



**Tank Car Derailment Damage  
FACTUAL REPORT**

**December 22, 2020, Derailment of BNSF Railway Freight Train  
U-TNDFEP-0-36T and Subsequent Hazardous Materials Release**

**Custer, Washington**

**HMD21LR001**

**34 Pages**

**Report Date: May 25, 2021**

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## 1. Accident Identification

Carrier: BNSF Railway  
Train No.: U-TNDFEP-0-36T  
Location: Custer, Washington  
Date/Time: December 22, 2020, 11:38 a.m. PST  
NTSB No.: HMD21LR001

## 2. Accident Summary

On Tuesday, December 22, 2020, about 11:38 a.m. PST, northbound BNSF Railway Company (BNSF) petroleum crude oil unit train U-TNDFEP-0-36T derailed 10 loaded tank cars at MP 111.75 on the BNSF Bellingham Subdivision, in Whatcom County, in the town of Custer, Washington (Figure 1). The train consisted of 2 head-end locomotives, one head-end buffer car, 106 loaded tank cars, one rear-end buffer car, and 2 distributed power locomotives. Three tank cars released an estimated total of about 29,000 gallons of petroleum crude oil, which ignited and burned uncontrolled for 2 hours. An evacuation was ordered for a 1/2-mile radius around the accident site, affecting 120 persons for about 4 hours.

No injuries were reported. Weather at the time of the accident was partly cloudy and 34 degrees Fahrenheit, with a 5-mph wind. Damages exceeded \$1.5 million.

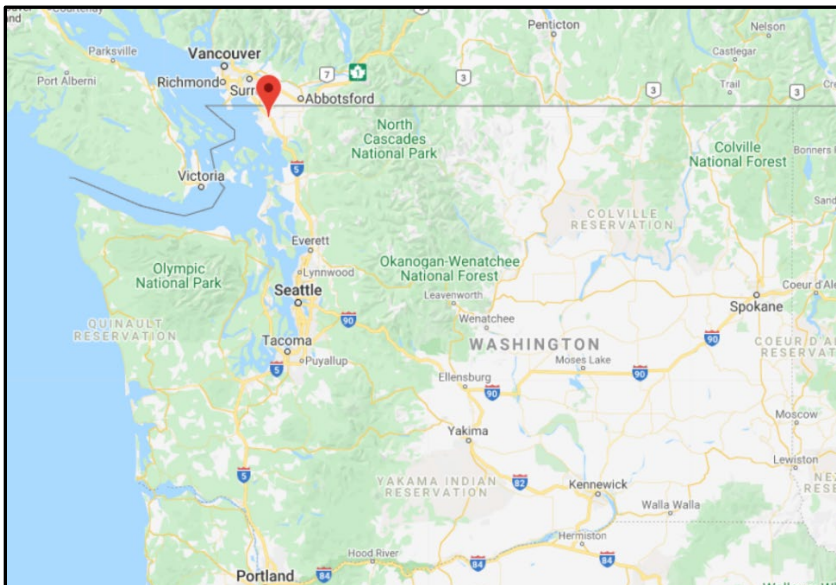


Figure 1. Accident location map.

The National Transportation Safety Board (NTSB) initiated a limited investigation into the accident performance of the DOT-117R tank cars and is working with the Federal Railroad

Administration (FRA) and the Washington Utilities and Transportation Commission (UTC) to collect information relative to the tank car damages. The Federal Bureau of Investigation and the FRA are investigating causal factors relating to the derailment.

### **3. BNSF Train U-TNDFEP-0-36T**

Train U-TNDFEP-0-36T was a crude oil unit train, classified by the U.S. Department of Transportation as a high-hazard flammable train.<sup>1</sup> BNSF was subject to the additional safety requirements of Title 49 CFR 174.310 for routing, maximum speed limit, and enhanced braking. The train contained 106 loaded tank cars, was 6,668 feet in length, and contained 15,279 trailing tons.

On December 17, 2020, Phillips 66 Company originated the shipment from the Savage Services Corporation rail terminal in Trenton, North Dakota. The hazardous material released in this accident consisted of UN1267 petroleum crude oil, a Class 3 flammable liquid in Packing Group I. Each derailed tank car was carrying about 30,000 gallons of petroleum crude oil.

Prior to the accident, train U-TNDFEP-0-36T had been stationary on yard track 4002, south of the derailment location near Custer. Locomotive event recorders indicated that the north bound train movement began at 11:29:22 a.m. on December 22. At the time of the derailment, the head end of the train was transitioning onto the Cherry Point subdivision, as it was destined for the Phillips 66 Ferndale Refinery in Ferndale, Washington.

Investigators examined security camera video from the Bonneville Power Administration Custer Substation, located about 1.0 miles south of the derailment location, which showed movement of train U-TNDFEP-0-36T prior to the accident. The video showed the stationary train as it started to pull forward. As the train continued to move forward, the rear end of the front segment came into camera view, showing that the train had become separated into two segments. After 17 seconds, the rear half of the train came into camera view. The trailing rear portion of the train was composed of 45 tank cars, a rear buffer gondola car, and two locomotives. Comparing this observation to the BNSF train consist, investigators determined that the train separated between line 64 (PPRX 172745) and line number 65 (TILX 360655).

The derailment sequence began when the tank car at line 65 in the rear segment collided with the tank car at line 64 in the front segment, as the separated rear end caught up with

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<sup>1</sup> Under 49 CFR 171.8, a high-hazard flammable train is defined as a single train transporting 20 or more loaded tank cars of a Class 3 flammable liquid in a continuous block or a single train carrying 35 or more loaded tank cars of a Class 3 flammable liquid throughout the train consist.

the front end of the train. Locomotive event recorder data for the distributed power rear end locomotives in positions 111 and 112 showed that the trailing rear train segment speed was between 21.1 mph and 21.9 mph prior to the collision.<sup>2</sup> Meanwhile, the front-end train speed recorded by both head end locomotives was 7 mph when its emergency brake application occurred at 11:38:38 a.m. The differential in train segment speed was between 14.1 mph and 14.9 mph at impact.

ATTACHMENT 1 – RAIL EQUIPMENT ACCIDENT RECORD, FRA FORM F6180.97,  
FEBRUARY 4, 2021

ATTACHMENT 2 – DERAILED TANK CAR WAYBILLS

ATTACHMENT 3 – LOCOMOTIVE EVENT RECORDER EXCERPTS, DECEMBER 22, 2020

ATTACHMENT 4 – HAZARDOUS MATERIALS INCIDENT REPORT, PHMSA FORMS 5800.1,  
JANUARY 8, 2021

#### 4. **Derailment Location**

The northbound BNSF freight train U-TNDFEP-0-36T was operating on the BNSF Bellingham Subdivision in Custer, Washington, and the point of derailment was MP 111.75, approximately 300 feet south of the Main Street crossing (Figure 2). The train was operating on yard track 4002, which was FRA Class 1 track with a maximum authorized speed of 10 mph. PTC was in effect on this subdivision.

