National Transportation Safety Board
Washington, D.C. 20594

Report Date: October 8, 2014

Hazardous Materials Group Factual Report

A. Accident Identification

Carrier:	BNSF Railway Company
Train No.:	U-FYNHAY4-05T
Location:	Casselton, North Dakota
Date/Time:	December 30, 2013, at 2:11 p.m. Central Standard Time
NTSB No.:	DCA14MR004

B. Hazardous Materials Group Members

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C. Accident Summary

On Monday, December 30, 2013, at 2:11 p.m. central standard time, a westbound BNSF Railway Company (BNSF) grain unit train derailed 13 cars at milepost 28.5 near Casselton, North Dakota. The grain train, operating on main track 1, consisted of 2 head-end locomotives, 1 rear distributive power unit (DPU) locomotive, and 112 cars. The 45th car from the head end of the grain train derailed onto main track 2, blocking the track.

An eastbound BNSF petroleum crude oil unit train, operating on main track 2, U-FYNHAY4-05T, (the crude oil train) collided with the derailed grain train car that was blocking the track. The crude oil train consisted of 2 head-end locomotives, 1 rear DPU locomotive, and 106 cars. The 2 head-end locomotives and the first 21 cars of the crude oil train derailed during the collision, releasing nearly one-half million gallons of crude oil and fueling a fire. An estimated 1,400 people were evacuated from the town of Casselton. No injuries to the public were reported.

The eastbound train crew from U-FYNHAY4-05T, consisting of an engineer and a conductor, escaped from the rear door of the lead locomotives uninjured. The crew from train GRYLRGT9-26A (the grain train) was not injured.

BNSF has estimated damages at $6.1 million, this does not include environmental remediation. The weather at the time of the accident was cloudy and -1 degrees Fahrenheit, winds north at 7 miles per hour (mph).

The parties to the investigation include the Federal Railroad Administration (FRA), the Pipeline and Hazardous Materials Safety Administration (PHMSA), the BNSF Railway Company, the Brotherhood of Local Engineers and Trainmen (BLET), the International Association of Sheet Metal, Air, Rail and Transportation Workers (SMART),[1] TrinityRail, and Standard Steel L.L.C.

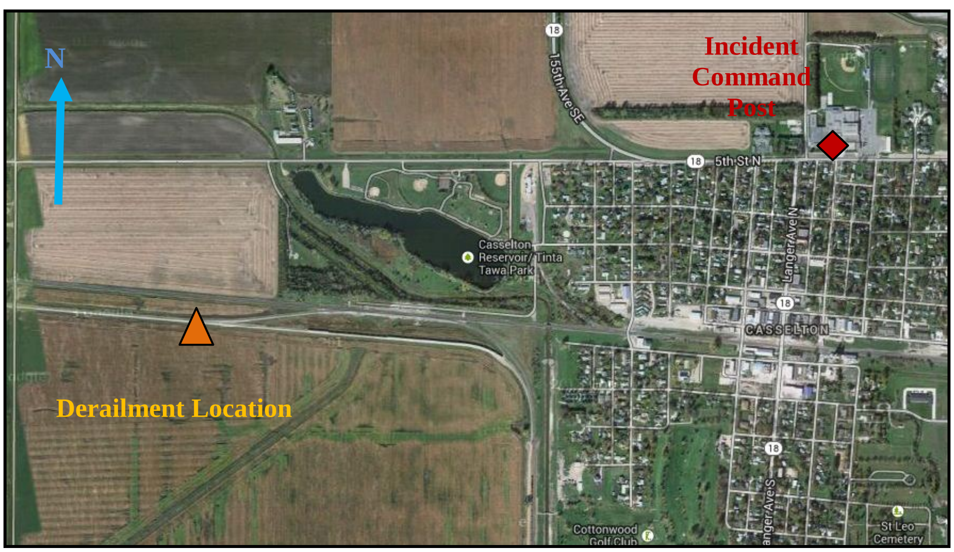

Figure 1: Accident location and the surrounding area of Casselton, North Dakota.

[1] Formerly the United Transportation Union (UTU).

D. Summary of Transported Hazardous Materials

The BNSF Railway Company crude oil train was a unit and "key train"[2] with a total of 104 tank cars containing petroleum crude oil which is designated by the US Department of Transportation (DOT) as a hazardous material when transported in commerce.[3] The commercial transport of petroleum crude oil is subject to the regulatory requirements of the Hazardous Materials Regulations (HMR) in Title 49 of the Code of Federal Regulations (CFR).[4] Table 1 provides information about the hazardous materials on the crude oil train.

Table 1: Summary of hazardous materials on train U-FYNHAY4-05T.

HAZARDOUS MATERIAL PROPER SHIPPING NAME	UNITED NATIONS IDENTI-FICATION NUMBER	HAZARD CLASS OR DIVISION	PACKING GROUP	POSITION(S) IN TRAIN	TOTAL NUMBER OF CARS
Petroleum Crude Oil	1267	3 - Flammable Liquid	I	2 through 105	104
TOTAL HAZARDOUS MATERIALS CARS					**104**

The original train consist carried by the crew was destroyed in the accident. However, a review of the automatic equipment identification (AEI)[5] scan taken of the train at Mandan Yard and the BNSF AEI/TSS scan comparison report indicate that the train consist matched the physical placement of the cars in the train with no exceptions taken.

ATTACHMENT 1 – COPY OF CONSIST FOR TRAIN U-FYNHAY4-05T
ATTACHMENT 2 – BNSF HAZARDOUS MATERIALS INSTRUCTIONS FOR RAIL
ATTACHMENT 3 – BNSF AEI READOUT – MANDAN STATION
ATTACHMENT 4 – BNSF AEI/TSS COMPARISON REPORT

E. Hazardous Materials Railcars Involved in the Accident

The first 21 railcars derailed in the accident. The railcar in position 1 was a buffer car. The twenty (20) other railcars, in positions 2 through 21, were general service specification DOT-111 tank cars that contained petroleum crude oil from the Bakken region of North Dakota. Eighteen (18) of these

[2] Definition of "key train" is provided by Association of American Railroads (AAR) publication OT-55-N, *Recommended Railroad Operating Practices for Transportation of Hazardous Materials*. "Key trains" have speed restrictions and other operating criteria. According to the BNSF Hazardous Materials Instructions for Rail, a key train includes a train with "A. One (1) or more car loads of Spent Nuclear Fuel (SNF) or High Level Radioactive Waste (HLRW) moving under the following Hazardous Material Response Codes (STCCs) - 4929142, 4929143, 4929144, or 4929147, or B. One (1) or more tank car loads of Poison or Toxic Inhalation Hazard (PIH or TIH) (Hazard Zone A, B, C, or D), anhydrous ammonia (UN1005), or ammonia solutions (UN3318), or C. Twenty (20) or more car loads (including intermodal portable tank loads) of any hazardous material."

[3] See 49 CFR 172.101, Purpose and Use of Hazardous Materials Table.

[4] See 49 CFR 171.1, Applicability of Hazardous Materials Regulations (HMR) to persons and functions.

[5] AEI readers detect identification tags on railcars as they pass by the reader. The collected information is automatically relayed to a central computer to update the master train consist.

tank cars were breached and released product. Two (2) tank cars, TAEX 1638 (position 20) and TAEX 1582 (position 21), derailed, but were not breached. None of the remaining 84 tank cars derailed or breached in the accident.

Figure 2: Aerial image of accident site taken from the Northwest. (Photograph courtesy of the US Customs and Border Patrol)

Figure 3: Aerial image of accident site taken from the North. (Photograph courtesy of the US Customs and Border Patrol)

Figure 4: Aerial image of accident site taken from the Northeast.
(Photograph courtesy of the US Customs and Border Patrol)

F. Pre-Accident Events

Hazardous Materials Shipper's Actions - Shipment Preparation

All 104 tank cars in the crude oil train were offered into rail transportation by, the shipper of record. They originated at the Great Northern Midstream facility, known as Fryburg Rail Terminal, in Fryburg, North Dakota. The tank cars were enroute to the consignee, Marquis Energy LLC, in Hayti, Missouri.

Figure 5: Great Northern Midstream Loading Facility in Fryburg, North Dakota.

The Fryburg Rail Terminal is a single-side loading facility, although double tracks exist at the location. The loading operations at the terminal are performed by Watco Company.

The tank cars on train U-FYNHAY4-05T were loaded on December 28 and 29, 2013.[6] The loading and inspection checklist records indicate that pre-loading, in-progress, and post-loading inspections of each tank car were performed. These inspections involved visually checking the tank cars for such things as the following: dents, gouges, cracks, punctures, or signs of leakage; legibility of car stenciling; required outage; currency of tank and safety valve test dates; integrity of valves and fittings; manway gasket condition; securement of the manway; safety valve (pressure relief device) condition; and closure of protective housings. Operators also inspected the bottom outlet fittings of each tank car for valve closure, and condition and securement of the valve cap and gasket. Finally, operators placed seals on the manways, housings, and bottom outlet fittings and recorded the seal numbers on the tank car loading and inspection checklist. No exceptions were noted in the loading and inspection records. After the inspections were completed, a second operator verified the inspections and certified that the loaded railcars were ready for transport.

PHMSA conducted a review of its enforcement history (over the past 10 years) of Watco Company operations at the Fryburg Terminal. Watco Company had only one defect/non-compliance report, a violation of 49 CFR 173.31 that was identified on May 8, 2013. The defect description states:

> Specifications and packaging requirements for this subchapter. Failure to maintain tank car to AAR specifications loaded UN1267 Class 3 tank car removed housing cover seal #1236367 applied seal #DOTFRA 8045 vapor line valve safety chain secured to car body with wire.

On December 29, 2013, Great Northern Midstream conducted quality analysis sampling of the petroleum crude oil that was loaded onto train U-FYNHAY4-05T. The tests measured sulfur content, API gravity, bottom sediment and water, and Reid vapor pressure. The results were provided to the NTSB.

Tank Car Lading Volumes and Capacities

Waybills indicate that the 20 derailed tank cars contained a total of 553,886 gallons of petroleum crude oil. Table 2 provides a summary of lading weights and volumes per tank car. These tank cars were examined for excessive weight and minimum outage. None were overloaded by weight. All had an outage that exceeded the minimum 1 percent required by 49 CFR 173.24b(a).[7]

[6] All of the 20 derailed tank cars were loaded on December 28, 2013.
[7] API gravity at 60°F is 44 (Specific gravity approximately 0.80). Lading was loaded at 37.3°F.

Table 2: Lading volumes of hazardous materials in tank cars.

POSITION IN TRAIN	TANK CAR REPORTING MARKS	LOAD LIMIT WEIGHT	LADING WEIGHT	NET BARRELS	LOAD LIMIT CAPACITY (GAL)	LADING VOLUME AT LOADING (GAL) [Ave. Temp 37.3°F]
2	GATX 33119	198,100	185,443	659	30,140	27,678
3	GATX 33123	198,200	185,417	659	30,130	27,674
4	TAEX 1549	197,200	185,426	659	30,000	27,676
5	TAEX 1475	196,900	185,459	659	30,000	27,681
6	ADLX 500176	196,800	185,434	659	30,060	27,677
7	TAEX 1472	197,000	185,431	659	30,000	27,676
8	SHPX 206675	197,100	185,457	659	30,070	27,680
9	SHPX 208541	197,700	185,555	659	30,070	27,695
10	SHPX 208638	198,000	185,476	659	30,070	27,683
11	SHPX 206670	196,700	185,490	659	30,080	27,685
12	SHPX 208536	198,000	186,743	664	30,060	27,872
13	TAEX 1528	197,500	185,434	659	30,000	27,677
14	TAEX 1602	197,700	185,443	659	30,070	27,678
15	SHPX 206708	196,700	185,445	659	30,080	27,678
16	SHPX 206668	196,700	185,547	659	30,060	27,694
17	GATX 33125	198,100	185,496	659	30,110	27,686
18	GATX 33139	198,500	185,389	659	30,130	27,670
19	TAEX 1630	197,700	185,769	659	30,070	27,727
20	TAEX 1638	197,500	185,724	659	30,070	27,720
21	TAEX 1582	198,100	185459	659	30,060	27,681
TOTAL				**13,185**		**553,888**

ATTACHMENT 5 – PHMSA ENFORCEMENT HISTORY OF WATCO RAIL TERMINAL
ATTACHMENT 6 – PRE-TRANSPORT INSPECTION CHECKLISTS
ATTACHMENT 7 – UMLER REPORT FOR TANK CARS
ATTACHMENT 8 – GREAT NORTHERN GATHERING AND MARKETING DECEMBER 2013 SHIPMENT REPORT
ATTACHMENT 9– GREAT NORTHERN GATHERING AND MARKETING SAMPLE RESULTS
ATTACHMENT 10 – WAYBILLS
ATTACHMENT 11 – GREAT NORTHERN GATHERING AND MARKETING METER TICKET 1
ATTACHMENT 12 – GREAT NORTHERN GATHERING AND MARKETING METER TICKET 2

G. Hazardous Materials Description and Information

Petroleum crude oil shipments are the fastest growing of all hazardous materials shipped by rail.

