National Transportation Safety Board
Washington, D.C. 20594

Date: April 16, 2015

Hazardous Materials Group Factual Report

A. Accident Identification

Carrier:	CSX Transportation
Train No.:	K08227
Location:	Lynchburg, Virginia
Date/Time:	April 30, 2014, at 1:57 p.m. Eastern Daylight Time
NTSB No.:	DCA14FR008

B. Hazardous Materials Group Members

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C. Accident Summary

On April 30, 2014, at about 1:54 p.m. eastern daylight time[1], an eastbound CSX Transportation Bakken crude oil unit train, identification number K08227, with two locomotives, one buffer car, and 104 tank cars, derailed 17 tank cars at about milepost CAB 145.7 on the James River Subdivision in Lynchburg, Virginia. One tank car of three that ended up partially submerged in the James River was breached spilling crude oil that caught fire and also released into the river. There were no injuries resulting from the derailment and fire. There was a local evacuation of about 6 blocks in the area of the derailment effecting about 350 residents and about 20 businesses to the south of the derailment along the river front. The fire was extinguished at about 4:00 p.m. and the evacuation was lifted about 6 p.m. The train was travelling at 23 mph. The maximum speed through the derailment area is 25 mph.

[1] All times in this report are eastern daylight time.

Initial damage estimates provided by CSX are $870,000, which does not include environmental remediation. The accident occurred during daylight with weather conditions of overcast skies, a temperature of 56° F, and wind from the southwest at 5 mph.

Parties to the investigation include: Federal Railroad Administration, CSX Transportation, the Brotherhood of Maintenance of Way Employes Division[2], Brotherhood of Locomotive Engineers and Trainmen, the International Association of Sheet Metal, Air, Rail and Transportation Workers (formerly known as the United Transportation Union) and American Railcar Industries.

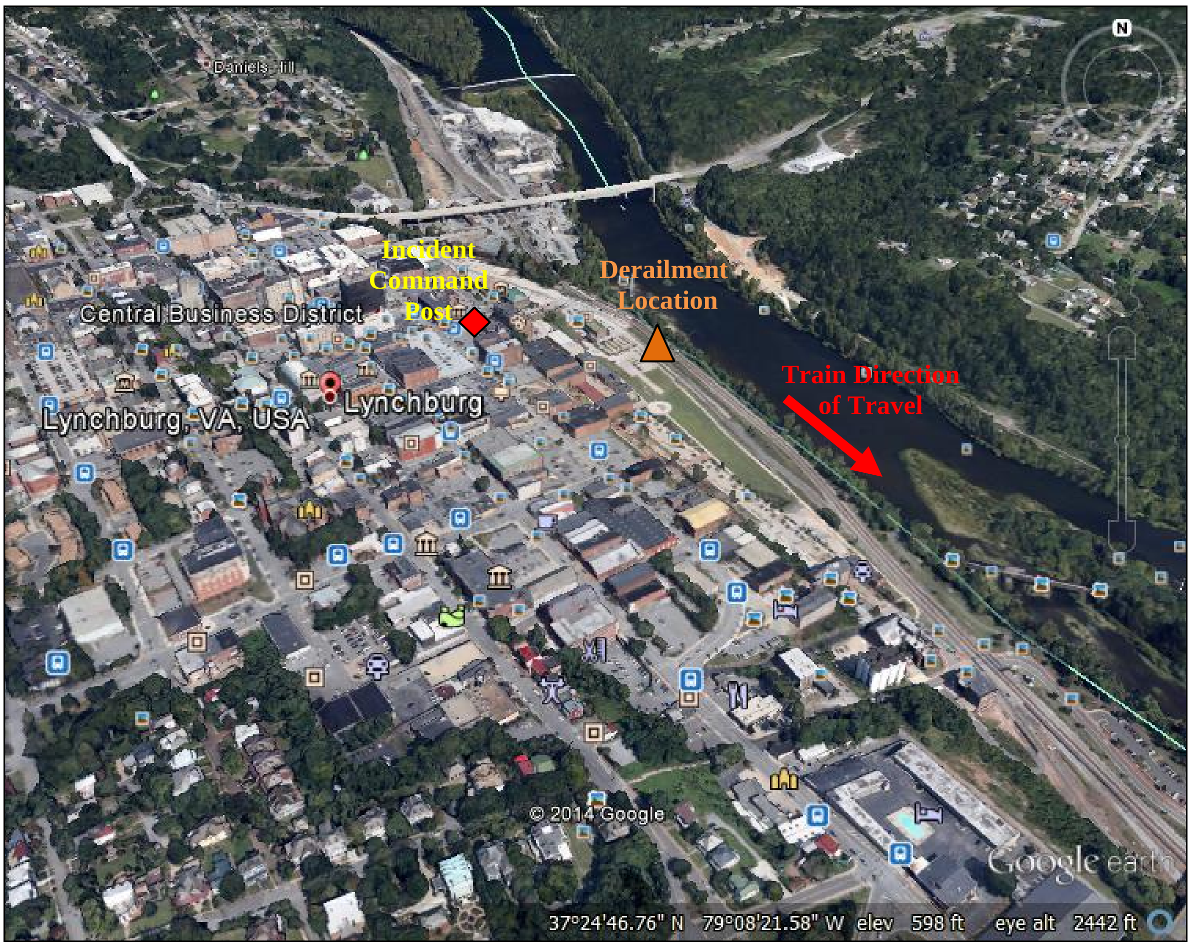

Figure 1: Derailment location and the surrounding area of Lynchburg, Virginia.

D. Summary of Transported Hazardous Materials

CSX train K08227 was a unit and "key train"[3] with a total of 104 tank cars containing petroleum crude oil which is designated by the US Department of Transportation (DOT) as a hazardous

[2] 'Employes' is a spelling from the Old English language.

[3] 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.

material when transported in commerce.[4] 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).[5] Table 1 provides information about the hazardous materials on the train.

Table 1: Summary of hazardous materials on train.

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 train had one buffer car (line position 1 in the train) between the two locomotives and the tank cars.

An inspection of the train indicated that its consist matched the physical position of the rail cars in the train. This information was also verified by the automatic equipment identification (AEI) scans taken of the train.[6]

ATTACHMENT 1 – CONSIST FOR TRAIN K08227
ATTACHMENT 2 – CSX AEI READOUT AT CAB146
ATTACHMENT 3 –BNSF AEI REPORT

E. Hazardous Materials Railcars Involved in the Accident

Seventeen (17) hazardous materials tank cars derailed in the accident. These tank cars were in positions 35 through 51 in the train (not including the two locomotives). All the derailed tank cars were general service specification DOT-111 that that were loaded with petroleum crude oil from the Bakken region of North Dakota. Fourteen (14) were built to the Association of American Railroads (AAR) Casualty Prevention Circular (CPC) 1232 standard.[7] The remaining three (3) were built to the legacy DOT-111 standard for cars ordered prior to October 2011. None of the remaining 87 tank cars were derailed or breached in the accident.

