National Transportation Safety Board
Washington, D.C. 20594

*Report Date: February 22, 2010*

# Hazardous Materials Group Chairman's Factual Report

## A. Accident Identification

| | |
|---|---|
| Carrier: | Canadian National Railway (CN) |
| Train No.: | U70691-18 |
| Location: | Cherry Valley, Illinois |
| Date/Time: | June 19, 2009, 8:38 p.m. CDT |
| NTSB No.: | DCA09MR006 |

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## C. Accident Summary

At about 8:36 p.m. (CDT) on Friday June 19, 2009, CN freight train U70691-18 derailed at the Mulford Road highway-rail grade crossing (MP 80.1) on the Freeport Subdivision in Cherry Valley, Illinois.

At the time of the derailment, several motor vehicles were stopped at the crossing waiting for the train to pass. The accident resulted in one fatality and nine persons were reportedly treated for injuries at two local medical facilities, including two firefighters that sustained minor injuries. Neither of the two crewmembers of the train was injured. The release of ethanol and resulting fire initiated a voluntary evacuation of about 600 residences within a ½-mile radius of the accident scene. Property damage was estimated to be in excess of $4.4 million.

The train originated in Tara, IA and was en route to Chicago, IL and consisted of 2 locomotives and 114 cars (78 loads/36 empties), 6,793 feet in length and trailing tonnage of about 11,125 tons. A total of 19 cars derailed (cars 57 to 75), all of which contained denatured ethanol as cargo. Thirteen of the tank cars in the wreckage were breached or lost product, and caught fire.

Weather at Rockford, IL (about 6 miles from the accident scene) was reported as partially overcast, 66 degrees F, and calm winds. Heavy rain (in excess of 3.25") was reported to have occurred in the area of the accident between 5:00 p.m. and 7:00 p.m.

FIGURE 1 – AERIAL PHOTOGRAPH OF THE DERAILMENT AT MULFORD ROAD CROSSING [1]

## D. Pre-Accident Events

### *Shipper's Actions*

The shipper, Valero Energy Corporation, is an independent petroleum marketer based in San Antonio, TX. Valero operates 16 petroleum refineries and seven ethanol plants, including the Valero Renewable Fuels Company LLC facility in Tara, Iowa. The Tara facility manufactures about 110 million gallons of ethanol and loads approximately 3,900 rail cars annually.

Between June 13 -15, 2009, Valero completed an inspection checklist for each of the 75 tank cars that would be incorporated into train U70691-18 at its Tara, Iowa ethanol refinery and then loaded these tank cars with denatured fuel ethanol. The pre-loading inspection procedure included verifying the cars were approved for loading ethanol by ensuring they were stenciled with DOT specification "111A100W1" and by checking that tank test due dates had not expired. The inspectors examined the condition of the wheel assemblies, wheel bearings, working surfaces, and placards. They inspected the bottom outlet valves to verify that the valve levers were secured in a closed position and that retaining pins properly locked the handles in place. Bottom outlet valves were also

[1] NTSB photograph, June 20, 2009, 4:04 p.m., looking northeast, Photograph 1.

checked for leakage, cracks, gouges, damaged threads, gaskets, caps, and plug chains. The inspectors opened the manway lids, checked vapor and liquid valves for closure, and verified that plugs were tool-tight. The inspectors checked the condition of pressure relief valves, inspected and replaced manway gaskets as necessary, and checked the manway lid bolts and washers for damage. The inspectors conducted visual internal tank inspections for evidence of debris or foreign materials. Valero employees are trained not to load any car if the inspection uncovers defect cards, damages to the safety appliances or car body, or if the car otherwise requires maintenance.

After loading each tank car, inspectors verified alignment of manway gaskets, checked that the manways were sealed by air wrench with a torque of between 90 and 125 ft-lbs, and placed security seals on manway bolts and valve protective housings. One inspector checked the bottom outlet valves for evidence of leakage, tightened bottom outlet valve caps tool-tight, and a separate inspector verified the valve closures and applied security seals. No exceptions to the pre-loading and post-loading inspections were noted on Valero's inspection sheets for each of the tank cars. The inspectors recorded the seal numbers on each of Valero's railcar inspection forms. Valero has not altered its tank car inspection or loading procedures since this accident.

On June 17, 2009, Valero assembled the shipment of 75 tank cars that contained a total of 2,158,724-gallons of denatured fuel ethanol. The consignee of the shipment was Valero Marketing and Supply, Sewaren, New Jersey. CN train U70691-18 included one non-hazardous buffer car and departed the Valero facility as a 76 car unit train[2] at about 5:55 a.m. on June 19, 2009.

SEE ATTACHMENTS 1 – 2

***Verification and Correction of Train Consist***

As the train departed Tara, Iowa, only three of the 76 cars reflected their current position on the train consist, as verified by the actual position in the train by the Fort Dodge, Iowa automatic equipment identification (AEI) scanner report.[3] The train consist carried by the initial train crew did not match the physical placement of rail cars in the train prior to departing Tara. A train crew change was performed at Waterloo, Iowa, and again at Dubuque, Iowa without any updated consist aboard the train. The 76 cars were transported in this condition a distance of about 259 miles to Freeport, Illinois. A total of 38 non-hazardous rail cars were added to the head of the train at Freeport. Prior to departure from Freeport, the train crew received a track list identifying the 114-car train. At this time, the train crew again did not update the original consist to indicate placement changes of the tank cars.

[2] Unit trains, sometimes referred to as virtual pipelines, are composed entirely of 70 to 100 ethanol tank cars that are dedicated to shuttle back and forth to large rail or petroleum terminals.
[3] AEI readers identify cars on a train by the identification tags on cars as they pass. The AEI reader automatically relays information back to CN's central computer to update the master train consist. The AEI reader at Fort Dodge, Iowa is located approximately 7 miles east of Tara, Iowa.