The Pipeline and Hazardous Materials Safety Administration's (PHMSA) August 1, 2014, Notice of Proposed Rulemaking (NPRM) titled, *Hazardous Materials: Enhanced Tank Car Standards and Operational Controls for High-Hazard Flammable Trains*,[8] states that the volume of crude oil carried by rail increased 423 percent between 2011 and 2012. According to a July 2014 AAR report titled, *Moving Crude Oil by Rail*,[9] the number of "originated carloads of crude oil on US Class I railroads (including the US Class I subsidiaries of Canadian railroads) rose from 9,500 in 2008 to 233,698 in 2012 to 407,761 in 2013." The report states that this increase in railroad crude oil transportation is largely attributed to increased oil production as a result of "technological advances — especially in hydraulic fracturing ("fracking") and horizontal drilling — along with higher crude oil prices [that] have made recovery of much of this oil and gas economically feasible."

According to the 2014 AAR report:

> Much of the recent increase in crude oil production has been in North Dakota, where crude oil production rose from an average of 81,000 barrels per day in 2003 to nearly one million barrels per day by early 2014, making it the second largest oil producing state. Crude oil output in Texas, the top crude oil producing state, was relatively flat from 2003 to 2009, but has skyrocketed since then, exceeding 2.9 million barrels per day by early 2014.

Crude oil is often transported in units of cars (blocks of crude oil cars within a train) and by entire unit trains consisting solely of crude oil tank cars. The crude oil loaded into these tank cars is often a blend of crude from a variety of oil wells which may have varying properties depending on the crude oil components.

The 2014 AAR report states:

> North Dakota, and the Bakken region more generally, have accounted for the vast majority of new rail crude oil originations. According to estimates from the North Dakota Pipeline Authority, close to 700,000 barrels per day of crude oil were moving out of North Dakota by rail as of early 2014, equivalent to more than 60 percent of North Dakota's crude oil production.

According to the PHMSA Central Region, on an average day, BNSF, Canadian National, and Canadian Pacific Railroads move approximately 1,400 to 1,500 railcars loaded with crude oil from North Dakota to various facilities across the US (East Coast, West Coast, and Gulf Coast).

In the Bakken region, petroleum crude oil is gathered from wells into gathering tanks which, at times may be located at the well. However, generally, the crude oil is moved from the wells using an intra-field gathering line. The crude oil is then separated in a three (3) phase separator where the water, the gases, and the crude oil are put in different tanks. At that time, depending on the field and the location, the crude oil is then either sent via pipeline or semi-truck cargo tank to one of 19 railroad loading facilities.

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[8] 79 FR 45015.

[9] AAR background paper titled, "Moving Crude Oil by Rail." Published at https://www.aar.org/safety/Pages/crude-by-rail-facts.aspx

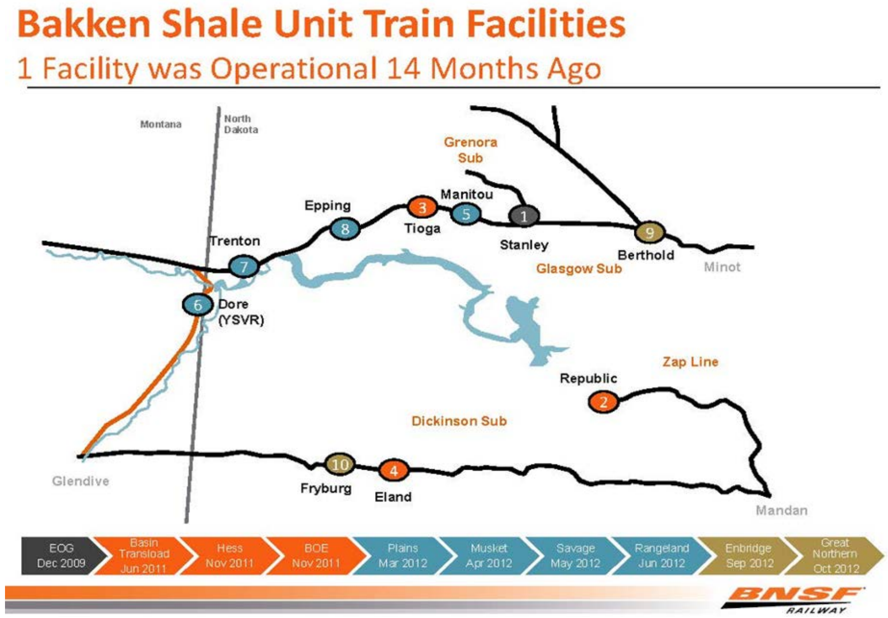

Figure 6: Map of BNSF-serviced petroleum crude oil terminals in North Dakota, including the Great Northern Midstream Loading Facility in Fryburg.

According to PHMSA, since September 2013, as a result of the accident in Lac Megantic, Canada, and enforcement efforts by US and Canadian regulatory agencies, shippers at the majority of the petroleum crude oil rail facilities now test the product for classification and determination of appropriate packing group. Verification of this classification is accomplished by random inspections and sampling conducted by PHMSA and the FRA.

Material Description and Properties[10]

Petroleum crude oil is a complex combination of hydrocarbons. It consists predominantly of aliphatic, alicyclic, and aromatic hydrocarbons. It may also contain small amounts of nitrogen, oxygen, and sulfur compounds as well as trace amounts of heavy metals such as nickel, vanadium, and lead. The volatile organic compounds (VOCs) in crude oil include mono-aromatic compounds such as benzene, toluene, and xylenes as well as aliphatic hydrocarbons such as cyclohexane and hexane. Crude oils are natural products and their chemical and physical properties can vary widely depending on their source and extraction method.

Petroleum crude oil is generally a dark yellow to brown or greenish black liquid with a hydrocarbon odor. If hydrogen sulfide is present, it has a rotten egg odor; however, it should not be used as a warning property of toxic levels because it can overwhelm and deaden the sense of smell.

[10] Information in this section was obtained from the shipper Material Safety Data Sheet (MSDS) and the US National Library of Medicine, Toxicology Data Network (TOXNET), ChemIDplus database found at http://chem.sis.nlm.nih.gov/chemidplus/chemidlite.jsp.

Petroleum crude oil is a volatile and flammable liquid. Vapors may cause flash fires. It should be kept away from heat, flame, and sources of ignition.

According to a 2014 quality assurance study commissioned by the North Dakota Petroleum Council (NDPC), Bakken crude oil is a light, sweet crude[11] with an average API gravity of 41°. The study also found that Bakken crude oil has a flash point below 73°F. The report's other key findings include:[12]

- Bakken crude is a light sweet crude oil with an API gravity generally between 40° and 43° and a sulfur content <0.2 wt.%. As such, it is similar to many other light sweet crude oils produced and transported in the United States.
- Bakken crude had an average vapor pressure of 11.5 and 11.8 psi, which is more than 60% below the vapor pressure threshold limit for liquids under the Hazardous Materials Regulations (43.5 psi).
- Bakken crude has a flashpoint of less than 73 degrees Fahrenheit, which is within normal range.
- The Initial Boiling Point (IBP) generally averaged between 95 degrees and 100 degrees Fahrenheit, which is within normal range for a light crude oil (using ASTM D86).
- The light ends concentration of Bakken crude was between three and nine percent, with five percent being the typical concentration.
- The qualities of Bakken were very consistent within the sample population and throughout the supply chain – from wellhead to rail terminal to refining destination. Test results showed no evidence of "spiking" with Natural Gas Liquids (NGLs) before rail shipment.

The American Petroleum Institute (API) analyzed more than 200 samples of Bakken crude oil and sent the data to PHMSA in response to a 2013 DOT letter regarding concerns about Bakken crude oil.[13] The API analysis also concluded that Bakken crude oil is very similar to other light, sweet crude oils. The API gravities for their samples ranged from 38.86° to 47.07° with the average being 42.66°. The average sulfur content (wt. %) was 0.1 percent. The average IBP was 91.96°F.

On July 23, 2014, PHMSA released a report titled, *Operation Safe Delivery Update*[14], which presents the results of samples collected and analyzed by the agency to determine if shippers were properly classifying Bakken crude oil for transportation. The PHMSA report includes the results of five samples that were collected at the Great Northern Gathering and Marketing Fryburg Terminal.

[11] The higher the API gravity, the lighter the crude. Light crude must have an API gravity of greater than 31.1°.
[12] http://www.ndoil.org/resources/bkn/

[13] API presentation dated May 19, 2014, titled, *Staff Analysis of Crude Oil Samples Submitted to PHMSA.* http://www.api.org/news-and-media/news/newsitems/2014/may-2014/~/media/Files/News/2014/14-May/Staff-analysis-of-Data-Submitted-to-PHMSA.pdf

[14] Report available at http://www.phmsa.dot.gov/hazmat/osd/chronology

All the samples had flash points under 50^{o}F and IBPs ranging between 86.7 and 91.7^{o}F. All the samples had sulfur content under 1 part per million (ppm). The report concluded:

> Based upon the results obtained from sampling and testing of the 135 samples from August 2013 to May 2014, the majority of crude oil analyzed from the Bakken region displayed characteristics consistent with those of a Class 3 flammable liquid, PG I or II, with a predominance to PG I, the most dangerous class of Class 3 flammable liquids. Based on our findings, we conclude that while this product does not demonstrate the characteristics for a flammable gas, corrosive liquid or toxic material, it is more volatile than most other types of crude, which correlates to increased ignitability and flammability.
>
> Bakken crude's high volatility level – a relative measure of a specific material's tendency to vaporize – is indicated by tests concluding that it is a "light" crude oil with a high gas content, a low flash point, a low boiling point and high vapor pressure. The high volatility of Bakken crude oil, and its identification as a "light" crude oil, is attributable to its higher concentrations of light end hydrocarbons. This distinguishes it from "heavy" crude oil mined in other parts of the United States.

When petroleum crude oil is released to the environment, it undergoes a process known as "weathering" that results in the loss of the more volatile components of oil.

Routes of Exposure and Target Organs[15]

The routes of exposure to petroleum crude oil include inhalation, ingestion, skin, and eye contact. Prolonged direct skin contact with crude oil may cause skin irritation, although short-term skin contact is unlikely to cause adverse effects. Repeated and long term skin exposure contact to components of this product has caused systemic toxicity and cancer in laboratory animals. Inhalation overexposure to the vapors of fresh crude oil may result in headache, dizziness, confusion, nausea, and vomiting. It can contain toxic levels of hydrogen sulfide vapors that accumulate in the vapor spaces of storage and transport compartments. Hydrogen sulfide vapors can cause eye, skin, and respiratory tract irritation and asphyxiation.

When crude oil or other petroleum products burn, they primarily produce particulate matter (PM), carbon monoxide, sulfur dioxide, VOCs including mono-aromatic hydrocarbons and aldehydes, and polynuclear aromatic hydrocarbons (PAHs). Short-term overexposure to PM, VOCs, or sulfur dioxide may result in irritation of the eyes and respiratory tract. Persons with respiratory disease such as asthma may be more sensitive to respiratory irritants produced by burning crude oil. Carbon monoxide primarily affects the central nervous system as a result of its ability to decrease the oxygen-carrying capacity of the blood. Overexposure to carbon monoxide is much less likely to occur in the outdoors due to dilution in the atmosphere.

[15] Eco-Energy Material Safety Data Sheet and the National Institute of Occupational Safety and Health (NIOSH) Pocket Guide to Chemical Hazards - Ethyl Alcohol and gasoline.

Petroleum crude oil contains carcinogens according to IARC, NTP, ACGIH and OSHA. It contains benzene; a regulated human carcinogen. Benzene is recognized as having the potential to cause anemia and other blood diseases, including leukemia, after repeated and prolonged exposure.

Table 3: Occupational Exposure Limits for Some Typical Components.