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."

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

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

[6] 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.

[7] In 2011, the AAR issued CPC-1232 that outlines industry-mandated safety requirements for additional safety equipment on DOT-111 tanks ordered after October 1, 2011, that will be used in ethanol and crude oil transportation service.

Only one (1) tank car, CBTX 741712 (position 44), was breached (shell breach) and released its contents that ignited, creating a large fire. See figures 2 and 3. Tank cars GATX 286291 (position 43) and CBTX 741672 (position 46) were also involved in the resulting fire; however, they were not breached and did not release their contents. See figure 4.

Figure 2: Large fire and smoke as a result of derailment.

Figure 3: Close-up view of post-derailment fire and smoke.

Figure 4: View of tank cars involved in post-derailment fire.

ATTACHMENT 4 – TANK CAR CERTIFICATE OF CONSTRUCTION-TRINITYRAIL
ATTACHMENT 5 – TANK CAR CERTIFICATES OF CONSTRUCTION AND OTHER DOCUMENTS-ARI

F. Pre-Accident Events

Hazardous Materials Shipper's Actions - Shipment Preparation

All the tank cars in unit train K08227 were offered into transportation by Plains Marketing LP the shipper of record. They originated at the Manitou Rail Terminal in Ross, North Dakota. The unit train was enroute to Plains Marketing LP's Terminal (formally known as Amoco Terminal) in Yorktown, Virginia.

The train's tank cars were loaded on April 23 and 24, 2014. The seventeen (17) derailed tank cars were loaded on April 24, 2014. Tank car loading and inspection checklist records indicate that pre-loading, during loading, 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 verified the proper placement of hazardous materials placards, placed seals on the manways and bottom unloading fittings, and recorded the seal numbers on the tank car loading and inspection checklist. No exceptions were noted in the loading and inspection records for the seventeen (17) tank cars.

DOT Flammable Liquid Classification Criteria

The HMR requires shippers to analyze hazardous materials to determine the appropriate hazard class and packing group based on the hazard they present. This classification[8] and characterization[9] is a key requirement for the selection of appropriate packaging.

According to 49 CFR 173.121(a)(1), flammable liquids (Class 3) are classified into three packing groups as shown in table 2.

Table 2: 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)

Plains Marketing LP collected 14 samples of its crude oil on April 14, 2014. These samples were submitted to Intertek on April 14, 2014, for analysis. Intertek analyzed the samples on April 21, 2014. All samples had initial boiling points (IBP) under 95^{o}F, making them a packing group I material. They all had flash points under 50^{o}F.

According to the Table of Hazardous Materials and Special Provisions in 49 CFR 172.101, bulk petroleum crude oil that is Class 3, packing group I must be packaged in accordance with instructions in 49 CFR 173.243 which authorizes the use of DOT-111 tank cars, among several others.

Tank Car Lading Volumes and Capacity

The Plains Marketing LP loading inspection checklists indicate that the seventeen (17) derailed tank cars contained a total of 500,940 gallons of petroleum crude oil. Table 3 provides a summary of lading weights and volumes per tank car. The tank cars were examined for excessive weight. None were overloaded by weight. According to the straight bills of lading provided by the shipper, the outage for each tank car met the minimum outage requirement of 1 percent of the total capacity of the tank car at the appropriate reference temperature as required by 49 CFR 173.24b.[10]

[8] Determination of a material's hazard class based on certain physical properties.
[9] Determination of a material's other relevant chemical and physical properties.
[10] According to a sample collected on April 26, 2014, by Plains Marketing LP that was analyzed by Intertek on May 5, 2014, the API gravity of its crude oil at 115^{o}F is 47.6^{o}. API gravity at 60^{o}F is 42.9 (Specific gravity approximately 0.81). Lading was loaded at temperatures ranging from 41.5- 41.6^{o}F.

Table 3: Lading weights and volumes in tank cars.

POSITION IN TRAIN	REPORTING MARKS	LOAD LIMIT WEIGHT (LBS)	LADING WEIGHT (LBS)	LOAD LIMIT CAPACITY (GAL)	LADING VOLUME AT LOADING (GAL)
35	CBTX 742045	211,000	203,764	31,800	29,944
36	CTCX 735779	197,400	189,138	30,100	27,795
37	CTCX 743047	210,800	203,690	31,790	29,934
38	CTCX 735774	197,100	190,567	30,090	28,005
39	CBTX 741925	210,500	202,227	31,820	29,719
40	CBTX 736244	198,100	188,936	30,070	27,765
41	CBTX 741725	210,800	201,755	31,800	29,649
42	CBTX 741864	210,600	202,294	31,780	29,729
43	GATX 286291	211,400	202,267	31,760	29,725
44	CBTX 741712	210,800	203,245	31,820	29,868
45	CBTX 741720	210,600	203,245	31,820	29,868
46	CBTX 741672	210,200	200,825	31,820	29,513
47	CTCX 743023	211,100	203,966	31,830	29,974
48	CBTX 743190	210,700	203,966	31,830	29,974
49	CBTX 743197	210,400	203,831	31,810	29,954
50	CBTX 743147	210,500	203,568	31,820	29,916
51	CBTX 743221	211,000	201,472	31,810	29,608
TOTAL			**3,408,756**		**500,940**

ATTACHMENT 6 – PRE-TRANSPORT INSPECTION CHECKLISTS
ATTACHMENT 7 – UMLER REPORT FOR TANK CARS
ATTACHMENT 8 –SAMPLE ANALYSIS
ATTACHMENT 9 –SAMPLE ANALYSIS - DENSITY
ATTACHMENT 10 – WAYBILL
ATTACHMENT 11 – STRAIGHT BILL OF LADING

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,*[11] 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,*[12] the number of "originated carloads of crude oil on US Class I

[11] 79 FR 45015.
[12] AAR background paper titled, "Moving Crude Oil by Rail." Published at https://www.aar.org/safety/Pages/crude-by-rail-facts.aspx

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.

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

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.

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[13] with an average API gravity of 41^{o}. The study also found that Bakken crude oil has a flash point below 73^{o}F. The report's other key findings include:[14]

- 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

[13] The higher the API gravity, the lighter the crude. Light crude must have an API gravity of greater than 31.1^{o}.
[14] http://www.ndoil.org/resources/bkn/

oil.[15] 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*[16], which presents the results of samples collected and analyzed by the agency to determine if shippers were properly classifying Bakken crude oil for transportation. All the samples had flash points under 50°F and IBPs ranging between 86.7 and 91.7°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.

As stated earlier, Plains Marketing LP conducted analysis of its Bakken crude oil and determined that it had an initial boiling point (IBP) under 95°F and a flash point under 50°F.

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[17]

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,

[15] 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

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

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

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.

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 4: Occupational Exposure Limits for Some Typical Components.

