NATIONAL TRANSPORTATION SAFETY BOARD

Office of Railroad, Pipeline and Hazardous Materials Investigations
Washington, DC

Track Factual Report

RRD18FR009

Collision between BNSF Intermodal Freight Train and BNSF CWR Work Train

Kingman, Arizona
June 05, 2018

Accident Summary:

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

Figure 1. Drone aerial photo of the accident collision. Picture courtesy of BNSF.

Rail Unloading Machine (RUM) Operations:

Herzog designed a Department of Motor Vehicles approved over-the-road tractor-trailer type truck with an attached rear-working trailer assembly that is equipped with both rubber tires and retractable railroad wheels[1] that makes it capable of traveling on railroad tracks (see figure 2). This unit is called the rail unloading machine or the RUM. This unit can be self-propelled and powered as a single unit or coupled to and powered by a freight train via a normal railroad

[1] Retractable railroad wheels or also known as hi-rail wheels are railroad wheels bolted to an electric or hydraulic retractable axle and mounted underneath a car or truck like vehicle that can be operated on public highways via rubber tires or operated over railroad tracks via its retractable railroad wheels.

coupler. BNSF contracts out the Herzog RUM unit for their continuous welded rail[2] (CWR) unloading operations. At the time of the accident the RUM was coupled to the rear of a CWR rail work train No. W-NEESGM1-05R.

The rear-working trailer is equipped with hydraulic extending "boom type" arms and rail handling attachments that unloads rail from a continuous welded rail train[3], and strategically places the CWR in staked out locations. The rear-working trailer is attached to the truck via a fifth-wheel or tractor-trailer attachment[4]. The rear-working trailer is equipped with a two-person operating cab equipped with two high-back "captains" chairs, where employees are seated to operate the joy-stick controlled rail unloading attachments (see figures 3 & 4). Herzog contract employees operate the CWR rail handling attachments and directs the movement of the CWR work train through radio communications with the work train conductor and engineer. When the R.U.M unit is coupled to the rear of a work freight train, a BNSF brakeman is positioned inside the cab to protect the trains backing or "shoving moves[5]" by providing "car-counts[6]" or a clear site distance measurement to the conductor.

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[2] Continuous welded rail or CWR means rail that has been welded together into lengths exceeding 400 feet.
[3] A continuous welded rail or CWR train is a train equipped with specialized coupled flatcars used to transport long lengths of rail to locations along the railroad for unloading and installation.
[4] A fifth wheel or tractor-trailer hitch is a hitch that provides the link or connection between a semi-trailer and a towing truck or tractor via a locking king pin.
[5] Shoving move means to reverse train directions with the locomotives now pushing the train backwards.
[6] Car counts is a clear to move sight distance when shoving in the reverse direction. Usually one car count equals fifty feet.

Figure 2. Photo of Herzog's rail unloading machine or RUM.

Figure 3. Photo of the RUM's attached trailer, work cab and rail handling attachments.

Figure 4. Photo of a high-back chair where the CWR rail attachments are operated via joy sticks


Figure 5. Photo of the RUM unloading rail from a CWR work train. Picture courtesy of BNSF.

BNSF's Continuous Welded Rail Work Train:

BNSF utilizes a freight train with specialized coupled flat cars for transporting long lengths of CWR to locations for loading and unloading operations. A fully loaded CWR train carries 72- rails, each measuring 1,680 feet in-length for a total rail length of 120,960 feet of CWR. The CWR rails are positioned and stacked on the rail flatcars six rails or tiers high and twelve rails wide for a total of 72- rails weighing 2,741.76 tons. The last flatcar in the CWR train is equipped with two working platforms or catwalks that span over-top the rails where maintenance-of-way employees are stationed to prep the rails for either transport or unloading operations (see figure 6). The CWR rail work train No. W-NEESGM1-05R that was involved in the accident consisted of two forward facing locomotives and 29- rail cars loaded with 38- CWR rail strings, each measuring 1,680- feet in length totaling 63,840 feet of CWR. The rail train had the lower 3- tiers by 12- pockets loaded for a total of 36- rails. Tier 4 had 2- additional rails loaded in pockets 5 and 6 totaling 38- rails overall. The total CWR weight carried totaled

1,447.04 tons. The work train was 1,800 feet in-length, which included the two locomotives and the coupled Herzog RUM. BNFS uses 1,680- feet lengths of continuous weld rail for areas needing new rail, especially in curved track areas.