SEE ATTACHMENTS 3 – 5

## E. Post-Accident Events

### *Emergency Response Activities*

The initial response to this accident occurred at about 8:39 p.m. on June 19, 2009, when the Cherry Valley Fire Protection District (CVFPD) and the Rockford Fire Department (RFD) jointly responded to reports of a train derailment and explosion near Shelburne Drive and Mulford Road in Cherry Valley, Illinois. A CVFPD chief, who served as the incident commander, arrived on scene at 8:46 p.m. and reported a major fire involving multiple derailed and burning tank cars. The incident commander summonsed additional resources that ultimately included a total of 242 Cherry Valley and mutual aid fire fighters, and emergency medical service personnel.

The RFD maintains the regional hazardous materials response capability and therefore supplied the hazardous materials team for this response. The hazardous materials team consisted of three RFD hazardous materials technicians and a fourth crew member. One hazardous materials technician served the role of hazardous materials branch chief within the incident command system.

At about 8:55 p.m., the incident commander and the hazardous materials branch chief conferred and increased the initial evacuation zone from ¼-mile to ½-mile. The decision to enlarge the evacuation zone was based on high pitch noises coming from tank car pressure relief valves that indicated some of the tank cars were under increased pressure, and the apparent hazard presented by some tank ends facing the responder's direction. Fire department units staged about ¼-mile from the accident at Mulford Road and Abington Drive on the north and Mulford and Sandy Hollow Roads on the south side of the derailment.

The hazardous materials branch chief's first indication of the type of hazardous materials on the train came from a motorist stopped at the rail crossing at the time of the accident. Within minutes of the hazardous materials branch chief's arrival, this witness reported seeing black tank cars bearing red placards. The hazardous materials branch chief told Safety Board investigators that from the placard description, he knew the incident involved a flammable material. The incident commander and hazardous materials branch chief decided to evacuate residents located north of the accident scene because they were concerned about the possibility of a tank car violently rupturing due to the flame impingement.

At about 9:15 p.m. a RFD chief contacted CN and was told that the train length was 114-cars, with 75 cars of ethanol and the rest of the train containing non-hazardous material. The RFD chief contacted the hazardous materials branch chief and informed him that all hazardous materials cars in the train contained ethanol.

At about 9:25 p.m., the hazardous materials branch chief contacted a Union Pacific Railroad (UP) hazardous materials manager who is known to the local firefighting community and requested his assistance in dealing with the burning ethanol tank cars. The UP hazardous materials manager recommended allowing the ethanol to burn itself out because he felt that it was unlikely application of firefighting foam would be effective in controlling a large ethanol fire. The UP hazardous materials manager further advised that there was no danger of a BLEVE[4] occurring with ethanol, and suggested placing a cooling stream on adjacent uninvolved tank cars to prevent the fire from spreading. The UP hazardous materials manager also recommended that the hazardous materials branch chief obtain a train consist and map the down-wind vapor plume.

Nicor Gas is the owner of a gas pipeline that runs parallel to Mulford Road and crosses underneath the CN railroad right of way. At about 9:30 p.m., in response to media reports of the accident, the Nicor Gas dispatch center contacted the RFD to offer assistance if needed. The fire department responded to Nicor that there was a large evacuation taking place, however there was no conflict with Nicor Gas and no pipeline company support was required.

At about 10:20 p.m., the train crew arrived at the command post and presented to emergency responders the 114 car Freeport track list and the original Tara consist.[5] The train crew verbally reported that although they did not know which specific cars were involved in the derailment, all of the tank cars behind car number 40 contained ethanol. The train crew provided the train consist to the hazardous materials branch chief, which the RFD photocopied at the incident command post. The emergency responders did not notice any discrepancy between the original consist and the track list, and concluded from the documents presented by the train crew that each of the tank cars involved in the derailment contained ethanol.

At about 10:30 p.m., two CN dangerous goods officers arrived on-scene and became hazardous materials liaisons to the fire departments. They provided additional guidance to the incident commander and hazardous materials branch chief throughout the remainder of the response.

At about 11:00 p.m. two CVFPD firefighters approached the accident scene from the south in order to determine how far to the east the derailment extended and how many tank cars were burning. The firefighters were overcome by chemical fumes and had to be extracted.

At about 11:30 p.m. a reconnaissance team consisting of a CN dangerous goods officer, the UP hazardous materials manager, and a CVFPD firefighter surveyed the derailment from the north. They observed that the front end of the train had disconnected from the derailed cars and moved further to the east where it was no longer at risk from the fire. The reconnaissance team observed that 12 to 14 tank cars in the pileup were impinged by

[4] A BLEVE is a boiling liquid-expanding vapor explosion that may occur during failure of containers of flammable liquefied gases or volatile liquids that are impinged by fire, resulting in a highly energetic explosion.
[5] For further information about the train crew's actions, see the Operations Group factual report.

flames. They estimated the fire zone to be about 250 to 300-feet wide, extending to both sides of the Mulford Road crossing. The reconnaissance team communicated their findings to the hazardous materials branch chief and firefighting efforts were then concentrated on cooling uninvolved tank cars located to the west of the derailment until the fire was extinguished.

The reconnaissance team did not observe any gas pipeline markers near the grade crossing. The reconnaissance team also did not notice the yellow fiberglass pipeline marker north of the grade crossing. When questioned by Safety Board investigators, neither the CVFPD nor the RFD reported having observed any pipeline markers nearby the railroad crossing. RFD stated that the pipeline markers, such as those located further from the accident scene along Mulford Road, do not indicate the direction the pipe travels underground.