INGREDIENT NAME	CAS NUMBER	EXPOSURE LIMIT
Benzene	71-43-2	ACGIH[16] TWA[17]= 0.5 ppm (skin); ACGIH STEL[18]= 2.5 ppm
Toluene	108-88-3	ACGIH TWA= 50 ppm
Ethylbenzene	100-41-4	ACGIH TWA= 100 ppm; ACGIH STEL = 125 ppm
Xylene, mixed isomers	1330-20-7	ACGIH TWA= 100 ppm
Hydrogen Sulfide	7783-06-4	ACGIH TWA= 5 ppm; ACGIH STEL= 10 ppm

Physical Hazards

Tank cars containing petroleum crude oil or other flammable liquids pose a significant explosion hazard when exposed to fire or other conditions that could cause a tank overpressure rupture. The catastrophic rupture or explosion of the tank can produce a damaging shock wave traveling at a subsonic speed. This shock wave pressure resulting from the explosion can cause significant damage to nearby structures and humans. The extent of the damaging effects of an explosion are determined by the overpressure and impulse.[19,20]

The 2012 Emergency Response Guidebook (ERG) instructs first responders to establish a half-mile isolation area in all directions around a flammable liquid-filled tank, rail car, or tank truck that is involved in a fire.[21] Responders must always stay away from tanks engulfed in fire. According to a 1970 Cornell Aeronautical Laboratory study for the FRA, "[p]robably the single most important element, from a consideration of the possibilities of catastrophic rupture is the presence of a large thermal load due to fire exposure.[22]" Additionally, such incidents can expose responders or bystanders to a high level of thermal radiation heat flux. After conducting a literature study to determine acceptable levels of thermal radiation heat flux for a risk assessment, the FRA concluded that "it is uncertain what level of thermal radiation heat flux can be considered 'safe' for exposing human beings to short duration fires resulting from accidents."[23]

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[16] American Conference of Government Industrial Hygienists.
[17] Time-weighted average.
[18] Short term exposure limit.
[19] F. Diaz Alonso et al. Characteristic overpressure–impulse–distance curves for the detonation of explosives, pyrotechnics or unstable substances. Journal of Loss Prevention in the Process Industries 19 (2006) 724-728.
[20] FRA Report Number FRA/ORD-92/34, "Hazardous Material Transportation in Tank Cars: Analysis of Risks." May 1993. Pages 6-20.
[21] 2012 ERG, Guide 131, Flammable Liquids - Toxic.
[22] FRA Report Number FRA-RT-71-74, "A Study to Reduce the Hazards of Tank Car Transportation." Final Report, November 1970. Page 5.
[23] FRA Report Number FRA/ORD-92/34, "Hazardous Material Transportation in Tank Cars: Analysis of Risks." May 1993. Page Ex-10.

DOT Flammable Liquid Classification Criteria

The HMR requires shippers to analyze the hazardous materials to determine the appropriate hazard class and packing group based on the hazard they present. This classification and characterization is a key requirement for the selection of proper packaging.

The HMR[24] classifies flammable liquids (Class 3) into three packing groups as shown in table 4.

Table 4: Packing group assignments.

PACKING GROUP	FLASH POINT (CLOSED-CUP)	INITIAL BOILING POINT
I		≤35°C (95°F)
II	<23°C (73°F)	>35°C (95°F)
III	≥23°C, ≤60°C (≥73°F, ≤140°F)	>35°C (95°F)

Great Northern Midstream was unable to produce any classification or characterization documentation to the NTSB. They did not conduct hazardous materials classification sampling, as required for classification and packing group determination prior to shipment. However, the shipper packaged and classified the petroleum crude oil as Class 3, packing group I, which is the highest risk and most conservative classification of a flammable liquid.

H. <u>Post-Accident Events</u>

Emergency Response Activities

The first telephone call came into the Red River Regional Dispatch Center (RRRDC) at 2:12:04 p.m. reporting a train derailment and fire.[25] Shortly thereafter, a Cass County Unified Command Post was established which included the Cass County Sheriff's Department and the Casselton Fire Department.[26] Multiple resources quickly integrated into the Cass County Unified Command Post to include the North Dakota Highway Patrol, Fargo Cass Public Health, and the Fargo Fire Department's Hazardous Material Response Team. At 4:14 p.m., the Cass County Sherriff ordered a ¾ mile isolation perimeter around the accident site. At 4:18 p.m., a Tactical Operations Center

[24] 49 CFR 173.121(a)(1)

[25] The RRRDC provides public safety emergency and non-emergency dispatch services for law enforcement, fire and EMS agencies in all cities and towns in Cass County, North Dakota (including the Cities of Fargo and West Fargo) and all cities and towns in the Clay County, Minnesota (including the City of Moorhead). (Source: http://www.rrrdc.com/call-stats/)

[26] The Casselton Fire Department has about 28 volunteer firefighters. They cover 378 square miles of Cass County, North Dakota which includes all or part of 12 townships, the City of Casselton and various small towns with a combined population of 3,680. We have approximately 50 miles of railroad tracks in our territory. (Source: Testimony of Tim McLean, Fire Chief of the Casselton (North Dakota) Volunteer Fire Department Before the Senate Homeland Security and Government Affairs Committee – March 25, 2014)

(TOC) was setup. The TOC coordinated response personnel and provided current information to the public. At 4:33 p.m., the Casselton Fire Department and Cass County Sherriff's Department began a voluntary evacuation. Approximately 1,400 people were eventually evacuated. Responders decided to let the tank cars burn, without implementing any firefighting measures.

At 4:43 p.m., the command post was moved to the Central Cass School (Casselton High School). Shortly thereafter, the Sherriff's Department, Fire Department and Red Cross personnel began canvasing the area to notify residents of the evacuation and provide assistance as needed. At 5:25 p.m., the Command Center Public Information Officer issued a public announcement for displaced people to go to the Casselton High School to be transported to Discovery Middle School in Fargo for reunification with their children. Weather information was obtained and distributed hourly. At 6:20 p.m., BNSF, Fargo Hazmat, County personnel and Casselton Fire Department discussed concerns with particulates and other chemicals that could pose a health hazard to Casselton residents. They determined that the best option was to encourage all Casselton residents to evacuate due to possible health concerns and changing wind directions that could carry the particulates and other combustion products to the residents. At 7:11 p.m., a voluntary evacuation order was issued for all of Casselton due to wind shifting to the West and a high pressure system that will force the smoke and combustion products to the ground. At 10:48 p.m., it was estimated that 65% of Casselton had evacuated.

During the incident, several of the derailed tank cars experienced thermal tears that resulted in energetic thermal releases.

Figure 7: Image of a violent energetic release from a tank car in Casselton, North Dakota. (Courtesy of Dawn Faught)

Several Hybrid Single-Particle Lagrangian Integrated Trajectory (HYSPLIT) models were developed to estimate the affected areas of the community. The HYSPLIT model is a complete system for computing simple air parcel trajectories to complex dispersion and deposition simulations.

On December 31, 2013, at 9:00 a.m., the Cass County Sherriff issued a public announcement detailing the number of people and animals that had been provided shelter by the Red Cross at the Discovery Middle School. While air quality conditions were improving, there were still ongoing concerns. At 5:00 p.m., the TOC was formally shut down.

BNSF hired the following contractors to assist with the incident response:

- Hulcher – Heavy Equipment
- RJ Corman – Heavy Equipment
- United Professional Services (UPS) – Hazmat/Fire Fighting
- Specialized Response Solutions (SRS) – Hazmat/Fire Fighting
- United States Environmental Services (USES) - Hazmat
- Beltrami Industrial Services – Environmental Remediation
- West Central Environmental Services - Environmental Remediation
- Centers for Toxicology and Environmental Health (CTEH) – Toxicology and Air Monitoring
- Pinnacle Engineering, Inc. – Environmental Remediation

CTEH developed and implemented the air monitoring plan for the response. The air monitoring plan detailed the sampled analytes and the used detection and action levels. The general description of the CTEH assessment techniques are provided in Table 3.

Table 5: Summary of general assessment techniques used by CTEH.

PROCEDURE	DESCRIPTION
Hand-held Survey	CTEH staff members utilized handheld instruments (e.g. MultiRAE Plus; UltraRAE, Gastec colorimetric detector tubes, etc.) to measure real-time airborne chemical concentrations outdoors around the incident location as well as inside of the affected residence. CTEH used these hand-held instruments primarily to measure the breathing zone and locate sources.
Analytical sampling	Analytical sampling was used to validate the hand-held real-time data monitoring data, and to provide data beyond the scope of the real-time instruments. Analytical samples were collected and sent to an off-site laboratory for further chemical analysis.

Throughout the response, CTEH conducted real-time air monitoring in the work areas and the nearby community for the constituents potentially associated with crude oil vapors: benzene, hydrogen sulfide, n-hexane, toluene, xylene and total VOCs; and for products of crude oil combustion: carbon monoxide, nitric oxide, nitrogen dioxide, sulfur dioxide, and respirable particulate matter with a median diameter of 2.5 microns (PM2.5). The lower explosive limit (LEL) and oxygen levels were also monitored. Fixed real-time stations were established in the closest occupied community to the incident and monitored throughout the response.

Table 6: CTEH sampling area descriptions.

SAMPLING AREA	DESCRIPTION
Work Area	The general area around the incident location where workers are actively or sporadically participating in remediation activities.
Community/Residence	The immediate area in and around the residences where individuals not participating in remediation activities could potentially be exposed to the spilled chemicals (i.e. homeowners).
Other	During the course of the remediation, some additional areas may be established which require a unique set of action levels or sampling (e.g. decontamination zones, etc.)

CTEH also monitored wind direction throughout the course of the response. CTEH found that during the initial hours of the incident on December 30, 2013, the winds were primarily blowing away from the nearest community to the east of the derailment. Due to an anticipated change in the wind direction later that day, the Cass County Sherriff advised the community to the east of the derailment to evacuate. On December 31, 2013, and January 1, 2014, the wind direction was predominantly from the north and not toward the community to the east. Properties directly south of the derailment site were agricultural and sparsely populated.

CTEH did not detect hydrogen sulfide in the community or work area. Prior to CTEH personnel arriving onsite, a BNSF Tactical Toxicology[27] responder reported VOC detections ranging between 0.1 and 0.6 ppm and hydrogen sulfide detections ranging between 1 and 2 ppm.

Benzene, carbon monoxide, hydrogen sulfide, nitric oxide, sulfur dioxide, and VOCs were not detected in the community.

CTEH found that PM2.5 levels in the community ranged from between 0.004 mg/m^3 and 0.222 mg/m^3. These readings represent short time periods (generally 5 minutes or less) at a specific location and monitoring periods less than one hour do not have applicable health-based guidelines. However, for periods ranging from 8 hours to 16 hours, averages of multiple readings throughout the community were well below the National Ambient Air Quality Standard (NAAQS) for PM2.5 that is protective of public health for a 24 hour period (0.035 mg/m^3).

The average concentration of PM2.5 from readings in the evacuated community from 7:00 a.m. to 3:00 p.m. on December 31, 2013, was 0.008 mg/m^3. The average concentration of PM2.5 from readings in the community between the time the evacuation was lifted (the evacuation was lifted at 3:00 p.m. on December 31, 2013) and the time the fires were out (7:00 a.m. on January 1, 2014) was 0.019 mg/m^3. These concentrations were below NAAQS 0.035 mg/m^3 for PM2.5 for a 24 hour period, and CTEH concluded that the average PM2.5 concentrations occurring in the community over December 31, 2013, and January 1, 2014, did not pose a public health risk. CTEH also concluded that due to the very cold temperatures that occurred during the response, very few persons

[27] BNSF's Tactical Toxicology (TacTox) Program is a network of specially trained contractors and consultants spread over the BNSF network that can be mobilized quickly to the location of a hazmat incident and conduct air monitoring that will quantify community and worker exposure, provide data for evacuation/shelter-in-placed decisions and provide important information that will be used to conduct air dispersion modeling.

were likely to have experienced outdoor exposure to smoke particulate during the response. CTEH's report states that "As noted in public health guidance, some protection from outdoor smoke particulate is afforded by remaining indoors."

According to CTEH, VOC air monitoring conducted at the derailment scene in Casselton indicated low concentrations of VOCs, likely a result of the effect of the very cold temperatures which reduced volatilization. Only low concentrations of VOCs were detected at the Casselton derailment and occurred only in the immediate location of the spilled oil. The maximum detected concentration of carbon monoxide in the work area of the derailment was 2 ppm. This concentration is 25 times lower than the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) for an eight-hour exposure period.

ATTACHMENT 14– TOC TIMELINE TRAIN DERAILMENT CASSELTON DECEMBER 30TH 2013
ATTACHMENT 15– COMMAND POST TIMELINE
ATTACHMENT 16– EMERGENCY RESPONSE STAGING TIMELINE
ATTACHMENT 17 – HYSPLIT DISPERSION MODELS
ATTACHMENT 18 – HYSPLIT TRAJECTORY MODELS
ATTACHMENT 19 – CASS COUNTY INCIDENT REPORT
ATTACHMENT 20 – CTEH AIR MONITORING PLAN
ATTACHMENT 21 – CTEH AIR MONITORING RESULTS SUMMARY
ATTACHMENT 22 – CTEH AIR MONITORING REPORT – FINAL

I. <u>Accident Injuries</u>

There were no injuries involved with the accident.

J. <u>Derailed Tank Cars</u>

Tank Car Descriptions

All of the derailed tank cars were general service specification DOT-111A100W1. They had a maximum gross rail load (GRL) of 263,000 pounds. The Applications for Approval and Certificates of Construction document the tank car builders' Quality Assurance Managers' certification that the constructed tank cars "…conform to…the …[AAR] approved description and to all applicable DOT and AAR requirements, including specifications, rules of interchange, and the DOT Railroad Safety Appliance Standards." Table 5 provides a summary of tank car information retrieved from the certificates of construction and UMLER report.