Figure 6. Photo of the last CWR flatcar with the 2- catwalks that span overtop the rails.

Consequences Prior to the Collision:

On June 5, 2018, CWR work train- W-NEESGM1-05R with the RUM coupled at the rear of the train was unloading 1,680-feet lengths of CWR on main track 1. The work train was occupying a block between westbound intermediate signal 478.707 and East Valentine and was moving back and forth between the signals to unload the rail. Once the work train was completed with the rail unloading operations, the train was instructed to reverse eastbound to drop off an employee at a clearing to get his vehicle. The work train consisting of two forward facing locomotives and 29- rail cars loaded with 63,840- feet of continuous welded rail reversed eastward with the lead unit now being the RUM. As the work train reversed eastbound at about 9- mph in an 8° ascending track grade curve, it collided with an approaching westbound intermodal freight train that was in the same block. One Herzog employee was killed in the collision and another Herzog employee was trapped in the wreckage and severely injured. Both Herzog employees were occupying the RUM trailer cab at the time of the collision. One BNSF maintenance-of-way employee jumped from the rail trains rear platform/catwalk which is located closest to the RUM trailer (Figures 1 & 5) prior to the collision. The remaining two BNSF Maintenance-of-way employees remained on the platforms/catwalks (figure 6) during the collision. These platforms/catwalks known as the tie down car is located near the center of the rail train. A BNSF brakeman that was positioned in the RUM's driver seat jumped from the unit after placing the train into an emergency brake application prior to the collision. A review of the downloads revealed at 14:50:23.8-MST; the engineer of the work train initiated the emergency braking application and not the brakeman in the RUM. No BNSF employees reported to be injured.

At the time of the collision there was a total of eight workers positioned on the work train as follows:

- 1- BNSF engineer located in the front locomotive
- 1- BNSF conductor located in the front locomotive
- 3- BNSF maintenance-of way employees located on the flatcar platforms/catwalks
- 2- Herzog employees located in the RUM trailer cab (1- fatal and 1- severely injured)
- 1- BNSF brakeman located in the RUM's semi-cab driver seat

Federal Railroad Administration- Track and Rail and Infrastructure Integrity Compliance Manual- Volume III Railroad Workplace Safety- Chapter 3 Roadway Worker Protection:

The Federal Railroad Administration (FRA) released in March 2018 a compliance manual that provides the railroad industry with interpretations of and guidance on the Railroad Workplace Safety regulations covered in Title 49 CFR Part 214. Chapter 3- Roadway Worker Protection breaks the interpretations and guidance down into seven sub-parts: Introduction, Summary, Principles, Railroad On-Track Safety Programs, Documentation of On-Track Safety Programs, Section by Section Guidance on Roadway Protection Rule, and Appendix- Defect Codes.

FRA's summary of Roadway Worker Protection Rule states the following- "The Roadway Worker Protection Rule requires railroads and contractors to railroads to devise and adopt procedures to protect their roadway worker employees from being struck by trains and other on-track machinery. The rule also requires roadway workers to follow the on-track safety procedures in order to protect themselves and others dependent upon them. Each railroad employer is required to have in place an on-track safety program, including rules, procedures, training, and equipment, to be used for the protection of roadway workers".

FRA continues to break the rule down into five elemental parts. The manual states the following:

Principles- The rule is based upon a few elemental principles:

1. A person not fouling a track will not be struck by a train.
2. A person who is fouling a track upon which a train will not move will not be struck by a train.

3. No person should foul a track unless that person:
    a. Knows that no train will arrive, or
    b. Will be able to move to a place of safety before the train arrives.
4. Each roadway worker bears the ultimate responsibility for his or her on-track safety.
5. Each employer is responsible for providing the means for achieving on-track safety to each roadway worker employee.

FRA defines the following Railroad Workplace Safety terminology in Title 49 Part 214.7:

On-Track Safety- "means a state of freedom from the danger of being struck by a moving railroad train or other railroad equipment, provided by operating and safety rules that govern track occupancy by personnel, trains and on-track equipment".

Fouling a Track- "means the placement of an individual or an item of equipment in such proximity to a track that the individual or equipment could be struck by a moving train or on-track equipment, or in any case is within four (4) feet of the field side of the near running rail".

Roadway Work Group- "means two (2) or more roadway workers organized to work together on a common task".