Prompted by a report of a pipeline marker on South Mulford Road, a RFD chief telephoned the Nicor Gas dispatch center at about midnight on June 19-20. The RFD chief asked whether any natural gas pipelines were present in the area of the derailment along Mulford Road, between Sandy Hollow Road and Harrison Avenue. A dispatch clerk told the chief that no gas main was in the area, and added that the closest gas main was situated along Linden Road, which is located about 0.5-miles south of Sandy Hollow Road, or about 0.7-miles south of the derailment.[6]

At 1:22 a.m. on June 20, 2009, the CN chief dispatcher emailed a correctly-ordered train consist to the Region 2 Coordinator of the Illinois Emergency Management Agency, who provided the document to the unified command. The train consist information was transferred to a bulletin board posted in the unified command post that listed the derailed cars in correct order.

At about 7:10 a.m. on June 20, 2009, the deputy chief of operations dismissed the hazardous materials team. Fire department response efforts continued through 5:00 p.m. on June 20, 2009, until the fire was extinguished and the tank cars were cooled. Evacuees were allowed to return to their residents around 5:30 p.m. on June 20, 2009, about 21-hours after the accident. The fire department maintained a presence on scene until about 3:30 p.m., June 21, 2009.

SEE ATTACHMENTS 6 – 10; PHOTOGRAPHS 2 AND 3

### *Actions of the Gas Pipeline Operator*

CN contacted Nicor Gas on June 20, 2009 at about 6:30 a.m. and Nicor confirmed that a 12-inch gas main was located in the vicinity of the derailment. At about 7:06 a.m., Nicor

[6] Nicor later informed the CVFPD that the information provided by the dispatch center clerk was erroneous because the clerk referred to an incorrect map when conveying the information.

dispatched an operations mechanic and a Watch and Protect[7] representative to the derailment scene to prevent excavation damage to the gas main during the wreckage clearing operations. Nicor established the location of the pipeline and conducted a leakage survey as close as possible to the derailment site. No evidence of a gas leak was found. Nicor reported to Safety Board investigators that the pipeline pressure charts revealed no evidence of a pressure drop that would indicate damage to the pipeline.

At about midnight on June 20 - 21, 2009, Hulcher Services assisted Nicor in excavating the gas main to perform a visual inspection of the pipeline. Hulcher removed six sets of rail car wheels and axles and two truck assemblies from on top of the gas main. Nicor's crew observed that the last set of wheels was directly impinged on the gas main.

Nicor conducted a visual and photographic examination of the gas main and identified two large dents in the 16-inch pipe casing, such that the 12-inch carrier pipe was likely dented as well. Dents in the gas main corresponded with the approximate width of a railcar wheel and were separated by a distance approximately the same as the span of a wheel and axle assembly.

During the afternoon of June 21, Nicor affixed line stoppers to the pipeline to allow for complete depressurization prior to railway reconstruction and to eliminate the potential for leakage. The line stoppers isolated the affected portion of the pipeline without larger-scale system interruption. By the morning of June 22, the gas pipeline was depressurized and purged of product. The affected 700-foot section of the pipeline was separated by performing pipe cuts and the railway reconstruction was allowed to commence. A new section of pipeline was installed on June 24, 2009.

SEE ATTACHMENTS 13 – 15; PHOTOGRAPH 4

***Post Accident Recovery Actions***

*Derailed Tank Cars*

CN expressed interest in moving the derailed cars as soon as possible in order to reopen the rail line to traffic. On June 20, 2009, Hulcher Services, Inc. and Quality Rail Service were present on the scene with large numbers of personnel and equipment ready to begin wreckage clearing operations. The movement of the derailed cars began shortly after the fire was extinguished and aerial photo documentation was completed. CN officials assured that foam would be placed inside of some cars that still contained ethanol in order to stabilize the material during movement. Before the tank cars were moved, it was unknown how much, if any, ethanol remained in each of the tanks.

During the overnight hours of June 20 to June 21, 2009, CN's contractors moved the tank car carcasses to a staging area they had established adjacent to the derailment on a vacant

[7] Watch and Protect is a voluntary Nicor Gas program that goes beyond any legal requirements in order to further protect critical pipelines. Under Watch and Protect, a Nicor representative is present when excavation occurs within 100-feet of a critical pipeline.

parcel of land located about 400-feet from the crossing, west of Mulford Road between the Union Pacific and CN tracks. The derailed cars were transported to the staging area by track-wheeled sidebooms, taking care to avoid causing additional car damage.

Once the Hazardous Materials Group inspected the tank cars, Midwest Environmental, Inc. pumped and purged them of product. Between June 21 and June 24 Midwest Environmental recovered about 107,745-gallons of ethanol, or about 25-percent of the original 431,708-gallons of lading from the 15 tank cars comprising the pileup. A total of 19 tank cars derailed, each of which was fully loaded with denatured fuel ethanol. As a result of the derailment, 13 tank cars released product from breaches, pressure relief devices, valves, and/or fittings. Four of the tank cars released full loads of ethanol. The total amount of lading consumed by fire or released to water, soil, and air in the accident was about 323,963 gallons.

SEE ATTACHMENTS 11, 22, 24 AND 25

*Re-railed Tank Cars*

Immediately following the accident, derailed cars **CITX 224226** (car 57) and **CITX 224199** (car 58) were dragged eastbound about 0.1 miles along with the train to MP 80. On June 19, 2009 CN re-railed the cars and moved them with the front of the train to the Genoa, Illinois siding at MP 66.

Derailed cars **NATX 303125** (car 74) and **NATX 302864** (car 75) were located on the west side of the derailment. On June 22, 2009, CN re-railed the two cars and moved them to the Rockford Siding located at MP 87.0.