INGREDIENT NAME	CAS NUMBER	EXPOSURE LIMIT
Benzene	71-43-2	ACGIH[18] TWA[19]= 0.5 ppm (skin); ACGIH STEL[20]= 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 physical hazard when exposed to fire or other conditions that could cause a tank overpressure rupture.[21] The catastrophic rupture of the tank can produce a damaging shock wave traveling at a subsonic speed. This shock wave pressure can cause significant damage to nearby structures and humans.

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.[22] 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.[23]" 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

[18] American Conference of Government Industrial Hygienists.
[19] Time-weighted average.
[20] Short term exposure limit.
[21] FRA Report Number FRA/ORD-92/34, "Hazardous Material Transportation in Tank Cars: Analysis of Risks." May 1993. Pages 6-20
[22] 2012 ERG, Guide 128, Flammable Liquids (Non-Polar/Water-Immiscible).
[23] FRA Report Number FRA-RT-71-74, "A Study to Reduce the Hazards of Tank Car Transportation." Final Report, November 1970. Page 5.

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.”[24]

ATTACHMENT 12 –PETROLEUM CRUDE OIL MATERIAL SAFETY DATA SHEETS

H. Post-Accident Events

Emergency Response Activities

According to the Incident Commander (a Lynchburg Fire Department Officer), at approximately 13:57 on April 30, 2014, the Lynchburg Fire Department was dispatched to address a vehicle fire. However, while enroute, he and other fire department officers quickly identified that the incident was a train derailment.

The City of Lynchburg is an incorporated jurisdiction that boarders three counties. Lynchburg Communications received numerous 911 calls immediately after the accident from individuals reporting a train derailment with a large fire and a billowing tower of smoke. One caller reported that the fire had “flames higher than a four story building.” Another caller reported that the train railcars were “all fuel trucks.” Another caller reported that the train is “a cargo train… carrying some type of flammable liquid… with flammable signs.” Several other 911 calls were received by the Campbell County Communications Center due to cell phone tower locations, but they were forwarded to Lynchburg Communications.

The train derailment resulted in a large fire along the embankment of the James River in downtown Lynchburg. The closest structures to the derailment were the Depot Grille Restaurant (approximately 45 yards) and Amazement Square, a children’s museum (approximately 125 yards away from the derailment). See figure 5.

[24] FRA Report Number FRA/ORD-92/34, “Hazardous Material Transportation in Tank Cars: Analysis of Risks.” May 1993. Page Ex-10.

Figure 5: Location of the Depot Grille and Amazement Square from the derailment site.

Lynchburg Communications continued to receive 911 calls. One was received from an employee of the Depot Grille who could be heard instructing people to “get away from the glass...” and to exit the restaurant through the back. This caller reported that she could feel the heat as soon as she walked out the door. She stated that the fire was “not even 50 yards away.” Before she hung up, she confirmed that the building had been evacuated.

An Incident Command Post (ICP) was established near the intersection of 9th Street and Jefferson Street. A Lynchburg Fire Department HAZMAT officer was given command of operations. Fire department personnel quickly determined from the tank car placards that they contained petroleum crude oil. A half-mile evacuation was ordered (which encompassed the entirety of downtown Lynchburg).

The Incident Commander did not receive a copy of the train consist for approximately 2.5 hours. However, he stated that his personnel were quickly able to determine the contents of the tank cars from their placards. The Incident Commander did not send anyone to meet the train crew to obtain the train consist. A review of the City of Lynchburg Communications Center calls indicated that the CSX Public Safety Coordination Center (PSCC) in Jacksonville, Florida, contacted Lynchburg Communications at approximately 13:59 and notified them that the train was transporting petroleum crude oil. The CSX PSCC employee requested a fax number to send the train consist, which he explained contained the list of contents of the tank cars and that it needed to get to the fire department. The Lynchburg Communication operator stated that she understood and would take care of this matter. According to CSX PSCC fax records, a train list was sent to City of Lynchburg Communications Center at approximately14:09. However, at approximately 16:23, the CSX PSCC employee contacted Lynchburg Communication to inquire why the Incident Commander still had not received the list he had faxed earlier. A Lynchburg Communications operator acknowledged the receipt of the fax and stated that she would forward it to the Incident Commander.

The CSX Trainmaster from Clifton Forge arrived at the ICP approximately 45 minutes to an hour after the accident. When the Incident Commander requested the train consist, the CSX Trainmaster contacted the crew to provide a copy. However, the train crew did not have a copy with them because they had exited the locomotive immediately after the derailment and left all of their personal belongings and train documents (including the train consist) inside the locomotive. They told NTSB investigators that they saw a large fire and feared for their safety. So, they exited the locomotive and went to the Lynchburg Rail Yard. At approximately 15:40, a City of Lynchburg game warden arrived and was provided with a newly printed copy of the train consist. This copy was taken to the Incident Commander.

The Incident Command decided to let the fire burn, while cooling the tank cars near the fire. Approximately 2 hours into the incident, the fire began to subside. At approximately 17:00, the evacuation was lifted and residents were allowed to return to their homes.

ATTACHMENT 13 –PSCC FAX LIST
ATTACHMENT 14 –PSCC INCIDENT REPORT #6599676
ATTACHMENT 15 –STATEMENT OF CREW MEMBER

I. Accident Injuries

There were no injuries involved with the accident.

J. Derailed Tank Cars

Tank Car Descriptions

All of the 17 derailed tank cars were general service specification DOT-111 tank cars. Fourteen (14) were built to the CPC-1232 standard[25] with a gross rail load (GRL) of 286,000 pounds. The remaining three (3) were built to the legacy DOT-111 standard for cars ordered prior to October 2011. These cars had a GRL of 263,000 pounds.

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 Title 49 of the Code of Federal Regulations (CFR) Part 179, Subpart D. Additional tank car industry standards, incorporated in the HMR by reference, are the Association of American Railroads (AAR) Manual of Standards and Recommended Practices, Section C-Part III, Specifications for Tank Cars, Specification M-1002.

[25] In 2011, the AAR issued CPC-1232 that outlines industry-mandated safety requirements for additional safety equipment on DOT-111 tanks ordered after October 1, 2011, that will be used in ethanol and crude oil transportation service.

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).[26]

CPC-1232 tank cars are built with additional safety features that exceed federal requirements. Non-jacketed CPC-1232 tank cars constructed using AAR TC128-B normalized steel are built with ½ inch half-height head shields, tops fittings housing protection, and ½ inch thick head and shell.

The Applications for Approval and Certificates of Construction document the tank car manufacturers' certification that the constructed tank cars conform to all applicable DOT and AAR requirements, including specifications, regulations, 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.

Tank Car Owners

The tank car owners are:

1. **CBTX**
   CIT Group/Capital Finance, Inc.,
   Chicago, Illinois

2. **CTCX**
   CIT Group/Capital Finance, Inc.,
   Chicago, Illinois

3. **GATX**
   GATX Corporation,
   Chicago, Illinois

[26] *Annual Report of Hazardous Materials Transported by Rail* (Association of American Railroads, Bureau of Explosives, 2011 and 2012).