Roadway Worker- "means any employee of a railroad, or of a contractor to a railroad, whose duties include inspection, construction, maintenance or repair of railroad track, bridges, roadway, signals and communications, electric traction systems, roadway facilities or roadway maintenance machinery on or near track or with the potential of fouling a track, and flagmen and watchmen/lookouts as defined in this section".

Roadway Maintenance Machine- "means a device powered by any means of energy other than hand power which is being used on or near railroad track for maintenance, repair, construction or inspection of track, bridges, roadway, signal, communications, or electric traction systems. Roadway maintenance machines may have road or rail wheels or may be stationary".

Seligman Subdivision:

The Seligman Subdivision is one of ten subdivisions that operate on BNSF's Southwest Division. The Seligman Subdivision is located and operates between East Winslow, Arizona, located at MP 284.5 and Needles, California, located at MP 578.4. The Seligman Subdivision consists roughly of about 294- track miles. Trains operating on the Seligman Subdivision travel in an east / west direction. The Seligman Subdivision consists of 286.6 miles of double multiple tracks and 7.3 miles of triple multiple tracks between MP 284.5 and MP 578.4; and has seven passing sidings. The type of operation on the Seligman Subdivision is Centralized Train Control (CTC), with Positive Train Control (PTC) in effect. The Seligman Subdivision operates both passenger and freight train services. The subdivision averages two daily Amtrak passenger trains, or 730- passenger trains per year; and averages seventy-nine daily freight trains or 28,835- freight trains per year. According to BNSF documentation, the 2017 total yearly tonnage figure for the Seligman Subdivision, which includes both freight and passenger train service was about 90- million gross tons per year. The collision occurred on main track 1 at MP 480.2 in an area known as Crozier Canyon to BNSF employees.

Track Description:

The accident occurred on main track 1 at MP 480.2 on the Seligman Subdivision in an area known as Crozier Canyon. The track consists of various sharp degree curves with descending track grades that "snake" left and right down through a deep narrow valley with steep sides located to the outside of both main tracks. Located to the inside curve portion of main track 1 is a steep ravine with tall trees that restricts the vision and site distance of approaching trains and equipment. Located to the outside curve portion of main track 2 is a steep ravine with a tall rock cliff that restricts the vision and site distance of approaching trains and equipment.

The main track description between MP 478.7 and ending about 8,000 feet westward past the accident site at MP 481.74 consists of two multiple main tracks with 14- foot track centers and various descending track grades ranging between -1.2% to -1.47% traveling west. Both tracks were constructed with concrete ties measuring 8-feet 6-inches long and spaced on 24-inch centers. The running rail section consisted of 141-pound "vacuum treated" (VT) continuous welded rail (CWR) with existing rail head gauge wear between .25- inches (1/4") to .375-inches (3/8") at the collision site curve. The rails were fastened to the concrete crossties using elastic clip fasteners. These elastic clip fasteners secure the rails to the ties and are used to maintain proper track gauge and track alignment. These elastic clip fasteners also serve as rail anti-creepers that assist in restraining longitudinal movement of the continuous welded rail due to train dynamic forces and temperature changes. The track was supported by AREMA #4 granite rock ballast with a standard ballast section. Investigators did not take exceptions to the rail restraint effectiveness of the elastic fasteners, crosstie condition, or ballast condition in the area of the collision.

The Seligman Subdivision timetable lists permanent speed restrictions on both main tracks between MP 479.0 to MP 480.6, due to the descending track grades and sharp degree curves. Both main tracks are speed restricted and classified as Class 2 Track under FRA Part 213.9(a), with a maximum allowable speed (MAS) of 25-mph for freight trains and 30-mph for passenger trains. Both main tracks are inspected and maintained to Class 2 Track Standards under FRA Part 213.233(c); other than main tracks and sidings.

