National Transportation Safety Board
Washington, D.C. 20594

Report Date: July 8, 2015

Tank Car Performance Factual Report

A. Accident Identification

Carrier:	CSX Transportation
Train No.:	M 30381 06
Location:	Mount Carbon, West Virginia
Date/Time:	February 16, 2015, 1:15 p.m. EST
NTSB No.:	DCA15FR005

B. Tank Car Inspection Team

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C. Accident Summary

On Monday, February 16, 2015, at 1:15 p.m. eastern standard time, eastbound CSX crude oil unit train K08014 derailed 27 loaded tank cars (line numbers 2 through 28) in Mount Carbon, Fayette County, West Virginia. The train consisted of 2 locomotives followed by a buffer car, 107 tank cars, and a single trailing end buffer car. The train was transporting about 3.1 million gallons of Bakken crude oil, UN1267, Class 3, Packing Group I, from Manitou, North Dakota, destined for the Plains Marketing Terminal in Yorktown, Virginia. Event recorder data indicated that the train was being operated at 33 mph at the time of the accident, below the 50 mph maximum authorized speed. At the time of the accident, CSX had a temporary 40 mph speed restriction on the territory due to cold weather. The weather was 15° F with eight inches of recent snow.

One house and an adjacent garage located about 72 feet east of the centerline of the number 2 track was destroyed by fire, and the resident received minor injury while evacuating. About 300 people were evacuated from within a one-half mile radius of the accident scene. About 378,000 gallons of crude oil were released from tank cars damaged by head and shell punctures, impacted valves and fittings, and tank car shell thermal failures. The released crude oil was discharged into the Kanawha River and contaminated soils in the area of the derailment. Much of the crude oil was consumed in the postaccident fire. Emergency responders allowed the fire to burn itself out and it was extinguished by 8:00 p.m. on February 17, 2015, more than 30 hours after the derailment. Total equipment damage is estimated to be $2.5 million.

All of the Department of Transportation (DOT) specification 111 tank cars involved in this accident were compliant with the Casualty Prevention Circular (CPC)-1232 industry standard for tank cars transporting crude oil and ethanol that requires thicker heads and shells and half-height headshields. None of the tank cars were equipped with jackets or thermal protection systems.

Investigators examined the damaged tank cars and learned that 19 of the 27 derailed tank cars became involved in a pileup and postaccident pool fire. Two tank cars were punctured during the derailment and released more than 50,000 gallons of crude oil. The examination revealed thermally induced tank shell failures (thermal tears) on 13 tank cars that released additional crude oil that contributed to the postaccident fire and environmental contamination.

The accident site was on the CSX New River Subdivision, which is located in the south center of West Virginia, and is part of the Huntington Division. The Huntingdon Division hosts Amtrak's Cardinal (50/51) which operates across the state three times a week. In addition to general freight trains that operate in each direction, loaded unit trains move coal eastbound. In December 2013, crude oil (CBR) unit trains began operating on the Huntington Division to Newport News, Virginia. On a typical day, there is one loaded CBR train eastbound and an empty CBR residue train westbound.

NTSB investigators traveled to Mount Carbon, West Virginia to inspect the tank cars on February 19, 2015. On March 3, 2015, NTSB investigators returned to the nearby CSX Handley, West Virginia yard to participate in a group examination of the tank cars after they had been purged of product and staged in a controlled environment.

The NTSB did not launch a full accident investigation team to the accident scene. Rather, a small team of investigators was tasked with examining the accident performance of the derailed tank cars as part of an investigation led by the Federal Railroad Administration. The scope of the NTSB investigation therefore does not include other causal or contributing factors to this accident.

Figure 1: Aerial view of the derailment scene, February 18, 2015.[1]