SEE ATTACHMENT 12

***Environmental Monitoring and Remediation***

*Air Monitoring*

CN contracted the Center for Toxicology and Environmental Health, LLC (CTEH) to monitor releases of hazardous materials to air and water. Real-time air sampling began in, and around the perimeter of the accident site at about 4:02 a.m. on June 20, 2009, and continued through June 25, 2009. The results of air monitoring at various locations for volatile organic compounds (VOC's), ethanol, particulate matter, and lower explosive limit (LEL) indicated no concentrations in excess of applicable action levels.

SEE ATTACHMENT 16

*Contaminated Soils*

On the morning of June 21, 2009 the Hazardous Materials Group observed evidence of product spillage in the tank car staging yard adjacent to the accident site. CN's contractor

Midwest Environmental, Inc. excavated and stockpiled contaminated topsoil from an estimated ½ -acre area in the staging yard. The excavated soil was commingled with contaminated soil removed from the derailment area. On June 23, 2009 testing of the stockpile characterized the soils as non-hazardous material, and from June 24 – 27 Mid West Environmental subcontractors removed 82 truck loads consisting of about 1,733 tons of excavated and contaminated soil to the Orchard Hills Sanitary Landfill in Davis Junction, Illinois.

Between June 25 – 30, 2009, CN contractor ARCADIS completed 55 soil borings, 2 hand augers, and 6 monitoring wells in order to investigate the extent of subsurface soil and groundwater contamination that occurred in the derailment zone and in the staging yard. Samples were tested for a wide range of chemical contaminants, including ethanol and petroleum hydrocarbons. The soil and groundwater results yielded no concentrations of these compounds that exceeded applicable remediation objectives.[8]

SEE ATTACHMENTS 17 - 18

*Water Pollution*

The Environmental Protection Agency (EPA), as the federal on-scene coordinator (FOSC), estimated that about 60,000-gallons of ethanol were released into an unnamed tributary of the Rock and Kishwaukee Rivers, and resulted in a significant fish kill. The FOSC reported that the fish kill likely resulted from depressed dissolved oxygen levels in the river from bio-oxidation of the released ethanol.

On June 21 at about 8:00 a.m., the Illinois Conservation Police received first reports of fish dying in the Grand Detour area of the Rock River. The fish kill ultimately affected about 53.6 miles of the Rock River, between Grand Detour and Erie, Illinois. Continuing for about 36-hours following the initial fish kill report, Illinois Department of Natural Resources biologists measured, counted and sorted affected fish species, including catfish, smallmouth bass, and walleye. The Department of Natural Resources estimates that approximately 72,372 fish were killed with an associated value of about $272,303.

Since there are no established action levels for ethanol in surface water, the primary pollutants of concern were the components of the gasoline that was used as a denaturant for the ethanol. On June 21 – 24, 2009, CTEH collected water samples at several stations along the Rock and Kishwakee Rivers which they tested for total petroleum hydrocarbons and gasoline-range organics. These tests did not yield any levels of detectable chemical compounds in excess of applicable human health and ecological screening levels.

On June 21, 2009 CTEH sampled a community well that services about 200 households about ½-mile north of the derailment site. CTEH sampled seven additional residential wells from nearby communities on June 24, 2009. These samples were tested for total

[8] Soil and groundwater analytical results were compared to remediation objectives set forth in Title 35 Illinois Administrative Code Part 742, known as the Tiered Approach to Corrective Action Objectives regulations.

petroleum hydrocarbons and gasoline-range organics, yielding no detectable chemical concentrations in excess of their applicable human health screening levels.

SEE ATTACHMENTS 17, AND 19 -21

*Waste Disposal*

Midwest Environmental was contracted by CN to conduct the accident site waste remediation activities. Depending on the degree of product contamination caused by the fire, waste materials resulting from transfer of liquids from the damaged rail cars were either shipped as recycled hazardous material or as hazardous waste. Virgin denatured fuel ethanol pumped from the tank cars was transported under hazardous materials bill of lading by subcontracted motor carriers to U.S. Oil Company in Madison, Wisconsin. Burnt sludge and residues were transported as characteristically ignitable hazardous waste to Pollution Control Industries in East Chicago, Indiana.

Once empty, the tank car carcasses were rinsed with a surfactant to eliminate product residues and flammable vapor. The tank rinseate was also hauled to Pollution Control Industries for disposal.

SEE ATTACHMENT 22

## F. Hazardous Materials Information

Denatured Fuel Ethanol manufactured by Valero Renewables Company, LLC is a colorless water-soluble liquid with an alcohol and gasoline-like odor. The product is regulated by the Department of Transportation (DOT) as a flammable liquid. The material is shipped under the DOT shipping information: UN1987, Alcohols, N.O.S., Class 3, PG II. The product is intended for use as a refinery feedstock for blending with gasoline. The product is a mixture of 95 to 99-percent ethanol and 0 to 5-percent gasoline. Denatured fuel ethanol weighs about 6.6 lbs/gal and has a typical flashpoint of -5º F.[9] The material is extremely flammable or explosive in the presence of open flames, sparks, or static discharge. Highly flammable vapors may accumulate in low or confined spaces or travel considerable distance to a source of ignition. Ethanol is thoroughly miscible with water and can continue to burn at a 5:1 dilution.[10] Toxic products of combustion include carbon monoxide, oxides of sulfur and nitrogen, particulate matter, and volatile organic hydrocarbons. The product is harmful or fatal if swallowed. Inhalation may result in respiratory tract irritation and central nervous system effects, including loss of consciousness, coma, or respiratory arrest with long-term exposure to high vapor concentrations.

