NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF RAILROAD, PIPELINE AND HAZARDOUS MATERIALS INVESTIGATIONS
WASHINGTON, D.C. 20594

Track & Engineering Group Factual Report

Accident

Type:	Over Speed Derailment
Date and Time:	May 12, 2015 at 9:21 p.m. EDT
Location:	Philadelphia, Pennsylvania
Vehicle:	Amtrak train 188
NTSB Accident#:	DCA15MR010

Synopsis

For a summary of the accident, refer to the *Accident Summary* report, within this docket.

Track and Engineering Group

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The Accident

On May 12, 2015, about 9:21 p.m. eastern daylight time, National Railroad Passenger Corporation (Amtrak) passenger train No. 188 derailed on main track #2 at mile post (MP) 82 minus 2,029 feet (MP 81.62) near Shore Interlocking in Philadelphia, Pennsylvania. The derailment occurred in the body of a 4-degree 2-minute curve with a maximum authorized speed (MAS) of 50 MPH. Event recorder data indicates the train was traveling 106 mph when the engineer made an emergency brake application; the train derailed in that curve shortly thereafter. See figure 1 for an aerial survey incorporated with a land survey of the derailment site.

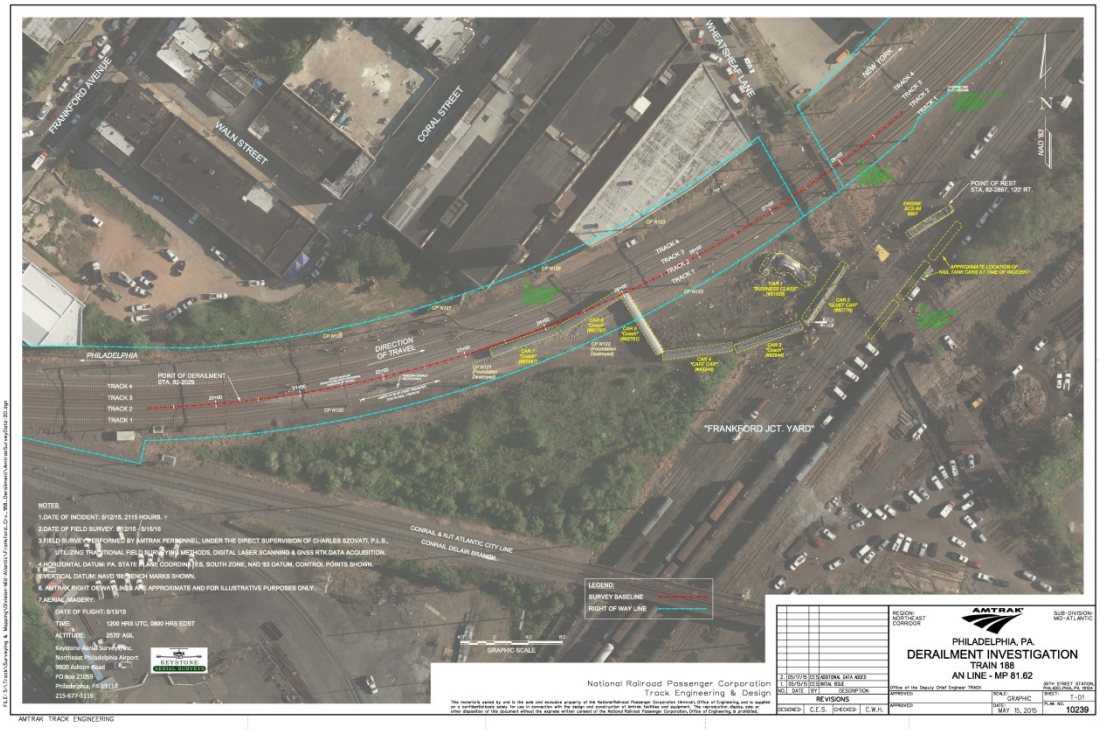

Figure 1
Survey of Derailment Site with Derailed Car Positions, Car Component Locations, Right of Way Boundaries, Noted Structure Damages, Track & Evidence Locations, Direction of Travel, and Point of Derailment Identified

Track Description

The track is designated as the Amtrak Main Line - New York to Philadelphia. It is on the NorthEast Corridor (NEC), on the Mid-Atlantic Division, and is oriented east and west geographically; as well as by timetable. The milepost (MP) locations on this line begins with MP 0.0 (Penn Station New York) and increases numerically as the track continues west to MP 88.0 (Philadelphia). The train was traveling towards New York.