A retail trade business located at 7585 Portal Way in Custer, was located between Portal Way and the rail line, immediately adjacent to the derailment footprint and within feet of the derailed tank cars. The closest residential structures were located about 185 feet east and about 250 feet southwest of the derailment location. No damage was reported to adjacent property or structures.

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<sup>2</sup> The event recorder data for line 111 BNSF locomotive 4723 showed its speed peaked at 21.1 mph at the time of the collision, whereas data for line 112 locomotive 7866 showed its speed peaked at 21.9 mph.



Figure 2. Accident scene looking south, December 23, 2020.

Published 2020 demographic data indicated that about 437 people lived within 1-mile of the accident location.<sup>3</sup>

On January 2, 2021, BNSF crews completed on-scene wreckage clearing operations at the accident scene. By January 12, 2021, BNSF crews completed on-scene work, including excavating oil-contaminated soils and installing groundwater recovery and monitoring wells. According to the Washington Department of Ecology, results of community air monitoring throughout the emergency response did not exceed applicable action levels.<sup>4</sup>

ATTACHMENT 5 – ANNOTATED CUSTER, WA BELLINGHAM SUBDIVISION MAP

ATTACHMENT 6 – BELLINGHAM SUBDIVISION TRACK CHART, CUSTER, WASHINGTON,  
JULY 18, 2014

## 5. **Hazardous Materials Information**

The hazardous material transported in BNSF train U-TNDFEP-0-36T was described as Bakken Region crude oil STCC 4910191, shipped as UN1267 Petroleum Crude Oil, Class

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<sup>3</sup><http://www.loopnet.com/property/7585-Portal-Way-Custer-WA-98240/53073-4001355583970000/>, accessed April 2, 2021.

<sup>4</sup> Washington State Department of Ecology, web page for Custer Crude Oil Derailment 2020, <https://ecology.wa.gov/Spills-Cleanup>

3, Packing Group I. Flammable hazardous materials classified in Packing Group I have an initial boiling point of less than, or equal to 95 °F.

Petroleum crude oil is a feedstock for petroleum and petrochemical refining. It is a highly flammable, variable, and complex mixture of volatile liquid hydrocarbons. Vapors may form explosive mixtures with air and may travel to a source of ignition and flash back. Most vapors are heavier than air and will spread along the ground and collect in low or confined areas. Petroleum crude oil presents a vapor explosion hazard when released and containers may explode when heated.<sup>5</sup>

ERG Guide 128 recommends an isolation distance of ½ mile in all directions if a rail car is involved in a fire.<sup>6</sup>

## **6. Shipper's Tank Car Inspections and Loading**

### ***6.1. Pre-trip Inspections***

On December 17, 2020, Savage Services loaded the tank cars that were involved in the derailment. The Savage Services loading operator conducted a pre-loading inspection of each tank car that included checks for the following items, among other things:

- Damaged or missing safety devices,
- Ensure bad order bracket/defect card holder is empty,
- Check wheels for cracks, chips, holes, shelling, or flat spots,
- Obvious defects in the truck assembly and all required springs are present and in good condition,
- Couplers checked for obvious damage and that it has a double shelf design with intact knuckle pin,
- Markings and stencils are legible and in inspection dates are within compliance,
- Placards (UN1267) are affixed,
- Bottom outlet valve closed and secured, cap and plug are secured by a chain to the rail car and gasket is in good condition,
- Tank shell inspection for dents, corrosion, cracks, or other defects,
- Manway bolt condition,
- Signs of leakage during the loading process,
- Air leakage from pressure relief device,

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<sup>5</sup> Computer-Aided Management of Emergency Operations, CAMEO Chemicals, version 2.7.1 rev. 3, (Washington, DC.: National Oceanographic and Atmospheric Administration).

<sup>6</sup> Emergency Response Guidebook: a Guidebook for First Responders during the Initial Phase of a Dangerous Goods/Hazardous Materials Transportation Incident. (Washington, DC.: U.S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration, 2020).

- Plug and cap securement,
- Manway gasket condition,
- Valve and fittings leak free and secured.

After the tank cars had been loaded, the Savage Services loading operator checked:

- Bottom outlet valve closed and secured, with handle properly stowed,
- Manway closed and secured tool tight with proper torque specification,
- Vapor and liquid valves closed, capped, and plugged tool tight,
- Protective housing free of debris, cover is closed and secured.

The loader found no exceptions with the pre-load and post-load condition of the tank cars involved in the derailment.

## 6.2. Loading

BNSF waybills identified the loading weight for each tank car. No loadings exceeded applicable load limits (by weight) for the derailed tank cars. Savage Services loading records provided the preset volume of crude oil loaded into each tank car (Table 1). The 10 derailed tank cars carried a total of 298,412 gallons, or 1,959,451 pounds, of petroleum crude oil.

*Table 1. Loaded tank car volumes and weights.*

Line #	Car Mark	Car Number	Tank Capacity (gal)	Loaded Volume <sup>7</sup> (gal)	Load Limit (lb.)	Lading Weight <sup>8</sup> (lb.)
61	PPRX	171143	31760	30013	200200	198442
62	PPRX	172350	31720	29975	197700	195945
63	PPRX	172933	31760	30013	197900	196231
64	PPRX	172745	31710	29966	197900	196082
65	TILX	360655	30260	28596	195100	193285
66	PPRX	172323	31690	29947	197900	196065
67	PPRX	172348	31760	30013	197800	195941
68	PPRX	172360	31710	29966	197500	195630
69	PPRX	172923	31680	29938	197200	195360
70	PPRX	171543	31730	29985	198200	196470
<b>Total</b>				<b>298,412</b>		<b>1,959,451</b>

= Hazardous materials released

ATTACHMENT 7 – SAVAGE SERVICES TANK CAR LOADING INSPECTION FORMS,  
DECEMBER 17, 2020

ATTACHMENT 8 – SAVAGE SERVICES RAILCAR PRELOAD REPORT, DECEMBER 17, 2020

<sup>7</sup> Loaded volumes were provided by a Savage Services rail car preload report, dated December 17, 2020.

<sup>8</sup> Lading weights were provided by BNSF tank car waybills.



## 7. Derailed Tank Car Information

Nine of the 10 derailed tank cars (all except TILX 360655) were originally constructed to specification DOT-111A100W1, with enhancements to the Association of American Railroads (AAR) CPC-1232 industry standard for tank cars ordered after October 1, 2011, for use in crude oil and ethanol service. The tank heads and shell were constructed of 0.5-inch-thick TC-128 Gr. B heads and shells. These tank cars were originally constructed without jackets or thermal protection systems.

