SMART TRANSPORTATION DIVISION
NATIONAL SAFETY TEAM

INTERNATIONAL HEADQUARTERS
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BEFORE THE NATIONAL TRANSPORTATION SAFETY BOARD
NTSB Case Number: RRD21MR017

Location: Joplin, Montana

Date: September 25, 2021

Accident Overview, Contributing Factors, and Safety Recommendations in connection with the derailment and subsequent fatalities that were sustained on September 25, 2021, when Amtrak Train No. 7 derailed near Joplin, Montana

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SUBMISSION

Accident Overview

On September 25, 2021, at 3:47 p.m. local time, Amtrak Train No. 7 (Empire Builder), which originated on September 24, derailed at Mile Post 1014.57 near Joplin, Montana. As a result of the accident, eight cars were derailed. Four cars derailed onto their sides, one car derailed leaning, two cars derailed upright, and one car derailed the trailing truck. The locomotives and the front two cars remained on the rail. There were 141 passengers, four operating crew, and nine onboard service personnel, for a total of 154 people on board the train. Three passengers who were onboard were fatally injured. There were an additional 28 passengers and crew transported and/or treated for injuries. Eleven of those required hospitalization.

Crew Interview:

A post-accident interview of the operating crew was conducted on September 27, 2021, at the Amtrak depot in Shelby, Montana. The operating crew consisted of an Engineer, Co-Engineer, Conductor and Assistant Conductor. The head end crew of Engineer and Co-Engineer stated they had reported for duty on September 25, 2021, at 0821 hours, local time, in Minot, North Dakota.[1] Upon arrival for duty, general track bulletins were obtained, a safety briefing occurred between crew members, and an air test of the train was conducted. The crew logged into positive train control and departed Minot at 0906 hours, on time.

The Assistant Engineer ran first and then swapped running the engine with the Engineer at every passenger stop enroute to their final crew destination at Shelby. At Havre, Montana, they switched for the last time and departed west. As the train approached East Buelow siding, the Engineer reported a severe jerk to the right, then to the left, then to the right again, and the train went into emergency braking. The Engineer made an emergency call to the BNSF dispatcher on the radio. The other Engineer went back to shut down power to the train and assist with the evacuation and rendering aid to the passengers.

On September 26, 2021, the investigative group viewed the outward-facing video taken from the in-cab camera on Amtrak Locomotive ATK 74, which was the lead locomotive on the train, as well as from two BNSF trains that had traversed the location prior to Amtrak Train No. 7.

First video viewed was from eastbound BNSF train ZSSECHC724, which traversed the area at approximately 1430, local time.[2] The train was traveling at approximately 40 mph when a deviation in the track was observed at which was later identified as MP 1014.5. The north rail appeared to be low and a misalignment of the track was evident. As the train went over the spot, the train exhibited significant lateral movement. The next video that was reviewed was from

[1] Human Performance Group factual report, page 2
[2] Operations Group factual report, page 13

BNSF train QPLLCHC323, another eastbound train that passed through the area at 35 mph at approximately 1442, local time. The video clearly showed the misaligned track. As it passed over the spot, lateral movement of the locomotive was evident.

Last video reviewed was from Amtrak Train No. 7, which was a westbound train. As the train approaches the area of the track deviation, the video shows what appears to be a worsening of the deviation. As the locomotive passed over the location, it shook laterally right (north), then left, and then right again, before the train began to slow and eventually stop.

Previous movements over the area were reviewed to determine if train handling or excessive braking caused or contributed to the severity of the misalignment. The operations group reviewed the event recorder data from the trains listed below that traversed the area prior to Amtrak Train No. 7.

6:16:19 AM WEST Z CHCPTL6 23W

7:00:24 AM EAST X VAWDYO9 22H

9:20:33 AM EAST V TACLPC1 22F

10:15:11 AM WEST G AGMKAL9 22H

10:55:49 AM EAST Z PTLCHC7 24A

11:56:41 AM EAST X PASULE9 22H

12:11:01 PM EAST Q SSECHC1 23A

12:40:18 PM WEST G PBNVAW9 23A

2:30:50 PM EAST Z SSECHC7 24A

2:47:19 PM EAST Q PTLCHC3 23A

The reviewed data indicated that the train handling methods utilized by the ten engineers were within normal operating parameters for the area and excessive braking did not cause or contribute to severity of the alignment deviation.[3]

The event recorder from Amtrak Train No. 7 was reviewed on September 26, 2021, by the operations group.

[3] Operations Group factual report, page 15

The wheel on lead locomotive ATK 74 was physically measured by Amtrak personnel at 39 inches.