Table 7: Summary of tank car build information.

LINE NUMBER OR POSITION IN TRAIN	FIELD WRECKAGE INDEX NUMBER	REPORTING MARK	TANK CAR MANUFACTURER	BUILD DATE (YYYYMMDD)	DOT SPECIFICATION	MATERIAL HEAD/SHELL	HEAD AND SHELL THICK-NESS (INCH)	PRESSURE RELIEF DEVICE [# OF PRD]
2	17	GATX 33119	TrinityRail	20050601	111A100W1	ASTM A516 GR 70/ TC 128 GR B	7/16	75 psi [1]
3	16	GATX 33123	TrinityRail	20050601	111A100W1	ASTM A516 GR 70/ TC 128 GR B	7/16	75 psi [1]
4	15	TAEX 1549	American Railcar Industries (ARI)	20080301	111A100W1	ASTM A516 GR 70/ TC 128 GR B	7/16	75 psi [1]
5	14	TAEX 1475	American Railcar Industries (ARI)	20080201	111A100W1	ASTM A516 GR 70/ TC 128 GR B	7/16	75 psi [1]
6	13	ADLX 500176	American Railcar Industries (ARI)	20080201	111A100W1	ASTM A516 GR 70/ TC 128 GR B	7/16	75 psi [1]
7	12	TAEX 1472	American Railcar Industries (ARI)	20080201	111A100W1	ASTM A516 GR 70/ TC 128 GR B	7/16	75 psi [1]
8	11	SHPX 206675	American Railcar Industries (ARI)	20031201	111A100W1	ASTM A516 GR 70/ TC 128 GR B	7/16	75 psi [1]
9	10	SHPX 208541	American Railcar Industries (ARI)	20080201	111A100W1	ASTM A516 GR 70 Norm / TC 128 GR B	7/16	75 psi [1]
10	9	SHPX 208638	American Railcar Industries (ARI)	20080301	111A100W1	ASTM A516 GR 70 Norm / TC 128 GR B	7/16	75 psi [1]
11	8	SHPX 206670	American Railcar Industries (ARI)	20031201	111A100W1	ASTM A516 GR 70/ TC 128 GR B	7/16	75 psi [1]
12	7	SHPX 208536	American Railcar Industries (ARI)	20080201	111A100W1	ASTM A516 GR 70 Norm / TC 128 GR B	7/16	75 psi [1]
13	6	TAEX 1528	American Railcar Industries (ARI)	20080301	111A100W1	ASTM A516 GR 70 Norm / TC 128 GR B	7/16	75 psi [1]
14	19	TAEX 1602	American Railcar Industries (ARI)	20080101	111A100W1	ASTM A516 GR 70 Norm / TC 128 GR B	7/16	75 psi [1]
15	5	SHPX 206708	American Railcar Industries (ARI)	20031201	111A100W1	ASTM A516 GR 70/ TC 128 GR B	7/16	75 psi [1]
16	18	SHPX 206668	American Railcar Industries (ARI)	20031201	111A100W1	ASTM A516 GR 70/ TC 128 GR B	7/16	75 psi [1]
17	4	GATX 33125	TrinityRail	20050601	111A100W1	ASTM A516 GR 70/ TC 128 GR B	7/16	75 psi [1]
18	3	GATX 33139	TrinityRail	20050606	111A100W1	ASTM A516 GR 70/ TC 128 GR B	7/16	75 psi [1]

LINE NUMBER OR POSITION IN TRAIN	FIELD WRECKAGE INDEX NUMBER	REPORTING MARK	TANK CAR MANUFACTURER	BUILD DATE (YYYYMMDD)	DOT SPECIFICATION	MATERIAL HEAD/SHELL	HEAD AND SHELL THICK-NESS (INCH)	PRESSURE RELIEF DEVICE [# OF PRD]
19	2	TAEX 1630	American Railcar Industries (ARI)	20080101	111A100W1	ASTM A516 GR 70 Norm / TC 128 GR B	7/16	75 psi [1]
20	1	TAEX 1638	American Railcar Industries (ARI)	20080101	111A100W1	ASTM A516 GR 70 Norm / TC 128 GR B	7/16	75 psi [1]
21	-	TAEX 1582	American Railcar Industries (ARI)	20080101	111A100W1	TBD	7/16	75 psi [1]

The DOT-111 tank car has been the predominant general purpose non-pressure tank car since the 1960's. There are numerous versions of the DOT-111 that have been introduced, with variances in design features such as tank lining, insulation, and materials of construction. General specifications applicable to the DOT-111 tank car are found in 49 CFR 179, Subpart D. The DOT-111A100W1 tank car was the predominant general purpose non-pressure tank car used for the transport of hazardous materials in 2011 and 2012, with about 100,404 used in 2011 (51 percent of tank car fleet used) and 109,342 used in 2012 (52 percent of tank car fleet used).[28]

Due to the large fire after the derailment, several current tank car reporting marks and numbers were burnt off many of the tank cars, revealing previous or historical reporting marks.[29] Table 6 provides a summary of the current and historical tank car reporting marks, the BNSF field wreckage index number, and the car's line number in the train.

Table 8: Summary of tank car reporting mark information history and position in train.

LINE NUMBER [POSITION IN TRAIN]	FIELD WRECKAGE INDEX NUMBERS	CURRENT MARK AND CAR NUMBER	SECOND OWNER - MARK AND NUMBER [HISTORICAL]	FIRST OWNER - MARK AND NUMBER [HISTORICAL]
2	17	GATX 33119	N/A	N/A
3	16	GATX 33123	N/A	N/A
4	15	TAEX 1549	ADLX 500237	BNBX 500237
5	14	TAEX 1475	ADLX 500163	BNBX 500163
6	13	ADLX 500176	N/A	BNBX 500176
7	12	TAEX 1472	ADLX 500160	BNBX 500160
8	11	SHPX 206675	N/A	N/A
9	10	SHPX 208541	N/A	N/A
10	9	SHPX 208638	N/A	N/A

[28] *Annual Report of Hazardous Materials Transported by Rail* (Association of American Railroads, Bureau of Explosives, 2011 and 2012).
[29] The tank car marks and numbers were changed when ownership of the tank cars changed.

LINE NUMBER [POSITION IN TRAIN]	FIELD WRECKAGE INDEX NUMBERS	CURRENT MARK AND CAR NUMBER	SECOND OWNER - MARK AND NUMBER [HISTORICAL]	FIRST OWNER - MARK AND NUMBER [HISTORICAL]
11	8	SHPX 206670	N/A	N/A
12	7	SHPX 208536	N/A	N/A
13	6	TAEX 1528	ADLX 500216	BNBX 500216
14	19	TAEX 1602	ADLX 500102	BNBX 500102
15	5	SHPX 206708	N/A	N/A
16	18	SHPX 206668	N/A	N/A
17	4	GATX 33125	N/A	N/A
18	3	GATX 33139	N/A	N/A
19	2	TAEX 1630	ADLX 500131	BNBX 500131
20	1	TAEX 1638	ADLX 500139	BNBX 500139
21	-	TAEX 1582	ADLX 500080	BNBX 500080

ATTACHMENT 23 – APPLICATION FOR APPROVAL AND CERTIFICATE OF CONSTRUCTION – TRINITYRAIL
ATTACHMENT 24 – APPLICATION FOR APPROVAL AND CERTIFICATE OF CONSTRUCTION – ARI-BNBX
ATTACHMENT 25 – APPLICATION FOR APPROVAL AND CERTIFICATE OF CONSTRUCTION – ARI-SHPX
ATTACHMENT 26 – TRINITYRAIL TANK CAR DETAIL SPECIFICATION – FOR OFFICAL USE ONLY
ATTACHMENT 27 – REPORT OF TANK REPAIRS, ALTERATION OR CONVERSION – GATX033123
ATTACHMENT 28 – REPORT OF TANK REPAIRS, ALTERATION OR CONVERSION – GATX033139

Tank Car Owners

The tank cars were owned by the following:

1. GATX
   GATX Corporation
   222 West Adams Street
   Chicago, Illinois 60606

2. TAEX
   The Andersons Rail Group
   P.O. Box 119
   480 W. Dussel Drive
   Maumee, Ohio 43597

3. ADLX
   Adler Funding, LLC (GATX Corporation owns a portion of the company)
   222 W. Adams St.
   Chicago, Illinois 60606

4. SHPX

American Railcar Leasing, LLC
100 Clark St, Suite 201
St. Charles, Missouri 63301

K. Tank Car Damages

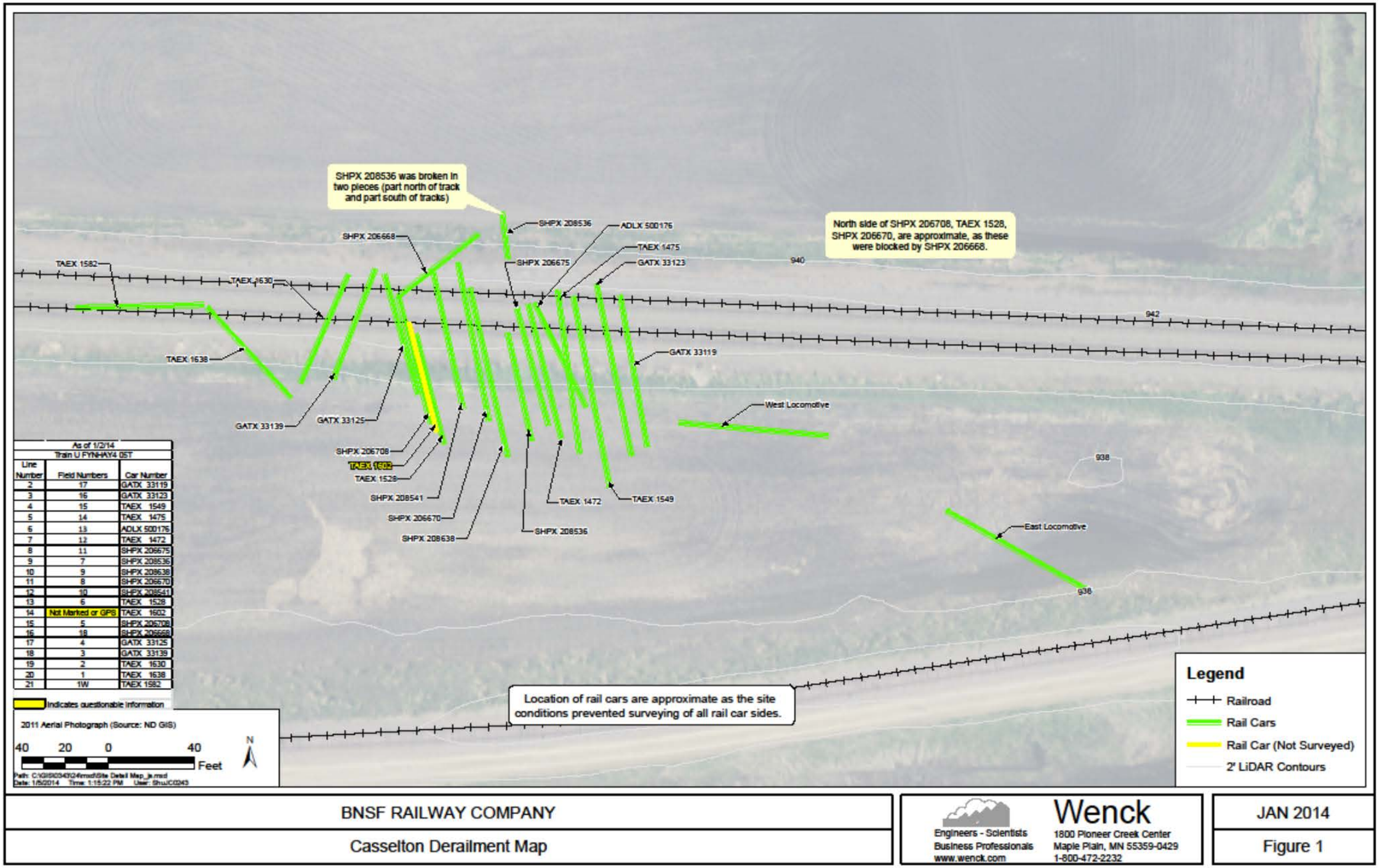
Photographs of the derailment site were collected and the tank cars were GPS tagged to record their positions in the derailment. A diagram was produced to indicate the GPS locations (see Figure 8).

The orientation of the tank cars in the train was captured by the AEI in Mandan. The table below lists the leading end (either A or B-end) of the tank car as it passed the AEI detector.

Table 9: Orientation of the tank cars in the train.