Table 5: Summary of tank car build information.

LINE NUMBER [POSITION IN TRAIN]	REPORTING MARK	CPC-1232 [YES/NO]	TANK CAR MANUFACTURER	BUILD DATE	DOT SPECIFICATION	STENCILED SPECIFICATION	MATERIAL HEAD/SHELL	HALF-HEIGHT HEAD SHIELD	HEAD AND SHELL THICKNESS [INCH]	GROSS RAIL LOAD	PRESSURE RELIEF DEVICE [# OF PRD]
35	CBTX 742045	YES	American Railcar Industries	9-2012	111A100W1	111S100W1	TC 128 GR B Normalized	Yes	0.5	286K	75 psi [1]
36	CTCX 735779	NO	American Railcar Industries	2-2012	111A100W1	111A100W1	TC 128 GR B Normalized	No	0.4375	263K	75 psi [1]
37	CTCX 743047	YES	American Railcar Industries	5-2012	111A100W1	111S100W1	TC 128 GR B Normalized	Yes	0.5	286K	75 psi [1]
38	CTCX 735774	NO	American Railcar Industries	2-2012	111A100W1	111A100W1	TC 128 GR B Normalized	No	0.4375	263K	75 psi [1]
39	CBTX 741925	YES	American Railcar Industries	9-2012	111A100W1	111S100W1	TC 128 GR B Normalized	Yes	0.5	286K	75 psi [1]
40	CBTX 736244	NO	American Railcar Industries	4-2012	111A100W1	111A100W1	TC 128 GR B Normalized	No	0.4375	263K	75 psi [1]
41	CBTX 741725	YES	American Railcar Industries	7-2012	111A100W1	111S100W1	TC 128 GR B Normalized	Yes	0.5	286K	75 psi [1]
42	CBTX 741864	YES	American Railcar Industries	8-2012	111A100W1	111S100W1	TC 128 GR B Normalized	Yes	0.5	286K	75 psi [1]
43	GATX 286291	YES	TrinityRail	11-2011	111A100W1	111A100W1	TC 128 GR B Normalized	Yes	0.5	286K	165 psi [1]
44	CBTX 741712	YES	American Railcar Industries	7-2012	111A100W1	111S100W1	TC 128 GR B Normalized	Yes	0.5	286K	75 psi [1]
45	CBTX 741720	YES	American Railcar Industries	7-2012	111A100W1	111S100W1	TC 128 GR B Normalized	Yes	0.5	286K	75 psi [1]

LINE NUMBER [POSITION IN TRAIN]	REPORTING MARK	CPC-1232 [YES/NO]	TANK CAR MANUFACTURER	BUILD DATE	DOT SPECIFICATION	STENCILED SPECIFICATION	MATERIAL HEAD/SHELL	HALF-HEIGHT HEAD SHIELD	HEAD AND SHELL THICKNESS [INCH]	GROSS RAIL LOAD	PRESSURE RELIEF DEVICE [# OF PRD]
46	CBTX 741672	YES	American Railcar Industries	07-2012	111A100W1	111S100W1	TC 128 GR B Normalized	Yes	0.5	286K	75 psi [1]
47	CTCX 743023	YES	American Railcar Industries	5-2012	111A100W1	111S100W1	TC 128 GR B Normalized	Yes	0.5	286K	75 psi [1]
48	CBTX 743190	YES	American Railcar Industries	04-2013	111A100W1	111S100W1	TC 128 GR B Normalized	Yes	0.5	286K	75 psi [1]
49	CBTX 743197	YES	American Railcar Industries	4-2013	111A100W1	111S100W1	TC 128 GR B Normalized	Yes	0.5	286K	75 psi [1]
50	CBTX 743147	YES	American Railcar Industries	3-2013	111A100W1	111S100W1	TC 128 GR B Normalized	Yes	0.5	286K	75 psi [1]
51	CBTX 743221	YES	American Railcar Industries	4-2013	111A100W1	111S100W1	TC 128 GR B Normalized	Yes	0.5	286K	75 psi [1]

ATTACHMENT 16 – ARI TANK CAR DETAIL SPECIFICATIONS

K. Tank Car Damages

The derailed tank cars were GPS tagged to record the position at which they came to rest after the derailment. Arcadis, a CSX contractor, produced a diagram of GPS locations which is provided in attachment 17. There is an error in the diagram - the locations of tank cars GATX 286291 and CBTX 741712 are reversed. Tank car CBTX 741712 came to rest on top of GATX 286291 and was located closer to the river embankment. This is supported by the photograph in figure 6.

Figure 6: Close-up of tank car reporting marks – CBTX 741712.

The train was traveling on track 2 moving eastbound[27] on the James River Subdivision in Lynchburg. As stated earlier, seventeen (17) tank cars (positions 35 through 51) derailed tank during the accident.

The seven (7) tank cars in positions 35 through 42 fell on their sides towards the James River, traversing track 1. These cars had their sides leaning against the south-side rail of track 1. See figures 7 and 8.

[27] According to the railroad timetable.

Figure 7: CBTX 742045 leaning against the south-side rail of track 1.

Figure 8: Overturned tank cars leaning against the south-side rail of track 1.

There was a large gap between tank cars 35 and 36. Another gap was found between tank cars 39 and 40. The two tank cars in line positions 43 and 44, GATX 286291 and CBTX 741712 respectively, traveled down the river embankment and were partially submerged (no more than 1/3) in the James River. GATX 286291 was overturned on its top fittings with CBTX 741712 resting against it, on its right-side. The breach in CBTX 741712 was submerged in the James River.

CBTX 741720 was found perpendicular to track 1 with its A-end on the embankment. The A-end head and portions of the shell were covered with unburnt crude oil. The oil had a directional spray pattern focused around the A-right body bolster. See figures 9 and 10. CBTX 741672 (position 46) was found on the river embankment with its A-end submerged in the river (1/3 submerged). The tank cars in positions 47 through 51 accordioned on the tracks.

Figure 9: A-end of CBTX 741720 with sprayed crude oil.

(a) (b)

Figure 10: Other angle views of A-end of CBTX 741720 with sprayed crude oil.

Only one (1) tank car, CBTX 741712, was breached (shell breach) and released product that ignited, creating a large fire. GATX 286291 and CBTX 741672 were also involved in the post-derailment fire; however, they were not breached and did not release their contents.

The orientation of the tank cars in the train was captured by a BNSF AEI.[28] The table below lists the leading end (either A or B-end) of the tank car as it passed the AEI detector.

Table 6: Orientation of the tank cars in the train.