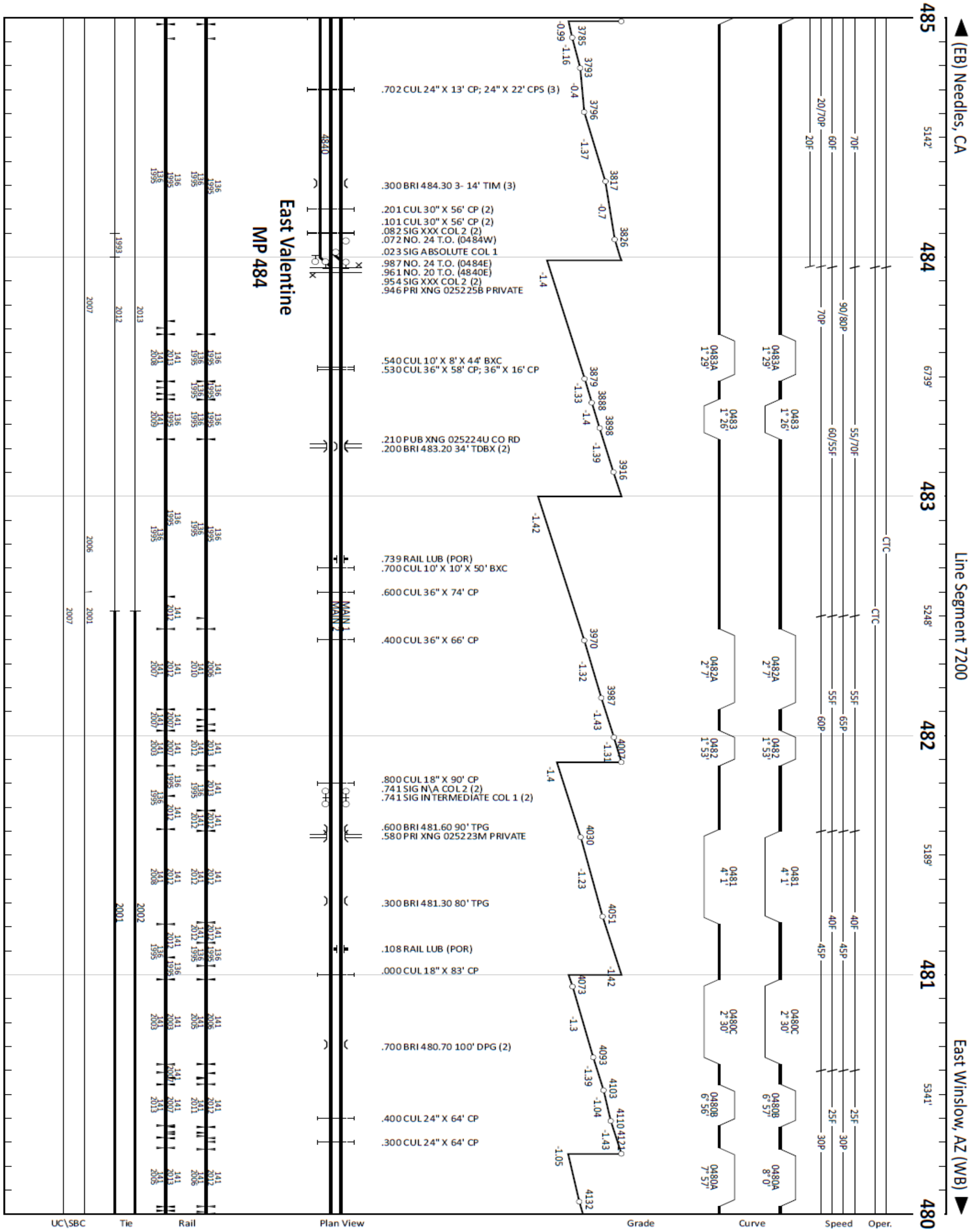

Figure 7. BNSF engineering track map showing track layout and civil design of collision area.

Post-Accident Hi-Rail Inspection:

The BNSF provided a division engineer equipped with a hi-rail vehicle so that a post-accident track inspection could be performed safely. The hi-rail inspection consisted of the division engineer as the driver / pilot of the hi-rail vehicle, an NTSB investigator and an FRA supervisory track safety specialist. The hi-rail inspection started at East Peach Springs[7] located at MP 465.8 and ended at East Valentine[8] located at MP 484.0. East Peach Springs is located about fourteen miles east of the accident site and East Valentine is located about four miles west of the accident site. The hi-rail inspection was performed on mainline track 1 heading in a westward direction towards the accident site location at MP 480.2. The hi-rail inspection starting at East Peach Springs up to intermediate signal 478.7 was roughly thirteen miles and was not part of the post-accident track inspection.

The post-accident hi-rail track inspection was conducted on main track 1 in a westward direction. The inspection started at intermediate signal 478.7 and proceeded westward to the collision site at MP 480.2. This westward inspection route was the same track route that the intermodal freight train traversed that led to the two-opposing moves and collision at MP 480.2.