AAR tank material construction standards for CPC-1232 tank cars specify the following:

Class 111 tank cars used to transport Packing Group I and II materials with the proper shipping names Petroleum Crude Oil, Alcohols, N.O.S., and Ethanol and Gasoline Mixture, must have heads and shells constructed on normalized TC128 Grade B steel or normalized A516-70 steel. Tank car heads must be normalized after forming, unless approval is granted by the AAR Executive Director of Tank Car Safety on the basis that a facility has demonstrated that its equipment and controls provide an equivalent level of safety. For tanks constructed on normalized TC128 Grade B steel, non-jacketed tanks must be at least 1/2-in. thick and jacketed cars must be at least 7/16-in. thick. For tanks constructed of normalized A516-70 steel, non-jacketed cars must be at least 9/16-in. thick and jacketed cars must be at least 1/2-in. thick. In all cases the cars must be equipped with at least 1/2-in. half-head shields.<sup>9</sup>

Prior to conversion to specification DOT-117R, each tank car had been equipped with top fittings protection to protect from commodity loss due to rollover in accordance with the AAR requirements for non-pressure cars.<sup>10</sup> Among the requirements of the standard, the top fittings protective housing must provide protection for top fittings without overstressing the tank shell and nozzles when subjected to specified horizontal and vertical loads. The protective housings were attached to the top fittings nozzles with twenty 1/2-inch bolts as specified by 49 CFR 179.202-13(h).

Federal regulations at 49 CFR 173.242 provide specification requirements for tank cars used to carry certain high-hazard liquids.<sup>11</sup> Additionally, 49 CFR 179.202-13 contains relevant requirements for tank cars converted to specification DOT-117R.

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<sup>9</sup> *Manual of Standards and Recommended Practices, Section C-III, Specifications for Tank Cars, M-1002*, paragraph 2.7. (Washington, DC: Association of American Railroads, 2014).

<sup>10</sup> AAR, M-1002, Appendix E, paragraph 9.2.1

<sup>11</sup> For the transportation of unrefined petroleum products, 49 CFR 173.243 states that DOT-111 tank cars built to the CPC-1232 standard are not authorized in transportation on or after April 1, 2020.

In 2019, the CPC-1232 tank cars were converted to specification DOT-117R100W. The conversions included the addition of 0.5-inch ceramic fiber thermal protection blanket with thermal conductivity of 0.238 (BTU-in/hr-ft.sq-deg.F), 11-gauge steel tank jackets, full ½ inch thick head shields, and 4-inch external bottom outlet valves with disengaging operating handle mechanisms designed to prevent unintended opening in accidents.<sup>12</sup> The design specifications for the pressure relief devices were 75 psi start-to-discharge pressure with 30,061 scfm flow capacity, sized under AAR MSRP equation 7.1.1.1A of Appendix A. The interior tank surfaces were lined with phenolic epoxy coating. The DOT-117R tank cars had a nominal light weight of about 87,900 pounds and a rail load limit of 286,000 pounds. The overall length to coupler faces was 59 ft. 4 ½ in.

One derailed tank car in position 63, TILX 360655, had been constructed to DOT-117J specifications and had been provided with all the above listed features for tank cars converted to DOT-117R except that the heads and shell were constructed of thicker 0.5625-inch TC-128 Gr. B steel. The tank car was provided with a pressure relief device set to discharge at 75 psi at 31,676 scfm. The DOT specifications of the tank cars involved in this derailment are summarized in Table 2.

*Table 2: Summary of derailed tank cars, breached cars are highlighted.*

Line #	Car Mark	Car Number	Builder	Specification	Shell Thickness	Head Thickness	PRD STD, PSI
61	PPRX	171143	Trinity Tank Car	117R100W	0.5	0.5	75
62	PPRX	172350	Trinity Tank Car	117R100W	0.5	0.5	75
63	PPRX	172933	Trinity Tank Car	117R100W	0.5	0.5	75
64	PPRX	172745	Trinity Tank Car	117R100W	0.5	0.5	75
65	TILX	360655	Trinity Tank Car	117J100W	0.5625	0.5625	75
66	PPRX	172323	Trinity Tank Car	117R100W	0.5	0.5	75
67	PPRX	172348	Trinity Tank Car	117R100W	0.5	0.5	75
68	PPRX	172360	Trinity Tank Car	117R100W	0.5	0.5	75
69	PPRX	172923	Trinity Tank Car	117R100W	0.5	0.5	75
70	PPRX	171543	Trinity Tank Car	117R100W	0.5	0.5	75

= Hazardous materials released

ATTACHMENT 9 – AEI REPORT/TRACK LIST DEPARTING BELLINGHAM, WASHINGTON,  
DECEMBER 22, 2020

<sup>12</sup> The AAR Application for Approval and Certificate of Construction No. M186159 covers PPRX 172000 through 172849, which is applicable for the three breached tank cars.

## 8. Derailment Damage Summary

Local Federal Railroad Administration and Washington Utilities and Transportation Commission hazardous materials investigators collected detailed tank car damage assessment data provided in Appendix A of this report.

The approximate resting locations of the breached derailed tank cars and the post-accident pool fire are depicted in the diagram shown in Figure 3.