SEE ATTACHMENT 23

[9] *Best Practices for Rail Transport of Fuel Ethanol*, issued November 19, 2009, Renewable Fuels Association, Washington, DC.
[10] *Responding to Ethanol Incidents*, [video], May, 2009, Renewable Fuels Association, Washington, DC.

***Renewable Fuels Overview***

In the Energy Policy Act of 2005 Congress directed the U.S. Environmental Protection Agency (EPA), in coordination with the U.S. Department of Agriculture (USDA) and the U.S. Department of Energy (DOE), to design a program that requires the blending of renewable fuels[11] into the Nation's motor-vehicle fuel supply. This program, called the Renewable Fuel Standard, is found in Title 40 *Code of Federal Regulations* (CFR), Part 80. The program is intended to reduce U.S. dependence on foreign sources of petroleum by increasing domestic sources of energy and is also expected to provide reductions in greenhouse gas emissions. On February 3, 2010, the EPA issued a final rule that revises the Renewable Fuel Standard Program as required by the Energy Independence and Security Act of 2007.[12] These revisions, known as RFS2, mandate incremental increases in the annual production of renewable fuels that must be used in transportation fuel, from the 2010 level of 12.95 billion gallons to 36 billion gallons by the year 2022.

In January 2009, 170 ethanol biorefineries were operating in 26 states, with 20 new facilities under construction.[13] Although pipelines are a preferred method for transporting petroleum products over long distances due to reliability and lower costs, ethanol is not currently shipped by pipeline because it is thought to cause stress corrosion cracking in pipeline walls. In its notice of proposed rulemaking the EPA states that because of the uncertainties regarding the future use of pipelines the agency assumes that ethanol will continue to be transported from production facilities by rail, barge, and truck to petroleum terminals where it will be blended into gasoline. The EPA believes that the distribution by these modes can be further optimized primarily through the increased shipment by unit train, potentially tripling the current number of ethanol shipments being transported in DOT-111 tank cars over the next 12 years.

In 2008, denatured ethanol was the top ranked hazardous material commodity transported by railroad in North America, with 218,902 tank car shipments originating in the United States. By comparison, the second most travelled commodity by railroad in 2008 was liquefied petroleum gas, with 105,364 tank car shipments.[14]

## G. Derailed Tank Car Descriptions and Damages

Of the 19 tank cars that derailed in this accident, seventeen of these tank cars were damaged as a result of the derailment and subsequent fire. Fifteen of the 19 cars were piled up at the accident scene, while the remaining four cars were re-railed and removed from the area (**Table 1**).

[11] Renewable fuels are fuels produced from plant or animal products or wastes rather than from fossil fuels. The most widely known renewable fuels are ethanol and biodiesel.
[12] The final rule is effective July 1, 2010. See Environmental Protection Agency docket EPA-HQ-OAR-2005-0161.
[13] Renewable Fuels Association, January, 2009.
[14] *Annual Report of Hazardous Materials Shipped by Rail* (Washington, DC: Association of American Railroads, Bureau of Explosives, 2008).

| Consist Order | Reporting Marks | Build Date | Capacity | Lading [15] | Amount Recovered | Amount Released [16] | Damage Resulting in Loss of Lading |
|---|---|---|---|---|---|---|---|
| 57 | **CITX 224226* | *6/2008* | *30,100* | *28,757* | *ALL* | *0* | n/a |
| 58 | **CITX 224199* | *5/2008* | *30,110* | *28,767* | *ALL* | *0* | n/a |
| 59 | CTCX 731600 | 9/2008 | 30,020 | 28,800 | 28,800 | 0 | n/a |
| 60 | CTCX 731601 | 10/2008 | 30,000 | 28,800 | 28,800 | 0 | n/a |
| 61 | CTCX 731599 | 9/2008 | 30,150 | 28,800 | 8,100 | 20,700 | Damaged Fitting |
| 62 | CTCX 730958 | 6/2008 | 30,145 | 28,800 | 3,000 | 25,800 | Shell Puncture |
| 63 | CITX 224236 | 6/2008 | 30,100 | 28,757 | 2,400 | 26,357 | Damaged Fitting |
| 64 | TILX 193772 | 12/2006 | 30,140 | 28,796 | 0 | 28,796 | Head Puncture<br>Damaged Fitting |
| 65 | NATX 303375 | 12/2006 | 30,080 | 28,738 | 5,500 | 23,238 | Head Puncture |
| 66 | NATX 303504 | 12/2006 | 30,140 | 28,796 | 0 | 28,796 | Head Puncture<br>Shell Puncture / Breach<br>Damaged Fitting |
| 67 | NATX 302974 | 4/2007 | 30,140 | 28,796 | 20 | 28,776 | Head Puncture<br>Shell Puncture |
| 68 | CTCX 731596 | 9/2008 | 30,145 | 28,800 | 1,800 | 27,000 | Head Puncture<br>Shell Breach |
| 69 | NATX 302968 | 4/2007 | 30,130 | 28,786 | 0 | 28,786 | Head Puncture |
| 70 | NATX 303067 | 2/2007 | 30,120 | 28,776 | 17,725 | 11,051 | Fittings |
| 71 | NATX 303174 | 3/2007 | 30,110 | 28,767 | 3,100 | 25,667 | Head Puncture |
| 72 | TILX 193767 | 4/2007 | 30,110 | 28,767 | 8,500 | 20,267 | Head Puncture |
| 73 | NATX 302969 | 4/2007 | 30,070 | 28,729 | 0 | 28,729 | Head Puncture |
| 74 | **NATX 303125* | *2/2007* | *30,110* | *28,767* | *ALL* | *0* | n/a |
| 75 | **NATX 302864* | *3/2007* | *30,090* | *28,745* | *ALL* | *0* | n/a |
| ***TOTALS*** | | | | **431,708** | **107,745** | **323,963** | **(U.S. gallons)** |