LINE NUMBER	REPORTING MARK	LEADING END (A or B)
1	BNSF 808314	B
2	GATX 33119	A
3	GATX 33123	A
4	TAEX 1549	B
5	TAEX 1475	B
6	ADLX 500176	B
7	TAEX 1472	B
8	SHPX 206675	A
9	SHPX 208541	A
10	SHPX 208638	B
11	SHPX 206670	A
12	SHPX 208536	A
13	TAEX 1528	A
14	TAEX 1602	B
15	SHPX 206708	A
16	SHPX 206668	A
17	GATX 33125	A
18	GATX 33139	B
19	TAEX 1630	A
20	TAEX 1638	B
21	TAEX 1582	B

Hulcher and RJ Corman removed the tank cars off the tracks and staged them in a field north of the derailment site. Tank cars were inspected at this location. Observations and measurements were recorded. Attachment 32 provides the Group’s detailed damage assessments. Table 8 summarizes the observed tank car damages.



As of 1/2/14		
Train U FYNHAY4 05T		
Line Number	Field Numbers	Car Number
2	17	GATX 33119
3	16	GATX 33123
4	15	TAEX 1549
5	14	TAEX 1475
6	13	ADLX 500176
7	12	TAEX 1472
8	11	SHPX 206675
9	7	SHPX 208536
10	9	SHPX 208638
11	8	SHPX 206670
12	10	SHPX 208541
13	6	TAEX 1528
14	Not Marked or GPS	TAEX 1602
15	5	SHPX 206708
16	18	SHPX 206668
17	4	GATX 33125
18	3	GATX 33139
19	2	TAEX 1630
20	1	TAEX 1638
21	1W	TAEX 1582

Figure 8: Labeled GPS diagram of derailment.

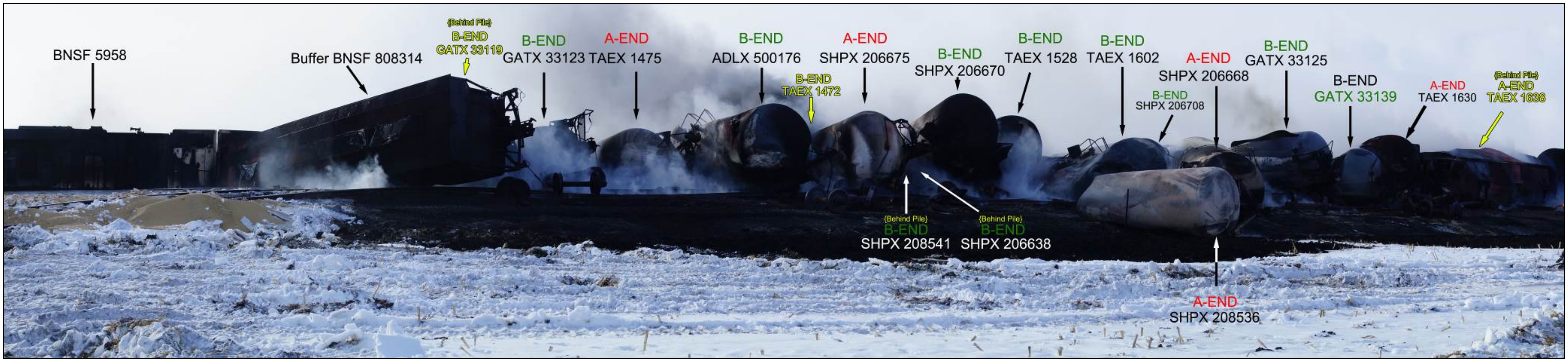


Figure 9: Labeled image of derailment (includes location of unseen tank cars in yellow).

Table 10: Summary of tank car damages.

Field Index #	Line #	Report-ing Mark	Tank Breach [Yes/ No]	Damage Description	Multi-Housing Compro-Mised	Valve Damage	BOV Nozzle Sheared	BOV Open	BOV Handle Damaged	Manway Compro-mised	Thermal Tear	Head Brace Pulled From Head Pad	Head Pad Pulled From Tank	Tank Pulled From Head Pad.
1	20	TAEX 1638	No	Minimal damage to tank head and shell - no damage other than scrapes. BOV was buried (condition unknown); however, tank car did not leak.	No	No	No	No	No	No	No	No	No	No
2	19	TAEX 1630	Yes	Manway intact. Multi-housing lid bent. Valves damaged, but PRD intact. A-left side section was bulging with three tears, one was 5' long. A-end head has 8" hole and 5'x7' dent. BOV and handle intact.	Yes	Yes	No	No	No	No	No	No	No	No
3	18	GATX 33139	Yes	Tank fractured in ring 1. The fracture runs across bottom of tank up the right-side and into area of melted steel. Area of melted steel estimated to be 5' x 5'. B-end head has two large dents. Right-side is deformed B to A-end. Multi-housing compromised. Valves not visible. Manway and PRD intact. BOV handle broken. BOV nozzle sheared off and BOV ball was open.	No	No	Yes	Yes	Yes	No	No	No	No	No
4	17	GATX 33125	Yes	Ring 1 appears to have a tear at 9:00 which extends into ring 2. Thinning of the metal was observed. Deformation was found left-side ring 1 and 2 which extended to the top of the tank. Both heads had dents. Deformation found on left-side near bottom of tank - extended from ring 1 to 4.	Yes	No	No	No	Yes	No	Yes	No	No	No

Field Index #	Line #	Report-ing Mark	Tank Breach [Yes/No]	Damage Description	Multi-Housing Compro-Mised	Valve Damage	BOV Nozzle Sheared	BOV Open	BOV Handle Damaged	Manway Compro-mised	Thermal Tear	Head Brace Pulled From Head Pad	Head Pad Pulled From Tank	Tank Pulled From Head Pad.
5	15	SHPX 206708	Yes	Bottom was deformed B-end to A-end. Manway intact. Multi-housing crushed and valves sheared. PRD bent and broken. BOV nozzle sheared and handle bent, but not broken. BOV remained closed. A-end head had three dents, one 8'x6', the second was 4'x3', and the third was 3'x4'. B-end head has two dents, one 1.5' x 1.5', and the second 4'x4'. Multiple dents on the right-side and a fracture/mechanical tear measuring 5.5' on B-right near 3:00 position.	Yes	Yes	Yes	No	Yes	No	No	No	No	No
6	13	TAEX 1528	Yes	B-end head pad pulled away from the tank, but not at the welds. Parent metal was torn from center of pad. Deformation from one end to the other on right-side and left. Tear on left-side that runs an estimated 8' from ring 2 into ring 1. Right-side of tank is bowed toward center line, and deformation end to end on the bottom. Manway intact. Multi-housing, PRD, and valves intact. BOV nozzle sheared, but closed. BOV handle is bent.	Yes	No	Yes	No	Yes	No	No	Yes	Yes	No

Field Index #	Line #	Report-ing Mark	Tank Breach [Yes/ No]	Damage Description	Multi-Housing Compro-Mised	Valve Damage	BOV Nozzle Sheared	BOV Open	BOV Handle Damaged	Manway Compro-mised	Thermal Tear	Head Brace Pulled From Head Pad	Head Pad Pulled From Tank	Tank Pulled From Head Pad.
7	12	SHPX 208536	Yes	Tank car cut in half at girth seam between rings 4 and 5. Ring 4 and 5 on the A-right has a dent that is 180" long. Manway intact with two loose bolts and one ear was bent. Multi-housing lid missing and valves sheared off. PRD intact, but one bolt sheared off. B-end of the top of the car had three dents 6'x5', 7'x7', and 6'x5' A-head had dent 5'x 4' and other 1'x1'. B-end head had two dents, one 2.5' x 2.5' and other 1'x1'.	Yes	Yes	No	No	No	Yes	No	No	No	No
8	11	SHPX 206670	Yes	Deformation seen on top, bottom right and left sides from B-end to A-end. A-right corner had a multi-directional tear estimated at 3' x 5'. A-right and head has a tear estimated at 3'x4' located at 09:00 position. A-head has another tear at 12:00 position estimated at 2' x 1'. There was also a 6'x6' dent in center of the head. B-end had two dents, one 3'x 2' and other in the center estimated at 6' x 6'	Yes	Yes	Yes	No	No	No	No	No	No	No
9	10	SHPX 208638	Yes	Multi-housing damaged. Valve condition unknown. Manway and PRD intact. B-end head has two dents, one 8' x 7' and second 3'x 3'. Large tear in right side at 3:00 position extending from ring 3 to ring 6.	Yes	Yes	No	No	No	No	Yes	No	No	No

Field Index #	Line #	Report-ing Mark	Tank Breach [Yes/ No]	Damage Description	Multi-Housing Compro-Mised	Valve Damage	BOV Nozzle Sheared	BOV Open	BOV Handle Damaged	Manway Compro-mised	Thermal Tear	Head Brace Pulled From Head Pad	Head Pad Pulled From Tank	Tank Pulled From Head Pad.
10	9	SHPX 208541	Yes	B-end head had a 2'x2' dent. The Ring 3 shell on left-side was melted through; area estimated 5' x 5'. Tear in A-left through rings 5 and 6 estimated at 5' x 5'. Manway lid intact. Multi housing had been challenged and was bent. Valve condition unknown. PRD bent. Right-side had deformation from B to A-end as does the left side and bottom. Top of tank was deformed from B to A-end as a result of deformation on the right and left sides.	Yes	No	Yes	Yes	Yes	No	No	No	No	No
11	8	SHPX 206675	Yes	PRD failed and bolts sheared. The stem was loose. Multi-housing lid crushed and valves damaged. Manway closed and bolts secure. BOV nozzle was sheared off and handle was intact. BOV ball was still closed. A-end head is torn mechanically - 16". Bottom has deformation at rings 4 and 5. Crack in A-end reinforcement pad. An 18" tear in ring 4 at 7:00 position.	Yes	Yes	Yes	No	No	No	No	No	No	No
12	7	TAEX 1472	Yes	PRD, manway, and multi-housing intact. Both heads have large dents: A-end 7' x 4' and B-end 6' x 7'. Both right and left sides are bent from one end to the other toward the longitudinal centerline of the tank. A 7' tear in ring 5 on A-left..	No	No	Yes	No	Yes	No	No	No	No	No

Field Index #	Line #	Report-ing Mark	Tank Breach [Yes/ No]	Damage Description	Multi-Housing Compro-Mised	Valve Damage	BOV Nozzle Sheared	BOV Open	BOV Handle Damaged	Manway Compro-mised	Thermal Tear	Head Brace Pulled From Head Pad	Head Pad Pulled From Tank	Tank Pulled From Head Pad.
13	6	ADLX 500176	Yes	Deformation visible on top, bottom right and left sides from B to A-end. B-end head had two dents, one at 10:00 position estimated at 2'x 2' and the second located at 5:00 to 09:00 position and estimated at 6'x6'. On rings 1 and 2 of B-right side there was a 9' x 2' burn through. Ring 3 had a tear 2.5' x 3'. Dents in A-left ring 6 measuring 2' x 2' and 8'x8'.	Yes	Yes	No	No	No	No	No	No	No	No
14	5	TAEX 1475	Yes	Top deformed from ring 2 to 6. Bulges in the steel in rings 5, 4, 3, and 2. The bulges in rings 3 and 2 are common and also had melted steel where the shell melted through. Multi-housing lid missing and valves sheared off. Manway lid bolted closed.	Yes	Yes	Yes	No	Yes	No	No	No	No	No
15	4	TAEX 1549	Yes	Tank bent from the top and bottom toward the car centerline. Manway intact. Multi-housing lid missing and valves sheared off. PRD intact. BOV nozzle sheared off and handle bent. BOV ball remained closed. B-end head had two large dents, one 5'x6', and second 5'x9'. The B-end head also had a large flat spot estimated at 7' and a large 8' fold. A-end head had minimal damage.	Yes	Yes	Yes	No	Yes	No	No	No	No	No

Field Index #	Line #	Report-ing Mark	Tank Breach [Yes/ No]	Damage Description	Multi-Housing Compro-Mised	Valve Damage	BOV Nozzle Sheared	BOV Open	BOV Handle Damaged	Manway Compro-mised	Thermal Tear	Head Brace Pulled From Head Pad	Head Pad Pulled From Tank	Tank Pulled From Head Pad.
16	3	GATX 33123	Yes	Multi-housing lid bent. Valves condition unknown. BOV nozzle bent. Manway intact. Tear on right side of the tank from ring 4 extending into ring 6, estimated at 180". Thinning of the metal at the edges of this tear (suspected to be a thermal tear). A-end head deformed to an oval shape.	Yes	No	Yes	Yes	Yes	No	No	No	No	No
17	2	GATX 33119	Yes	Breach found at center of tank car. Shell ripped from 5:00 to 7:00 and was opened to an estimated width of eight feet. This appears to be a thermal tear, thinning of the shell material at the edges was found, although its location indicates it may have been under the commodity line. Air inlet valve missing, PRD failed. Multi-housing lid missing.	Yes	Yes	No	No	Yes	No	Yes	No	No	No
18	16	SHPX 206668	Yes	Deformation full length of the car. B-right had dent estimated at 6' x 20'. PRD, BOV, BOV handle, manway. Multi-housing intact. B-end head had two small holes. A-end head had two dents and a hole that was 5'x3'.	No	No	No	No	No	No	No	No	No	Yes

Field Index #	Line #	Report-ing Mark	Tank Breach [Yes/ No]	Damage Description	Multi-Housing Compro-Mised	Valve Damage	BOV Nozzle Sheared	BOV Open	BOV Handle Damaged	Manway Compro-mised	Thermal Tear	Head Brace Pulled From Head Pad	Head Pad Pulled From Tank	Tank Pulled From Head Pad.
19	14	TAEX 1602	Yes	Manway and PRD intact. Multi-housing lid missing. BOV nozzle sheared off, but the ball is closed. BOV handle intact. The car was bowed from top to center and from bottom up toward center. B-end head had three holes and three dents. A-end head had a large 5'x5' hole and a dent that was 9.5' x 9.5'.	Yes	No	Yes	No	No	No	No	No	No	Yes
20		TAEX 1582	No	Re-railed and moved to Casselton.	No	No	No	No	No	No	No	No	No	No
TOTAL (No)			2		5	10	9	17	10	19	17	19	19	18
TOTAL (Yes)			18		15	10	11	3	10	1	3	1	1	2

Figure 10: Tank car TAEX 1582 was partially derailed (arrow pointing to derailed truck).