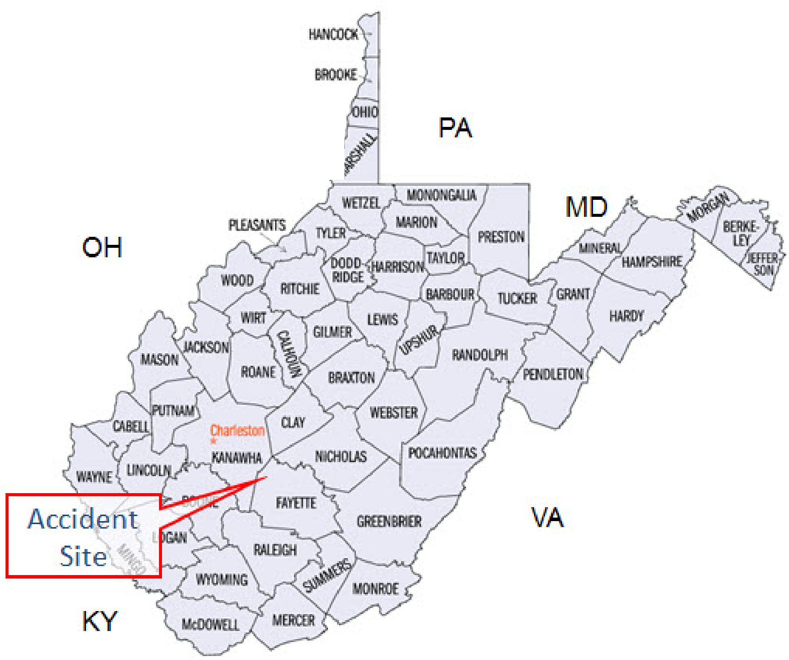

Figure 2: Accident location map, Mount Carbon, West Virginia

[1] Courtesy Federal Railroad Administration

D. CSX Train K08014

CSX Train K08014 consisted of two locomotives, 107 loaded tank cars, and two covered hopper buffer cars (one at each end). The train was 6,721 feet long and 15,261 tons (including engines), and was transporting 3,103,320 gallons of Bakken crude oil.[2] On February 16, 2015, at 1:15:41 p.m. EST, the train was traveling eastbound at 33 mph with the throttle at position 8 when it experienced an undesired emergency brake application (UDE) at MP CA-424.31. A total of 27 tank cars derailed from positions 2 through 28 of the consist. The locomotives traveled 636 feet to a stop following the UDE. The engineer and conductor then moved the engines and one coupled buffer car an additional 999 feet east to MP-424.0, where FRA downloaded the event recorder.

About 1:12 p.m., just prior to K08014 derailing, it passed westbound empty coal train E51215 that was moving on the adjacent track. FRA investigators examined the head end video of K08014 and E51215 and did not observe any irregular issues such as cars rocking or sparks.

No defects were noted when the train passed the closest hot box defect detector prior to the derailment site at MP CA-436.6, about 12 miles west of the derailment site. There were no dragging equipment detectors on the New River or prior subdivisions.

E. Derailment Location

The derailment occurred on double main track territory. Train K08014 was on main track No. 2, which has a designated maximum authorized speed of 50 mph for freight and 65 mph for passenger trains (FRA Class 4). CSX limited the train to 40 mph because of a cold weather restriction. The accident location is not designated a high-risk urban zone and thus does not ordinarily restrict CBR trains to 40 mph on this territory.

FRA determined the likely point of derailment was at MP 424.40 at the middle of a segment of compound curve. The track was constructed with wood crossties, double shoulder tie plates, cut spikes, and continuous welded 136 lb. rail that was box anchored at every other tie.

F. Hazardous Materials Information

The entire train consist of 107 tank cars contained Bakken crude oil with the proper shipping name UN1267, Petroleum Crude Oil, Class 3, Packing Group I. The train originated from Plains Marketing LP, Manitou, North Dakota and was destined for the Yorktown Rail Terminal in Amoco, Virginia. The vapor pressure characteristics of the crude oil were determined by analyses of a sample that was collected prior to the shipment on February 9, 2015 (see Table 1).

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[2] The original 104 car train had 3,018,320 gallons of crude oil when it departed Manitou, North Dakota. At Hamlin, Illinois, CSX added 3 cars containing about 85,000 gallons to the train, for a total of 3,103,320 gallons.

Table 1: Intertek Crude Oil Sample Testing[3]

Method	Test	Result	Units
ASTM D6377[4]	Vapor Pressure of Crude Oil (Expansion Method)		
	VPCR 4 (100° F)	13.93	psi
	VPCR 4 (80° F)	11.08	psi
	VPCR 4 (60° F)	8.67	psi
	VPCR 4 (40° F)	6.96	psi
ASTM D5191	Dry Vapor Pressure Equivalent	11.55	psi
ASTM D5002	Average API Gravity	42.9	°API

Pre-accident samples the Pipeline and Hazardous Materials Safety Administration (PHMSA) collected from the Plains Marketing LP terminal on April 30, 2014 yielded a flash point of less than 50°F, an initial boiling point of 84.2 °F, and a VPCR 4 (100° F) of 14.28 psia, thus meeting the definition of Class 3, Packing Group I. The sample analysis also revealed the material contained 6.68 percent light alkanes (C1-C4).[5]