**Involved in the derailment, but removed by train from the site. Not included in totals.*

TABLE 1 – DERAILED HAZARDOUS MATERIALS TANK CARS

SEE ATTACHMENTS 24 - 25

### *Tank Car Descriptions*

All of the 19 tank cars in the derailment were manufactured by Trinity Tank Car, Inc. as DOT specification 111-A100W1 tank cars. These cars were intended for transportation of ethanol, products authorized in 49 CFR Part 173 for which there are no special

[15] The lading quantities were determined from Valero bills of lading.
[16] The figures for the amount of recovered ethanol are based on an inventory Mid West Environmental, Inc provided for liquids pumped from each tank car, and hazardous waste manifests and bills of lading for the recovered liquids.

commodity requirements, and non-regulated commodities that are compatible with this class of car. The nominal full water capacity of the cars was 30,145-gallons. The DOT-111 tank cars in this accident were not insulated, had bottom outlet valves and multiple fittings. The dates of manufacture ranged from December 2006 to October 2008.

The DOT-111 tank car has been the predominant general purpose non-pressure tank car since the 1960's, with 225,028 type 111's currently in use, making up about 69-percent of the national tank car fleet.[17] Numerous versions of the DOT-111 have been introduced, with variances in design features such as tank lining, insulation, and materials of construction. DOT-111 specification tank cars are not equipped with head shields or jacketed thermal protection. General specifications applicable to the DOT-111 tank car are found in 49 CFR 179.200.

Title 49 CFR 179.200-17 requires that DOT-111 cars equipped with bottom outlet valves must also be equipped with valve protection, such as recessed valves, breakaway design on structures below the valves, and skid protection structures that are designed to prevent damage to the valve and loss of lading during a derailment. The valve operating mechanisms must also be provided with a suitable locking arrangement to insure positive closure during transit.

There are a number of fittings and appurtenances that can be located on the top of a tank car, such as loading and unloading valves, pressure and vacuum relief devices, and manways. Top fittings can be damaged or sheared off during a derailment, causing lading to be released. Top fittings protection is optional for DOT-111 type tank cars.

The minimum head and shell thickness authorized for DOT-111A100W1 tank cars by 49 CFR 179.201-1 is 7/16-inch (0.4375-inch), and these metals must be of specification AAR TC 128, grade B or ASTM A 516 grade steels.

Tank cars **TILX 193772** (car 64) and **TILX 193767** (car 72) were owned by Trinity Rail and were constructed pursuant to AAR Certificate of Construction no. L066043A, approved on May 11, 2006. The tank heads were constructed of 0.4375-inch thick ASTM A516 grade 70 carbon steel. The tank shells were constructed of 0.4375-inch thick AAR TC-128 grad B steel. These tank cars were each equipped with one pressure relief device, with a start-to-discharge setting of 75-psig.

**NATX 303375** (car 65), **NATX 303504** (car 66), **NATX 302974** (car 67), **NATX 302968** (car 69), **NATX 303067** (car 70), **NATX 303174** (car 71), **NATX 302969** (car 73), **NATX 303125** (car 74), and **NATX 302864** (car 75) were owned by GE Equipment Services and were constructed pursuant to AAR Certificate of Construction no. L066085, approved on December 21, 2006. Both the tank heads and shells were constructed of 0.4375-inch thick AAR TC-128 grade B normalized steel. These tank cars were each equipped with one pressure relief device, with a start-to-discharge setting of 165-psig.

[17] *Universal Machine Language Equipment Register* (UMLER) (Washington, DC: American Association of Railroads, February 2009).

**CITX 224226** (car 57), **CITX 224199** (car 58), **CTCX 731600** (car 59), **CTCX 731601** (car 60), **CTCX 731599** (car 61), **CTCX 730958** (car 62), **CITX 224236** (car 63), and **CTCX 731596** (car 68) were owned by CIT Rail and were constructed pursuant to AAR Certificate of Construction no. L076086, approved on May 4, 2007. The tank heads were constructed of 0.4375-inch thick ASTM A516 grade 70 carbon steel. The tank shells were constructed of 0.4375-inch thick AAR TC-128 grade B steel. These tank cars were each equipped with one pressure relief device, with a start-to-discharge setting of 75-psig. On June 13, 2008, Trinity Tank Car filed an R-1 Report of Tank Repairs, Alteration or Conversion for these tank cars, indicating that the bottom outlet valve was rotated 90 degrees so that the handle operates in the transverse direction rather than in the longitudinal direction. A hole in the valve handle is designed to weaken the handle and cause it to break away in case of longitudinal shearing of the handle during a derailment.

SEE ATTACHMENTS 26 - 28

***Tank Car Damages***

Most, if not all, of the tank cars involved in the derailment were fire damaged as evidenced by scorched or burnt-away paint. Most of the derailed cars in the pileup sustained varying degrees of dents, deformations and breaches, and valve and fitting damage ranging from sheared nozzles to broken handles. See Figures 2 – 5 for examples of these damages. Detailed tank car damage descriptions are included in this section.

FIGURE 2 – TOP FITTING DAMAGE, CAR TILX 193772 [18]

[18] Tank car TILX 193772 photographs taken at staging area. Overview by Trinity Tank Car June 23, 2009; close-up by CN June 22, 2009. Photograph 5.

FIGURE 3 – TANK SHELL BREACH, CAR NATX 303504 [19]

FIGURE 4 – BENT VALVE HANDLE AND OPEN BOTTOM OUTLET, CAR NATX 303504[20]

[19] FRA photograph taken at derailment scene, June 20, 2009. Photograph 6.

