National Transportation Safety Board
Washington, D.C. 20594

Railroad Accident Brief

Accident No.:	DCA-05-FR-010
Location:	Home Valley, Washington
Date:	April 3, 2005
Time:	9:35 a.m., Pacific daylight time[1]
Railroad:	BNSF Railway Company
Property Damage:	$854,000
Injuries:	30
Fatalities:	None
Type of Accident:	Amtrak passenger train derailment

The Accident

On April 3, 2005, about 9:35 a.m., westbound Amtrak (National Railroad Passenger Corporation) passenger train No. 27, consisting of a single locomotive unit and four passenger cars, derailed at milepost (MP) 58.56[2] on the BNSF Railway Company's (BNSF's) Northwest Division. The train was traveling 60 mph on single main line track when it derailed as it was traveling through a cut section of the Columbia River Gorge on the north side of the Columbia River near Home Valley, Washington. The train remained upright; however, the cars came to rest leaning up to approximately 35° against the outside curved embankment. (See figure 1.) There were 106 passengers and 9 Amtrak employees on board. Thirty people (22 passengers and 8 employees) sustained minor injuries; 14 of those people were taken to local hospitals. Two of the injured passengers were kept overnight for further observation; the rest were released. Track and equipment damages, in addition to clearing costs associated with the accident, totaled about $854,000.

The derailment occurred during daylight hours. The weather was cloudy with mist and intermittent rain. The temperature was about 45° F with 8 mph southeast winds.

On the day of the accident, westbound Amtrak passenger train No. 27 was scheduled to travel from Pasco, Washington, to Portland, Oregon, a distance of about 232 miles. The engineer performed a running air brake test at 6:35 a.m. before departing Pasco. The engineer noted nothing remarkable during the test.

1 All times in this brief are Pacific daylight time.

2 MP 58.56 is on the Fallbridge Subdivision.

Figure 1. Derailment site.

There were three crewmembers on Amtrak passenger train No. 27—an engineer, a conductor, and an assistant conductor—and all three stated that the trip was uneventful as the train approached the accident area. The engineer was operating the train on a clear signal indication at a recorded speed of 60 mph. A hot box/dragging equipment detector[3] was also located near the wayside signal, and no train defects were recorded or transmitted by radio to the train crewmembers. As the train approached the accident site, the engineer was seated at the controls on the right (north) side of the locomotive. The conductor and assistant conductor were riding in the coach cars. The conductor was attending to paperwork, and the assistant conductor was monitoring the train radio transmissions.

[3] A *hot box detector* determines whether any bearings are overheating. A *dragging equipment detector* determines whether any equipment, such as brake rigging or mechanical connections, is dragging or whether any debris that can damage the track connections, ties, or switches has become lodged under the train.

The Amtrak train traversed about 1 1/4 miles of straight (tangent) track before it entered a 3° left-hand curve and derailed. (See figure 2.) The engineer stated that he first became aware of the derailment when an emergency brake application occurred that he had not initiated. The conductors and passengers stated that they became aware of the derailment when they were thrown around and jostled in the coach cars, followed by clouds of dirt and debris entering the cars.