The safety data sheet (SDS) provided by Statoil, Austin, Texas, describes this material as Bakken Crude Oil, a dark yellow, brown or green highly flammable blend of petroleum hydrocarbons. Bakken crude oil contains numerous constituents that are subject to OSHA permissible exposure limits, including n-heptane, octane, hexane, toluene, pentane, propane, ethylbenzene, benzene, and naphthalene. According to the SDS, the material has a boiling point of 130°F, a flash point of less than 50°F, and a specific gravity of 0.76.

G. North Dakota Crude Oil Conditioning Requirements

On December 9, 2014 the North Dakota Industrial Commission approved Order Number 25417 that establishes oil conditioning standards that requires all oil producers in North Dakota install and utilize oil-conditioning equipment to significantly reduce the vapor pressure of all Bakken crude oil beginning April 1, 2015. The accident shipment occurred prior to implementation of these oil-conditioning requirements.

Oil conditioning is a process that is performed at the well site. The order requires that all wells in the Bakken petroleum system be produced through a gas-liquid separator and/or emulsion heater-treater that effectively separates the production into gaseous and liquid hydrocarbons. It uses commission-prescribed temperatures and pressures to produce a consistent product with a vapor pressure (VPCRx) no greater than 13.7 psi, or 1 psi less than the vapor pressure of crude oil as defined in the latest version of ANSI/API RP3000, whichever is lower. All VPCRx shall be performed in accordance with the latest version of ASTM D6377. The Industrial Commission stated that its goal is to produce crude oil

[3] Intertek Laboratory, Bismarck, North Dakota, samples tested on February 10, 2015.
[4] This method replaces ASTM D323for measurement of true vapor pressure (TVP). The vapor pressure is determined by this method at a vapor-liquid ratio of 4:1 (VPCR 4). The VPCR 4 at 100°F is comparable to the vapor pressure determined when tested by method ASTM D323.
[5] The sample contained a 6.68% mixture of methane, ethane, propane, and butane.

that does not exceed a Vapor Pressure of 13.7 psi., while noting that winter blend gasoline has a comparable vapor pressure of 13.5 psi.

H. Derailed Tank Car Information

A total of 27 tank cars derailed from positions 2 through 28 of the consist. All tank cars involved in this accident were specification DOT-111A100W1 built to the Association of American Railroads CPC-1232 industry standard for tank cars ordered after October 1, 2011 for use in crude oil or ethanol service in Packing Groups I and II. These tank cars were equipped with half-height head shields, and bare steel heads and shell with no jacket, no thermal protection, and no insulation. Table 2 provides a summary of the derailed tank car specifications as reported from the Universal Machine Language Equipment Register (UMLER) and from tank car certificates of construction.

Table 2: Summary of Derailed Rail Cars

Consist Order	Reporting Mark	Builder[6]	Build Date	DOT Specification[7]	Shell[8]	Heads[9]	PRD[10]
02	CBTX 742201	ARI	10/05/2012	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	75 psi 25,636 cfm
03	CBTX 742774	ARI	10/25/2012	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	75 psi 25,636 cfm
04	CBTX 742792	ARI	10/23/2012	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	75 psi 25,636 cfm
05	GATX 286233	TRIN	9/28/2011	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	165 psi 35,608 cfm
06	GATX 286285	TRIN	12/13/2011	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	165 psi 35,608 cfm
07	GATX 286241	TRIN	9/30/2011	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	165 psi 35,608 cfm
08	GATX 286232	TRIN	9/15/2011	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	165 psi 35,608 cfm
09	GATX 286214	TRIN	8/31/2011	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	165 psi 35,608 cfm
10	GATX 286292	TRIN	11/18/2011	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	165 psi 35,608 cfm
11	GATX 286274	TRIN	11/10/2011	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	165 psi 35,608 cfm

[6] ARI = American Railcar Industries; TRIN = Trinity Tank Car.
[7] All tank cars were compliant with the AAR industry standard CPC-1232.
[8] All tank cars are unjacketed with no thermal protection.
[9] All heads protected with a 0.5-inch half head shield.
[10] PRD = pressure relief device settings in start-to-discharge pressure and rated flow capacity.