Below is an overview of the event recorder data:[4]

At 3:57:03 p.m., one-quarter mile from the train line-induced emergency, the throttle was in Notch 8 and the speed of the train was 78 mph.

Between 3:57:03 p.m., and 3:57:35 p.m., when the train line-induced emergency occurred, the Engineer changed throttle notches a couple times between Notch 8 and Notch 5/6.

The train line-induced emergency occurred at 3:57:35 p.m., with the train traveling 77 mph. At the same time as the train line-induced emergency, the throttle was changed from Notch 8 to Notch 2. At the time of the train line-induced emergency, independent brake cylinder pressure begins to build, but then shows being released by actuation of the independent brake. Six seconds after the train line-induced emergency, the event recorder shows an engineer-induced emergency application; no additional braking is present (dynamic or independent). Nine seconds after the train line-induced emergency, blended braking shows up on the event recorder.

After the train line-induced emergency, the head end portion of Amtrak Train No. 7 traveled 875 ft in 19 seconds as it came to a stop. Event recorder data from lead locomotive ATK 74 indicates that the train handling methods utilized by the Engineer were within the normal operating parameters for the area and did not cause or contribute to the severity of the accident.

Review of the Track and Engineering Group Factual Report:

The Hi-Line Subdivision extends from milepost 964.8 in Havre, Montana, to milepost 1217.5 in Whitefish, Montana, in a timetable east-west direction.[5] The mileposts on the Hi-Line 7 Subdivision increase when traveling in a westward direction. The subdivision consists of 133.40 miles of single main track and 119.30 miles of double main track with thirteen passing sidings. Maximum authorized timetable speed is 79 mph for passenger trains and 60 mph for freight trains under 100 ton per operative brake and 55 mph for 100 ton and over per operative brake. Where the maximum authorized speed is 79 mph for passenger trains, the FRA

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[4] Operations Group factual report, pages 16, 17

[5] Track Factual report, page 8

requires compliance with FRA Class 4 Track Safety Standards (TSS). FRA requires that main tracks be inspected twice weekly, with at least one day between inspections. In addition to being a passenger route, the Hi Line Subdivision is a high tonnage and hazardous materials route.

The point of derailment was determined to be MP1014.57 along the high side rail running in curve 1014.[6] Evidence of the high rail departure marks indicate the high side (south rail) derailed to the outside of the high rail. Impact markings on the high rail, approximately 11 feet west of the point of derailment, appear to be from an inside wheel brake disc.

Recent Maintenance History:

On 7/23/21, a plug rail[7] was installed on the low side at the west end of curve 1014 due to a 10% defective weld. The defect was detected by a rail flaw detection car. Upon the post-accident inspection, both 36" standard joint bars had the required four track bolts, nuts and washers installed. Investigators noted that the east suspended plug rail joint had evidence of train wheel flange contact at the top surface of the gauge side joint bar.

Between 8/26/21 and 8/27/21, 700 cross ties were installed between MP1014.00 and MP 1015.00. On 9/2/21, a surfacing crew went through and surfaced the track and a temporary 30 mph speed restriction was placed. On 9/3/21, the temporary speed restriction was raised to 45 mph, and on 9/4/21 the speed restriction was removed.

Post-accident investigators noted an inconsistent rail anchoring pattern between milepost 1014.00 to milepost 1014.60, with both locking style and channel style rail anchors being utilized on both the high-side and low-side running rails. The newly installed crossties had a consistent "box 4 anchored" rail anchoring pattern on the high-side and low-side running rails with the rail anchors being tight and sound up against both sides of the crossties. The older existing ties had an inconsistent rail anchoring pattern between milepost 1014.00 and milepost 1014.60, whereas rail anchors were missing, and most of the rail anchors were not tight and sound up against the sides of the crossties. Investigators measured

[6] Track Group factual report, page 17. See Figures 3 and 4, pictures depicting departure marks from wheels.
[7] Plug rail means a length of rail that has been removed from one track location and stored for future use as a replacement rail at another location.

longitudinal rail movement between 1.5-inches to 4-inches under spike heads and through rail anchors. Further inspections showed indications of track lateral movement on both ballast shoulders by the indications of ballast voids at the ends of the crossties in the east tangent area of the track. Investigators measured some ballast voids at the ends of the crossties to be up to 2” in length.