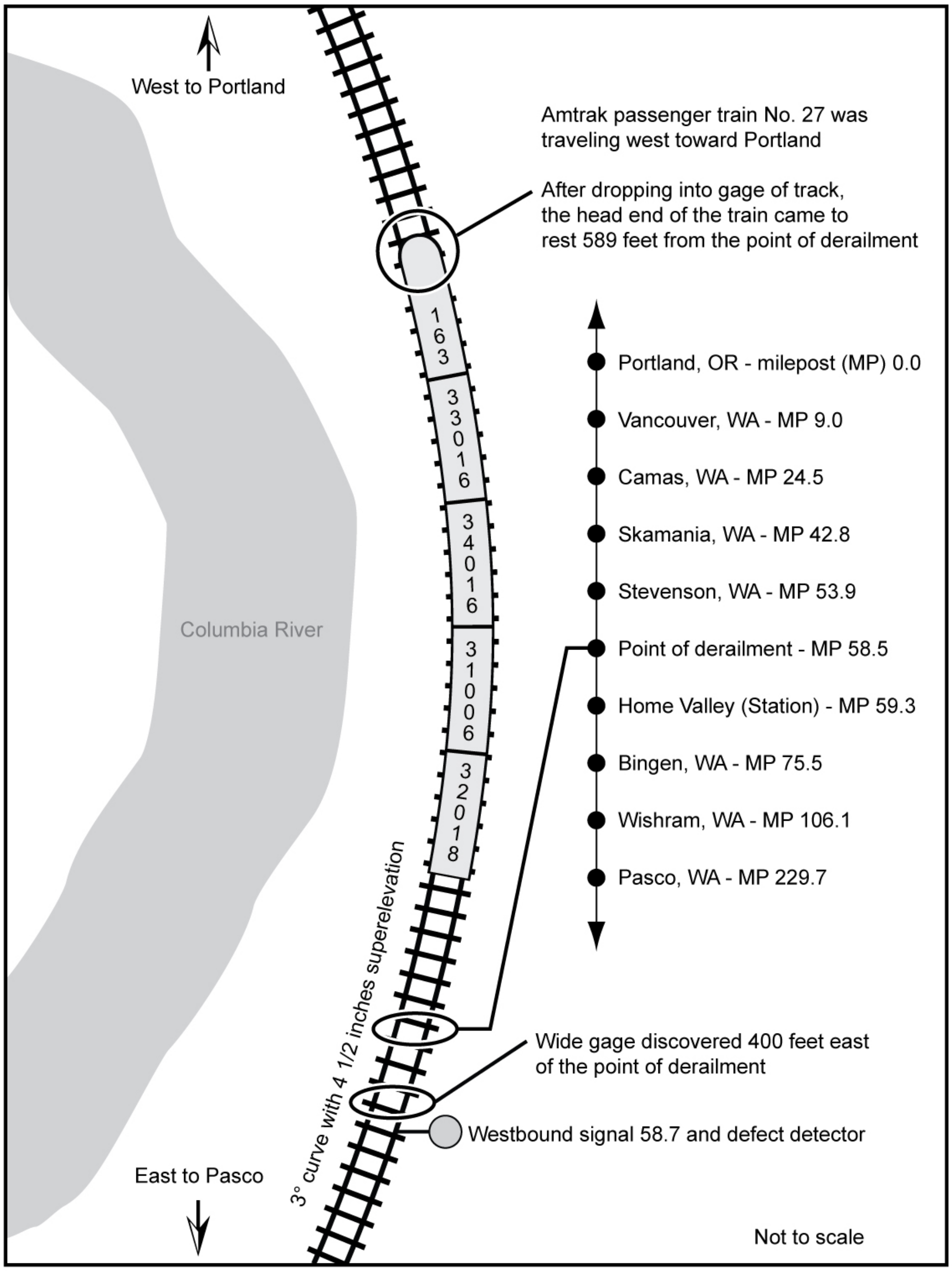

Figure 2. Sketch of accident site.

Rough Track Reports

During the 12 days prior to the accident, four separate “rough riding” reports were made regarding the area where the train later derailed. As further discussed below, the first report was not followed by an inspection, but followup inspections were conducted in response to the subsequent three reports. Only one of the three followup inspections was conducted by the BNSF track inspector regularly assigned to the track area[4] where the accident occurred. The other two inspections were conducted by a substitute BNSF track inspector normally assigned to an adjacent track territory.[5]

The first report of rough track was submitted on March 23, 2005, by a Federal Railroad Administration (FRA) inspector who was riding in the locomotive of Amtrak passenger train No. 27 as it traveled from Pasco to Vancouver, Washington, when he noted two locations in the curve at MP 58.4 causing lateral movement. He e-mailed an FRA inspection report to the BNSF roadmaster[6] in charge of track maintenance for that area. The roadmaster did not inform the track inspectors about the FRA report, nor did he order a followup inspection before the accident.[7]

On March 28, an Amtrak train crew reported to the BNSF train dispatcher that their train rode rough through the area of MP 58.7. Because the track inspector regularly assigned to this area was not available, a substitute BNSF track inspector was dispatched to evaluate the rough track and take appropriate remedial action as required.[8] The inspector walked the track from about MP 58.9 to MP 58.7, found no improper track conditions, and no further action was taken.

