National Transportation Safety Board

Railroad Accident Brief

Norfolk Southern Railway Company Train Derailment and Hazardous Materials Release

Accident No.:	DCA12MR006
Location:	Columbus, Ohio
Date:	July 11, 2012
Time:	2:03 a.m. eastern daylight time
Railroad:	Norfolk Southern Railway Company
Property Damage:	$1.2 million
Injuries:	1
Fatalities:	0
Type of Accident:	Train derailment (hazardous materials release)

The Accident

On July 11, 2012, at 2:03 a.m. eastern daylight time, eastbound Norfolk Southern Railway Company (NS) freight train 186L809 derailed 17 cars on the NS Sandusky District at milepost (MP) S2.2 on main track 1.[1] The derailment occurred on the NS Lake Division and within the city limits of Columbus, Ohio. The train consisted of 2 leading locomotives, 97 loaded freight cars, and 1 empty freight car.

The train crew consisted of an engineer, a locomotive engineer trainee, and a conductor. After reporting to work on July 10, 2012, at 7:55 p.m. at the NS yard in Bellevue, Ohio, the crew received a list of the rail cars in the train, the contents of each, and the hazardous materials (hazmat) classifications, where applicable. The train departed Bellevue at 8:45 p.m., en route to Portsmouth, Ohio, a distance of about 192 miles.

During postaccident interviews conducted by National Transportation Safety Board (NTSB) investigators, the train crew said they had a green (proceed) signal aspect as the train approached MP S4.4 on main track 1.[2] The locomotive engineer trainee, who was operating the train, said that as the train entered the curve, he released the train air brakes, but he continued to apply full dynamic brakes. The engineer told NTSB investigators that as the train moved through the curve, the crew felt a "nudge" in the train movement, and the emergency brake system was activated. The locomotives and first 2 cars stopped on the tracks and the next 17 cars derailed.

The derailment destroyed both main tracks (1 and 2). The 3rd through the 19th cars derailed.[3] Cars 12 through 14 contained denatured ethanol (a hazardous material).[4] One of these tank cars was punctured during the derailment. The denatured ethanol from this punctured tank

[1] All times in this brief are eastern daylight time; Main track 2 ran alongside main track 1.

[2] The dragging equipment detector at MP S4.4, which is a wayside automatic inspection system, indicated that the train had no defects.

[3] Car numbers are referenced by their position behind the leading locomotives (that is, car 1 is the first car behind the locomotives).

[4] The substance consisted of 98 percent ethanol and 2 percent denaturant.

car fueled a large pool fire. The two other tank cars that were carrying denatured ethanol were engulfed in the pool fire and split open. Witnesses observed multiple energetic fire eruptions when these two tank cars ruptured. (See figure 1 for an overview of the accident scene.)

Figure 1. Aerial photograph of the derailment. (Photo by Columbus Police Department)

The train crew was not injured; however, one person near the derailment site sustained minor burns.[5] About 100 people in a 1-mile radius of the derailment were evacuated. The damages were estimated to total $1.2 million. At the time of the accident, the sky was clear, and the temperature was 70°F.

Emergency Response

On July 11, 2012, about 2:04 a.m., the Columbus Fire Department received several 911 calls reporting a large fire with flames that reached 60 to 70 feet. About 2:07 a.m., Columbus emergency responders arrived at the main entrance of the Central Ohio Transit Authority (COTA) bus terminal to the south of the derailment site. After assessing the scene, the firefighters realized that the fire involved a train derailment on the tracks adjacent to the COTA facility. At 2:18 a.m., the Columbus Fire Department Hazardous Materials Unit was notified to respond.

[5] The individual was at 8th Avenue when he heard screeching from the train tracks followed by a loud crash. This individual, along with a friend, ran to the accident to investigate if anyone was hurt or injured.

About 2:30 a.m., NS faxed a copy of the train consist to the Columbus Fire Dispatch; at the same time, the train conductor gave the on-scene emergency responders a copy of the train consist. Soon after, firefighters established an initial command post south of the derailed train.