Figure 11: Tank cars SHPX 206708 (field wreckage index #5) and TAEX 1528 (field wreckage index # 6) after derailment.

Figure 12: Tank car GATX 33119 (field wreckage index #17) on top of tank car GATX 33123 (field wreckage index # 16) after derailment.

Figure 13: Thermal tear in tank car GATX 33119 (field wreckage index #17).

Figure 14: Half of tank car SHPX 208536 (field wreckage index #7) which was located north of the derailment.

Figure 15: Fire coming out of thermal tear in tank car GATX 33125.

Figure 16: Image of derailment taken from the North.

(a) *(b)*

Figure 17: Image of TAEX 1638 (Field Wreckage Index#1) (a) Left side (b) Right side.

(a) *(b)*

Figure 18: Breaches in TAEX 1630 (Field Wreckage Index#2): (a) Tears in bulging on A-left side; (b) Hole in A-end head.

(a) *(b)* *(c)* *(d)* *(e)*

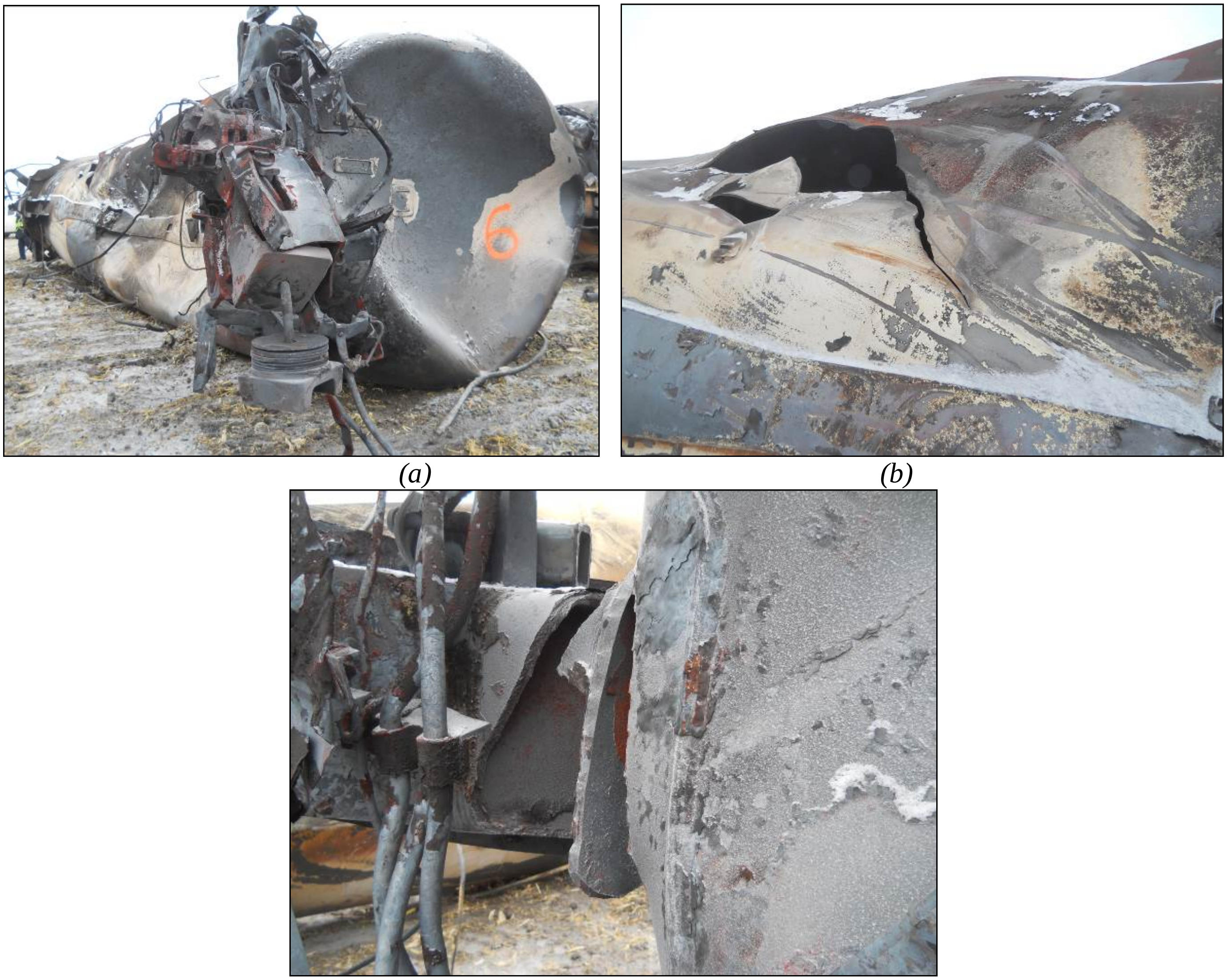
Figure 19: GATX 33139 (Field Wreckage Index#3): (a) Open BOV; (b) Deformation to right-side of tank car; (c) Ring fracture; (d) Ring fracture (alternate view); (e) Melted Shell/burn through on right side.

(a) *(b)*

Figure 20: GATX 33125 (Field Wreckage Index#4): (a) Tear in B-left side through rings 1 and 2; (b) Dent on B-end head.

(a) *(b)*

Figure 21: SHPX 206708 (Field Wreckage Index#5): (a) Damage to A-end head and bottom of tank car; (b) Fracture and mechanical tear in B -right side.



(a) *(b)*

(c)

Figure 22: TAEX 1528 (Field Wreckage Index#6): (a) Damage to A-end and bottom of tank car; (b) Breaches in left side of tank (rings 2 and 3); (c) Damage to B-end head pad.

(a) *(b)*

(c) *(d)*

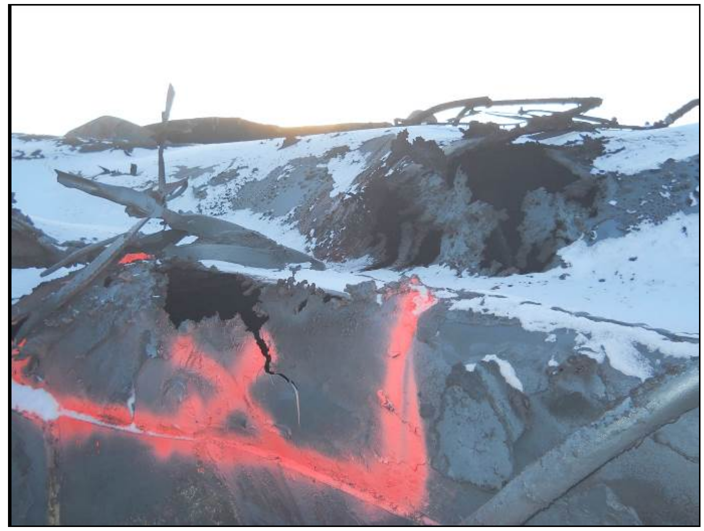
Figure 23: SHPX 208536 (Field Wreckage Index#7): (a) Two halves of tank car; (b) B-end piece of tank car; (c) B-end half collapsed on itself with BOV nozzle against top of tank; (d) Sheared off valve under missing multi-housing.

(a) *(b)*

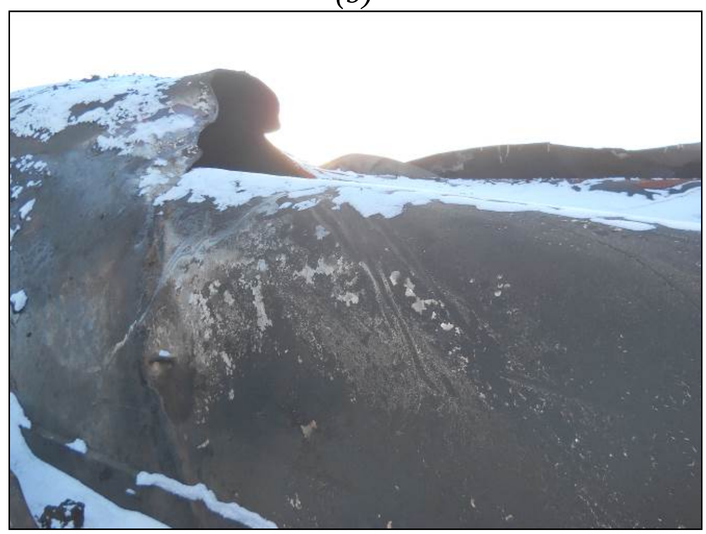
Figure 24: SHPX 206670 (Field Wreckage Index#8): (a) Multi-directional tear in A-right side and A-end head; (b) Dent in center of A-end head and tears at 9:00 and 12:00 positions.

(a) *(b)*

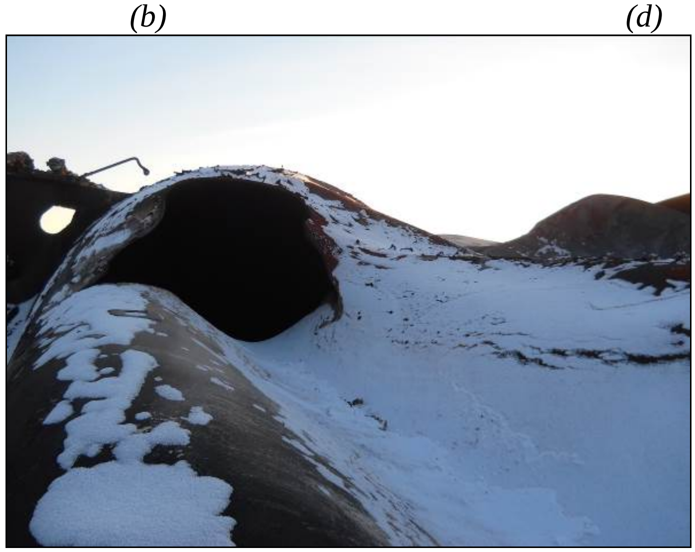
Figure 25: SHPX 208638 (Field Wreckage Index#9):(a) Large tear in right side of tank car; (b) Alternate view of tear.



(a) *(b)*



(b) *(d)*



(e)

Figure 26: SHPX 208541 (Field Wreckage Index#10):(a),(b),and (c) Images of tank car shell burn through; (d) and (e) Images of shell tear in rings 5 and 6 in A-left.

(a) *(b)*

Figure 27: SHPX 206675 (Field Wreckage Index#11): (a) Tear in right side of tank car; (b) Breach in A-end head and deformation of top of tank car.