LINE NUMBER	REPORTING MARK	LEADING END (A or B)
34	CTCX 735749	A
35	CBTX 742045	A
36	CTCX 735779	B
37	CTCX 743047	A
38	CTCX 735774	A
39	CBTX 741925	A
40	CBTX 736244	A
41	CBTX 741725	A
42	CBTX 741864	B
43	GATX 286291	B
44	CBTX 741712	B
45	CBTX 741720	B
46	CBTX 741672	A
47	CTCX 743023	B
48	CBTX 743190	A
49	CBTX 743197	A
50	CBTX 743147	B
51	CBTX 743221	B

The derailed tank cars were staged along the river embankment where they were inspected. Damage assessment diagrams and field notes were compiled and are provided as attachments. SPSI documented tank car pressures and lading temperatures. A damage summary is provided in table 7.

[28] According to CSX, their AEI detectors are not capable of documenting the A and B-ends like BNSF AEI detectors.

Table 7: Tank car damage summary.

LINE NUMBER	REPORT-ING MARK	BUILDER	CPC-1232 [YES/NO]	BREACH [YES/NO]	BREACH LOCATION (SHELL/HEAD)	MULTI-HOUSING COMPROMISED	VALVES DAMAG-ED	BOV ADAPT-OR SHEARED	BOV OPEN OR LEAK-ED	BOV HANDLE DAMAGED	MANWAY COMPR-OMISED	THERMAL TEAR	MECHANICAL TEAR
35	CBTX 742045	American Railcar Industries	YES	NO	N/A	NO	NO	NO	NO	NO	NO	NO	NO
36	CTCX 735779	American Railcar Industries	NO	NO	N/A	NO	NO	YES	NO	NO	NO	NO	NO
37	CTCX 743047	American Railcar Industries	YES	NO	N/A	NO	NO	NO	NO	NO	NO	NO	NO
38	CTCX 735774	American Railcar Industries	NO	NO	N/A	NO	NO	YES	NO	NO	NO	NO	NO
39	CBTX 741925	American Railcar Industries	YES	NO	N/A	NO	NO	NO	NO	NO	NO	NO	NO
40	CBTX 736244	American Railcar Industries	NO	NO	N/A	NO	NO	NO	NO	NO	NO	NO	NO
41	CBTX 741725	American Railcar Industries	YES	NO	N/A	NO	NO	NO	NO	NO	NO	NO	YES
42	CBTX 741864	American Railcar Industries	YES	NO	N/A	NO	NO	NO	NO	NO	NO	NO	NO
43	GATX 286291	TrinityRail	YES	NO	N/A	NO	YES	NO	NO	YES	NO	NO	NO
44	CBTX 741712	American Railcar Industries	YES	YES	Shell (right-side)	NO	NO	YES	NO	YES	NO	NO	NO

LINE NUMBER	REPORT-ING MARK	BUILDER	CPC-1232 [YES/ NO]	BREACH [YES /NO]	BREACH LOCATION (SHELL/ HEAD)	MULTI-HOUSING COMPROMISED	VALVES DAMAG-ED	BOV ADAPT-OR SHEARED	BOV OPEN OR LEAK-ED	BOV HANDLE DAMAGED	MANWAY COMPR-OMISED	THERMAL TEAR	MECHANICAL TEAR
45	CBTX 741720	American Railcar Industries	YES	NO	N/A	NO	NO	NO	NO	NO	NO	NO	NO
46	CBTX 741672	American Railcar Industries	YES	NO	N/A	NO	NO	NO	NO	NO	NO	NO	NO
47	CTCX 743023	American Railcar Industries	YES	NO	N/A	NO	YES	YES	NO	NO	NO	NO	NO
48	CBTX 743190	American Railcar Industries	YES	NO	N/A	NO	NO	NO	NO	NO	NO	NO	NO
49	CBTX 743197	American Railcar Industries	YES	NO	N/A	NO	NO	NO	NO	NO	NO	NO	NO
50	CBTX 743147	American Railcar Industries	YES	NO	N/A	NO	NO	NO	NO	NO	NO	NO	NO
51	CBTX 743221	American Railcar Industries	YES	NO	N/A	NO	NO	NO	NO	NO	NO	NO	NO
Total (No)			3	16	1	17	15	13	17	15	17	17	16
Total (Yes)			14	1	0	0	2	4	0	2	0	0	1

The Hazardous Materials Group inspected all derailed tank cars. However, additional attention was given to CBTX 741720 and CBTX 741712 because the crude oil spray on CBTX 741720 and the dimensions of the tear in CBTX 741712 and a CBTX 741720 body bolster indicated to the Hazardous Materials Group that the two tank cars came into contact during the accident.

CBTX 741712 had a mechanical tear approximately 95-inch long in its right-side shell that ran through rings 4 and 5. See figures 11 and 12. The tear occurred below the right-side centerline. The examination indicated that an object scraped the shell of the tank car and, at the longitudinal seam weld between rings 4 and 5, tore into the shell producing two coiled up rolls of metal extending into the inside of the tank. See figure 13.

Figure 11: Mechanical tear in shell of CBTX 741712 with dimensions.

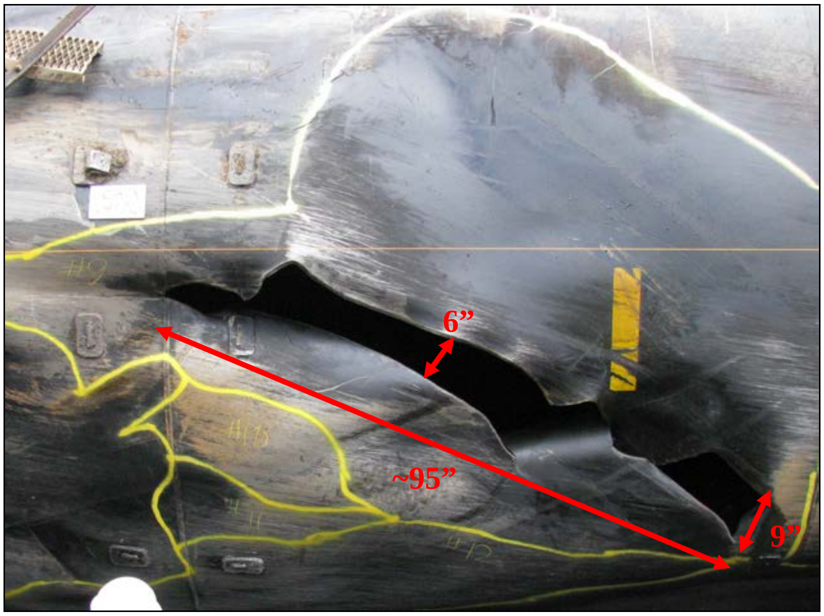

Figure 12: Mechanical tear in shell of CBTX 741712 with dimensions.

Figure 13: Coiled up shell metal inside the tear in CBTX 741712.