Video Technical Review:

A camera mounted on the lead locomotive windshield recorded video that showed laterally displaced rails ahead of the train. Figure 1 shows one frame from that video. This and other frames from the video were used to estimate the maximum lateral displacement of the rails from their undamaged location. The video was recorded by a March Networks video system.[8] It had 702 x 240 resolution that the March Networks DVR Player stretches vertically to generate 702 x 480 video for viewing and for video frame extraction. The video frame in Figure 1 is in the 702 x 480 format. The frame rate of the video was 15 frames/second.

Figure 1

[8] Joplin Video Study, page 2

Video captured by a locomotive camera was used to estimate the maximum lateral displacement of the right and the left rails and the length of the damaged track section at a location where rail cars derailed. It was estimated that the maximum lateral displacements of the rails were 2.9±1.0 inches, the length of the track where the lateral rail displacements were significant was about 40 feet, and the total length of the damaged track section was about 60 feet.

Contributing Factors

1. There was a plug rail installed using joint bar and bolts, and the plug rail had not been welded.[9] Investigators noted that the east suspended plug rail joint had evidence of train wheel flange contact at the top surface of the gauge side joint bar.[10] The plug rail was installed and the following specifications were noted: Gap: 1.75 inches, Pull: 1.75 inches, Rail temperature: 55°, Prebreak RNT: 105.56°, and final RNT: 105.56°.[11] Plug rails were welded on August 18, 2021, at MP 1014.750; the right and left rails were welded with final rail neutral temperatures of 127°.

2. On August 22, 2021, rails at MP 1014.270 left and right rail, the right rail's final rail neutral temperature was 125°; final rail neutral temperature on the left was 130°; and the recommended rail neutral temperature was 95° as per BNSF's TRLT regional map.[12] BNSF has established CWR rail "target neutral temperatures" (TNT's), or target rail laying temperatures (TRLT's), which provides a specific desired rail neutral temperature to prevent track buckling occurrences.[13]

[9] Track Group factual report, page 22, plug rail was installed on July 23, 2021

[10] Track Group factual report, page 10, investigators noted that the east suspended plug rail joint had evidence of train wheel flange contact at the top surface of the gauge side joint bar. See Figure 2 in the factual report.

[11] Track Group factual report, page 24, BNSF list of mobile in track welding and rail adjustments.

[12] Track Group factual report Figure 5, BNSF target rail laying temperature reference map.

[13] A rail's "rail neutral temperature" (RNT) is defined as the temperature at which a rail is neither in tension, nor compression. To safely control CWR rail tension and compression forces (rail longitudinal movement), BNSF has established CWR rail "target neutral temperatures" (TNT's), or target rail laying temperatures (TRLT's), which provides a specific desired rail neutral temperature to prevent track buckling occurrences.

Safety Recommendations

Recommendations to BNSF are as follows:

1. Plug rails that have been installed should be welded within 30 days. A railroad must properly maintain CWR rail, and its desired neutral temperatures, specific maintenance, inspection, and reporting procedures and processes must be followed to prevent the risk of track buckling occurrences in hot weather and rail pulling-apart in cold weather.

2. The track inspector said in his interview he had worked a lot of 7-day work weeks on multiple subdivisions[14], and, when asked about a typical work week, the inspector stated that he worked about 100 hours per week but that he gets his required FRA inspections completed.[15] Working that many hours and that many territories bring in to question the quality and the detail of the track inspection. Relief should be provided to this individual.

Recommendations to FRA are as follows:

1. Heavy tonnage freight railroads hosting Amtrak and other passenger railroads should be mandated to have more visual track inspections as the track design and curves on freight railroads are not engineered or maintained for lighter passenger trains. The current push from freight railroads is to move to automated track inspections; however, these inspections only look for 26 percent of the items required in the Code of Federal Regulations.[16] (See Table 1 on page 10). While the machines can augment the work of human track inspectors, they are not a substitute for human inspections; and replacing human inspections with machine inspections makes the railroads less safe, not safer. Regulation 49 CFR 213.233 mandates certain minimum frequencies of human visual track inspections depending on track type. The regulation also requires immediate remediation of track defects, which can be done by track inspectors, but not by machines.

2. To perform an adequate track inspection required under 213.233, all of the following items must be inspected: Roadbed (drainage and vegetation);

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[14] Track Group factual report, page 56

[15] Track Group factual report page 58. The inspector stated that he worked about 100 hours per week but stated that he gets his required FRA inspections completed.