FIGURE 5 – TANK HEAD PUNCTURES, NATX303174 (FOREGROUND) AND NATX302969[21]

Between June 21 and June 22, 2009 the Hazardous Materials Group visually inspected 15 of the derailed tank cars (position 59 through 73) that comprised the pileup along about 400-feet of the rail line, centered on the Mulford Road crossing in Cherry Valley, Illinois. The car inspections were conducted after CN staged them on an adjacent vacant parcel located west of Mulford Road between the Union Pacific and CN tracks. While all 15 cars in the pileup were damaged as a result of the derailment and subsequent fire, only two of the tank cars (CTCX 731600 and CTCX 731601) retained their entire lading. Of the remaining 13 cars that released all or part of their contents, 11 cars (CTCX 731599, CTCX 730958, CITX 224236, TILX 193772, NATX 303375, NATX 303504, NATX 302974, CTCX 731596, NATX 302968, NATX 303067, NATX 303174, TILX 193767, and NATX 302969) were breached while two cars (CTCX 731599 and NATX 303067) lost product solely from pressure relief devices and/or other fittings. The derailed tank cars sustained a total of 15 head punctures or tears and four tank shell punctures or tears. Three top valves and three bottom valves were found to be damaged, partially opened or fully opened. Also, the burnt paint on one car suggests that its pressure relief valve activated and released lading. The inspection also revealed one damaged manway cover.

On June 25, 2009 the Hazardous Materials Group inspected the four derailed cars that had been re-railed and moved to sidings east (Car CITX 224226 and CITX 224199) and west (NATX 303125 and NATX 302864) of the derailment. Because of the damage sustained by cars CITX 224199 and NATX 303125, these cars were trans-loaded into other tank cars before being released into transportation.

[20] FRA photograph taken at derailment scene, June 20, 2009. Photograph 7.
[21] FRA photograph taken at derailment scene, June 20, 2009. Photograph 8.

**CITX 224199** (car 58), was the first re-railed car on the east end of the derailment. The car came to rest upright off of its B-end wheel axles. Although the tank sustained no shell damage or leakage, the B-end safety appliances were damaged. The B-end drawbar was bent upward from contact with a separated wheel axle and the left and right bolster bottom cover plates were bent. The car retained its entire lading of 28,767-gallons.

**CTCX 731600** (car 59) was the first derailed car in the pileup at the east side of the derailment. The car came to rest upside down in the stream south of and parallel to the tracks, with the B-end was facing west. The bottom outlet adaptor was sheared-off outward of the skid protection plate and the bottom outlet valve was closed. The bottom left side[22] of the tank sustained a score the length of the tank between the bolsters. The tank was not breached, and the entire lading of 28,800-gallons was retained.

**CTCX 731601** (car 60) was oriented with the B-end facing northeast, angled down from the tracks about 25-degrees towards the A-end. The A-end was within the stream bed south of the tracks and the B-end side was in contact with the rail. The car rested on its left side where it sustained eight dents though its midsection ranging in depth from 2 to 3 5/8-inches. The B-end head sustained a dent near the edge at about 2-o'clock that measured 47 x 29-inches, and was 6-inches deep. The A-end head sustained a 68 x 73-inch dent in the lower center-right, 19.5-inches deep, with two severe gouges centered within the dent. The A-end stub sill was bent upward about 4.5-inches. This car retained its entire lading of 28,800-gallons.

**CTCX 731599** (car 61) was perpendicular to the tracks with the B-end facing south. The car was tilted towards the right and angled down about 10-degrees towards the A-end, which rested in a ditch north of the tracks. The B-end right side of the car sustained a 61 x 44-inch dent, 5-inches deep. The left center of the car received a 47 x 49-inch dent, 3 ½-inches deep. The left half of the protective housing cover was crushed such that a valve lever stem protruded through the cover. One of eight fasteners was sheared from the pressure relief valve. The bottom of the car exhibited seven additional dents ranging in depth from 1 to 8-inches, and two wheel gouges. One 86-inch gouge extended along bottom longitudinal center line of the tank and included a crease in the A-end side of the skid plate. The bottom outlet valve handle was bent, and the outlet adaptor was sheared off at the flange exposing an opened and blued (thermally damaged) bottom outlet valve ball.[23] The right side of the tank exhibited burnt paint above the bottom outlet valve. The A-end also exhibited evidence of fire damaged paint. The B-end stub sill was broken off at the head brace, and the A-end stub sill was bent several inches to the right. About 20,700-gallons of product was lost from this car.

**CTCX 730958** (car 62) was oriented with the B-end facing north, positioned across the tracks on its left side and leaning onto CTCX 731599. The car was angled down about 20-degrees towards the A-end, which came to rest in the stream channel south of the

[22] All orientation observations are indicated from the perspective of facing the B-end of the tank cars.
[23] FRA personnel observed the opened bottom outlet valve. The bottom outlet valve was closed to prevent loss of remaining lading when the tank was removed from the derailment site.

tracks. The left side of the tank shell sustained a 33 x 9-inch puncture within a 33 x 53-inch dent, mid-way between the man-way and the B-end. The B-end left side sustained three additional dents measuring 43 x 36-inches and 2-inches deep; 24 x 41-inches, 4-inches deep; and 14 x 18 ½-inches containing a 9 x 5/8-inch gouge. The center-right side of the tank shell sustained a buckle and crease, measuring 103 x 60-inches, and 18-inches deep. The A-end head received a dent extending from its center to about the 2-o'clock edge, 97 x 48-inches, and 15-inches deep with a crease through the middle of the dent having a tear on the edge measuring about 15 mm deep. The A-end head received two additional dents: at 3 o'clock measuring 17 x 13-inches, 2 ½-inches deep containing two 10 x 1 ½-inch gouges; and at 12 o'clock measuring 11 x 15-inches, 1-inch deep. An area of burned paint extended on left side of the tank shell from the area of the puncture to the B-end head. The B-end stub sill was bent upward several inches, and the coupler was engaged with another coupler and piece of broken stub sill from the B-end of car CTCX 731599. About 25,800-gallons of product was released from this car.