Other damage to CBTX 741712 included a large dent extending the full width of shell rings 2 and 3 (see figure 14), a sheared off bottom outlet valve nozzle (see figure 15), a large dent in the A-head (above the half-height head shield) that was approximately 9.5 inches deep (see figure 16), a large dent in rings 5 and 6 on the underside of the tank car’s right-side (see figure 17), a 4 inch deep dent in ring 3 of left-side that was approximately 36 inches by 67 inches, and bulging of the left-side shell towards the B-end that was submerged in the river water (see figure 18). There was no damage to the multi-housing or valves of the tank car (see figure 19). The A-end half-height head shield was torn off the tank; however, the B-end shield remained attached.

Figure 14: Large dent in shell rings 2 and 3 of right-side of CBTX 741712.

Figure 15: Sheared off bottom outlet nozzle of CBTX 741712.

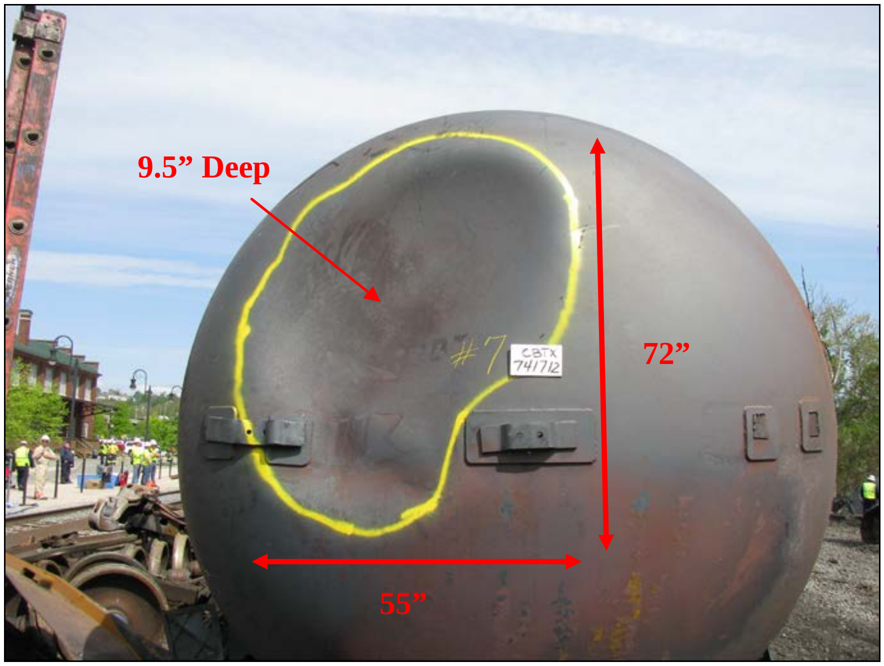

Figure 16: Large dent in the A-head of CBTX 741712.

Figure 17: Large dent in rings 5 and 6 on the bottom of the right-side of CBTX 741712.

Figure 18: Bulging of the left-side shell of CBTX 741712 towards the B-end that was submerged in the river water.

Figure 19: Multi-housing of CBTX 741712.

Most damage to CBTX 741720 occurred on the right-side of the tank, particularly to the A-right body bolster. The lower portion of the body bolster web was deflected outboard toward the A-end, while the upper portion - made of solid 2inch thick steel- was partially deflected outboard. An 18.5 inch section of the A-right body bolster pad (toward the middle of the tank) was pulled apart 1.25 inches from the shell. See figures 20 through 23. The bottom right-side had several large dents that extended the entire length of the tank car. The A-end half-height head shield was torn off the tank; however, the B-end head shield remained attached. There was minimal damage to the left-side of the tank. See figure 24.

Figure 20: Tank car CBTX 741720.

Figure 21: Damage to CBTX 741720 A-right body bolster.

Figure 22: CBTX 741720 A-right body bolster pad separation from shell.


Figure 23: Deflection of CBTX 741720 A-right body bolster.

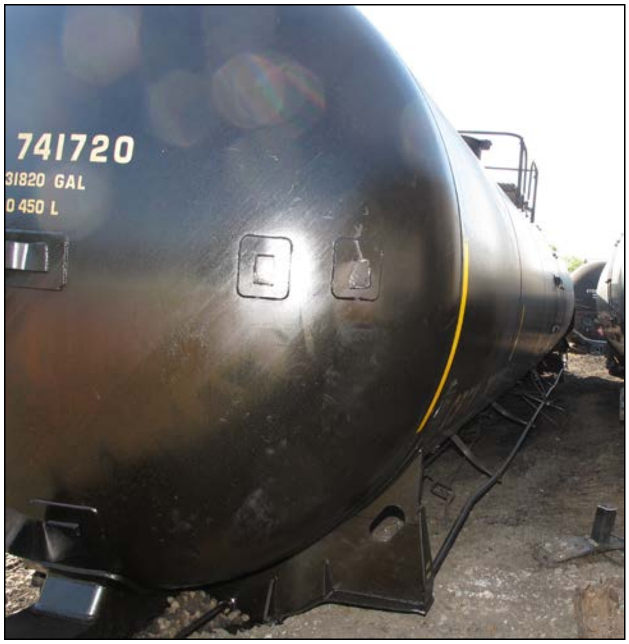

Figure 24: Minimal damage to left-side of CBTX 741720.

Three tank cars (CBTX 741864, CBTX 741712, and CBTX 743190) had impact dents on a head that occurred above the half-height head shield. See figures 25 and 26.

Figure 25: Head impact above half-height head shield (A-end) on CBTX 741864

Figure 26: Head impact above half-height head shield (A-end) on CBTX 743190.

CBTX 741672 sustained a head impact that dented the A-end half-height head shield and resulted in a large dent behind the head shield. This dent measured approximately 3.5 feet in diameter and was about 10 inches deep.


Figure 27: Head impact behind the half-height head shield (A-end) on CBTX 741672.

A three-dimensional (3D) laser scanner was used to record the 3D data of two tanker cars (CBTX74712 and CBTX741720). This scan inspection took place at a rail facility located near Gladstone, Va. The tank cars were examined and scanned using a FARO Focus 3D X330[29] laser scanner. The scanning activity was conducted post-recovery and may not represent the condition of the tanker cars immediately after the accident. A total of 28 individual scans were performed during this investigation. The results of this scanning are provided in a separate factual report.

ATTACHMENT 17 – CSX GPS SURVEY OF TANK CAR LOCATIONS
ATTACHMENT 18 –DAMAGE ASSESSMENT NOTES

L. Retained Tank Car Evidence

The following tank car material was retained for metallurgical examination by the NTSB:

1. NTSB Evidence Control # 14FR008-HM-001
   CBTX 741712 - rectangular section encompassing the entire breach in the right-side of the tank car.
2. NTSB Evidence Control # 14FR008-HM-002
   CBTX 741712 - rectangular section encompassing a non-affected longitudinal weld between shells 3 and 4.
3. NTSB Evidence Control # 14FR008-HM-003
   CBTX 741720 – A-right body bolster.