At 2:51 a.m., the incident commander established a 1-mile evacuation radius as a precaution against a possible catastrophic tank car rupture. Eight minutes later, the Columbus Fire Department contacted NS to request hazmat response assistance and determine when hazmat responders would arrive. Because the emergency response was expected to take several days, the incident command post was relocated to the nearby state fairgrounds, to the north of the derailment site. (See figure 2.)

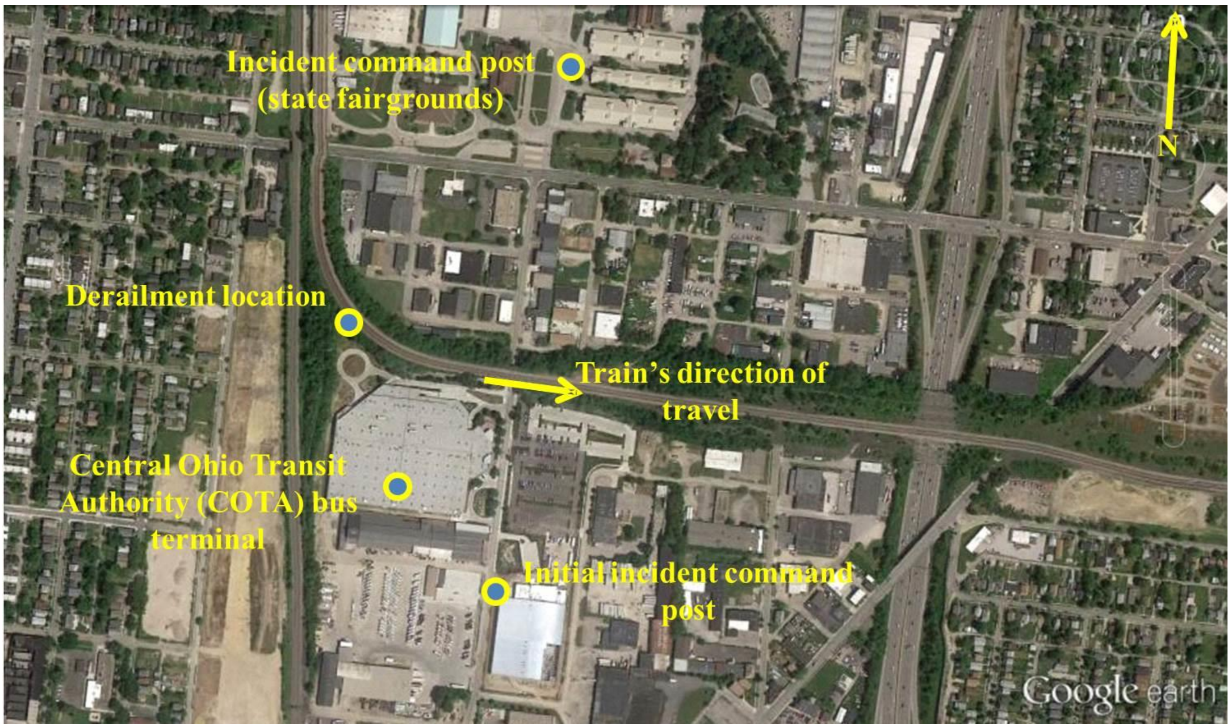

Figure 2. Satellite view of the accident site. (Image courtesy of Google Earth.)

By about 7:00 a.m., firefighters had extinguished the fire; clean-up operations started shortly thereafter. Overall, the NTSB found that the measures taken during the emergency response were adequate and appropriate.

The Investigation

NTSB investigators found that the train's event recorder data indicated the train was moving at 25 mph immediately prior to the derailment, which was the authorized speed for the area. After reviewing the crew work histories, NTSB investigators determined that the crew had sufficient off-duty time before they reported for work.

Signal System

NS train operations on the Sandusky District are governed and authorized by signal indications of a traffic control system. Trains in the accident area operate on two main tracks signaled for bidirectional movement.

NTSB investigators reviewed the maintenance and inspection records and downloaded data from the signal system. The signal system detected no abnormal track conditions, such as a broken rail, prior to the accident train’s arrival. Postaccident investigation indicated no problems with the signal system.