[16] Code of Federal regulations, Subpart 213.233, visual track inspections

Track Geometry (track gauge, track alignment, curves; elevation and speed limitations); Track Surface (combined track alignment and surface deviations); Track Structure (ballast, crossties, defective rails, rail end mismatch, continuous welded rail, rail joints, tie plates, rail fastening systems, switches and derails); Automotive or Railroad crossings at grade; and Right of Way (trespassers, suspicious items, vandalism). A qualified track inspector is expected to look simultaneously for all of these sorts of track defects and to consider whether deviations or deformities in these categories that might not constitute defects on their own, together constitute conditions that must be remedied. Currently, Class 4 track requires that main tracks be inspected twice weekly with at least one day between inspections. The last inspection on this track was 9/23/21, two days prior to the derailment.[17] A compelling argument can be made that more visual track inspections could be beneficial to both the host (heavy tonnage railroads) and safer for passenger railroads as the increased visual inspections provide more information on current track conditions. Cost of increased inspection should not be a factor as the safety of all human beings on board any train, whether passenger or freight, must be paramount.

[17] Track Group factual report, page 57

Key: x= Inspected for X = NOT Inspected For

	FRA Defects	Human Visual	ATI
Sub Part B	**Roadbed**		
	213.33 - Drainage	x	X
	213.37 - Vegetation	x	X
Sub Part C	**Track Geometry**		
	213.53 - Gauge	x	x
	213.57 - Curves, Elevations, and speed limitations	x	x
	213.55 - Track alinement	x	x
	213.59 - Elevation of curved track; runoff.	x	x
	213.63 - Track surface	x	x
	213.65 Combined track alinement and surface deviations	x	x
Sub Part D	**Track Structure**		
	213.103 - Ballast; general	x	X
	213.109 - Crossties	x	X
	213.113 - Defective rails	x	X
	213.115 - Rail end mismatch	x	X
	213.121 - Rail joints	x	X
	213.122 - Torch cut rail	x	X
	213.123 - Tie plates	x	X
	213.127 - Rail fastening systems.	x	X
	213.133 - Turnouts and track crossings generally	x	X
	213.135 - Switches	x	X
	213.137 - Frogs	x	X
	213.139 - Spring rail frogs	x	X
	213.141 - Self-guarded frogs	x	X
	213.143 - Frog guard rails and guard faces; gage	x	X
Subpart E	**Track Appliances and Track-Related Devices**		
	213.205 Derails	x	X
Non-Regulatory			
	Trespassers	x	X
	Vandalism	x	X
	Track Obstructions	x	X
	Right of Way	x	X

Table data consistent with industry raw data available in the federal register under ATI test raw data.

Table #1 provided courtesy BMWE Roy Morrison, Director of Safety.

Recommendations to Amtrak are as follows:

1. Video reviewed from Amtrak was used to determine the distance of shift in the track. In looking at the factual report from the NTSB, it becomes abundantly clear the camera resolution and the frames per second of the camera used on Amtrak Engine No. 7 are relatively low for still imaging. The camera used was March Networks video system. It had 702x240 resolution that the March Networks DVR Player stretches vertically to generate 702x480 video for viewing. The frame rate of the video was 15 frames/second. These specifications are barely usable for determining any useful information in a still picture (See Image 2 on page 11.). This is the second incident this investigator has been involved in where the outward-facing video was crucial in determining what happened during an incident. The train was traveling roughly 78 mph, which equals approximately 115 feet per second divided by 15 frames per second equals 7.5 feet per frame. A

frame-by-frame review shows Amtrak Train No. 7 approaching the track deviation the next frame it is on top of it and no longer visable. Video systems with much higher resolution and more frames per second are readily available and would allow for a more detailed analysis, resulting in a smaller error rate.

Image #2 from Amtrak Train No. 7 depicting track deviation. The lack of resolution is evident.

2. During the human performance group interview of the crew members, the conductor detailed his efforts to assist in the extrication of passengers from the damaged and overturned cars. The difficulty came when passengers had to be evacuated from windows and lowered to the ground. At times the conductor was using his own leg as a step to assist the passengers in getting out. He added that if the cars were equipped with emergency ladders the extrication process would have been easier and faster. As it was, passengers had to be lowered to the ground with the assistance of others until the emergency responders arrived.

3. The conductor remembers the emergency light was not working, so the cars were dark and someone was using a flashlight. He stated he was unable to get to the glow sticks in the tipped over cars.

4. He also said they could have used more sterile gloves in the emergency kits and more training on how to delegate authority in an emergency.

Amtrak should look at these issues and develop a plan to address the following safety concerns:

1. The outward-facing video recorders in their fleet should be upgraded to a modern system with higher resolution and clarity.

2. Passenger cars and locomotives should be equipped with emergency ladders.

3. Emergency lighting needs to be tested and repaired.

4. First aid kits should be audited and supplemented with extra gloves.

5. Additional training should be provided to crew members on how to handle catastrophic incidents.