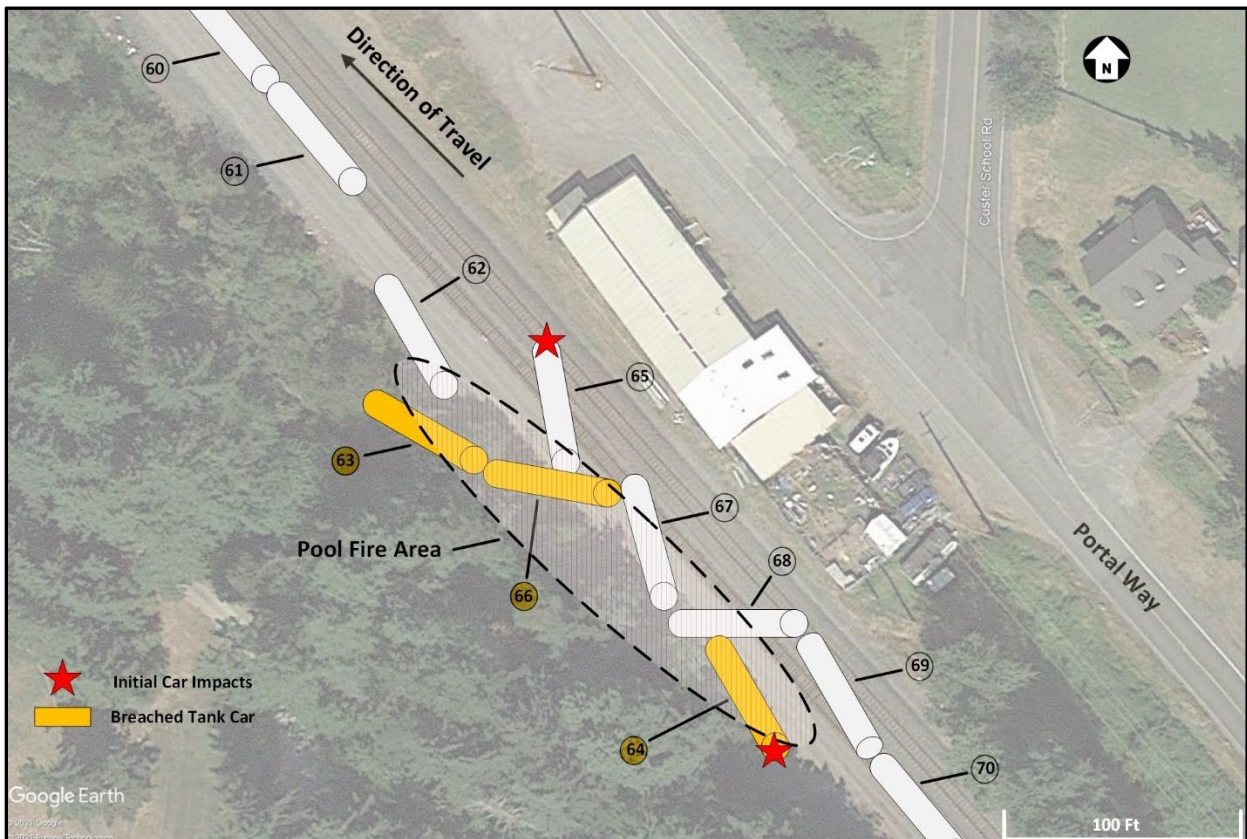


Figure 3. Derailment diagram with approximate tank car resting positions overlaid on pre-accident Google Earth image. Breached tank cars are indicated in orange. Base imagery date: August 15, 2020.

Video evidence showed the train had separated between line numbers 64 and 65. The impacting car was the separated leading A-end head of line 65 (TILX 360655), and the impacted car was the trailing A-end head of line 64 (PPRX 172745), see Figure 4.



Figure 4. Impacting A-end of TILX 360655 (left) and impacted A-end of PPRX 172745 (right), courtesy Washington UTC.

### 8.1. Breaching Damage

The A-end of the tank car in line 63 (PPRX 172933) sustained a shell buckle and crack that breached the car. Underframe damage at the B-end head contributed to the breach and release of crude oil.

The impacted A-end stub sill of line 64 (PPRX 172745) folded under the car almost 180 degrees and the tank shell buckled with a crack that breached the car inboard of the bolster.

The tank car in line 66 (PPRX172323) released crude oil from pressure relief device activation and thermal damage to the manway gasket.

Tank car breaching damage is summarized in Table 3.

Table 3. Tank car breach summary.

Position	Tank Car	Damage Related to Product Release
63	PPRX 172933	Inward dent to lower B-end head, pulling the head away from the sill pad with a tear in tank material. Crack in buckled A-end tank shell inboard of body bolster.
64	PPRX 172745	Crack in buckled A-end tank shell inboard of body bolster.
66	PPRX 172323	Fire damage to manway gasket. Pool fire exposure actuated pressure relief device.

## ***8.2. Impact Resistance***

Derailed tank cars in positions 62, 63, 65, 66, and 67 sustained impacts to head shields that did not result in tank breaches. The A-end head shield of line 66 was punctured, but the underlying tank head was only dented.

## ***8.3. Thermal Protection Systems***

Derailed tank cars between positions 62 through 68 sustained pool fire exposure for about 2 hours. However, there was no evidence of tank shell structural damage attributable to the fire exposure, such as thermal tears. A pressure relief device activated on one tank car in position 66.

## ***8.4. Bottom Outlets***

Three tank cars in positions 64, 65, and 66 sustained bottom outlet nozzle separation. The bottom outlet ball valves remained closed and did not release product.

## ***8.5. Top Fittings***

Tank cars in positions 62 and 64 rolled over onto top fittings protective housings, however the top fittings were not mechanically damaged.

ATTACHMENT 10 – FEDERAL RAILROAD ADMINISTRATION TANK CAR DAMAGE ASSESSMENT FORMS, DECEMBER 28, 2020

ATTACHMENT 11 – UAS AERIAL IMAGERY DERAILMENT SCENE, DECEMBER 23, 2020  
ATTACHMENT 12 – AERIAL IMAGERY DERAILMENT SCENE, DECEMBER 22, 2020

## **9. Hazardous Materials Release Estimate**

BNSF estimated the total amount of crude oil released in this accident was about 28,961 gallons. Based on mass-balance recovery figures, BNSF estimated the following release amounts from three tank cars:

- Line 63: PPRX 172933 – 9,762 gallons
- Line 64: PPRX 172745 – 17,159 gallons
- Line 66: PPRX 172323 – 2,041 gallons

According to the Washington Department of Ecology, much of that amount was consumed in the post-accident fire, evaporated, or was recovered by cleanup crews. The Department stated that 5,400 to 8,000 gallons of the released crude oil was not recovered.

## **10. Tank Car Underframe Attachments**

To minimize the likelihood of a crack occurring in tank material at reinforcing pad attachments, welds attaching draft sill components to reinforcing pads are designed to sacrificially break under load, leaving the reinforcing pad attached to the tank. According to AAR general design and test requirements for tank cars, the welds securing the sill to the reinforcing plate must have a total throat area not exceeding 85 percent of the total throat area of the reinforcing plate-to-shell welds.<sup>13</sup>

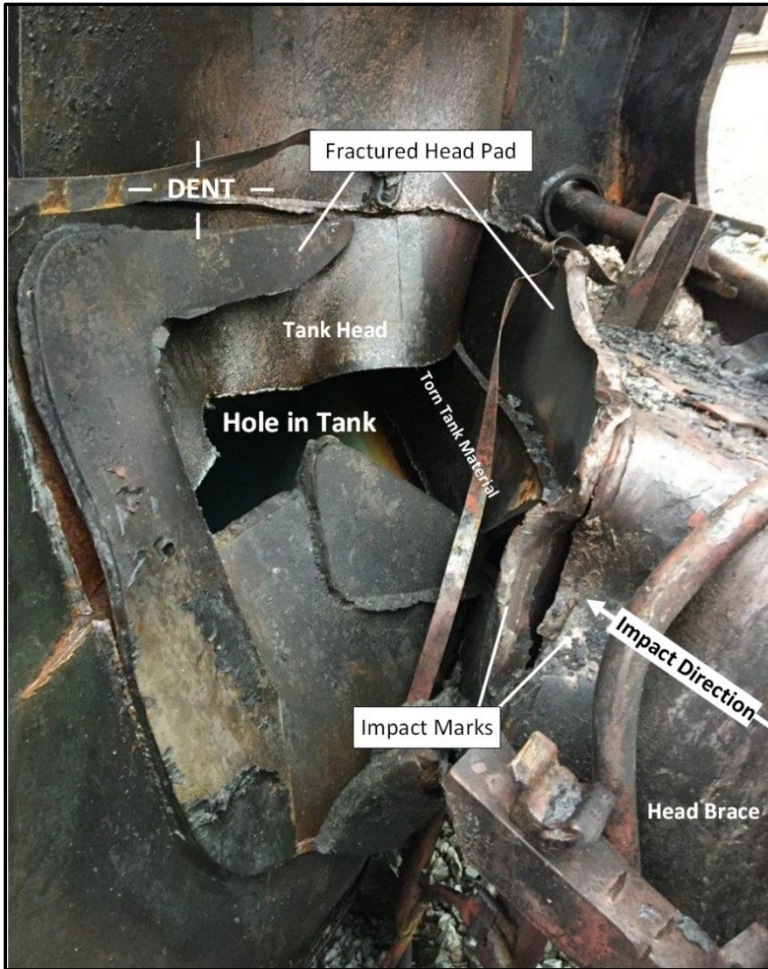
Although head pads separated from tank cars PPRX 172933 and PPRX 172745, examination of the head pad and underframe attachment welds for compliance with AAR requirements was not within the scope of this limited investigation. However, this section provides details of observed damages in these areas.