Consist Order	Reporting Mark	Builder[6]	Build Date	DOT Specification[7]	Shell[8]	Heads[9]	PRD[10]
12	CBTX 741512	ARI	6/18/2012	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	75 psi 25,636 cfm
13	CBTX 741926	ARI	9/27/2012	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	75 psi 25,636 cfm
14	CBTX 742035	ARI	9/12/2012	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	75 psi 25,636 cfm
15	CBTX 741702	ARI	7/31/2012	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	75 psi 25,636 cfm
16	CTCX 743030	ARI	5/25/2012	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	75 psi 25,636 cfm
17	CBTX 741944	ARI	8/23/2012	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	75 psi 25,636 cfm
18	CBTX 741431	ARI	5/31/2012	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	75 psi 25,636 cfm
19	CBTX 742778	ARI	10/18/2012	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	75 psi 25,636 cfm
20	CBTX 741516	ARI	6/18/2012	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	75 psi 25,636 cfm
21	CBTX 741651	ARI	7/11/2012	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	75 psi 25,636 cfm
22	CBTX 742087	ARI	9/18/2012	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	75 psi 25,636 cfm
23	CBTX 741946	ARI	8/27/2012	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	75 psi 25,636 cfm
24	CBTX 741956	ARI	8/23/2012	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	75 psi 25,636 cfm
25	CTCX 743002	ARI	5/29/2012	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	75 psi 25,636 cfm
26	CBTX 741530	ARI	6/19/2012	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	75 psi 25,636 cfm
27	CBTX 741697	ARI	7/20/2012	DOT111A100W1	0.5-inch TC128B	0.5-inch TC128B	75 psi 25,636 cfm
28	CBTX 743212	ARI	4/18/2013	DOT111S100W1	0.5-inch TC128B	0.5-inch TC128B	- -

DOT-111 Tank Cars Built to AAR CPC-1232 Specifications

AAR CPC-1232 enhanced general service DOT-111 tank cars must be constructed to the following standard as specified in the AAR Manual of Standards and Recommended Practices, Specifications for Tank Cars, M-1002, which states 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.

I. Thermal Protection

At the time of this accident, neither the DOT-111 tank cars nor those manufactured to the CPC-1232 standard were required to be equipped with thermal protection systems to protect the tank from exposure to pool or torch fire conditions that can occur in accidents.[11]

Thermal protection systems for tank cars are intended to limit the heat flux to the containers when exposed to fire. Appropriately designed thermal protection systems will prevent a rapid increase in the temperature of the lading and commensurate increase in vapor pressure in the tank, and are intended to limit the volume of material required to be evacuated through the pressure relief device, thereby limiting dangerous overpressurization of the tank.

Exposing a bare steel, flammable-liquid filled tank car to a large pool fire from product released in an accident can result in tank failure from a thermal tear in the tank that was not otherwise breached in a derailment. When the tank is exposed to heat from a pool fire, the internal pressure increases while the strength of the tank decreases. The tank will rupture if the pressure relief device cannot sufficiently relieve internal pressure. The resulting thermal tear in the shell material suddenly releases built-up pressure, ejecting vapor and liquid to ignite in a violent fireball eruption. Research studying accidents involving tank cars has shown that use of tank cars with thermal protection and a jacket

[11] Some tank cars may have insulation (typically fiberglass, mineral wool blankets, or foam) applied over the tank and enclosed within a metal jacket. Insulation is used to moderate the temperature of the lading during transportation, but disintegrates at high temperature. In contrast, a thermal protection system is designed to protect the tank car from the high temperature of a pool fire or torch fire.

will significantly reduce the amount of product released in accidents.[12] PHMSA estimates that jacketed CPC-1232 tank cars with thermal protection systems could provide an 18 percent reduction in lading loss in accidents relative to comparable accidents involving non-jacketed CPC-1232 tank cars.[13]

As stated in 49 CFR 179.15, all tank cars used to transport flammable materials, regardless of whether equipped with thermal protection, must be equipped with a pressure relief device. Pressure relief devices are affixed to the top of the tank in the normal vapor space and are designed to limit internal tank pressure when exposed to fire to prevent catastrophic tank failure. Pressure relief devices are rated by their start-to-discharge pressure in pounds per square inch gauge (psig) and venting capacity in standard cubic feet per minute (SCFM). The pressure relief device performance standard of 49 CFR 179.15 requires in part that the pressure relief device must have sufficient flow capacity to prevent excessive pressure build up in the tank under fire conditions. The regulation further requires that the start-to-discharge pressure may not be lower than 75 psig, or exceed 33 percent of the minimum tank burst pressure.