(a) *(b)*

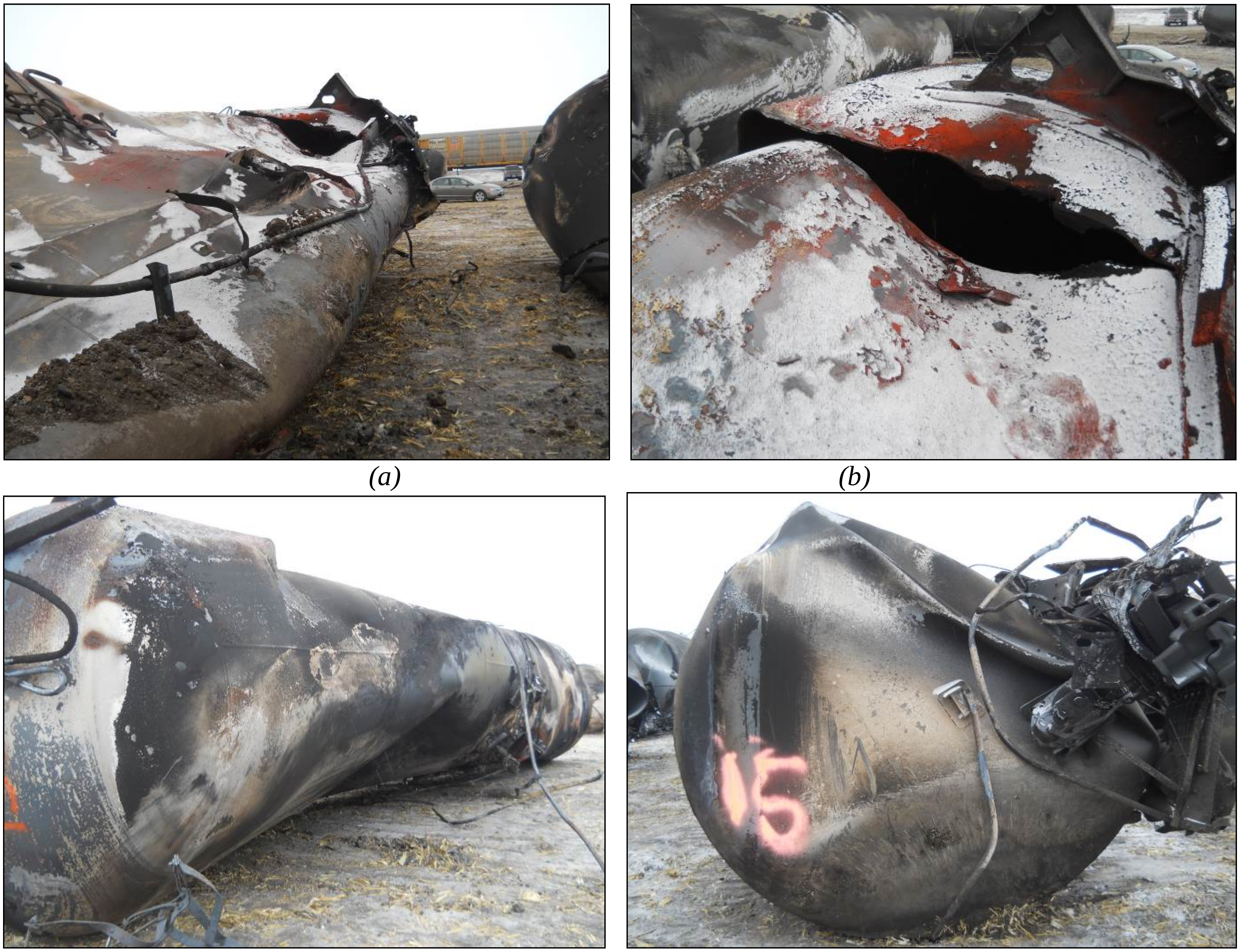
Figure 28: TAEX 1472 (Field Wreckage Index#12): (a) A-end head dent and damage to top of tank car; (b) Tear in ring 5 on A-left side.

(a) *(b)*

Figure 29: ADLX 500176 (Field Wreckage Index#13): (a) and (b) Burn through and tear in shell on right side of tank car.

(a) *(b)*

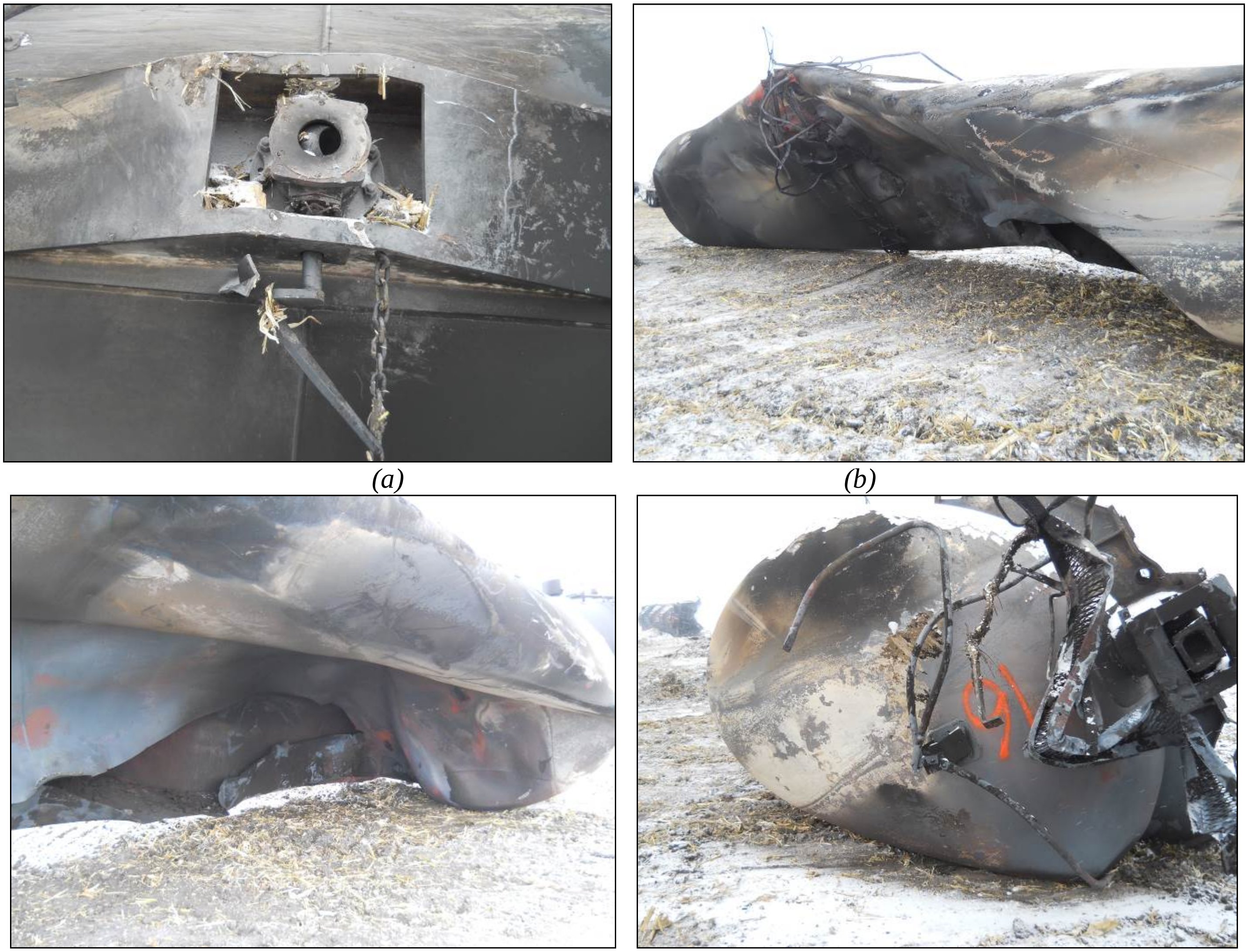
Figure 30: TAEX 1475 (Field Wreckage Index#14): (a) Burn through and tear in shell on B-left side right side of tank car; (b) Crack/tear in tank shell on A-right side.



(a) *(b)*

(c) *(d)*

Figure 31: TAEX 1549 (Field Wreckage Index#15): (a) and (b) Damage to bottom of tank car and large tear in A-right side; (c) Dents and damage to the top of the tank car; (d) Dents and large fold on B-end head.



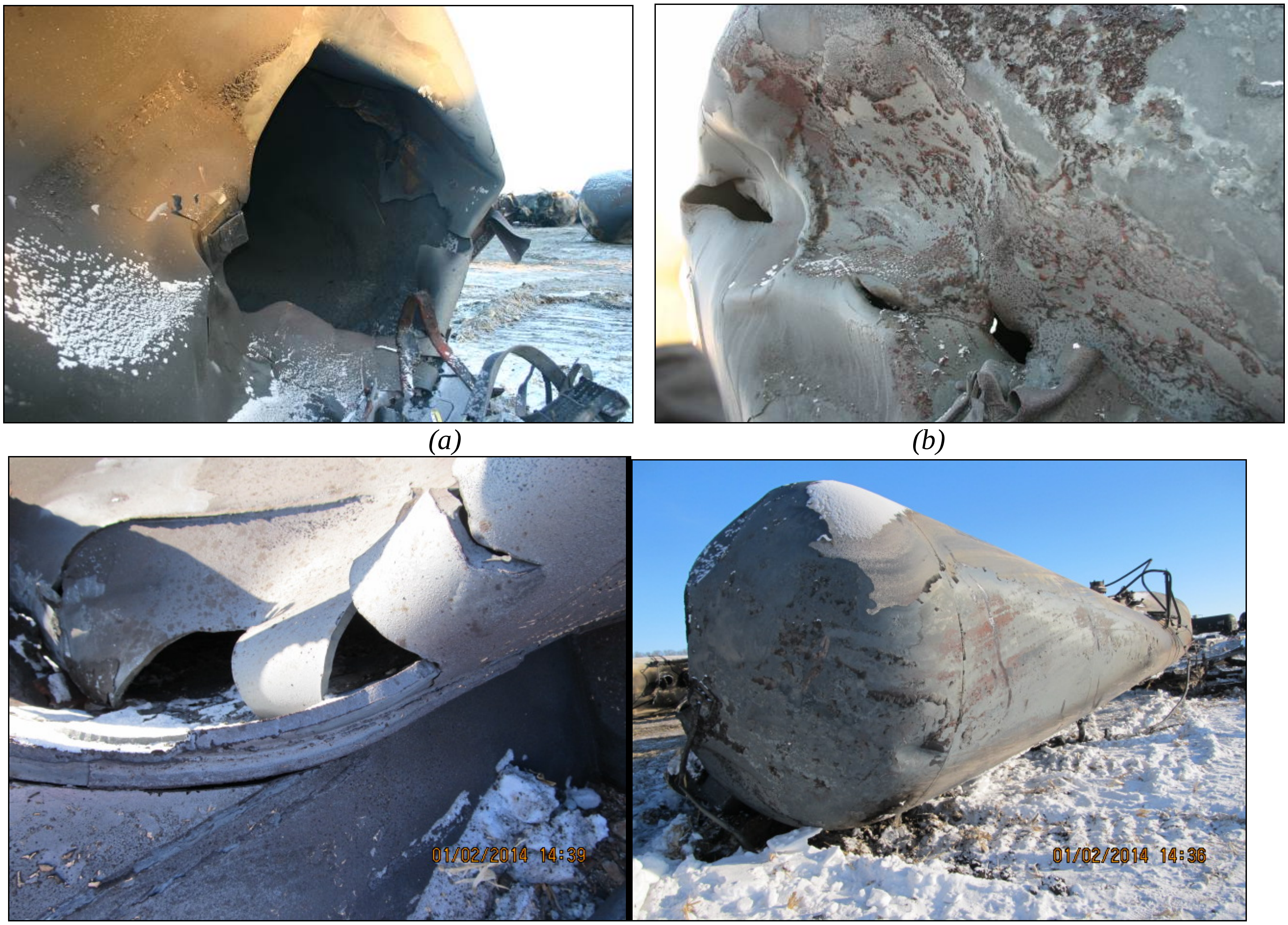
(a) *(b)* *(c)* *(d)*

Figure 32: GATX 33123 (Field Wreckage Index#16): (a) Damage to BOV and partially open ball; (b) Tank car crushed; (c) Tear in A-right side of tank car; (d) A-end head deformed to an oval shape.

(a) *(b)*

Figure 33: GATX 33119 (Field Wreckage Index#17): (a) and (b) Large tear in middle section of tank car.

Figure 34: SHPX 206668 (Field Wreckage Index#18): Large puncture in A-end head.



(a) *(b)* *(c)* *(d)*

Figure 35: TAEX 1602 (Field Wreckage Index#19) (a) Large puncture in A-end head; (b) Three punctures in B-end head; (c) Head pad damage and separation; (d) Center of tank car crushed.

ATTACHMENT 29 – BNSF GPS SURVEY OF TANK CAR LOCATIONS – SURVEY 1
ATTACHMENT 30 – BNSF GPS SURVEY OF TANK CAR LOCATIONS – SURVEY 2
ATTACHMENT 31 – BNSF GPS SURVEY OF TANK CAR LOCATIONS – SURVEY 3
ATTACHMENT 32 –DAMAGE ASSESSMENT FORMS
ATTACHMENT 33 –LABELED IMAGES OF THE DERAILMENT

L. Site Cleanup and Waste Disposal

On Monday, December 30, 2013, BNSF activated its Environmental Emergency Response Teams[30] to the site. Response teams met with local officials and emergency responders to develop a safe course of action. Initial actions included removing approximately 70 rail cars that were not derailed from the derailment area to prevent further spread of the fire. Contractors also staged sand near the ditches leading out of the derailment area to prevent possible runoff from leaving the area.