Wreckage Description

The locomotives and the first two cars in the train did not derail. The third car derailed one axle. The 4th through the 19th cars derailed and overturned. Tank cars 12 through 14, which were general service specification (DOT-111A-100W1 [DOT-111]) tank cars, contained denatured ethanol. These three tank cars were identified as NATX 364017, NATX 364083, and NATX 364118. Tank car NATX 364083 was breached during the derailment, and its cargo caught on fire. The other two tank cars, NATX 364017 and NATX 364118, eventually experienced thermal tears resulting from exposure to the pool fire that resulted from the breach of tank car NATX 364083. (See figure 3.)

Figure 3. Derailed tank cars exhibiting breach and thermal tears. (Photo by Columbus Police Department)

In all, these three tank cars contained about 87,000 gallons of denatured ethanol. The total volume of product consumed by fire or otherwise released to the sewer (sanitary/storm drain), soil, or air was estimated to be 54,748 gallons. Environmental contamination from the denatured ethanol was negligible. All the other derailed cars contained non-hazardous materials, such as corn syrup and grain, which were collected and shipped to a waste disposal facility.

Inspection of tank car NATX 364083 indicated that it was punctured by a coupler or an object on an adjacent tank car. Tank car NATX 364118 exhibited a tear in the top longitudinal weld metal of a shell ring, and tank car NATX 364017 exhibited a longitudinal tear through three shell rings. The NTSB Materials Laboratory found that the tank wall thickness of NATX 364118 in the area of the longitudinal fracture was reduced and contained an outward bulge deformation consistent with release of internal pressure. Investigators found no evidence of a preexisting crack on the fracture faces of the tank car, and the welds showed no evidence of anomalies (such as weld defects).

Equipment

Investigators inspected the two locomotives from the accident train with no discrepancies noted.

Inspection of a rear wheel of the second car behind the locomotive (a car that did not derail) showed a distinctive lateral impact mark on the wheel tread that was consistent with a facing rail fracture found near the identified point of derailment. The marks were located on the tread of the wheels perpendicular to the running surface, which is consistent with the train encountering a broken rail.

Track and Engineering

The derailment occurred on main track 1, in the body of a 9.5 degree right-hand curve (for a westbound train movement) with an average of 2 inches of super-elevation.[6] The NS designated main track 1 as FRA Class 2 track, with a maximum authorized timetable speed of 25 mph. The NS operates an average of 24 freight trains daily on main track 1, constituting an annual gross tonnage of 37.7 million gross tons (mgt); it operates an average of 19 freight trains daily on main track 2, with an annual gross tonnage of 39.0 mgt. These tracks are not passenger routes.

The rail in the area of the accident on main track 1 was a section that had been installed on September 2, 2011, as a replacement made necessary by a September 1, 2011, inspection that found 14 defects in the rail at this location. NS had moved this replacement rail from another location. NS records show that Sperry Rail Services had tested the replacement rail for internal defects on September 1, 2010, prior to its installation on main track 1. No defects were found at that time.

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[6] *Super-elevation* is the outer rail's vertical distance above the inner rail in a curve.

FRA regulations in Title 49 *Code of Federal Regulations* (CFR) 213.237 require a continuous inspection for internal rail defects for Class 4 track and Class 3 track over which passenger trains operate once every 40 mgt or once a year, whichever interval is shorter. According to federal regulations, NS was not required to inspect this track for internal rail flaws because it was designated as Class 2 and was not a passenger route. However, NS contracted with Sperry Rail Service to inspect this track segment ultrasonically for rail defects twice in 2011; on March 16 and September 1. The NS also contracted with Sperry Rail Service to conduct an ultrasonic test to detect rail flaws on NS main track 1 on April 5, 2012, which was 97 days prior to the accident. Documents supplied by NS indicate three rail defects were found on main track 1 at MP S2.146, S2.177, and S2.178 during the April 5 rail inspection. The defects were corrected the same day.

An NS track inspector had last inspected main track 1 on July 9, 2012, 2 days before the accident. The NS inspector did not document any defects in the area of the derailment on the inspection report. The FRA had last inspected main track 1 on April 20, 2011. The FRA inspection found no track defects in the area of the derailment.