On May 8, 2015, PHMSA published a final rule titled Enhanced Tank Car Standards and Operational Controls for High Hazard Flammable Trains (HHFT).[14] New bulk packaging requirements for certain high-hazard liquids (Packing Group I) in 49 CFR 173.243 no longer authorize the transport of flammable liquids after April 1, 2020 in bare shell CPC-1232 tank cars in a HHFT unless the car is retrofitted to the DOT Specification 117R standards or the DOT Specification 117P performance standards provided in part 179 subpart D. Similarly, the bulk packaging requirements for certain medium-hazard liquids and solids (Packing Group II and III) in 49 CFR 173.242 no longer authorize the transport of flammable liquids in CPC-1232 tank cars in a HHFT after July 1, 2023 and May 1, 2025, respectively, unless retrofitted to the DOT Specification 117R or 117P standards.

After October 1, 2015, new tank cars manufactured for use in a HHFT must meet DOT Specification 117, or 117 P performance standard in part 179, subpart D; or be an authorized tank specification as specified in part 173, subpart F.

J. <u>Tank Car Damages</u>

On February 19, 2015, NTSB investigators first gained access to the accident scene and observed the wreckage as it was situated following the derailment. Tank cars between lines 7 and 24 of the consist were derailed accordion-style and were generally oriented perpendicular to the track. The tank car pileup was confined to a 430-foot segment of the right-of-way, centered roughly on the point-of-derailment (MP 424.40). The cars were constrained on the west side of the track by a steep sloping hill. East of the right-of-way the hill continued down gradient toward the Kanawha River. Melted snow cover gave an

[12] *Safety Performance of Tank Cars in Accidents: Probabilities of Lading Loss*, Report RA-05-02, Railway Supply Institute and Association of American Railroads Safety Research and Test Project (January, 2006).
[13] *Calculating Effectiveness Rates of Tank Car Options,* PHMSA Docket PHMSA-2012-0082.
[14] 80 FR 26643

indication of the size and geometry of the pool fire that engulfed the derailed tank cars between lines 8 and 25 of the consist (see Figure 3).

Figure 3 provides a labeled aerial photograph of the derailment scene indicating the line positions of each derailed car in the consist. In this figure, two (2) cars that released crude oil lading from puncture damage are highlighted in red, while 13 cars that sustained thermal tears in their tank shells are highlighted in green. Four (4) that are not highlighted in the figure released product from valves and fittings. For one car (number 24), the mechanism of release could not be determined.

Figure 3: Tank car locations. Punctured cars are highlighted in red, cars with thermal tears are highlighted in green. (Courtesy Federal Railroad Administration, February 18, 2015)

On March 3, 2015, NTSB investigators joined a tank car examination group that included the following organizations: Federal Railroad Administration, Pipeline and Hazardous Materials Safety Administration, Transportation Safety Board of Canada, CSX Transportation, GATX Corporation, Trinity Rail, American Railcar Industries, and the Railway Supply Institute / Association of American Railroads. To facilitate detailed inspection, CSX cleaned and purged the tank cars and staged them at its Handley, West Virginia, rail yard, about 5 miles northwest of the Mount Carbon accident scene. The Group’s tank car damage observations for the 27 derailed tank cars are contained in Appendix A.

Table 3 provides a summary of tank car damages and release modes, generally categorizing the damages as puncture, valve or fitting failure, or thermal tear of the tank shell. The tank car examination found two (2) cars that were punctured, five (5) cars that released product from valves and fittings, and 13 cars that sustained thermal tears. The tank cars that sustained thermal tears from exposure to the post-accident pool fire showed no other evidence of breaching damage from impacts related to the derailment.