### ***10.1. PPRX 172933, Line 63***

A portion of the B-end head pad was torn from the tank and remained attached to the stub sill as it separated. Both the head pad and tank head fractured during this separation, leaving a hole in the tank that measured roughly 12 inches in diameter. Localized impact and inward deformation of the tank head close to the head brace fractured the head pad. Witness marks left by the impacting object were found at the front of the head brace and head pad. A segment of the head brace-to-head pad weld was cracked at the location of this impact. A piece of torn tank head material remained attached to the portion of fractured head pad retained by the stub sill welds (Figure 5).

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<sup>13</sup> *Manual of Standards and Recommended Practices, Design, Fabrication, and construction of Freight Cars, CII (M-1001)*, chapter 6.1.2.4.1. (Washington, DC: Association of American Railroads, 2011).



*Figure 5. B-end Head breach as seen after tank jacket removal. The stub sill is attached to the tank head at through the head pad, January 5, 2021, courtesy Washington UTC.*

The B-end of line 63 (PPRX 172933) was coupled to the A-end of line 62 (PPRX 172350) in the train. The lower shelf of the A-end coupler of PPRX 172350 was fractured and missing. Examination of the B-end head of PPRX 172933 at the accident scene found a puncture in the tank jacket at the location of the damage shown in Figure 5 (see Figure 6).

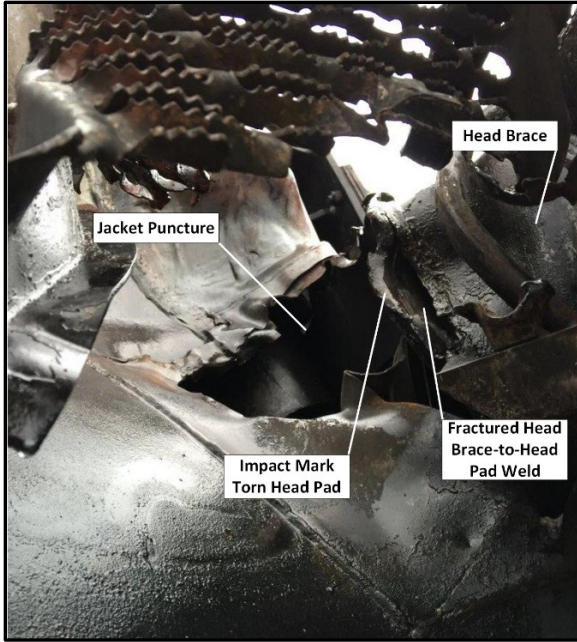


Figure 6. PPRX 172933 B-end head impact location, showing punctured jacket material forward of the head brace, December 30, 2020, courtesy Washington UTC.

At the opposite end of the tank car, the A-end head pad fillet welds were fractured as the pad pulled away from the tank head, however the cracked weld did not transition into tank head parent metal and no breach occurred (Figure 7). Downward force on the stub sill was associated with severe tank buckling inboard of the body bolster near the termination of the stub sill tail piece. The A-end of the tank was bent about 45 degrees downward at this location.

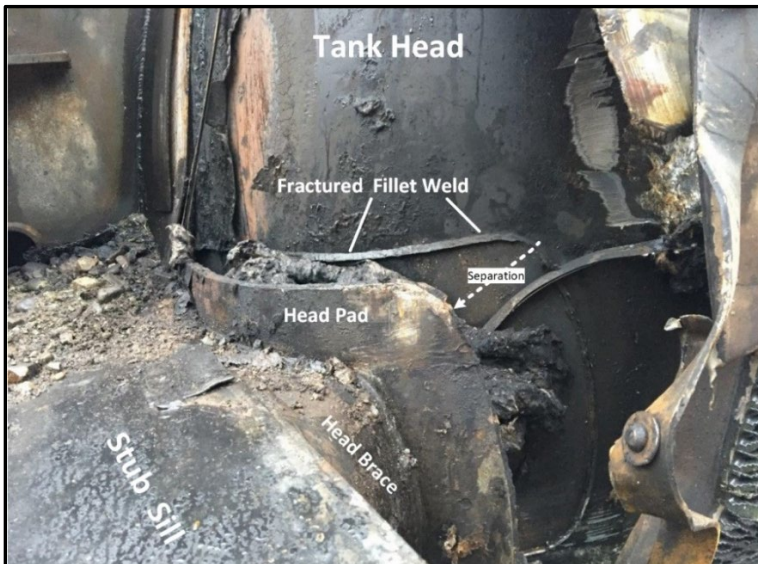
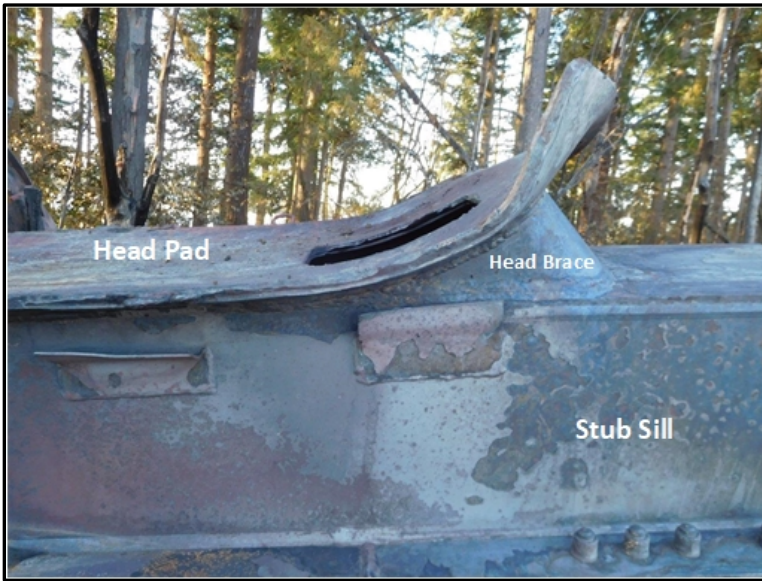


Figure 7. A-end head pad separation from tank, fractured fillet weld, January 5, 2021, courtesy Washington UTC.