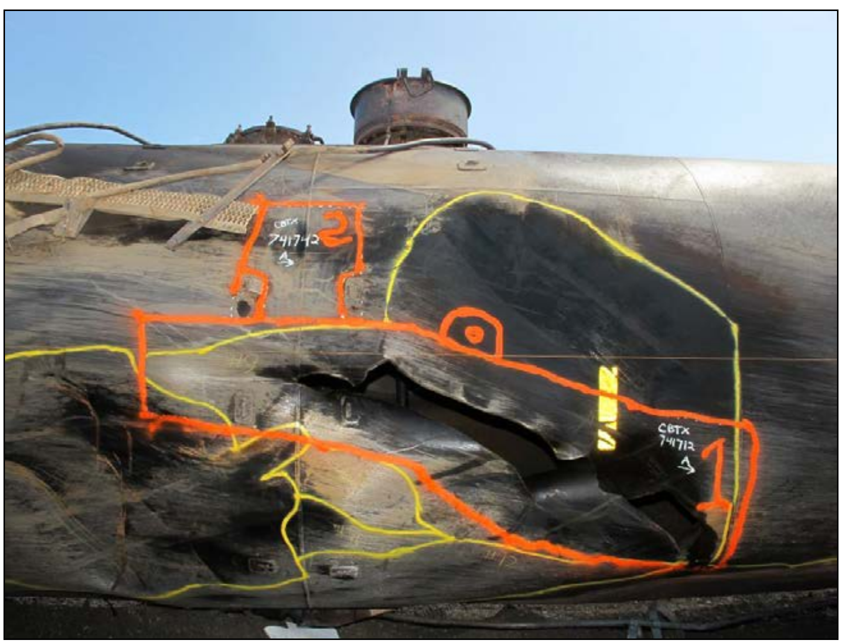

Figure 28: Mechanical tear in shell of CBTX 741712 outlined in orange and the #1.

[29] The FARO Focus X330 laser scanner has an advertised scan range of 330 meters.

Figure 29: A-right body bolster of CBTX 741720 outlined in orange.

ATTACHMENT 19 –EVIDENCE CONTROL FORMS

M. Site Cleanup and Waste Disposal

In response to the accident, CSX mobilized its employees (from HAZMAT, Corporate Citizenship, Community Affairs and Safety, State Government Affairs, Environmental, Engineering, Mechanical, Risk Management, Communications, Transportation, and Train Control) and more than 90 emergency response consultants and contractors (RJ Corman, Donahue Brothers, Test America, Galson Laboratories, New Fields, WEL Environmental, ARCADIS, HEPACO, EnviroScience, Tri-State Bird Rescue & Research, SPSI, Crane Masters, and Center for Toxicology and Environmental Health LLC) to respond to the incident.


Figure 30: Accident scene showing crude oil sheen moving down river.

On April 30, 2014, the Center for Toxicology and Environmental Health (CTEH) began providing air monitoring support for the community and worker protection. Air monitoring was conducted in four phases (Phases I through IV, each phase defined by the ongoing abatement activities at the time) using a combination of real-time air monitoring instruments (UltraRae 3000, MultiRAE Plus, MultiRAE Pro, Gastec tubes, Aerosol Monitor 510, AreaRAE) and analytical air sampling methods. The air monitoring evaluated the potential presence of atmospheric hazards associated with crude oil and/or with an active construction site, including the following constituents:

- Particulate matter (PM2.5 and PM10)
- Benzene, toluene, ethylbenzene, and xylenes (BTEX)
- Carbon monoxide (CO)
- Hexane
- Hydrogen sulfide (H2S)
- Lower explosive limit (LEL)
- Oxygen (O2)
- Volatile organic compounds (VOCs)

Phase I air monitoring was completed during initial incident response and recovery efforts from April 30 through May 4, 2014. Phase II air monitoring was conducted from May 5 through May 8, 2014, during oil transfer operations. Phase III air monitoring was conducted from May 9 through May 13, 2014, surrounding and throughout the Lynchburg Rail Yard, where the empty tank cars were staged after transfers were completed. Phase IV air monitoring was conducted from May 19 through June 11, 2014, during the transport of derailed tank cars to the Gladstone Rail Yard, and the cleaning and purging of the empty cars.

Phase I air monitoring began at 19:55 on April 30, 2014, and throughout the duration of Phase I, CTEH conducted air monitoring to evaluate the potential presence of airborne crude oil constituents in the work area and surrounding community using real-time air monitoring equipment and analytical air sampling methods. There were no detections of H2S, LEL, or benzene during real-time air monitoring activities in the community. All VOC detections in the community were 1 ppm or less and intermittent in occurrence. CO and PM10 detections in the community did not approach the concentrations of one-hour Protective Action Criteria (PAC). There were no detections of n-hexane, xylene, or toluene during real-time air monitoring activities within the work areas. Intermittent detections of H2S, benzene, LEL, and VOCs were reported in the work areas; however, these detections were not sustained above site-specific action levels. Analytical analyses found no concentrations of the chemicals of interest at or above the concentrations specified by applicable exposure standards, guidelines, or protective action criteria in the work area or community.

The overall results of air monitoring conducted in support of the derailment abatement activities are summarized below:

- Over 1.1 million readings were recorded in support of the derailment abatement activities.
- Site specific action levels were employed in all monitoring zones (i.e. Community, Work Zones) to provide information for corrective action to limit chemical exposure.
    - These levels were a conservative concentration limit to protect worker and public safety before regulatory exposure limits were reached.
- No atmospheric constituents were detected by CTEH in the community above the site specific action levels.
- Responses to action levels within the work zones resulted in corrective action, including engineering controls and personal protective equipment (PPE) upgrades.

According to ARCADIS, harbor containment were deployed around the three cars located in the James River and near the Mt. Athos boat ramp, located approximately 10 miles downstream of the accident site. Due to the strong river current, deployment of the harbor containment booms occurred from May 1 through May 3, 2014. Approximately 1,750 feet of oil snare on a rope was deployed approximately 130 miles from the incident location (Route 288 Bridge – Powhatan County), and 800 feet of oil snare on a rope was installed at Mt. Athos boat ramp. Absorbent boom and pads were also installed within the containment boom around the incident location to absorb any recoverable oil contained within the boom. Only oil sheen was detected within the containment boom, and there was no evidence of recoverable crude oil throughout the response efforts.

Aerial reconnaissance surveys via helicopter were performed to document the location and extent of sheen on the James River. Initial aerial reconnaissance was performed by the Virginia State Police with a Virginia HAZMAT officer on April 30. CSX HAZMAT was added to that reconnaissance on May 1. From May 1 through May 3, 2014, aerial reconnaissance surveys were conducted by CSX and its consultants. ,and the Aerial surveys covered approximately 240 river miles from Lynchburg to Jamestown Island. Boat surveys were conducted to verify the sheen locations. The main sheen body on the James River was observed near Scottsville at 12:04 on May 1, 2014, between approximately 63 and 80 miles downstream of the incident location. The only sheen subsequently observed on May 2 and 3, 2014, was at Buzzards Island, approximately 10 miles downstream of the incident location. Throughout response efforts no separate phase crude oil was observed. Sheen was not observed on any other waterways besides the James River during the aerial surveys.