In the area of the derailment there are 4 main tracks that are numbered 1 through 4 from south to north respectively, and are parallel to each other. The point of derailment (POD) was determined to occur in the full body of curve #298, at MP 81.62 (GPS 40° 0’

4.46” latitude and -75° 5’ 43.19” longitude). See figure 2 for the marks on the rail head that showed a wheel departure.

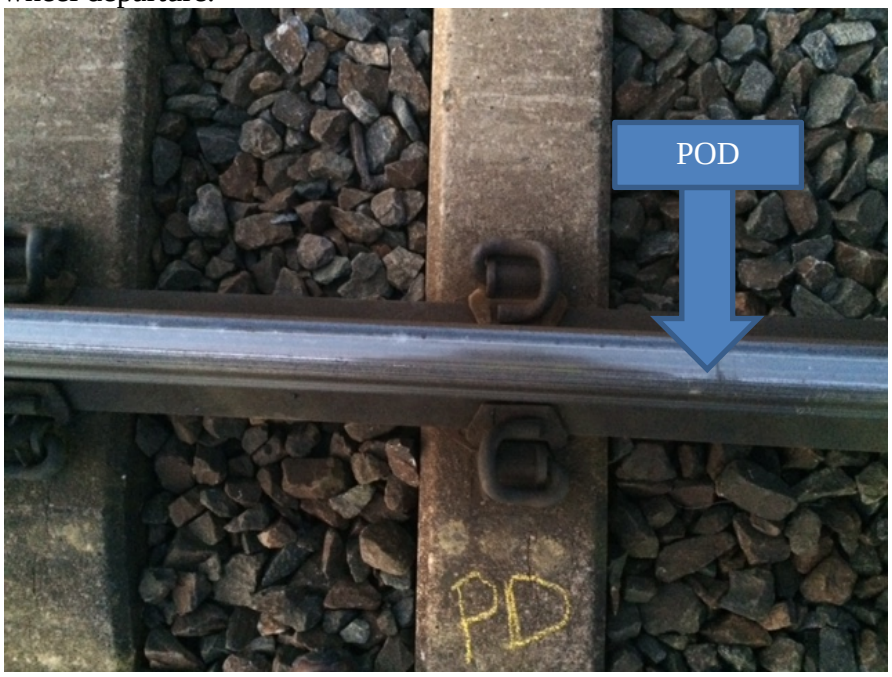

Figure 2
View of the POD on the south rail

Amtrak is required to maintain the track structure in this area to Federal Railroad Administration (FRA) Class 3 track standards, which allow for a MAS of 60 mph for passenger trains. However, train No. 188 is classified as Train Type “B” and has a MAS of 50 mph in the curve where the train derailed.[1]

Approximately 57 eastbound passenger trains are operated during weekdays and 40 passenger trains on operated on weekends over main track 2. The annual tonnage on main track #2 is about 9.5 million gross tons (MGT).

Approaching the POD from the west at MP 84.8 there are, in succession: a tangent 4,837 feet in length; a compound curve 2 degree 33 minute and 0 degree 21 minute to the right for 4,127 feet (curve #299); a tangent 6,763 feet in length; a 4 degree 2 minute curve to the left for 560 feet (curve #298) to the POD at MP 81.62, and then the curve continues 1,540 feet beyond. Beginning at MP 83.8 the track grade is descending at an average of 0.6% through the POD continuing to MP 81.3.

Corresponding with the track geometry described above and approaching the POD from the west at MP 84.8, there is a permanent 60 mph speed restriction within the limits of Clearfield Interlocking. East of Clearfield Interlocking at MP 84.5, the MAS is 80 mph on tangent track and continues east to curve #299 at MP 83.9. At curve #299, the MAS is 65 mph. Exiting curve #299 at MP 83.1, the MAS increases to 80 mph and continues on tangent track to curve #298 at MP 81.8, which has a permanent speed

[1]Train Type “A” refers to high speed trainsets, with tilt system active, with MAS of 60 mph in this curve.

restriction of 50 mph.