Table 3: Tank Car Damage Summary

Pos.	Tank Car	Quantity Released (gal)	Quantity Recovered (gal)	Damage Related to Product Release
02	CBTX 742201	None	Full load	No breaches
03	CBTX 742774	None	Full load	No breaches
04	CBTX 742792	None	Full load	No breaches
05	GATX 286233	Minimal	Full load	Bottom outlet valve impacted
06	GATX 286285	None	Full load	No breaches
07	GATX 286241	8,490	21,100	Bottom outlet valve open
08	GATX 286232	8,520	27,150	Thermal tear/ fire damage
09	GATX 286214	27,951	1,500	Thermal tear/fire damage
10	GATX 286292	29,433	0	Thermal tear/fire damage
11	GATX 286274	21,283	8,150	Bottom outlet valve leakage/fire damage
12	CBTX 741512	19,390	10,050	Thermal tear/fire damage
13	CBTX 741926	13,180	16,180	Thermal tear/liquid line dislodged
14	CBTX 742035	24,019	5,650	Thermal tear/fire damage
15	CBTX 741702	17,686	11,720	Liquid line dislodged/fire damage
16	CTCX 743030	29,608	0	Shell impact and puncture
17	CBTX 741944	1,224	28,162	Thermal tear/fire damage
18	CBTX 741431	29,460	0	Thermal tear/fire damage
19	CBTX 742778	21,223	8,300	Head and shell impact and puncture
20	CBTX 741516	29,556	0	Thermal tear/fire damage
21	CBTX 741651	29,350	0	Thermal tear/fire damage
22	CBTX 742087	5,005	24,300	Thermal Tear
23	CBTX 741946	29,450	0	Thermal tear/fire damage
24	CBTX 741956	3,776	25,600	Product loss no apparent source
25	CTCX 743002	29,430	0	Thermal tear
26	CBTX 741530	None	Full load	No breaches
27	CBTX 741697	None	Full load	No breaches
28	CBTX 743212	None	Full load	No breaches
Total Amount Released:		**378,034 gallons**		

Punctured
Thermal Tear
Valve/Fitting

Investigators found consistent evidence of shell material thinning and bulging from overpressure in the vicinity of the thermal tears in the vapor space of tank cars that experienced thermal tears. Larger thermal tears (line numbers 9, 10, 12, 18, 20, 21, 23, and 25) were characterized as longitudinally-oriented breaches in the vapor space of the tank shell with flaps of steel peeled outward from the tank (see Figures 4 and 5). Smaller thermal tears (line numbers 8, 13, 14, 17, and 22) appeared as a longitudinal split in the shell material with little evidence of energetic release (see Figure 6).

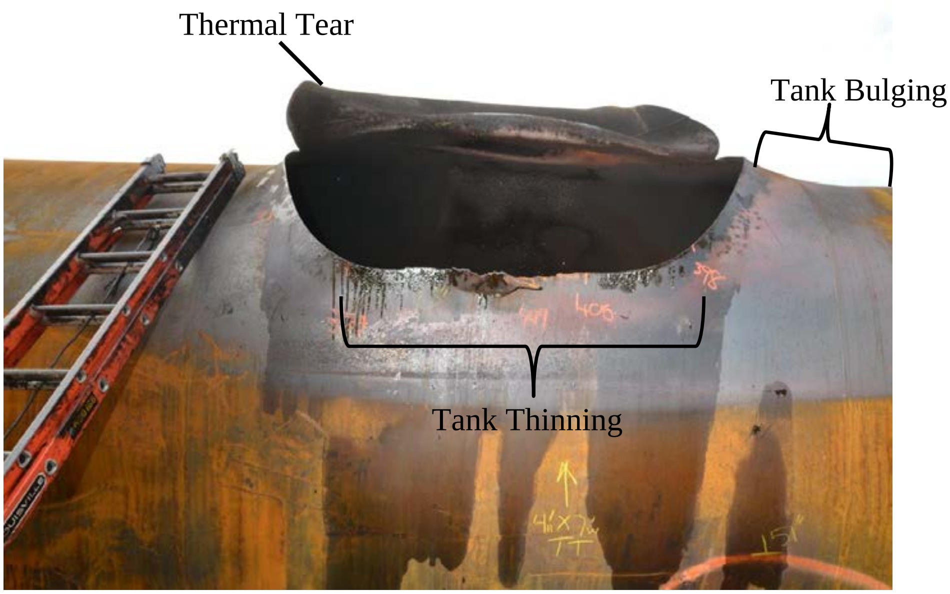

Figure 4: Tank car CBTX 741946 thermal shell tear surrounded by bulging and thinning shell.

Figure 5: Tank car CBTX 741431 thermal shell tear.

Figure 6: Examples of small thermal tears CBTX 741944 (left) and CBTX 742035 (right).

K. Emergency Response and Remediation

Evacuation

The derailment prompted the evacuation of approximately 2,400 residents. On the day of the accident, the Governor of West Virginia declared a State of Emergency for Kanawha and Fayette Counties. About 300 residents of Adena Village/Mount Carbon that resided within one-half mile of the accident scene were evacuated, as well as many residents of Boomer, located on the opposite bank from the accident scene on the Kanawha River. Two shelters were established that housed 85 evacuees.