Two days later, on March 30, another Amtrak train crew reported to the BNSF train dispatcher that their train rode rough through the area of MP 58.7. The BNSF track inspector regularly assigned to that track territory was subsequently dispatched to evaluate the rough track. The inspector walked the track between MP 58.6 and MP 58.8. He also walked the track between curves No. 58A and No. 58B, which was about 1/4 mile from the area where the accident train later derailed. He identified some low spots in an area near a bridge approach at MP 58.8, about 1,270 feet east of the derailment. He raised and concurrently tamped the crossties.

On April 1, 2 days before the accident, a BNSF train crew reported to the BNSF train dispatcher that their train rode rough through the area of MP 58.7. The same

[4] The regular track inspector’s assigned territory was MP 54.8 to MP 112.8.

[5] The substitute track inspector’s assigned territory was MP 54.8 to MP 9.8.

[6] *Roadmasters* are front-line managers who are responsible for the track maintenance within their assigned territory.

[7] The FRA *Inspection Compliance Manual* recommends that the reporting inspector conduct a followup inspection within 30 to 60 days.

[8] After identifying a track problem, track inspectors are required to repair the track. If they cannot, they must restrict train speed or remove the track from service.

substitute track inspector who had inspected the track on March 28 was again dispatched to evaluate the rough track. The track inspector identified some concrete crosstie abrasion[9] in an area at MP 58.6, about 211 feet east of the derailment. He reported the condition to the BNSF roadmaster. However, no remedial action was taken.

Description of Track

The track where the accident occurred was designated as FRA Class 4, with maximum allowable operating speeds of 60 mph for freight trains and 80 mph for passenger trains. However, because of geographical characteristics and track curvatures, the maximum allowable operating speeds through the derailment area were 55 mph for freight trains and 60 mph for passenger trains.

Approaching the derailment site from the east, there is about 1 1/4 miles of straight track that leads to a series of curves. The first curve, where the derailment occurred, curve No. 58B, is a left-hand 3° curve that is about 1,500 feet long with 4 1/2 inches of superelevation. It is followed by about 500 feet of straight track and then curve No. 58A, a right-hand 3° curve, which is about 1,800 feet long. The track grade through this area is essentially level. This segment of track follows the north bank of the Columbia River.

The track structure was built with 136-pound sections of continuous welded rail (CWR)[10] on concrete crossties. The CWR was affixed to the crossties with “Safelok” clips and insulators. A special concrete tie pad separated the CWR from the concrete crosstie rail seat. (See figure 3.) The concrete tie pad consists of a three-piece pad system. The polyethylene gasket pad is about 1.5 millimeters (mm) thick, and it is placed on the seat of the concrete crosstie underneath a layer of 1.4-mm thick steel and a 6.0-mm heavy-duty plastic pad beneath the base of the rail.

The track structure was supported on cut granite 2-inch stone ballast with an approximate depth of 28 inches under the concrete crossties. The concrete crossties were installed in 1990. Crossties were spaced about 24 inches apart on center, or about 19 crossties per 39-foot rail length. The outside curve rail was replaced in 1996.

[9] See the “Rail/Crosstie Interaction and Abrasion” section of this brief for a detailed explanation of concrete crosstie abrasion.

[10] *CWR* consists of rail segments that are welded together to eliminate rail joints.