The following track description are the physical characteristics for main track 1 that the intermodal freight train crew encountered when they started the westward route towards the collision site departing from intermediate signal 478.7:

[7] East Peach Springs is a location equipped with a railroad crossing where hi-rail inspection vehicles can set-on for the purpose of performing hi-rail inspections. East Peach Springs is also equipped with crossover switches between absolute signals.
[8] East Valentine is a location equipped with a railroad crossing where hi-rail inspection vehicles can set-on for the purpose of performing hi-rail inspections. East Peach Springs is also equipped with crossover switches between absolute signals.

- Train departs westward from intermediate signal 478.7 and traverses 1,525- feet of tangent (straight) track up to curve #479. Train is on a descending track grade ranging between -.88% to -1.27%;
- Train traverses into a 209-foot right-hand 4° 15’ curve (curve #479) with .66-inches of super-elevation. Train is on a descending track grade ranging between -.88% to -1.27%;
- Train departs curve #479 and traverses 1,579 feet of tangent track. Train is still on a descending track grade ranging between -1.12% to -1.27%.
- Train traverses into a 1,052-foot right-hand 3° 56' curve (curve #479A) with 2.88- inches of super-elevation;
- Train departs curve # 479A and traverses 300- feet of short tangent track to curve #480. Train is on a descending track grade ranging between -1.35% to -1.27%;
- Train traverses into a 2,630-foot left-hand 8° 0’ curve (curve #480) with 1.61-inches of super-elevation. Train is on a descending track grade ranging between -1.35% to -1.31%;
- Train departs curve #480 and traverses 1,400- feet of tangent track up to curve #480A. Train is on a descending track grade of -1.31%;
- Train traverses into a 1,600-foot right-hand 8° 0’ curve (curve #480A) with 2.08-inches of super-elevation where the collision occurred. Train was on a descending track grade ranging between -1.31% to -1.43%;
- **Collision Site**- Curve #480A located at MP 480.2 is where the collision occurred;

[Track Physical Characteristics westward past the Accident Site]

- Train proceeds westward through the accident site location and departs curve #480A and traverses 534- feet of tangent track up to curve #480B. Train is on a descending track grade ranging between -1.05% to -1.43%;

- Train traverses into a 1,054-foot right-hand 6° 57’ curve (curve #480B) with 1.46-inches of super-elevation. Train is on a descending track grade ranging between -1.43% to -1.39%;
- Train departs curve #480B and traverses 1,068-feet of tangent track up to curve #480C. Train is on a descending track grade ranging between -1.04% to -1.39%;
- Train traverses into a 1,970-foot left-hand 2° 30’ curve (curve #480C) with .79-inches of super-elevation. Train is on a descending track grade ranging between -1.39% to -1.42%;
- Train departs curve #480C and traverses 1,816-feet of tangent track up to curve #481. Train is on a descending -1.42% track grade;
- Train traverses into a 2,079-foot left-hand 4° 1’ curve (curve #481) with 2.6-inches of super-elevation. Train is on a descending track grade ranging between -1.42% to -1.23%;
- Train departs curve #481 and traverses 1,037- feet of tangent track up to the Intermediate Signal located at MP 481.74;
- Post-accident track inspection was ended at MP 481.74 or roughly 8,000 feet west of the accident site.

Investigators took no exceptions to the hi-rail post-accident track inspection between MP 478.7 to MP 481.74.

The following track description are the physical characteristics for main track 1 that the CWR work train crew encountered when they reversed back eastward towards the collision site departing from intermediate signal 481.74:

- Train reverses eastward from intermediate signal 481.74 with the RUM as the lead unit and traverses 519- feet of tangent (straight) track up to curve #481. Train is on an ascending track grade between +1.4% to +1.23%;

- Train traverses into a 2,079- foot right-hand 4° 1' curve (curve #481) with 2.6- inches of super-elevation. Train is on an ascending track grade between +1.23% to +1.42%;
- Train departs curve #481 and traverses 1,816- feet of tangent track up to curve #480C. Train is on as ascending +1.42% track grade;
- Train traverses into a 1,970-foot right-hand 2° 30' curve (curve #480C) with .79-inches of super-elevation. Train is on an ascending track grade between +1.42% to +1.39%;
- Train departs curve #480C and traverses 1,068- feet of tangent track up to curve #480B. Train is on an ascending track grade between +1.39% to +1.04%;
- Train traverses into a 1,054-foot left-hand 6° 57' curve (curve #480B) with 1.46-inches of super-elevation. Train is on an ascending track grade between +1.39% to +1.43%;
- Train departs curve #480B and traverses 534-feet of tangent track up to curve #480A. Train is on an ascending track grade between +1.43% to +1.05%;
- Train traverses into a 1,600- foot left-hand 8° 0' curve (curve #480A) with 2.08- inches of super-elevation where the collision occurred. Train is on an ascending track grade between +1.05% to +1.31%,
- **Collision Site-** Curve #480A located at MP 480.2 is where the collision occurred.