Figure 7: Derailment scene viewed from Highway 61 looking east, February 18, 2015 (Courtesy Federal Railroad Administration).

The residual pool fire was allowed to burn itself out, and continued to smolder until Saturday, February 21, 2015 (see Figure 7). Crude oil remaining in the tank cars was transloaded to tank trucks. Once the risk of fire or explosion had been eliminated, the evacuation order for Boomer was lifted at 9:00 p.m. on February 19, and the evacuation order for Adena Village/Mount Carbon was lifted at 10:43 a.m. on February 20.

First Responder Observations

Emergency responders reported that the first thermal failure with energetic fireball eruption occurred about 25 minutes after the accident. By about 65 minutes after the accident, at least four thermal failures with fireball eruptions had occurred (see Figure 8). The 13th and last thermal failure occurred more than ten hours after the accident.

Figure 8. Fireball eruption from the Mount Carbon, West Virginia derailment scene, February 16, 2015. (Photo courtesy WWVA News Radio, Wheeling, West Virginia.)

Fayette County, West Virginia, 911 Call Center records indicate the following:

- 1:18 p.m. first responding units were enroute
- 1:23 p.m. Highway 61 closed down
- 1:26 p.m. the dispatcher contacted CSX railroad noting a train derailment and structure fire

- 1:27 p.m. the call center was advised that the train contained 109 cars of highly flammable material and that Adena Village needed to be evacuated
- 1:46 p.m. the Coast Guard was notified
- 2:24 p.m. National Response Center was notified (incident number 1108255)
- 2:24 p.m. explosions prompted responders to stage further from the incident scene towards Montgomery, West Virginia

Post-accident Remediation

The U.S. Coast Guard assumed responsibility as the lead federal agency with the assistance from the U.S. Environmental Protection Agency. The Coast Guard reported that as of February 18, 2015, a 35 by 155-foot area of product was contained in the Kanawha River near the derailment site. An unconfirmed amount of product had also entered Armstrong Creek, an adjacent tributary. Much of the waterway was covered in ice, thus limiting mobilization of the released crude oil. The responsible party, CSX, deployed contractors that contained oil with interceptor trenches on land and oil booms in the river. The contractors used vacuum trucks and absorbents to recover spillage. In addition, the contractors installed a metal sheet pile wall along the shoreline as alternative containment due to the presence of ice in the river. The EPA reported visible amounts of oil in the Kanawha River and Armstrong Creek until February 23, 2015.

On February 23, 2015, the damaged tank cars were transported to the CSX Handley, West Virginia yard, where CSX contractors cleaned and purged them of residue. CSX staged the tank cars to facilitate the accident investigation examination.

Federal, state and local agencies on-scene included:

- Federal Railroad Administration
- Pipeline and Hazardous Materials Safety Administration
- U.S. Coast Guard
- Environmental Protection Agency
- West Virginia Public Health
- West Virginia State Police
- West Virginia State Fire Marshall
- West Virginia Department of Environmental Protection
- West Virginia Department of Highways
- West Virginia Department of Transportation
- Kanawha County Emergency Management

As of April 3, 2015, responders had removed from the accident scene over 236,000 gallons of oily water, over 19,000 gallons of liquid oil skimmed from frac tanks and other sources, over 9,400 tons of oil-contaminated soil, and 23 tons of contaminated sorbents.

On March 3, 2015, the Environmental Protection Agency issued an administrative consent order to CSX Transportation, Inc. that required, among other things, continued containment and recovery efforts on Armstrong Creek, Kanawha River, and adjoining shorelines to contain and recover as much oil as practicable until EPA determines the action is no longer necessary. The consent order also required CSX to provide long-term monitoring of water bodies and shorelines to detect and characterize all oil discharges until such time as EPA determines that monitoring is no longer necessary. CSX is also responsible for restoring the impacted areas to their original pre-spill condition to the maximum extent practicable as determined by EPA in consultation with Natural Resources Trustees.[15]

Water and Air Monitoring

The Kanawha River was closed from mile marker 88 to 91. The West Virginia American Water Company in Montgomery, West Virginia, three miles downstream from the accident site, closed intake valves to its water treatment plant as a precaution. However water testing found no evidence of contaminants.