Track Structure Description

Main track #2 through the accident area in curve #298 consists of Continuous Welded Rail (CWR) directly fixed on concrete ties with Pandrol "e clips" and insulators.[2] The south rail in the curve (outside curve rail) was 136 pound-RE controlled cooled (CC) rail section manufactured by Bethlehem Steelton in August of 1995[3]. The north rail (inside curve rail) was 140 pound-RE CC manufactured by Bethlehem Steelton in May of 1980.

The ballast section is crushed granite. The tie cribs appeared to be full with an average of 12 inches of shoulder ballast. At the POD, the track was sitting on an average of 4 feet of fill above the ditch line.

There is a gage face rail lubricator at MP 81.82 approximately 155 feet west of curve #298. Lubrication was evident on the rail gage face throughout the length of the curve.

Pre-Accident Track Inspection

An Amtrak track inspector visually inspected main track #2 twice weekly as required by Federal Track Safety Standards. The track is scheduled to be inspected every Tuesday and Friday. The Amtrak track inspector is accompanied by a watchman as two tracks are simultaneously inspected as they walk in one direction for approximately 2.9 miles. The inspection team returns in the opposite direction, inspecting the other two tracks. The last visual track inspection for main track #2 occurred on May 12th, 2015. The FRA Department of Transportation (DOT) track inspector reviewed the Amtrak track inspection records for the main tracks for the period beginning January 1st, 2015 through the time of the derailment. The review of the records determined that Amtrak was in compliance of the required inspection frequency. Also, the inspection records were reflective of the track conditions in curve #298 which included curve worn rail on main track #2; causing maintenance gage conditions, but not a FRA track defect.

Amtrak conducts track geometry car testing over the NEC twice a month. The last two geometry inspections were conducted on May 12th, 2015 and on April 21st, 2015. No track geometry defects were noted on main track #2 in the derailment area for the May 12th test. The line graph data showed that a maximum maintenance gage of 57.63 inches was recorded approximately 171 feet east of the POD. The FRA maximum gage limit is 57.75 inches and Amtrak's maintenance limit is 57.5 inches. An Amtrak representative said that the maintenance gage was a reflection of the curve worn rail, and the rail was

[2] The concrete ties are manufactured by Rocla in 1992.

[3] A 136 pound rail section is defined as 136 pounds per three feet of rail. RE is derived from American Railway Engineering Association (AREA) design specifications for the rail. AREA is now called American Railway Engineering and Maintenance-of-Way Association (AREMA).

scheduled for replacement in 2016.[4] In addition, the new replacement rail was previously delivered and was lying east of the derailment.[5]

The geometry car data includes rail profile measurements. For main track #2, curve #298 rail profile showed a gage face wear angle of 24.1° and the Amtrak maximum allowable gage face wear angle is 30°. With a vertical head loss of 0.14 inches, the Amtrak maximum gage face wear limit is 0.6875 inches; and the data showed a gage face wear of 0.44 inches.[6]

Amtrak's frequency for internal rail inspection is twice annually. The last two internal rail inspections on main track #2 for defects in curve #298 were on October 26th, 2014 and on April 27th, 2014. No internal rail defects were detected on main track #2 in curve #298. The next rail inspection for internal defects was scheduled in May 2015.

Amtrak is not required to conduct a gage restraint measurement system (GRMS) test for main track #2 in curve #298.[7] However, a test was conducted on May 19th, 2014, and no track geometry defects were recorded for this track in the curve.

The last time a FRA DOT track inspector evaluated the track conditions and compared them to the Track Safety Standards was on October 28th, 2014. The limits of the evaluation were between MP 87 and MP 80.9. No track defects were noted on main track #2 in curve #298.

Postaccident Track Evaluation

On May 13th, 2015, representatives from Amtrak, the FRA, and the NTSB conducted a walking evaluation of track and structure damages following the derailment. The POD was identified and agreed upon by the group. An Amtrak representative took track geometry measurements for gage, crosslevel, and alignment.[8] The FRA and NTSB representatives verified these measurements and no geometry exceptions for Class 3 track were found.