Investigators took no exceptions to the hi-rail post-accident track inspection between MP 481.74 to MP 480.2.

Post-Accident Site Track Inspections:

A post-accident walking inspection was performed on main track 1 between MP 480.0 to MP 480.4 or roughly 2,000 of track. Track gauge and cross-level measurements were taken through the accident site location and were noted to be in-compliance to BNFS Track Maintenance Practices and FRA's Part 213.9(a); Track Safety Standards for class two track operations; which allows for a maximum authorized speed (MAS) of 25-mph for freight trains and 30-mph for passenger trains. Investigators determined that about forty feet of track was damaged from the collision and subsequent derailment between the two trains. The following post-accident damage and repairs were noted:

- Twenty concrete ties and about forty feet of track in the full body of curve #480A was damaged during the collision. Temporary repairs were made by BNSF maintenance-of-way employees by installing twenty standard timber crossties measuring 9- inches by 7-inches by eight foot 6 inches long (9"x7"x 8'6"). These temporary track repairs were made before the arrival of investigator to the collision site (see figure 8).
- A 1- inch rail alignment deviation (rail was bent) existed on the high-rail in curve #480 from the forces of where the two trains collided/ point-of-collision (POC).

As of June 19, 2018, all temporary track repairs have been permanently made to include the completion of a forty-foot concrete tie track panel, the replacement and welding of eighty feet of rail on the high-side of curve #480 and track surfacing on both main tracks to eliminate the track geometry deviations created by the train collision, subsequent derailment and re-railing/clean-up efforts. BNSF engineering personnel conveyed that the post-accident damage and repairs were estimated at $31,650. This figure includes the costs of the temporary track repairs and includes the final cost repairs for the installation of one forty-foot concrete tie panel, the replacement and welding of eighty feet of running rail, track tamping/surfacing on both main tracks and other replacement track materials.


Figure 8. Picture looking eastward into curve #480A or collision site with an exemplar RUM.

BNSF Track Inspection Records:

Federal Railroad Administration (FRA) regulations found in 49 CFR part 213 requires that a rail carrier's track inspections shall be made in accordance with the following schedule under FRA's Track Safety Standards Part 213(d). Due to timetable permanent speed restrictions and the operation of passenger train service, BNSF has elected to operate at FRA class 2 and 3 between MP 479.0 to MP 481.6. This requires BNSF personnel to inspect the main tracks at least twice weekly per calendar week with at least one (1) day interval between inspections. Investigators reviewed BNSF track inspection reports dated between the dates of May 21, 2018 to June 05, 2018, that covered inspections between MP 470.0 to MP 482.0 with no exceptions noted.

Class of Track	Type of Track	Required Frequency
Excepted track and Class 1, 2 and 3 track.	Main track and sidings	Weekly with at least 3 calendar days interval between inspections, or before use, if the track is used less than once a week, or twice weekly with at least 1 calendar day interval between inspections, if the track carries passenger trains or more than 10 million gross tons of traffic during the proceeding calendar year.

BNSF Internal Rail Testing Data:

Investigators reviewed the last five (5) months of internal rail testing inspections that was conducted by Sperry Rail Service with detector car numbers SRS757 and SRS375. According to BNSF documentation that NTSB requested, Sperry Rail Service operated and tested rail on both main tracks on the Seligman Subdivision between the months of January 03, 2018, to April 26, 2018. Investigators took no exceptions to any BNSF internal rail testing data for the dates above.

BNSF Track Geometry Data:

BNSF operated a track geometry car over the Seligman Subdivision between MP 480.0 to MP 481.0 on January 24, 2018, and May 23, 2018. These track geometry car inspections were conducted on main track 1 with BNSF geometry cars No. CAR080 and CAR087 respectively with the dates above. These inspections covered through the collision site location, too include a portion measuring roughly 1,056 feet east and west of the collision site location. Investigators took no exceptions to BNSF's track geometry car data.