the Port Authority light rail system servicing Pittsburgh, including nearly a three-week service disruption and $1,800,000 in damage to infrastructure.

Estimated railroad damages were $314,952 to track and signal, and $773,275 to equipment.

Post-Accident/Incident Investigation

The Federal Railroad Administration (FRA) disciplines that performed the investigation included Track, Motive Power and Equipment (MP&E), Signal and Train Control (S&TC), Operating Practices (OP), and Rail Integrity. As an investigative process to identify probable cause and potential contributing factors, certain aspects of the track structure, mechanical equipment, signal system, and human factors were inspected and scrutinized. The initial on-site post-accident investigative findings provided a suspect POD and potential probable cause. Through a collaborative effort with NS and Sperry, the fractured rail at the suspect POD and the last Sperry ultrasonic rail flaw detection test were thoroughly analyzed and conclusions formulated.

Analysis and Conclusions

Analysis – Toxicological Testing: The accident did not meet the criteria for Title 49 Code of Federal Regulations (CFR) Part 219 Subpart C – Post-Accident Toxicological Testing.

Post-accident toxicological testing was not performed since the accident did not meet the testing criteria; however, FRA concluded drugs and alcohol could not have had any effect on the derailment.

Conclusion: FRA determined drugs and alcohol did not contribute to the cause or severity of the derailment.

Analysis – Fatigue Analysis of Train Crew Members: FRA performed a fatigue analysis using the Fatigue Avoidance Scheduling Tool (FAST). FRA uses an overall effectiveness rate of 77.5 percent as the baseline for fatigue analysis. At or above this baseline, FRA does not consider fatigue as probable for any employee. Software sleep settings vary according to information obtained from each employee. FRA obtained fatigue-related information, including a 10-day work history for the employees involved with Train 1.

The analysis indicated fatigue was probable for both employees; however, FRA concluded fatigue could not have had any effect on the derailment.
Conclusion: FRA determined fatigue did not contribute to the cause or severity of the derailment.

Analysis – Operating Crew: The Engineer and Conductor of Train 1 were interviewed for proper train handling and procedures. FRA interviewed the crew to determine compliance with NS Operating Rules, FRA regulations, or any additional actions that may have impacted the train's operation. Crew actions and train handling that occurred before, during and immediately after the accident were discussed. Crew work histories, rest cycles, experience, and training were also reviewed.

FRA analyzed the event recorder data provided by the NS for the lead locomotive NS 1009. The maximum authorized speed at the derailment location was 25 mph. There was a proper (gradual) reduction in throttle positions to reduce in-train forces as slack condition changed from draft to bunch. The engineer then used gradual dynamic braking until just prior to the derailment. The train was traveling at 18 mph. The event recorder data prior to the derailment was consistent with proper train handling and no exceptions were taken.

Conclusion: FRA determined the operating crew did not contribute to the cause or severity of the derailment.

Analysis – Mechanical: FRA reviewed locomotive and car records for inspection testing and maintenance. The last records prior to the derailment indicated the equipment had received a mechanical inspection and a Class I air brake test, performed by qualified mechanical inspectors, on August 5, 2018, at the NS Harrisburg Terminal. Train 1 passed through mechanical defect detectors

prior to the POD. The last Wheel Impact Detector was in Mill Creek, Pennsylvania, at MP PT 197.6, and the last Hot Box Detector was in Homestead, Pennsylvania, at MP ML 12.1.

FRA inspected Train 1 equipment after the derailment and determined that the derailed head-end 11th and 12th articulated cars had traversed over the broken rail prior to the principal first car derailed in position 13. The right wheels on the high rail in the POD curve for the 11th and 12th B-end leading cars had evidence of blunt strike marks on the wheel flanges and horizontal strike marks on the tread which were consistent with striking a broken rail. FRA MP&E Inspector found the L7 wheel flange on the 12th head-end articulated car (SFLC 7352) was worn to a thickness of 7/8 of an inch, or less, at a point 3/8 of an inch above the tread of the wheel. Although a defective flange wear condition was found, FRA did not deem this condition to be a contributing or causal factor to the derailment since the wheel with this condition was on the low rail.

Conclusion: FRA determined the mechanical condition of the equipment did not contribute to the cause or severity of the derailment.

Analysis – Signal: The area of the derailment was Traffic Control System (TCS) territory. FRA Signal & Train Control (S&TC) Inspector reviewed the signal system test records and trouble tickets that were collected during the investigation. No deficiencies or exceptions were noted in NS testing of its signal system at the derailment location.

Conclusions: FRA determined the signal equipment did not contribute to the cause or severity of the derailment.

Analysis – Track Structure: The track leading up to the derailment site was constructed of wood crossties spaced at approximately 18 inch centers, box anchored every tie with 136 lb. continuous welded rail (CWR). The derailment curve was 5-degrees and 350 feet long with an entry spiral, full body, and exit spiral. Elevation was 1 inch. The low rail (east rail) was identified as 136 RE STN manufactured and laid in 2017. The high rail (west rail) was mostly 136-10 CC Bethlehem Steelton manufactured in 1995 and laid in 1996. Both rails had 18-inch double-shoulder tie plates with five spikes per plate and double-gage spiked. Main Track No. 1 was last tied and surfaced in May 2014, and the last program surfacing job was in July 2016.