Three phases of soil excavation were completed at the accident site, on May 2, 3, and 20, 2014. Soil excavation was performed to remove impacted material from the track bed and slope without de-stabilizing the embankment. Approximately 260 tons of soil and ballast were removed during the excavations.

Figure 31: Soil excavation and collection from the accident site.

A total of sixteen soil samples were collected during soil and ballast excavation activities:

- 13 samples were collected from the excavation areas,
- one sample was collected on the right descending bank (RDB) approximately 500 feet downstream of the incident location, and
- two background soil samples were collected from locations approximately 80 and 150 yards upstream of the incident location, respectively.

Only two soil sample locations contained benzene in exceedance of the Voluntary Remediation Program (VRP) 25 Tier II soil criteria.

Table 8 provides a summary of the volumes of crude oil lost.

Table 8: Summary of crude oil lost.

LINE NUMBER	CAR NUMBER	LADING VOLUME AT LOADING (GAL)	LOSSED VOLUME (GAL)
35	CBTX 742045	29,944	N/A
36	CTCX 735779	27,795	N/A
37	CTCX 743047	29,934	N/A
38	CTCX 735774	28,005	N/A
39	CBTX 741925	29,719	N/A
40	CBTX 736244	27,765	N/A
41	CBTX 741725	29,649	N/A
42	CBTX 741864	29,729	N/A
43	GATX 286291	29,725	N/A
44	CBTX 741712	29,868	29,868
45	CBTX 741720	29,868	N/A
46	CBTX 741672	29,513	N/A

LINE NUMBER	CAR NUMBER	LADING VOLUME AT LOADING (GAL)	LOSSED VOLUME (GAL)
47	CTCX 743023	29,974	N/A
48	CBTX 743190	29,974	N/A
49	CBTX 743197	29,954	N/A
50	CBTX 743147	29,916	N/A
51	CBTX 743221	29,608	N/A
TOTALS			**29,868**

According to an ARCADIS environmental report, a Monte Carlo simulation model was used to develop a range of estimates for the volume of crude oil consumed in the fire, based upon the expected burn rate of the crude oil (United States Coast Guard [USCG] Oil Spill Response Offshore; In-Situ Burn Operations Manual, 2003), field observations including the burn time and expansion and contraction of the pool dimensions as the fire proceeded, and published data. The results of the simulation are as follows:

- The median estimate of crude oil consumed was 29,245 gallons, or 97.7% of the estimated 29,916[30] gallons contained in CBTX741712.
- There is a 95% probability that more than 23,400 gallons of oil burned on the water.

Based upon this estimate and the results of the additional investigation and abatement activities performed, ARCADIS completed a mass balance calculation to estimate the recovered and potentially remaining volumes of crude oil at the site. The summary of the results are as follows:

- 97.7 percent was consumed in the pool fire;
- 1.3 percent formed a sheen on the James River;
- 0.6 percent (about 186 gallons) was recovered from the tank car;
- 0.8 percent entered the embankment soils; and,
- Trace amounts of crude oil were recovered during ballast and soil excavations and via absorbent materials.

Note: The total mass balance percentage of 100.4% is a result of the variability of the Monte Carlo simulation.

ATTACHMENT 20 – CTEH AIR MONITORING REPORT - PHASE I
ATTACHMENT 21 – CTEH AIR MONITORING REPORT - PHASE II
ATTACHMENT 22 – CTEH AIR MONITORING REPORT - PHASE III-IV
ATTACHMENT 23 – ABATEMENT REPORT - FOUO
ATTACHMENT 24 – EXCERPTS FROM ARCADIS ENVIRONMENTAL REPORT

[30] ARCADIS report assumed 29,916 gallons were contained in the tank car.

N. Route Selection and Risk Analysis

In February 2014, the AAR and the Secretary of the Department of Transportation developed an AAR subscriber commitment to enhance safety for crude oil and ethanol transportation. One of the commitments stated that "By no later than July 1, 2014, Railroad Subscribers will apply any protocols developed by the rail industry to comply with the existing route analysis requirements of 49 C.F.R. § 172.820(c) – (f) and (i) to the movement of trains transporting 20 or more loaded railroad tank cars containing petroleum crude oil (Key Crude Oil Trains)." While this accident occurred prior to the completion date, CSX shared with the NTSB the results of its route selection and risk analysis that was completed in June 2014.[31] CSX had selected four potential routes for moving crude oil shipments from Chicago to Yorktown, VA. CSX route risk analysis, using FRA-accepted risk model methods, concluded that the route their trains were using (being routed through Lynchburg) was the most suitable route according to their analysis.

O. CSX Training and Outreach to Communities and Emergency Responders

CSX told the NTSB that since 2005 it has provided the following training and outreach in Virginia:

- It has been a key sponsor at the Virginia State Hazmat Conference every year since 2005.
- It sent 11 responders (all expenses paid) to training at Transportation Technology Center, Inc. (TTCI) in Pueblo, Colorado since 2005.
- It brought the CSX Safety Train to Fredericksburg, Quantico, Richmond, and Newport News for training emergency responders.
- It conducted a full scale multi-county exercise in Quantico in 2012.
- It trained approximately 3,000 first responders using the safety train.
- It donated $30,000 to the Yorktown Virginia State Hazmat/CBRNE training facility in Yorktown, VA (States Hazmat training Center).
- It donated several props, ties, and moved rail cars for free to the training center.

The NTSB contacted the City of Lynchburg Local Emergency Planning Committee (LEPC) and inquired about its activities and coordination with CSX. According to the LEPC, prior to this accident, it had not requested a commodity flow (or density flow) study from CSX, nor had CSX sent one to it on its own. After this accident, CSX provided the LEPC with guidance regarding their emergency response capabilities and ancillary contractors that can be provided during an accident. The City of Lynchburg LEPC has not developed hazardous materials response plans that are specific to the commodities transported by rail. Prior to the accident, CSX had not provided any information regarding oil spill response plans. However, the City of Lynchburg received a power point presentation from the Virginia Department of Emergency Management about petroleum crude oil shipments, which was shared with the LEPC on April 16, 2014.

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

[31] NTSB and CSX meeting on February 19, 2014, at NTSB headquarters in Washington, DC.

ATTACHMENTS

ATTACHMENT 1 – CONSIST FOR TRAIN K08227
ATTACHMENT 2 – CSX AEI READOUT AT CAB146
ATTACHMENT 3 –BNSF AEI REPORT
ATTACHMENT 4 – TANK CAR CERTIFICATE OF CONSTRUCTION-TRINITYRAIL
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