A review of service failure records indicated that five rail failures occurred in this curve on NS main track 1 since Sperry Rail Service had last conducted a rail flaw detection test on April 5, 2012. (See table 1.)

Table 1. Recent service failures on main track 1 in derailment curve.

Failure Date	Milepost	Rail Manufactured	Defect
May 14, 2012	S2.3	September 1981	40% transverse defect
June 4, 2012	S2.2	January 1981	40% transverse defect
June 12, 2012	S2.2	September 1981	30% transverse defect
June 19, 2012	S2.3	September 1981	20% transverse defect
July 1, 2012	S2.2	January 1996	30% transverse defect[a]

The NS examined the rail specimens from the accident location during the on-scene phase of the investigation. They identified 19 transverse defects with size ranges from about 5 percent to about 60–70 percent with relationship to gage corner fatigue.[7]

Rail Recovery and Analysis

During the NTSB's reconstruction of the rail recovered after the derailment, investigators identified 24 oxidized internal cracks that fractured during the derailment. The NTSB Materials Laboratory conducted metallurgical analyses and rail head wear measurements on several rail samples. The running surface of the rail pieces showed evidence of flaking and severe rolling contact fatigue cracks, also referred to as head checks.[8] Other pieces showed no evidence of

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[7] *Gage corner* refers to the side radius portion of the rail's running surface closest to the centerline of the track.

[8] *Flaking* refers to small shallow flakes of surface metal generally no more than 1/4 inch in length or width that break out of the gage corner of the rail head; *Head check* refers to hairline cracks that appear in the gage corner of

flaking damage on the head portions of the rail. The exposed fracture faces of some rail sections showed evidence of transverse detail fractures that extended from the gage side of the rail head in areas that coincided with head check and flaking damage.[9] The metallurgical evidence indicated that the rail was stressed by rolling contact fatigue, which caused the rail to break under the train, leading to the derailment.

Previous NTSB Investigations

On October 20, 2006, an NS train en route from Illinois to New Jersey derailed due to a broken rail while crossing a railroad bridge in New Brighton, Pennsylvania.[10] The NTSB issued three safety recommendations, R-08-09 through -11, to the FRA to address ultrasonic rail inspection and rail defect management, as well as the oversight of internal rail inspection processes and requirements, which concern underlying rail conditions brought on by rolling contact fatigue.

<u>R-08-9</u>

Review all railroads' internal rail defect detection procedures and require changes to those procedures as necessary to eliminate exceptions to the requirements for an uninterrupted, continuous search for rail defects.

<u>R-08-10</u>

Require railroads to develop rail inspection and maintenance programs based on damage-tolerance principles, and approve those programs. Include in the requirement that railroads demonstrate how their programs will identify and remove internal defects before they reach critical size and result in catastrophic rail failures. 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.

<u>R-08-11</u>

Require that railroads use methods that accurately measure rail head wear to ensure that deformation of the head does not affect the accuracy of the measurements.

The NTSB has classified Safety Recommendations R-08-9 and -10 "Closed—Acceptable Action." Safety Recommendation R-08-11 is classified "Open—Acceptable Response."

Another accident previously investigated by the NTSB that involved rolling contact fatigue occurred in Ellicott City, Maryland, on August 20, 2012, when a CSX Transportation coal

the rail head, at any angle with the length of the rail. When not readily visible, the presence of such checks may often be detected by feeling for sharp edges.

[9] A *detail fracture* is a progressive fracture originating at or near the surface of the rail head.

[10] See National Transportation Safety Board, *Derailment of Norfolk Southern Railway Company Train 68QB119 with Release of Hazardous Materials and Fire, New Brighton, Pennsylvania, October 20, 2006*, NTSB/RAR-08/02 (Washington, DC: National Transportation Safety Board, 2008).

train derailed.[11] The NTSB determined that the probable cause of the accident was a broken rail that showed evidence of rolling contact fatigue. The rail failure discovered in the Columbus, Ohio, investigation had many similarities to the New Brighton, Pennsylvania, and Ellicott City, Maryland, accidents in that rails with similar wear conditions failed because of detail fractures from shelling caused by rolling contact fatigue.