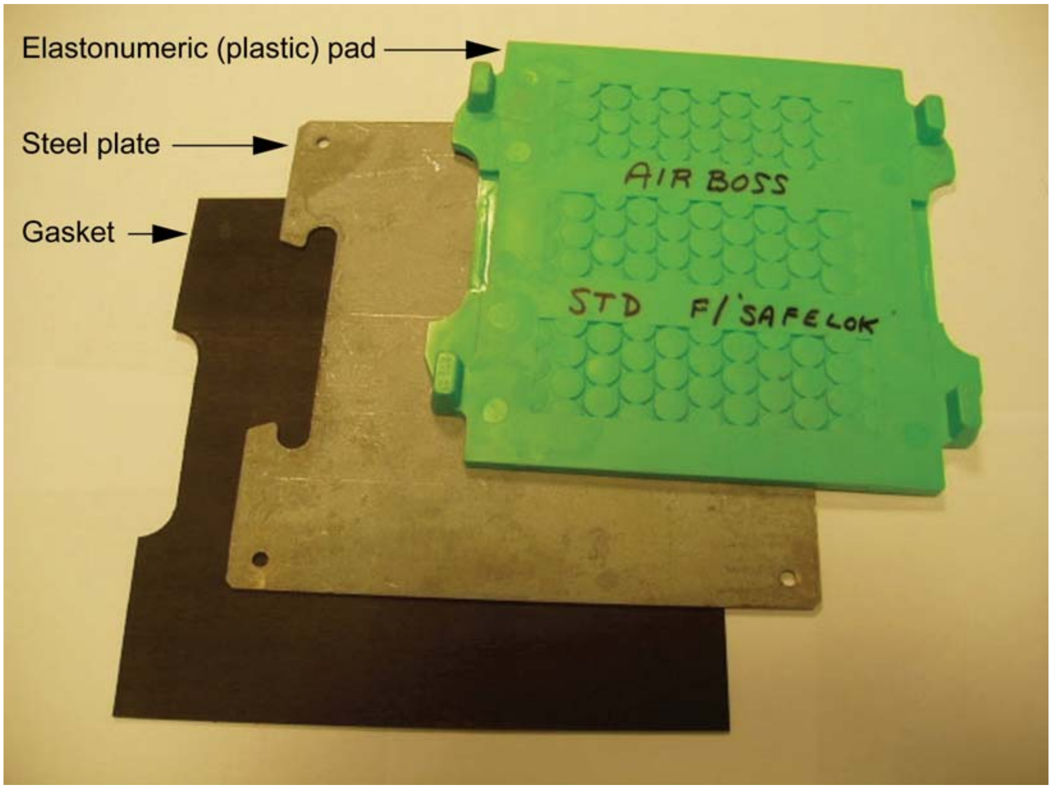

Figure 3. Three-piece tie pad system.

Preaccident Track Inspections

Title 49 *Code of Federal Regulations* (CFR) 213.233 requires that Class 4 track be inspected twice weekly with at least 1 calendar day between inspections. According to BNSF policy, inspectors are also responsible for repairing identified defects that they can handle alone. The BNSF track inspector responsible for the area where the accident occurred inspected the track three times per week: Monday, Wednesday, and Friday. During inspections, he also applied rail lubricant[11] to the outside curve rails on Monday and Friday and to the inside curve rails on Wednesday. For about a month prior to the accident, the track inspector had been working by himself because his helper had been reassigned.

The track was inspected by the BNSF track geometry car[12] on May 25, 2004, and again on September 23, 2004. During both inspections, the area of curve No. 58B was

[11] *Rail lubricant* is used to reduce friction between train wheel flanges and the gage face of the rails.

[12] A *track geometry car* is an on-track vehicle that measures deviations (such as those found in track gage, warp, and twists; crosslevel; and rail cant) as it traverses over the track and compares the measurements to track standard specifications for the class of track and records the measurements when they exceed limiting values.

flagged yellow[13] as a maintenance area for gage.[14] According to the track inspector, the roadmaster did not give him a copy of the September geometry car values until December 2004. Both the regular inspector and the substitute inspector from the adjacent territory indicated that they had received little, if any, training on concrete crosstie inspection. Both inspectors spoke of being "self-taught," and neither inspector indicated that he had received any training about how to read reports generated by the track geometry car.