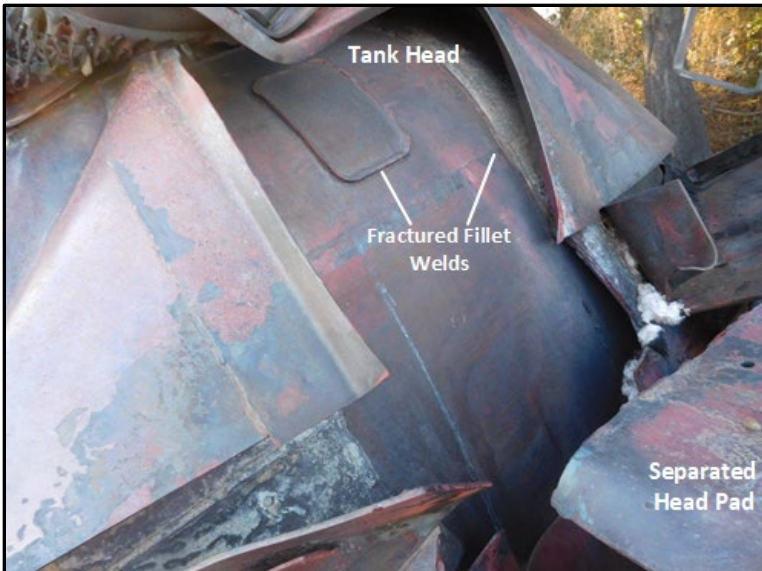


**10.2. PPRX 172745, Line 64**

The trailing A-end stub sill was folded down and inboard almost 180 degrees. The head pad-to-tank fillet welds were fractured, and head pad was torn from the head without tank penetration. The stub sill and head brace-to-head pad welds did not fracture (Figures 8 and 9).



*Figure 8. PPRX 172745 A-end stub sill with separated head pad, December 24, 2020, courtesy Washington UTC.*



*Figure 9. PPRX 172745 A-end head and separated head pad, December 24, 2020, courtesy Washington UTC.*

## 11. Previous DOT-117 Accident History

Recent NTSB accident investigations involving the derailment of specification DOT-117 tank cars include the following:

- The February 13, 2020, 25 mph derailment of 4 tank cars in a high-hazard flammable train carrying ethanol in Draffin, Kentucky.<sup>14</sup> Although the DOT-117R tank cars in front of and to the rear of two breached DOT-111 tank cars sustained significant impact damage, their head shields protected these cars from breaching. About 38,400 gallons of denatured ethanol released from the two breached DOT-111 tank cars and fueled a post-accident fire that engulfed the locomotives.
- The April 24, 2019, 26 mph derailment of 25 tank cars in a high-hazard flammable train carrying ethanol in Fort Worth, Texas.<sup>15</sup> The derailment involved 17 DOT-117R and 7 DOT-117J tank cars. Two DOT-117R and one DOT-111 tank car were mechanically breached releasing about 74,000 gallons of denatured ethanol. One DOT-117R tank car was breached as a result of a shell tear around a bent body bolster and top fittings damage. The shell of the other DOT-117R car was punctured. The released ethanol fueled pool fires that prompted the evacuation of between 6 and 10 nearby homes.
- The June 22, 2018, 47 mph derailment of 33 tank cars in a high hazard flammable unit train in Doon, Iowa. Ten of the derailed specification DOT-117R tank cars were breached and released about 160,000 gallons of petroleum crude oil, resulting in the evacuation of 18 – 20 people and contamination of surface waters. This accident was the first mainline derailment involving a significant number of specification DOT-117R tank cars.<sup>16</sup>

Other recent derailments involving Class 117 tank cars are under investigation by the Transportation Safety Board of Canada. These derailments involve:

- The February 6, 2020, 42 mph derailment of 32 specification DOT-117J tank cars of a crude oil unit train near Guernsey, Saskatchewan.<sup>17</sup> Several tank cars were breached, and an undetermined amount of petroleum crude oil product was released. A post-accident pool fire engulfed 19 of the derailed tank cars.
- The December 9, 2019, 45 mph derailment of 33 tank cars of a crude oil unit train near Guernsey, Saskatchewan. The derailed tank cars consisted of 9 DOT-117R and

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<sup>14</sup> *Placement of DOT-111 Tank Cars in High Hazard Flammable Trains and the Use of Buffer Cars for the Protection of Train Crews*, RSR-20/01 (Washington, DC: National Transportation Safety Board, 2020).

<sup>15</sup> National Transportation Safety Board, 2020.

<sup>16</sup> See NTSB docket HMD18LR002, DOT-117R Tank Car Performance Factual Report, (Washington DC, National Transportation Safety Board, 2019).

<sup>17</sup> See Transportation Safety Board of Canada website for railway investigation R19W0025 for further details at <https://www.tsb.gc.ca/eng/enquetes-investigations/rail/2020/r20w0025/r20w0025.html>, accessed May 3, 2021.

24 CPC-1232 tank cars.<sup>18</sup> About 20 of the derailed tank cars were breached and became engulfed in a large pool fire that burned for about 24 hours.

- The February 16, 2019, 46 mph derailment of 37 specification DOT-117R tank cars of a crude oil unit train in St-Lazare, Manitoba.<sup>19</sup> At least 14 breached tank cars released about 217,000 gallons of product.

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*Sr. Hazmat Accident Investigator*

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<sup>18</sup> See Transportation Safety Board of Canada website for railway investigation R19W0320 for further details at <https://www.tsb.gc.ca/eng/enquetes-investigations/rail/2019/R19W0320/R19W0320.html>, accessed May 3, 2021.

<sup>19</sup> See Transportation Safety Board of Canada website for railway investigation R20W0050 for further details at <https://www.tsb.gc.ca/eng/enquetes-investigations/rail/2019/r19w0050/r19w0050.html>, accessed May 3, 2021.

## Appendix A: Tank Car Examinations

Tables A-1 through A-10 summarize field observations collected for the derailed tank cars.

Key to abbreviations used in this Appendix

**B-end:** the end of the car with the handbrake wheel

**A-end:** the end of the car opposite the B-end

**A-L:** A-end, left side

**A-R:** A-end, right side

**B-L:** B-end, left side

**B-R:** B-end, right side

**BOV:** bottom outlet valve

**PRD:** pressure relief device

**Top:** 4-feet to the right and left of the top longitudinal centerline

**Bottom:** 4-feet to the right and left of the bottom longitudinal centerline

All observations and orientations provided are from the perspective of facing the B-end of the tank car.

Table A-1: Tank Car PPRX 171143, 117R100W

Consist order	<b>61</b>
Orientation in the consist	A-end leading
Derailed resting position	The car came to rest upright with B-end trucks derailed.
Heads	The A-end and B-end heads had no impact damage.
Shell	No impact damages. No fire exposure.
Bottom outlet valve	No damage.
Top fittings, PRD and Manway	There was no damage to the top fittings protective housing or the manway.
Stub sills and couplers	Knuckle with fractured shank from trailing car, PPRX 172350 was retained in the B-end coupler.