In the case of the New Brighton derailment, postaccident testing revealed that the defect had grown to 78 percent of the remaining rail head area; in the Columbus accident, the defect had grown to 70 percent. By contrast, in the case of the Ellicott City accident, the defect extended across just 24 percent of the remaining rail head area. These percentages indicate that rail stress was most likely lower when the New Brighton and Columbus derailments occurred than during the Ellicott City derailment.

Rail Safety Advisory Committee Rail Failure Working Group Recommendations

As a result of the NTSB safety recommendations from the New Brighton investigation and the NTSB investigations into the Columbus and Ellicott City derailments, the FRA determined that each of the accidents resulted from rail failures. In September 2012, the FRA established a Rail Safety Advisory Committee (RSAC) Rail Failure Working Group to study the effects of rail head wear and the resulting rail surface conditions (known as rolling contact fatigue), and how such rail conditions can adversely affect the results of ultrasonic rail testing. (See appendix A.)

The RSAC Rail Failure Working Group met four times between January and July 2013. The group proposed new performance-based recommendations for determining rail wear and internal rail inspection criteria. The new criteria, which establish best practices, have improved the FRA's ability to monitor rail integrity programs and should help to ensure that track owners can quickly identify, as well as promptly and effectively remediate, problems with rails that could lead to a derailment in populated areas or to track-related accidents involving trains transporting passengers or hazmat. The FRA efforts and the industry's acceptance of these best practices should reduce the number of accidents caused by rail breaks due to rolling contact fatigue and improve the operation of industry rail risk management programs.

On April 16, 2014, the RSAC adopted the recommendations from the Rail Failure Working Group. The final recommendations, which were developed with industry consensus, are provided in appendix B. On July 25, 2014, the FRA distributed the final Rail Failure Prevention Program guidance document to the RSAC and the Rail Failure Working Group, and requested that they distribute it throughout the railroad industry. The FRA also stated that the FRA Administrator would formally issue the guidance document to railroads.

[11] See National Transportation Safety Board, *CSX Transportation Coal Train Derailment Killed Two Individuals, Ellicott City, Maryland, August 20, 2012*, NTSB/RAB-14/07 (Washington, DC: National Transportation Safety Board, 2014).

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was a broken rail that exhibited evidence of rolling contact fatigue.

Adopted: September 18, 2014

For more details about this accident, visit www.ntsb.gov/investigations/dms.html and search for NTSB accident ID DCA12MR006.

The NTSB has authority to investigate and establish the facts, circumstances, and cause or probable cause of a railroad accident in which there is a fatality or substantial property damage, or that involves a passenger train. (49 U.S. Code § 1131 - *General authority*)

Appendix A

US Department of Transportation
Federal Railroad Administration
Task No.: 12-01 Railroad Safety Advisory Committee Task Statement
Rail Failure Working Group
Date initially presented to the RSAC: September 27, 2012

Purpose: To consider specific improvements to the Track Safety Standards (TSS) or other responsive actions designed to monitor rail life and reduce the adverse risks of rail failures.

Background: Under Task No. 08-03, the Track Standards Working Group recently addressed the effect of rail head wear, surface conditions, and other relevant factors on the acquisition and interpretation of internal rail flaw test results.

Description: Review and understand:

- Railroad engineering instructions concerning rail performance management.
- The factors that influence rail life.
- The impact of train dynamics on rail.
- The effects of head wear on rail strength and structural integrity.
- The effects of rolling contact fatigue on rail and how it can impact rail defect development.

Issues requiring specific report:

- 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 improved 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 formally standardized.
- Evaluate whether methods for non-destructive rail inspections can be improved in terms of inspection effectiveness and efficiency.

Establish following working group: Rail Failure Working Group

Target Dates: Report recommendations to the Committee by March 2014.

Disposition: Accepted **Accepted Date:** September 27, 2012

Appendix B

Railroad Safety Advisory Committee Rail Failure Working Group Recommendations and Federal Railroad Administration Guidance Document

National Transportation Safety Board (NTSB) investigators coordinated with the Federal Railroad Administration (FRA) in tasking the Railroad Safety Advisory Committee (RSAC) and contributed to the final recommendations designed to enhance track maintenance and reduce rolling contact fatigue.