[30] Pinnacle Engineering served as the environmental contractor.

On Tuesday, December 31, 2013, BNSF contractors initiated cleanup operations. Crude oil tanker cars were separated with machinery to isolate the cars that were burning from the remaining cars. Operations to remove the cars were conducted throughout the day and into the next morning. BNSF representatives met with the North Dakota Department of Health Officials to discuss cleanup procedures and plans.

On Wednesday, January 1, 2014, railcars were removed from the track area and environmental cleanup operations began. All grain and crude oil cars were removed from the tracks, and placed into holding areas. Immediately crews began the process of removing the contents of the crude oil cars to limit any further environmental impacts. Concurrent with these operations, excavation was initiated to remove impacted soil from the right of way prior to replacing the railroad tracks. Soil was also excavated on the north side of the rail bed that was impacted by the crude oil.

BNSF had the following actions planned for the site:

- Excavating impacted soil to the north and south of the BNSF main lines.
- Excavating soil to the north of the Red River Valley & Western Railroad’s tracks.
- Performing additional sampling of environmental media (e.g., soil).
- Properly managing and disposing of excavated materials.
- Establishing an erosion and sediment control system in the excavated areas.
- Establishing control measures to prevent any sheen from leaving the site in the storm water or snowmelt runoff.
- Repairing private properties affected by the incident to an acceptable condition to property owners.

All excavation in the initial emergency response activities were focused on removing the gross contamination on the site.

Figure 36: Image of derailment location and spilt crude oil/debris field.

Residual product was trans-loaded from the derailed tank cars. The residual product was pumped out of the tanks by vacuum trucks and metered. Table 9 provides a summary of the volumes of crude oil lost or recovered.

Table 11: Summary of crude oil lost or recovered.

LINE NUMBER	FIELD NUMBERS	CURRENT CAR NUMBER	LADING VOLUME AT LOADING (GAL)	RECOVERED VOLUME (GAL)	LOSSED VOLUME (GAL)
2	17	GATX 33119	27,678	0	27,678
3	16	GATX 33123	27,674	0	27,674
4	15	TAEX 1549	27,676	0	27,676
5	14	TAEX 1475	27,681	6,000	21,681
6	13	ADLX 500176	27,677	0	27,677
7	12	TAEX 1472	27,676	0	27,676
8	11	SHPX 206675	27,680	0	27,680
9	10	SHPX 208541	27,695	0	27,695
10	9	SHPX 208638	27,683	0	27,683
11	8	SHPX 206670	27,685	50	27,635
12	7	SHPX 208536	27,872	0	27,872
13	6	TAEX 1528	27,677	0	27,677
14	Not Tagged (19)	TAEX 1602	27,678	0	27,678
15	5	SHPX 206708	27,678	0	27,678
16	18	SHPX 206668	27,694	1,000	26,694
17	4	GATX 33125	27,686	0	27,686
18	3	GATX 33139	27,670	3,000	24,670
19	2	TAEX 1630	27,727	12,000	15,727
20	1	TAEX 1638	27,720	No Release	No Release
21	-	TAEX 1582	27681	No Release	No Release
TOTALS			**553,888**	**22,050**	**476,437**

ATTACHMENT 34– ENVIRONMENTAL RESPONSE WORK PLAN

M. Petroleum Crude Oil Sample Evidence

Three tank cars from the derailment were identified for crude oil sampling. These were tank cars that were not involved in the accident and subsequent fire. These tank cars arrived at the Marquis Energy Terminal in Hayti, Missouri on January 8, 2014. The three tank cars were segregated from the unit train and placed on a siding for sample collection. The sample collection was completed on January 9, 2014.

The three tank cars were:

1. Tank Car 1 - SHPX 205162 (position 22 in train)
2. Tank Car 2 - TAEX 1516 (position 26 in train)
3. Tank Car 3 - TAEX 1634 (position 28 in train)

Figure 37: Tank cars as arranged for sampling at Marquis Energy Terminal in Hayti, MO.

The weather on the day that samples were collected was rainy with an ambient air temperature around 34°F, the tank cars were frosted along the bottom half with some icing at the top.

Samples were collected manually through the top manway of each tank car using methods outlined in ASTM D4057, *Standard Practice for Manual Sampling of Petroleum and Petroleum Products*. The security seals were cut on each of the tank cars in the presence of the NTSB and PHMSA witnesses and compared against a master list to ensure that the manways had not previously been opened. The broken seals were documented and photographed.

The manway was removed and the level of each tank car was estimated by visual observation and recorded. Marquis Energy personnel collected the samples from each tank car. A Brass Core Thief, measuring about 16 inches long and about 2-inches in diameter, was used to collect the samples from each tank car. Three 1-quart spot samples were collected at three different levels within each tank using the core thief (See Figure 40). The samples were collected in the following order: top, middle, then bottom sample last. Each tank car was grounded to a ground rod placed adjacent to the rail and the core thief was bonded to the tank car.

Samples were collected using the core thief at the manway. After the samples were collected – the temperature of the crude oil was measured at a level of about 3-feet below the free surface. The results are recorded in Table 10.

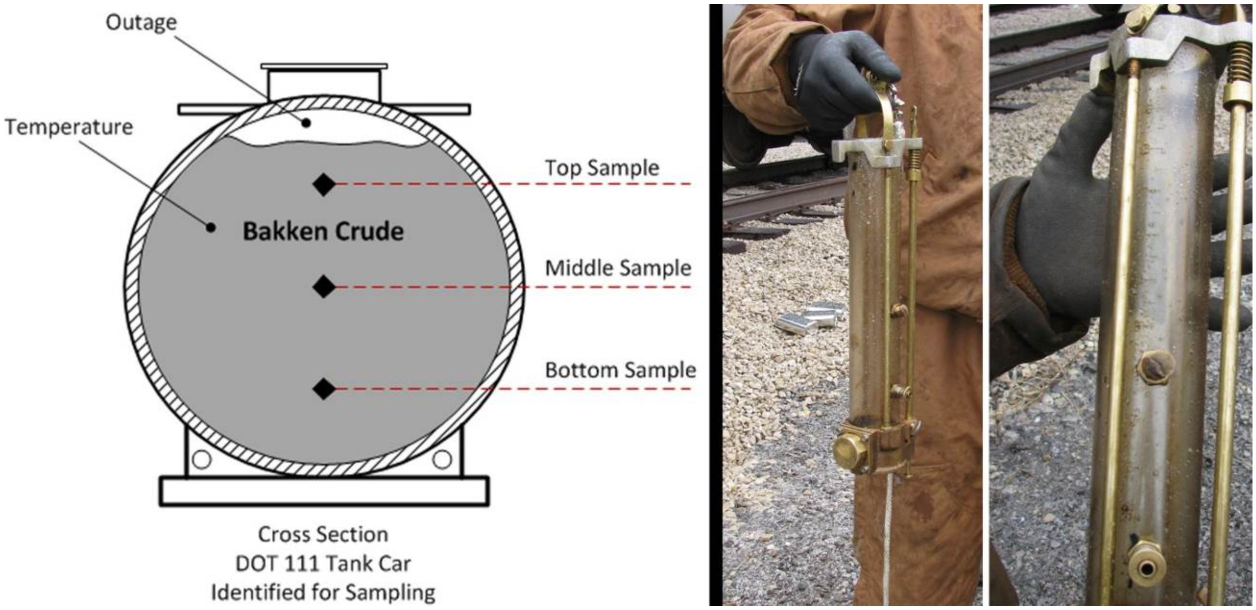


Figure 38: Schematic of tank cross section identifying the location of samples and photo of the core thief used for sampling of the tank cars.

The sample containers consisted of new metal 1-quart cans with screw caps. Sample containers were supplied by PHMSA. Each sample can was filled to about 2/3rds of its volume to allow for expansion. The sample containers were labeled with the date, tank car number and whether it was a bottom middle or top sample. The metal containers were sealed with evidence tape and stored in a cooler with ice for transport to the analysis laboratory. PHMSA representatives transported the crude samples to Intertek Laboratories for analysis.

Figure 39: Photograph of seals from each tanker and sample containers labeled, sealed, and ready for transport to the lab.

As a precautionary measure, Marquis Energy collected three additional 1-quart samples, one from each of the identified tank cars, and held onto them. These samples were composite, flow stream samples taken at the time of off-loading (performed to Marquis Energy standards).

Table 12: Results of data recorded during sample collection.

TANK CAR	CRUDE OIL TEMPERATURE	TANK LEVEL	SAMPLES
SHPX 205162	28°F	8-10 inches below T-gauge	Three samples: <1 quart each: Top, Middle, and Bottom
TAEX 1516	26°F	8-10 inches below T-gauge	Three samples: <1 quart each: Top, Middle, and Bottom
TAEX 1634	26°F	8-10 inches below T-gauge	Three samples: <1 quart each: Top, Middle, and Bottom

The analytical testing results are contained in the NTSB Office of Research and Engineering factual report.

BNSF Petroleum Crude Oil Analysis for Marquis Energy

BNSF collected crude oil samples from tank cars TAEX 1582 and TAEX 1638 to determine whether or not the Marquis Energy would accept the product from these two tank cars (both involved in the accident). These tank cars were in close proximity to the accident fire and their content's properties/characteristics may have changed due to the intense heat exposure. The sampling analysis results that were provided to Marquis Energy are provided in Attachment 34.

ATTACHMENT 35 – SAMPLE RESULTS FOR TANK CARS TAEX 1582 AND TAEX 1638 – JAN 9 2014
ATTACHMENT 36 – SAMPLE RESULTS FOR TANK CARS TAEX 1582 AND TAEX 1638 – JAN 12 2014

Muhamed A. El-Zoghbi
Safety Engineer/Hazardous Materials Accident Investigator

ATTACHMENTS

ATTACHMENT 1 – COPY OF CONSIST FOR TRAIN U-FYNHAY4-05T
ATTACHMENT 2 – BNSF HAZARDOUS MATERIALS INSTRUCTIONS FOR RAIL
ATTACHMENT 3 – BNSF AEI READOUT – MANDAN STATION
ATTACHMENT 4 – BNSF AEI/TSS COMPARISON REPORT
ATTACHMENT 5 – PHMSA ENFORCEMENT HISTORY OF WATCO RAIL TERMINAL
ATTACHMENT 6 – PRE-TRANSPORT INSPECTION CHECKLISTS
ATTACHMENT 7 – UMLER REPORT FOR TANK CARS
ATTACHMENT 8 – GREAT NORTHERN GATHERING AND MARKETING DECEMBER 2013 SHIPMENT REPORT
ATTACHMENT 9– GREAT NORTHERN GATHERING AND MARKETING SAMPLE RESULTS
ATTACHMENT 10 – WAYBILLS
ATTACHMENT 11 – GREAT NORTHERN GATHERING AND MARKETING METER TICKET 1
ATTACHMENT 12 – GREAT NORTHERN GATHERING AND MARKETING METER TICKET 2
ATTACHMENT 13 –PETROLEUM CRUDE OIL MATERIAL SAFETY DATA SHEET
ATTACHMENT 14– TOC TIMELINE TRAIN DERAILMENT CASSELTON DECEMBER 30TH 2013
ATTACHMENT 15– COMMAND POST TIMELINE
ATTACHMENT 16– EMERGENCY RESPONSE STAGING TIMELINE
ATTACHMENT 17 – HYSPLIT DISPERSION MODELS
ATTACHMENT 18 – HYSPLIT TRAJECTORY MODELS
ATTACHMENT 19 – CASS COUNTY INCIDENT REPORT
ATTACHMENT 20 – CTEH AIR MONITORING PLAN
ATTACHMENT 21 – CTEH AIR MONITORING RESULTS SUMMARY
ATTACHMENT 22 – CTEH AIR MONITORING REPORT – FINAL
ATTACHMENT 23 – APPLICATION FOR APPROVAL AND CERTIFICATE OF CONSTRUCTION – TRINITYRAIL
ATTACHMENT 24 – APPLICATION FOR APPROVAL AND CERTIFICATE OF CONSTRUCTION – ARI-BNBX
ATTACHMENT 25 – APPLICATION FOR APPROVAL AND CERTIFICATE OF CONSTRUCTION – ARI-SHPX
ATTACHMENT 26 – TRINITYRAIL TANK CAR DETAIL SPECIFICATION – FOR OFFICAL USE ONLY
ATTACHMENT 27 – REPORT OF TANK REPAIRS, ALTERATION OR CONVERSION – GATX033123
ATTACHMENT 28 – REPORT OF TANK REPAIRS, ALTERATION OR CONVERSION – GATX033139
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ATTACHMENT 36 – SAMPLE RESULTS FOR TANK CARS TAEX 1582 AND TAEX 1638 – JAN 12 2014