*1(a) Resting position, trailing B-end head, derailed trucks.*



*1(b) B-end trailing head, looking north, direction of travel.*

Table A-2: Tank Car PPRX 172350, 117R100W

Consist order	<b>62</b>
Orientation in the consist	B-end leading
Derailed resting position	The car came to rest on the right-of-way, west of the track, upside down and resting on its top fittings.
Heads	Rounded dent to upper-right A-end head, 85 in. x 80 in., 6 in. deep.
Shell	No impact damages. About 15% of the shell/jacket surface was thermally damaged.
Bottom outlet valve	No damage.
Top fittings, PRD and Manway	Protective housing was impacted by rollover. No breaching damage to top fittings or manway.
Stub sills and couplers	A-end broken lower coupler shelf. B-end coupler shank broken at striker plate.



2(a) A-end head before jacket removal.



2(b) A-end head after jacket and headshield removal. Former reporting mark is showing.

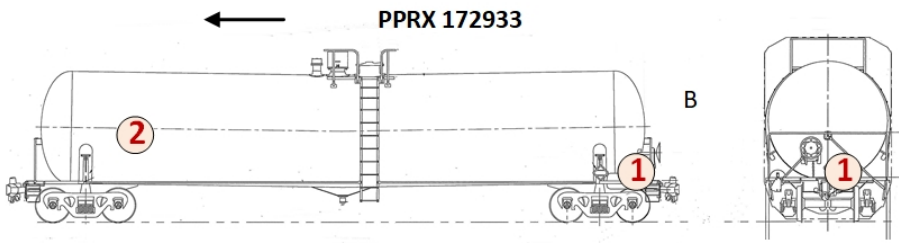


2(c) Staging area, B-end head.



2(d) Resting position, rollover-impacted top fittings protective housing.

Table A-3: Tank Car PPRX 172933, 117R100W

Consist order	<b>63</b>
Orientation in the consist	A-end leading
Derailed resting position	The car came to rest west of the track about 90 degrees on its left side.
Heads	<p><b>Breaching damage:</b></p> <ol style="list-style-type: none"> <li>40 in. x 60 in. crescent-shaped dent to lower B-end head, pulling the head away from the sill pad with a 12 in. x 12 in. tear in tank material.</li> </ol> <p>The left side of the B-end head sustained a 32 in. x 34 in. dent. The A-end sill pad fillet weld had fractured, separating the pad from the tank head.</p>
Shell	<p><b>Breaching damage:</b></p> <ol style="list-style-type: none"> <li>The tank was buckled with about a 45-degree downward deformation across the tank bottom, inboard of A-end body bolster. Shell crease terminated at about the middle of the A-R and A-L sides. The tank shell was cracked within the folded shell material.</li> </ol> <p>About 30 % of the shell/jacket surface was thermally damaged.</p>
Bottom outlet valve	No damage.
Top fittings, PRD and Manway	No damage. PRD did not activate.
Stub sills and couplers	A-end coupler pushed upward 90-degrees, tearing into stub sill top plate. B-end coupler was broken at the striker plate.
Other	 <p><i>Breaching damage locations</i></p>



3(a) Buckled A-end tank shell, bottom view.



3(b) Buckled A-end tank shell top view.



3(c) Impacted B-end head after jacket and head shield removal.



3(d) Fractured B-end head pad and hole in tank.



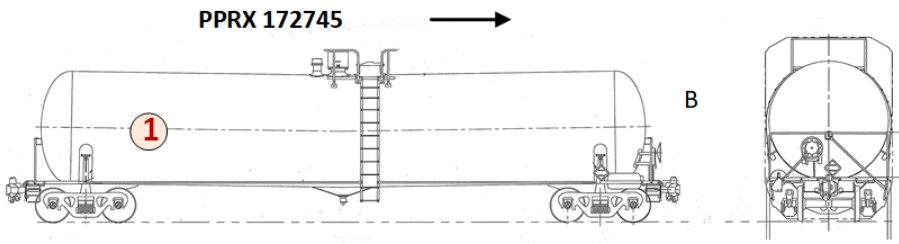
3(e) Impact mark B-end head brace, head brace weld, and fractured head pad.



3(f) Separated A-end head pad and fractured fillet weld.



Table A-4: Tank Car PPRX 172745, 117R100W

Consist order	64
Orientation in the consist	B-end leading
Derailed resting position	Tank car came to rest west side of the track and upside down.
Heads	Dent to center of A-end head, 54 in. x 63 in.
Shell	<p><b>Breaching damage:</b></p> <ol style="list-style-type: none"> <li>1. The tank was buckled with about a 45-degree downward deformation across the tank bottom, inboard of A-end body bolster. Shell crease terminated at about the middle of the A-R and A-L sides. The tank shell was cracked within the folded shell material.</li> </ol> <p>About 100% of the shell/jacket surface was thermally damaged.</p>
Bottom outlet valve	BOV nozzle was sheared off, valve remained closed.
Top fittings, PRD and Manway	Car was resting on the top fittings protective housing, but it was not damaged.
Stub sills and couplers	The A-end stub sill folded down and back (inboard) almost 180 degrees. The head pad-to-tank fillet welds were fractured, and head pad was torn from the head without tank penetration. The stub sill and head brace-to-head pad welds did not fracture. The A-R and A-L body bolster structure was torn near the stub sill.
Other	 <p style="text-align: center;">PPRX 172745      →</p> <p style="text-align: center;"><i>Breaching damage location</i></p>



*4(a) Resting position upside-down, viewing A-R side.*



*4(b) Resting position, B-R side looking towards A-end.*



*4(c) A-R buckled tank shell, cracked, and releasing material.*



*4(d) A-end stub sill folded 180 degrees inboard, head pad remained attached to sill and head brace*



*4(e) A-end head pad-to-head brace attachment. Head pad has separated from the tank.*



*4(f) A-end separated head pad attachment point. No tank head/shell breaching damage.*

Table A-5: Tank Car TILX 360655, 117J100W

Consist order	<b>65</b>
Orientation in the consist	A-end leading
Derailed resting position	The tank car came to rest upright, about 45 degrees across the track, A-end to the east.
Heads	A-end head 65 in round dent, 10 in. deep at 2 o'clock; 16 in. x 12in. jacket dent at 7 o'clock.
Shell	The bottom B-L side near the B-end head was dented 5 ft. long. x 3 ft. trans. and 4 in. deep. A 70 in. jagged gouge in jacket, bottom, left side of BOV. About 40% of shell/jacket surface was exposed to fire, left side thermal damage.
Bottom outlet valve	The BOV nozzle was sheared off. Splintered wood and mud were packed around the valve saddle. The operating handle sleeve was separated from the valve stem. The valve remained closed.
Top fittings, PRD and Manway	No damage. PRD did not activate.
Stub sills and couplers	The A-end stub sill bottom plate was missing, and the yoke was deflected downward. The B-end coupler shank was broken at the key slot, with the left side stub sill plate bent outward. Bending deformation of the B-end stub sill to the left.