The Rail Failure Working Group was tasked on September 27, 2012, to consider improvements to the Track Safety Standards or other responsive actions designed to monitor rail life and reduce the risk of rail failures. The Rail Failure Working Group reached consensus on its recommendations on July 31, 2013. On April 16, 2014, the full RSAC adopted the consensus recommendations made by the Rail Failure Working Group. On July 25, 2014, the FRA distributed the final guidance document for the Rail Failure Prevention Program to the RSAC and the Rail Failure Working Group, with a request that they distribute these guidelines throughout the railroad industry. The FRA also stated that the FRA Administrator would formally issue the guidance document to railroads. These efforts, coupled with the industry's acceptance of the guidance, represent progress in the effort to reduce broken rail accidents caused by rolling contact fatigue and are enabling better management of industry risk management programs.

RSAC Language for Industry Guidance from the FRA Rail Failure Prevention Program

The FRA recommends that track owners consider developing and maintaining a Rail Failure Prevention Program for rail in the following main track:

- Class 2 track with annual tonnage of at least 25 million gross tons (mgt), or is a HAZMAT route;
- Class 3 track with annual tonnage of at least 25 mgt, is a HAZMAT route, or has regularly scheduled passenger service; and
- Class 4 and 5 track.

The Rail Failure Prevention Program should contain the following:

1. Rail head wear guidelines.
2. Guidelines that address the identification and management of visible rolling contact fatigue damage and improve rail performance.
3. An inspection plan that includes rail head wear measurements for comparison with established guidelines and means for identification of visible rolling contact fatigue damage.
4. Corrective actions to be taken when rail head wear guidelines are exceeded or visible rolling contact fatigue damage is identified.

5. Training for the implementation of the procedures listed above.

Specific Rail Failure Prevention Program Content

The FRA recommends that the Rail Failure Prevention Program contain the following elements:

A. Rail head wear guidelines that include:

   1. Consideration of rail section, class of track, alignment, and other criteria as determined by the track owner.

   2. Specification of the measurement methods to be used and definition of reference points for these measurements.

B. An inspection plan to measure rail head wear that considers alignment, class of track, and other criteria as determined by the track owner.

C. Guidelines for the management of visible rolling contact fatigue damage and improved rail performance. Procedures may include lubrication, friction modification, or grinding.

   1. Lubrication or friction modification practices should consider train traffic, alignment, curvature length, and grade.

   2. Rail grinding or other techniques that address maintenance of rail head profile to improve rail surface conditions and reduce visible rolling contact fatigue damage.

D. Guidelines that address the monitoring of visible rolling contact fatigue damage, including the following:

   1. Inspection procedures to identify areas of visible rolling contact fatigue damage. The inspection procedures should include prioritization methods for assessing the severity of these conditions.

   2. Establishment of inspection frequencies to monitor development of visible rolling contact fatigue damage that consider alignment, track class, and other factors as determined by the track owner.

E. Guidelines for applying rail grinding or other techniques that improve rail head profile and visible rolling contact fatigue damage. The guidelines should identify:

   1. The techniques used.

   2. Application of the techniques considered, taking into account alignment, tonnage, class of track, or other factors as determined by the track owner.

   3. Prioritized corrective action for areas of significant visible rolling contact fatigue damage to reduce defect development.

F. Recordkeeping procedures for each inspection performed under the Rail Failure Prevention Program. The record should include the following items:

1. The limits of the territory inspected.

2. Head wear measurements.

3. Areas identified as having significant visible rolling contact fatigue damage and type of rail surface degradation.

G. Guidelines for rail service life monitoring that consider class of track, tonnage, rail section, rail wear, visible rolling contact fatigue damage, defect development, rail failure history, and other factors as determined by the track owner.

H. Recommended corrective action to be taken when rail head wear or visible rolling contact fatigue damage guidelines are exceeded.

I. A system or process designed for the recording and tracking of rail defects and rail failure incidents with the capability to identify locations with sudden or accelerated failure rates.

J. Training for employees involved in the implementation of the written Rail Failure Prevention Program, with provisions for periodic retraining for those individuals.