The Center for Technology and Environmental Health (CTEH) conducted air monitoring surveys between February 16 and 18, which included the following analytes: benzene, hydrogen sulfide, sulfur dioxide, volatile organic compounds, percent lower explosive limit, nitrogen dioxide, and particulate matter. On February 18, CTEH reported:

> At the present time, results of hand-held real-time air monitoring in the community indicate the absence of detectible levels of crude oil associated volatile organic compounds (VOCs) or related products of crude oil combustion (excluding particulates as fire smoke). Whereas particulate matter has been observed within the community, no exceedances of the action level as identified In the Air Sampling and Analysis Plan have been observed in the community. Additionally, a mobile AreaRAE Unit operating in the nearby communities yielded no verified detections of VOCs.

L. <u>Weather</u>

The NOAA station at Charleston Yeager Airport reported that at the time of the accident, approximately 8 inches of snow had accumulated and the temperature was 15 degrees F.

[15] The applicable natural resource trustees include the U.S. Fish and Wildlife Service, the U.S. National Oceanic and Atmospheric Administration, and the West Virginia Division of Natural Resources.

L. Urgent Safety Recommendations

In connection with this accident, on April 12, 2015, the NTSB issued four urgent safety recommendations to PHMSA that address the retrofitting of thermal protection systems for DOT specification 111 tank cars used to transport Class 3 flammable liquids. The recommendations urged PHMSA to take the following action:

> Require that all new and existing tank cars used to transport all Class 3 flammable liquids be equipped with thermal protection systems that meet or exceed the thermal performance standards outlined in Title 49 *Code of Federal Regulations* 179.18(a) and are appropriately qualified for the tank car configuration and the commodity transported. (R-15-14)
>
> In conjunction with thermal protection systems called for in safety recommendation R-15-14, require that all new and existing tank cars used to transport all Class 3 flammable liquids be equipped with appropriately sized pressure relief devices that allow the release of pressure under fire conditions to ensure thermal performance that meets or exceeds the requirements of Title 49 *Code of Federal Regulations* 179.18(a), and that minimizes the likelihood of energetic thermal ruptures. (R-15-15)
>
> Require an aggressive, intermediate progress milestone schedule, such as a 20 percent yearly completion metric over a 5-year implementation period, for the replacement or retrofitting of legacy DOT-111 and CPC-1232 tank cars to appropriate tank car performance standards, that includes equipping these tank cars with jackets, thermal protection, and appropriately sized pressure relief devices. (R-15-16)
>
> Establish a publically available reporting mechanism that reports at least annually, progress on retrofitting and replacing tank cars subject to thermal protection system performance standards as recommended in safety recommendation R-15-16. (R-15-17)

Paul L. Stancil
Sr. Hazmat Accident Investigator

APPENDICES

APPENDIX A – TANK CAR DERAILMENT ORIENTATION
APPENDIX B – TANK CAR GROUP EXAMINATION OBSERVATIONS, MARCH 3, 2015

ATTACHMENTS

ATTACHMENT 1 – RAIL CAR STANDING ORDER REPORT
ATTACHMENT 2 – RAIL CAR AUTOMATIC EQUIPMENT IDENTIFICATION REPORT
ATTACHMENT 3 – SAFETY DATA SHEET FOR CRUDE OIL
ATTACHMENT 4 – SHIPPER'S BILL OF LADING
ATTACHMENT 5 – PHMSA CRUDE OIL TEST RESULTS, 2014 SHIPPER SAMPLING
ATTACHMENT 6 – PLAINS MARKETING ACCIDENT TRAIN CRUDE OIL TEST RESULTS
ATTACHMENT 7 – TANK CAR SPECIFICATIONS
ATTACHMENT 8 – AAR T-87.6 TASK FORCE AFFTAC MODELING REPORT
ATTACHMENT 9 – AAR ENHANCED AFFTAC MODELING
ATTACHMENT 10 – TANK CAR DAMAGE ASSESSMENT NOTES – ON SCENE
ATTACHMENT 11 – LOCOMOTIVE 1349 EVENT RECORDER, LEAD UNIT DOWNLOAD
ATTACHMENT 12 – LOCOMOTIVE 5243 EVENT RECORDER REAR UNIT DOWNLOAD
ATTACHMENT 13 – DERAILMENT MAP WITH EXCLUSION ZONES
ATTACHMENT 14 – CSX SITUATION REPORT FOR FEBRUARY 18, 2015