Prior to the accident, the BNSF had minimal concrete crosstie inspection criteria. In addition, there are no Federal standards specific to concrete crossties in the "Track Safety Standards" for Classes of Track 1 through 5[15] that are similar to those standards for Classes of Track 6 and higher (used for higher speed operations).[16]

The regular track inspector for the area where the derailment occurred stated that his territory included both concrete and wood crossties. The concrete crossties were predominately in the curved track segments. Safety Board investigators asked the track inspector what he did when he observed concrete crosstie abrasion. He said that crosstie abrasion was not considered a track defect in the FRA sense, but if it was a "worse spot,"[17] he would unclip the rail and make an epoxy repair. He indicated that concrete tie abrasion was not a priority item during his track inspections. He also stated that he was not aware of a concrete crosstie abrasion problem in the area of the derailment.

Because of the high amount of train traffic (approximately 57 trains a day over the 58 miles of the inspector's assigned territory), the track inspector said that he had about 1/2 hour or less to get from station to station while inspecting track from a hi-rail vehicle.[18] Stations were about 10 to 15 miles apart. He stated that his track inspection speed varied from 20 to 25 mph. The track inspector stated that on occasion he conducted a walking inspection of the curves but that it had become too difficult after he lost his helper. The BNSF procedures did not require that curves be visually inspected via a walking inspection. Further, the BNSF electronic inspection form did not provide a data field for the track inspector to indicate how he inspected curves. Therefore, there was no record of which curves had been inspected while walking versus from the hi-rail vehicle.

[13] If the track geometry car records a measurement value that is flagged *yellow*, the area is to be watched and maintained/repaired as time allows. When the geometry car records a measurement value that is flagged *red*, the area is verified by visual inspection and measured by a BNSF-designated qualified person following the geometry car. If remedial action is necessary, it is taken at that time.

[14] Track *gage* is the distance between the inner sides of the parallel rail heads in railroad track. For this class of track (Class 4), the nominal gage is 56 1/2 inches with an allowable minimum of 56 inches and a maximum of 57 1/2 inches.

[15] Title 49 CFR 213.109, "Crossties."

[16] Title 49 CFR 213.335(d), "Crossties."

[17] The track inspector categorized "*worse spot*" as concrete abrasion of more than 1/2-inch in depth.

[18] A *hi-rail vehicle* is usually a commercial pickup truck equipped with small-flanged railroad wheels that can be lowered onto the rail to travel on the railroad tracks.

The extent of concrete crosstie rail seat abrasion affects the rail's resistance to rollover. Resistance cannot be ascertained by visual inspections alone. Currently, the best way to reliably measure rollover resistance is through the use of a gage restraint measurement system (GRMS) vehicle[19] in conjunction with the use of a light load fixture.[20] The BNSF did not use its GRMS vehicle over the Fallbridge Subdivision, so rail rollover resistance was not determined.

Rail/Crosstie Interaction and Abrasion

Concrete crossties are primarily used in freight rail systems where wood has failed and in areas where high traffic density and high tonnage trains are typical. Although concrete crossties are much stronger than wood, a potential problem with concrete crossties is the rail seat abrasion that occurs under the tie pads that are placed between the rail and the crossties. In the rail pad contact areas, the cement surface of the tie is abraded by repeated flexing of the rail under load, aided by the presence of moisture and gritting agents. The partially exposed stones aggregate and deteriorate the rail seat area under the pad, thereby reducing the toeloads exerted by the spring clip fasteners. As abrasion of the rail seat increases in depth, the rail head can rotate outward and allow the gage to widen under train traffic. Once the pad area starts to deteriorate, the concrete abrasion process accelerates rapidly, and rail cant[21] is compromised. In the curve where the accident occurred, the outer rail base corner (field side) tended to rotate outward and dig into the crossties. Maintaining rail cant lessens rail rollover tendencies. A rail cant (slope) of 1:40 is used by the BNSF on its concrete crossties and is cast into the rail seat.[22]

Postaccident Track and Record Inspections

The investigation determined that the point of derailment was at MP 58.56 in curve No. 58B. Around that location, there were 19 consecutive concrete crossties that exhibited rail seat abrasion, which ranged in depth from 1/16 inch to 1 1/4 inches into the concrete surface on the field side[23] of the outside curve rail. The abrasions created voids between the bottom of the rail base and the top of the concrete crossties, which allowed the rail to deflect downward and rotate outward under load. (See figures 4 and 5 for two

[19] A *GRMS vehicle* is capable of applying a lateral force on the rails to detect whether gage widens under train wheel loads.