Observation of main track #2 revealed that there were marks on the outside curve rail at the west end of curve #298. It appears that a wheel flange climbed the gage face of high rail, traveled approximately 22 feet, and dropped onto the concrete ties on the field side of the outside rail as the train began or rolled over. See figure 3. There was no evidence at the POD where the wheels on the inside of the curve contacted the ties within the gage. However, there was sand and arching marks on the inside rail just west of the POD which is evident of wheel lift and grounding of electricity from the overhead catenary propulsion system. See figure 4. About 155 feet east and across from the POD

[4] Both the inside and outside rails on main track #2 in curve #298 were going to be replaced.
[5] The replacement rail was a 136 pound section.
[6] Amtrak's *Limits and Specifications for Track Safety, Maintenance and Construction, MW1000:* Rail Wear Criteria, Revision; March 1, 2013
[7] GRMS is not required in curve #298 because it is not classified as high speed track in Subpart G.
[8] The track geometry measurements were taken at 46 stations; 1 station east of the POD, and 45 stations west of the POD. The stations were 15 foot-6 inches apart.

on main track #1, there was evidence of blue paint or decal transfer on the rail head that extended eastward for about 155 feet. About midway in that transfer location was passenger car window gasket materials. See figure 1 and figure 5.

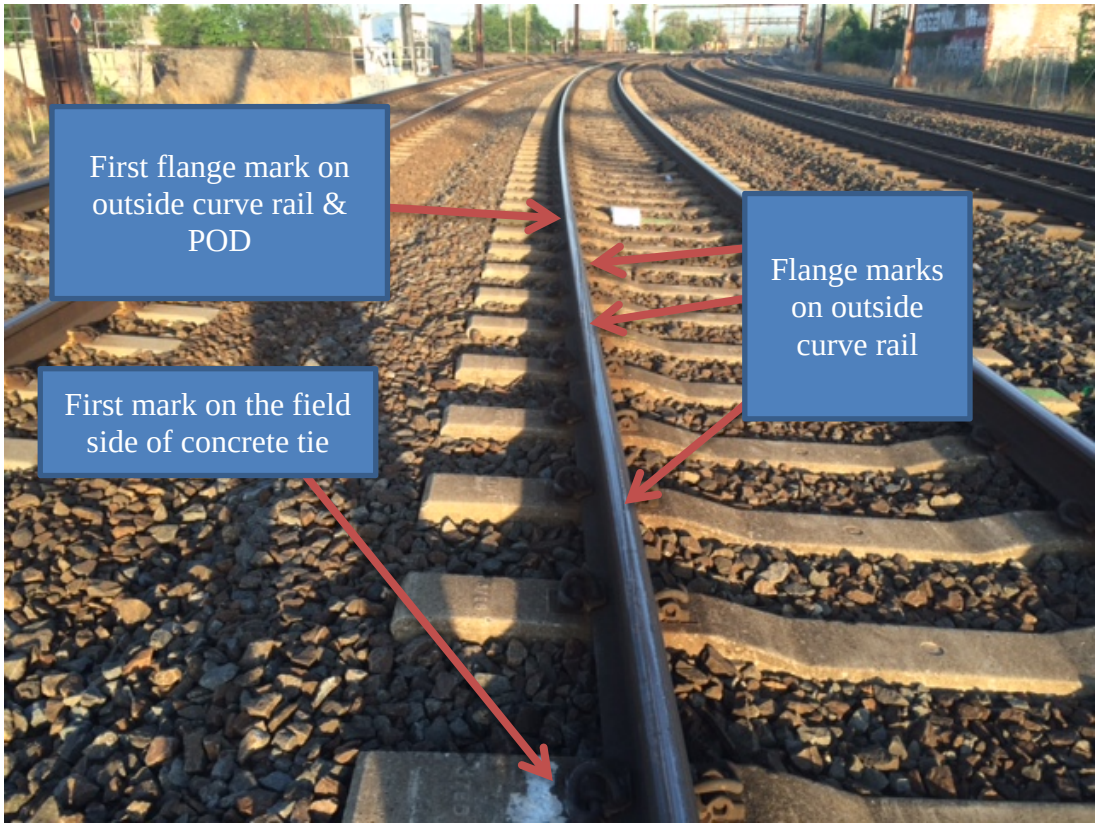

Figure 3-Wheel marks

Figure 4-sand and arching on inside curve rail - west of POD