5(a) Staging area, A-end leading head.



5(b) Staging area, top surface.

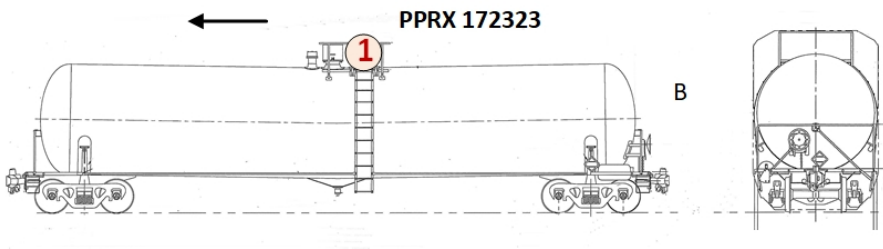


5(c) Resting position, left side, thermal damage to jacket.



5(d) Resting position, B-L side and B-end head in contact with trailing car, line 64.

Table A-6: Tank Car PPRX 172323, 117R100W

Consist order	<b>66</b>
Orientation in the consist	A-end leading
Derailed resting position	The tank car came to rest, rolled about 45 degrees on its lower left side, west of the track.
Heads	A-end head was dented 39 in. x 29 in., 4 in. deep, about 7 o'clock. The head shield was penetrated by an approx. 12 in. vertical gouge near the center of the dent. The underlying tank head was dented. B-end head was dented 51 in. x 48 in., 3.5 in. deep, near the center.
Shell	Bottom center dent was 63 in. long. x 56 in. trans., 4 in. deep. Right and left A-end jacket sustained thermal damage. About 70% of shell/jacket surface area was thermally damaged.
Bottom outlet valve	The BOV nozzle was sheared off. The BOV remained closed.
Top fittings, PRD and Manway	<b>Breaching Damage:</b> 1. Fire damage to about ¼ of manway gasket. The corresponding interior surface of the manway lid was burnt and partly covered with soot.  The PRD activated during the pool fire.
Stub sills and couplers	A-end draft sill bent toward the right. A-R bolster web bent inboard.
Other	 <p style="text-align: center;">PPRX 172323</p> <p style="text-align: center;"><i>Breaching damage location</i></p>



6(a) Left side, top fittings, and manway.



6(b) Resting position, right side.



6(c) Manway and burnt gasket and interior cover surface.



6(d) Dented B-end head.



6(e) Dented A-end head. Penetrated head shield.



6(f) Lower right-center dent, sheared BOV nozzle.

Table A-7: Tank Car PPRX 172348, 117R100W

Consist order	<b>67</b>
Orientation in the consist	A-end leading
Derailed resting position	The tank car came to rest on its lower left side with front trucks separated and leaning to the left about 15 degrees. The trailing B-end was about 12 ft. west of the track.
Heads	A-end head 2 ft. round dent, 4 in. deep, about 4 o'clock. Jacket between the head shield and tank was buckled.
Shell	About 33% of shell/jacket surface area was thermally damaged.
Bottom outlet valve	No damage.
Top fittings, PRD and Manway	No damage. PRD did not activate.
Stub sills and couplers	A-end coupler shank pushed upward. The top draft sill plate was torn and bent upward. Both A-end draft gear bottom carrier plates were deformed downward.



7(a) Resting location, right side.



7(b) Resting location, A-end head



7(c) B-end underframe, bottom.



7(d) Displaced A-end coupler. Torn draft sill top plate.

Table A-8: Tank Car PPRX 172360, 117R100W

Consist order	<b>68</b>
Orientation in the consist	A-end leading
Derailed resting position	The tank car came to rest upright leaning 10 degrees toward the left. The leading A-end was about 12 ft. west of the track.
Heads	No damage.
Shell	The left side shell/jacket was thermally damaged end to end.
Bottom outlet valve	No damage.
Top fittings, PRD and Manway	The interior surface of the manway cover was thermally discolored. The PRD did not activate.
Stub sills and couplers	No significant damage.



8(a) Resting position, right side.



8(b) Thermal damage to left side.



8(c) Top fittings, thermal damage to manway cover.



8(d) Manway cover, interior surface thermal damage.

Table A-9: Tank Car PPRX 172923, 117R100W

Consist order	<b>69</b>
Orientation in the consist	A-end leading
Derailed resting position	The tank car came to rest leaning toward the right, with the leading A-end about 4 ft. east of the track. The B-end trucks were also derailed.
Heads	No damage.
Shell	No damage.
Bottom outlet valve	No damage.
Top fittings, PRD and Manway	No damage.
Stub sills and couplers	No damage.
Other	Safety appliance damage at A-end.



9(a) Resting position, right side.



9(b) Resting position, A-end head.



Table A-10: Tank Car PPRX 171543, 117R100W

Consist order	<b>70</b>
Orientation in the consist	A-end leading
Derailed resting position	The car came to rest upright with leading A-end trucks derailed.
Heads	No damage.
Shell	No damage.
Bottom outlet valve	No damage.
Top fittings, PRD and Manway	No damage.
Stub sills and couplers	No damage.
Other	



10(a) Resting position, left side.

## **List of Attachments**

- ATTACHMENT 1 – RAIL EQUIPMENT ACCIDENT RECORD, FRA FORM F6180.97,  
FEBRUARY 4, 2021
- ATTACHMENT 2 – DERAILED TANK CAR WAYBILLS
- ATTACHMENT 3 – LOCOMOTIVE EVENT RECORDER EXCERPTS, DECEMBER 22, 2020
- ATTACHMENT 4 – HAZARDOUS MATERIALS INCIDENT REPORT, PHMSA FORMS 5800.1,  
JANUARY 8, 2021
- ATTACHMENT 5 – ANNOTATED CUSTER, WA BELLINGHAM SUBDIVISION MAP
- ATTACHMENT 6 – BELLINGHAM SUBDIVISION TRACK CHART, CUSTER, WASHINGTON,  
JULY 18, 2014
- ATTACHMENT 7 – SAVAGE SERVICES TANK CAR LOADING INSPECTION FORMS,  
DECEMBER 17, 2020
- ATTACHMENT 8 – SAVAGE SERVICES RAILCAR PRELOAD REPORT, DECEMBER 17, 2020
- ATTACHMENT 9 – AEI REPORT/TRACK LIST DEPARTING BELLINGHAM, WASHINGTON,  
DECEMBER 22, 2020
- ATTACHMENT 10 – FEDERAL RAILROAD ADMINISTRATION TANK CAR DAMAGE  
ASSESSMENT FORMS, DECEMBER 28, 2020
- ATTACHMENT 11 – UAS AERIAL IMAGERY DERAILMENT SCENE, DECEMBER 23, 2020
- ATTACHMENT 12 – AERIAL IMAGERY DERAILMENT SCENE, DECEMBER 22, 2020
- ATTACHMENT 13 – BNSF RAILWAY RELEASE AMOUNT CALCULATIONS, JANUARY 21,  
2021