FRA's post-accident inspection of the track, including track geometry measurements were taken approaching the POD, complied with Title 49 CFR Part 213 for the class of track. At the POD, approximately 350 feet of double track was catastrophically destroyed in which track panels were utilized to restore service.

The last track inspection was performed by a qualified NS track inspector on August 3, 2018, and no defects were noted near the POD. Track on this portion of the Mon Line is inspected twice weekly which meets the FRA's minimum requirement.

The last NS geometry test car operated over this portion of the Mon Line on April 12, 2018, and no defects were noted. NS conducts geometry car tests on the Mon Line at a frequency of twice annually.

The last ultrasonic rail flaw detection test was conducted on July 16, 2018, by Sperry. Among the B scan responses and the camera images from the July 16, 2018 test, the Sperry car chief operator had multiple opportunities to recognize a potential defect and follow up with a ground inspection. Even though a hand test was not technically required given that the C Insensitive response was not repeated during the re-run, the rail testing experts agreed that the operator should have performed a hand test, based on the multiple sources of rail inspection information available to the operator at that time. In addition, the Sperry car has automated cameras that take top and side-view images of the rails. Whenever a trigger from an ultrasonic or induction response is recognized, Sperry stores the image. Triggers include bolt holes (from the 45° transducers), welds (both plant and field welds can generate a response from a 70° transducer), transverse defects (70° transducers and the induction channels), rolling contact fatigue (various 70° transducers) and loss of bottom (0° transducers). The Sperry operator is not required to view these camera images during (or after) a test. Camera images 2171 and 2203 from the July 16, 2018 test shows a broken rail. The operator's decisions to disregard induction channel responses from the initial test and not utilize the camera images were serious oversights. NS conducts ultrasonic rail flaw detection tests on the Mon Line at a frequency of twice annually which exceeds the FRA's minimum requirement.

It is unusual for a broken rail to have remained in track undetected for 20-plus days, particularly in signaled territory. It appears that an anchor may have spanned the break from the time of the Sperry test to the derailment, serving as a clamp to minimize relative rail-end movement and, more importantly, as an electrical connection between the rail ends. The anchor provided continuity for the track circuit and allowed trains to run on signal indication.

The POD was in the high rail (west rail) towards the north end of the exit spiral of the curve. A 16.5-inch section of rail that contained the suspect POD fracture, along with three other fractured pieces that matched the rail near the POD, were delivered to the NS rail analysis laboratory on August 7. The suspect broken rail that caused the derailment had a partial brand indicating the year and month of manufacture to be 1985 June; thus, it was determined to have originated from a maintenance plug rail. As stated earlier, most of the high side rail recovered after the derailment was branded with a manufacture year of 1995. NS Rail Added & Removed Records indicated that the last time a portion of the west rail was changed for maintenance near the POD (designated as the "R" or right rail in the NS Rail Added & Removed Records) was on December 28, 2017, due to a service failure (broken rail). After the plug rail was installed, the next Sperry rail flaw detection test at this location occurred on January 10, 2018, in which there were no indications in the B scan of an existing rail defect. At the time of the derailment, the broken rail piece had 7/16-inch vertical wear and 2/16-inch gage face wear and significant gage-corner shelling.

The suspect detail fracture (DF) in the initial broken rail was of unknown origin because the fracture faces

were polished due to the rail ends rubbing against each other for at least three weeks. Images of the broken rail were from the July 16, 2018, Sperry rail flaw detector test -- prior to the derailment. It is reasonable to conclude that the cause of the fracture was a detail fracture, similar to the cause of the break in the rail on the opposite (south) end of the 16.5-inch section of rail. The detail fracture on the south end had a 30 percent detail fracture which originated beneath a gage-corner shell. This rail end shows minimal receiving batter; thus, this 16.5-inch section of rail may have dislodged quickly after the second break. The additional bending stress caused by the original break in the rail 16.5 inches away likely contributed to the growth of this defect, and to the eventual fast fracture of the remaining cross-section.

Conclusion: FRA determined a broken rail caused by a detail fracture from shelling or head check is the probable cause of the accident. (Cause code T207)

Additionally, the Sperry car chief operator's decisions to disregard induction channel responses from the initial test and not utilize the camera images during the July 16, 2018 test contributed to the cause of the derailment. (Cause code H993)

Overall Conclusion

The FRA investigation determined the probable cause was a broken rail because of a detail fracture from shelling or head check on the high side rail of the curve at MP ML 5.95, cause code T207. A causal factor was among the B scan responses and the camera images from the last Sperry car rail flaw detector test on July 16, 2018. It was evident that the Sperry chief operator had multiple opportunities to recognize a potential defect at the POD and follow up with a ground inspection. Rail testing experts agreed that the operator should have performed a hand test, based on the multiple sources of rail inspection information available to the operator during the Sperry car test. The operator's decisions to disregard induction channel responses from the initial test and not utilize the camera images were serious oversights. This accident was not PTC preventable.

Probable Cause and Contributing Factors

FRA determined probable cause of the derailment was T207 – Broken rail – Detail fracture for shelling or head check.

Additionally, FRA determined a contributing factor in the accident was H993 – Human factor – Track.