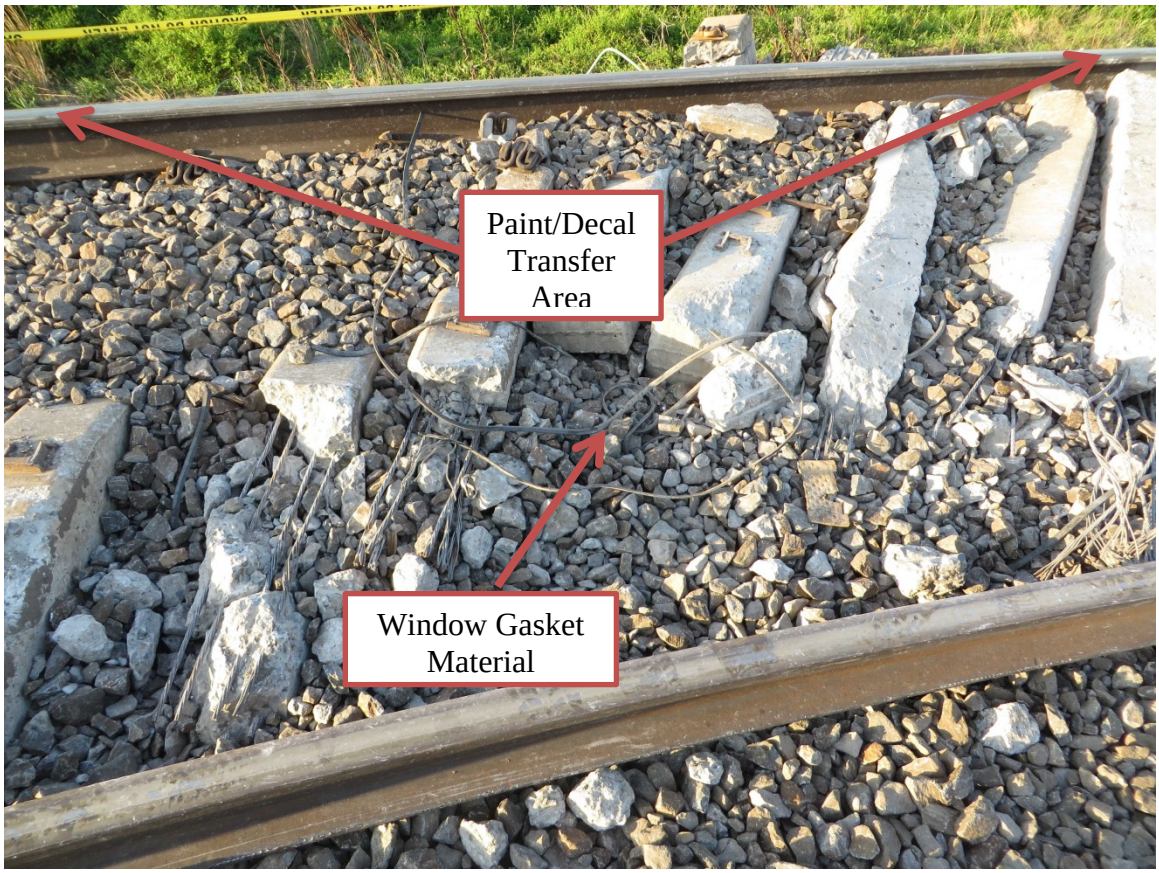

Figure 5 – Window Gasket Material and Blue Paint/Decal Transfer

Both the inside and outside rail profiles were measured at selected locations near the POD by Amtrak representatives and observed by the FRA. Also, the train's wheel profiles were measured. All measurements and the track geometry data were sent to the Volpe Center for wheel/rail interaction. The Volpe Center, using Nadal's formula, calculated the dynamic L/V ratio, and the results from that calculation showed that wheel climb on the outside curved rail did not occur.[9] In addition, Volpe calculations indicated that forces were large enough to initiate the lead passenger car rollover.[10]

Production Track Maintenance

Amtrak performed the following production track maintenance in curve #298:

- Production Tie Replacement in 1992
- Production Rail Grinding on January 26, 2008

[9] L and V refer to the lateral and vertical forces acting upon the rail and wheel. This ratio is accomplished by matching the train's wheelset with the appropriate rail head profile to achieve the L/V ratio desired. If the L/V ratio gets too high, the wheel flange will be pressing against the rail face, and during a turn this will cause the wheel to climb the face of the rail, potentially derailing the railcar.

[10] A wayside security camera showed the lead passenger car initiating rollover.

- Production Surfacing in 2013

Damage Estimates

Amtrak Track Department = $1.65 million

Amtrak Electric Traction Department = $1.75 million

Amtrak Structures = $300,000.00

Conrail Track Department = $330,000.00

END OF REPORT