[20] The *light load fixture* is a portable tool that introduces a measurable lateral load on the rail to determine rail rollover resistance.

[21] *Rail cant* is the inward inclination of a rail used to improve wheel/rail contact. This inclination is usually achieved by the use of inclined-surface tie plates; however, on concrete crossties the inclination is cast into the surface of the concrete crosstie.

[22] Some tie plates of 1:14 and 1:30 cant are used primarily in curves. A rail cant of 1:40 is generally used in North America.

[23] Toward the outside of the track.

views of the rail seat abrasion at the derailment site.) This rotation of the rail resulted in gage widening as trains passed over the area. Another sign of the gage widening under the load of the train was the streaking[24] in the center of the rail head of the inside curve rail. The locomotive unit of Amtrak passenger train No. 27 was the first vehicle to derail. It appeared that a wheel first derailed near the deepest abrasion.

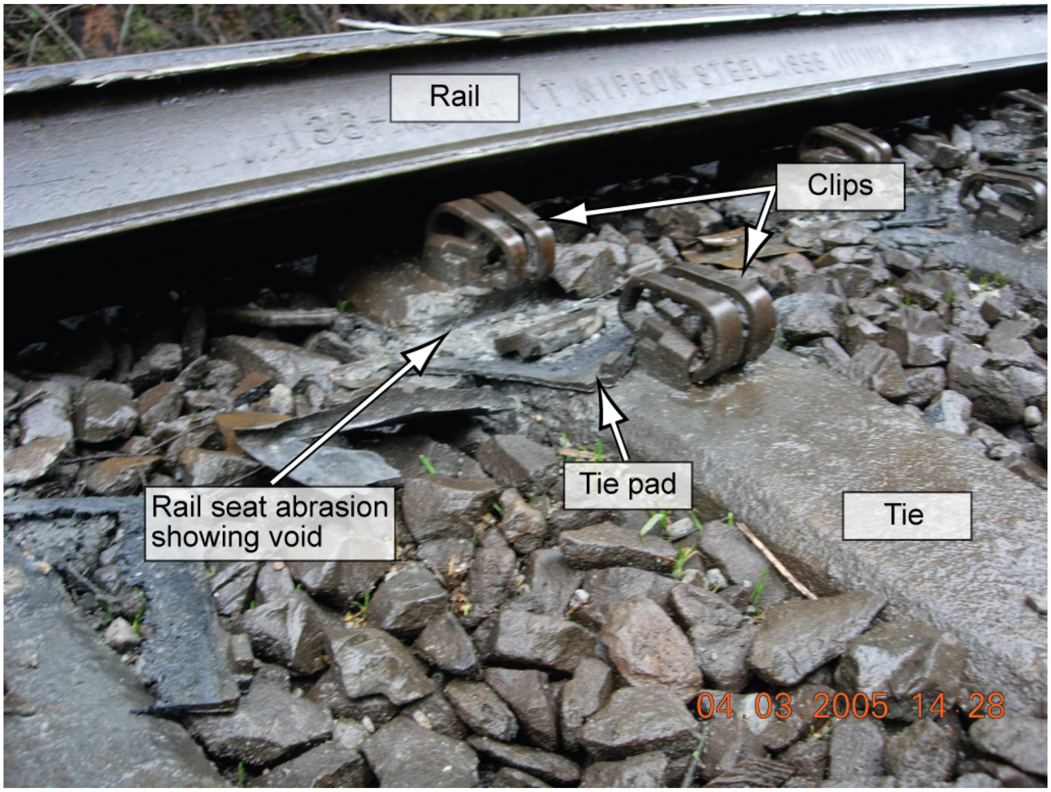

Figure 4. Rail rollover and rail seat abrasion at derailment site.

A second location, about 400 feet east of the derailment, also was discovered to have significant concrete rail seat abrasion. There were 11 concrete crossties in this area that had abrasions at least 5/8 inch in depth, which correspond to a track gage of 58 inches. The maximum allowable gage in 49 CFR 213.53 for Class 4 track is 57 1/2 inches. Three other locations with consecutive abraded concrete crossties that had gage measured at 57 11/16 inches, 57 13/16 inches, and 57 15/16 inches also were discovered in this area.

[24] *Streaking* refers to elongated marks on the inside of the rail head caused by unusual wheel/rail contact as the rails progressively spread apart.

Figure 5. Concrete crosstie abrasion of about 1 inch at derailment site.

The FRA does not specify concrete crosstie abrasion limits for Classes of Track 1 through 5. It does have abrasion limits for Classes of Track 6 and higher. Although the FRA did not issue the BNSF violations for concrete crosstie abrasion, the FRA did issue the BNSF violations for wide gage track defects at both the point of derailment and 400 feet east of the derailment site.

The BNSF track inspection records were examined to determine whether the records reflected the concrete crosstie conditions found after the accident and also to determine whether the records were accurately completed. The FRA found numerous report completion defects and three report completion violations as a result of its review of the records. A hi-rail and walking inspection of curves No. 86A, No. 86B, No. 112A, and No. 112 within the subdivision was also conducted. No exceptions to FRA standards were noted, but there were several concrete tie pads not properly seated.

Four concrete crossties from the derailment zone were tested at a private laboratory to determine whether the crosstie material met American Railway Engineering and Maintenance of Way Association (AREMA) specifications. The results showed that the structural characteristics of the concrete crossties were within AREMA specifications.

Track Personnel Information

The regular track inspector was hired by the BNSF in 1995 as a laborer on a tie replacement production crew. Since then he had worked as a truck driver, track foreman, and track inspector. From January through July 2001, he also temporarily taught engineering instructions and rules. However, the track inspector had not been evaluated by the BNSF track inspector audit program,[25] which is designed to ensure a track inspector's knowledge and ability.

The substitute track inspector was hired in August of 1995 by the BNSF as a track laborer, a position he had held intermittently for more than 9 years prior to the accident. He also held several other track related positions, which varied depending on seniority and railroad needs. In January 2005, he became a track inspector for the first time. He spent the first month inspecting the branch line of the Oregon Trunk Subdivision and was then assigned to the Class 4 main line track from MP 54.8 to MP 9.8 for the 2 months prior to the accident. He had not yet been evaluated by the BNSF track inspector audit program.

The roadmaster was hired by a BNSF predecessor, the Santa Fe Railroad, in 1966. Throughout the 1970s and 1980s, he worked a number of positions, including track inspector, rail train supervisor, and welding foreman. In 1993, he was assigned as the division roadmaster in San Bernardino, California; and in 1999, he became roadmaster of the railroad that included the accident site. At the time of the accident, the roadmaster oversaw the railroad from McCree, MP 158.4, to McGaughlin, MP 14.9, which was about 134 main line track miles and 6 branch line miles. He also supervised 3 track inspectors and 20 section workers.

Postaccident Developments

After the Home Valley derailment occurred, the BNSF changed its engineering practices by developing an annual training module for concrete crosstie abrasion and issuing an informative *Engineering Newsletter* on "Concrete Tie Rail Seat Abrasion," dated April 2005, and System General Order 27, dated February 2006. The BNSF has since incorporated the information from all of these sources into new Engineering Instruction Standards entitled *Concrete Tie Handbook*, dated August 2006. The handbook has been distributed, and training has been provided to track maintenance and inspection personnel regarding the following:

- Rail seat abrasion
- Causes of rail seat abrasion
- Signs and symptoms of rail seat abrasion

[25] The BNSF considers the *track inspector audit program* to be a form of training.

- Geometry car data potential indicators of rail seat abrasion
- Preventing and containing rail seat abrasion
- Concrete crosstie rail seat abrasion repair
- Minimum walking inspection requirements for concrete crosstie curves

The BNSF has reported that it is implementing fastener improvements to reduce the problem of concrete crosstie abrasion and enhancing technology to identify when multiple problem reports ("trouble tickets") are submitted within a 30-day period. Currently, when multiple trouble tickets are submitted within a 30-day period, dispatcher maintenance desk personnel apply a 25-mph speed restriction in the area. Afterward, a BNSF supervisor is required to conduct an inspection and sign a release prior to removal of the speed restriction.

BNSF Track Inspector Audit Program

The BNSF track inspector audit program includes a checklist of knowledge and skills that a track inspector is required to demonstrate to a group of roadmasters from different territories. The intent of the audit program is to identify any weaknesses inspectors may have and then to coach, counsel, and retrain the inspectors. Prior to the accident, the checklist did not include a description of concrete crosstie abrasion nor explain what to do about it when it was observed. As of May 2006, the BNSF reported that it has begun to audit its track inspectors on their recognition of the signs and symptoms of rail seat abrasion.

Sprague, Washington, Derailment

On January 28, 2006, another Amtrak train derailed on the BNSF's Northwest Division.[26] The derailment occurred in a curve near Sprague, Washington. The BNSF identified concrete crosstie abrasion and wide gage as factors in that accident. Further, as in the Home Valley accident, the locomotive unit was the first vehicle to derail in the accident that took place near Sprague.

[26] No "rough riding" track conditions were reported prior to the January 28, 2006, derailment.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the April 3, 2005, derailment of Amtrak passenger train No. 27 near Home Valley, Washington, was the BNSF Railway Company's inadequate response to multiple reports of rough track conditions that were subsequently attributed to excessive concrete crosstie abrasion, which allowed the outer rail to rotate outward and create a wide gage track condition. Contributing to the accident was the Federal Railroad Administration's failure to provide adequate track safety standards for concrete crossties.

Recommendations

As a result of its investigation of the April 3, 2005, Amtrak train derailment near Home Valley, Washington, the National Transportation Safety Board made the safety recommendations listed below. For more information about these recommendations, see the safety recommendation letters[27] to the recipients.

To the Federal Railroad Administration:

> Extend to all classes of track safety standards for concrete crossties that address at a minimum the following: limits for rail seat abrasion, concrete crosstie pad wear limits, missing or broken rail fasteners, loss of appropriate toeload pressure, improper fastener configurations, and excessive lateral rail movement. (R-06-19)

To the BNSF Railway Company:

> As part of your track inspector audit program, determine whether inspectors are provided adequate track time to perform their duties, and take corrective action if necessary. (R-06-20)

[27] These letters are available on the National Transportation Safety Board's web site.

To the Association of American Railroads and the American Short Line and Regional Railroad Association:

> Using the circumstances of the April 3, 2005, accident near Home Valley, Washington, emphasize to your members through your publications, web site, and conferences, as appropriate, the need to establish inspection guidelines for track inspectors that address the problems and characteristics unique to concrete crossties for all classes of track. As your members develop these guidelines, encourage them to consider the elements in 49 *Code of Federal Regulations* Part 213, "Track Safety Standards," for concrete crossties for Classes of Track 6 and higher. (R-06-21)

To the American Railway Engineering and Maintenance of Way Association:

> Using the circumstances of the April 3, 2005, accident near Home Valley, Washington, emphasize to your railroad members through your publications, web site, and conferences, as appropriate, the need to establish inspection guidelines for track inspectors that address the problems and characteristics unique to concrete crossties for all classes of track. As your railroad members develop these guidelines, encourage them to consider the elements in 49 *Code of Federal Regulations* Part 213, "Track Safety Standards," for concrete crossties for Classes of Track 6 and higher. (R-06-22)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

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Adopted: October 18, 2006