**CITX 224236** (car 63) was laying on its right side on a level plane over the track with the B-end facing south. The valve housing cover was missing and both liquid and vapor valves were sheared from their fittings. The manway cover sustained damage on the left side breaking off a man-way bolt eyelet and about a 45-degree section of the cover flange. The tank shell sustained an irregular dent and diagonal crease on the top of the tank at the B-end, extending from the head to beyond the Ring 5-6 weld seam.[24] The tank also sustained a 16-inch-deep tapered dent running more than half the length of the right side of the car from the B-end beyond the man-way assembly. The A-end head received two dents that measured 67 x 45-inches, 6-inches deep near center, and 32 x 21-inches, 3-inches deep at 10 o'clock. The A-end head also received a 36-inch wheel gouge at 12 o'clock. The painted surface of the entire car exhibited evidence of fire damage. The A-end stub sill was bent upward. About 26,357-gallons of product was released from this car.

**TILX 193772** (car 64) was oriented perpendicular to and centered on the tracks, laying on its left side with its B-end facing south. The A-end was elevated between car CITX 224236 and NATX 303375, and the car angled down about 20-degrees towards the B-end. The right half of the B-end head was deformed approximately 43-inches inward. The B-end also sustained head punctures measuring 8.5 x 2-inches at the 10 o'clock edge and 2.5 x 0.5-inches at the center. The bottom outlet valve handle was bent and the adaptor was sheared off, revealing an open ball valve. The protective housing cover had been pushed to the left, shearing off the vapor valve (**Figure 2**). The B-end stub sill was bent upward at a 90-degree angle. The entire lading of 28,796-gallons was released from this car.

**NATX 303375** (car 65) was situated roughly parallel to the track bed, with the B-end facing northeast. The car was sloped about 10-degrees toward the B-end, which was in contact with the A-end of car TILX 193772. The A-end head was in contact with the A-end of car NATX 303504. The B-end head sustained a 1 5/8 x 3/8-inch puncture in the

[24] The tank shell is constructed of six rings that are welded together. By convention, Ring 1 is located at the A-end, while Ring 6 is located at the B-end.

upper left center and two dents measuring 50 x 24-inches, 8 ½-inches deep in the lower left quadrant, and 42 x 53-inches, 10-inches deep in the lower right quadrant. The upper half of the B-end head was wrinkled with several irregular dents and gouges. The A-end head sustained a centered and rounded dent that was greater than half the circumference of the tank. Both the B-end and the A-end exhibited areas of scorched paint. About 23,238-gallons of product was released from this car.

**NATX 303504** (car 66) was positioned on its right side with its B-end facing southeast resting in the stream channel south of the tracks. The A-end of this car extended to the east edge of Mulford Road at the grade crossing, where it rested between the A-ends of cars NATX 303375 and NATX 302974. The B-end head sustained a 101 x 56-inch horizontal dent, 18-inches deep. The B-end stub sill was bent downward at a 90-degree angle.

The B-end of the tank was breached adjacent to the bolster pad such that a large section of the shell, including the draft sill, head brace, and head brace pad folded back along a line in the shell at the inboard end of the draft sill to an approximate 90-degree angle (**Figure 3**). The front sill pad was designed with a window located under the head brace to facilitate welding of the outer fillet welds to provide additional attachment. The front sill pad peeled back from the head. The draft sill to the head brace weld and the head brace to the sill pad weld were both intact. See Attachment 32 for additional description of the B-end tank shell fracture surfaces and other damages.

A 5 x 3-inch puncture occurred in the bottom longitudinal center line of the tank near the 5-6 ring seam. The A-end stub sill was bent more than 90-degrees upward into the tank head, where the head was dented with two punctures measuring about 11 x 25-inches near center and 2 ½ x 2 ¼-inches at about the 7 o'clock edge. The top of the tank shell was dented and creased down the centerline between the manway and A-end. The right side of the tank also sustained a longitudinal dent nearly the entire length of the car. The bottom outlet adaptor was sheared-off at the flange, revealing a partially opened ball valve (**Figure 4**). The bottom outlet valve handle was in contact with the ground, bent and pulled away from its mounting bracket. Scorched paint was evident across the bottom and left side of the car. All 28,796-gallons of product contained in this car were released.

**NATX 302974** (car 67) was situated on its left side across the east shoulder of Mulford Road with its B-end facing south. A white passenger van that was destroyed in the fire was stationed about 18-inches from the tank car, parallel to the B-end top half of the tank. The manway cover was the closest tank appurtenance to the passenger van. Five of the six manway cover bolts were wrench-tight; the sixth bolt was loose. The manway gasket was not damaged. The top liquid and vapor valves were closed. Although they were covered with soot, the top valves and vacuum relief, and pressure relief devices had no visible damage.

The A-end of the car was buckled and creased at about the 1-2 ring seam where it was in contact with the A-end of car NATX 303504, resulting in the A-end head pointing about

45-degrees downward from the tank longitudinal axis. A fracture ran approximately 6-inches along the top of the folded tank shell. Right of the stub sill, the bottom of the A-end tank head received a 4 x 12-inch puncture across the head-shell weld seam and within a dent measuring about 18 x 22-inches. The B-end head was punctured and torn from an 8-inch wide impact mark at its center toward the top of the tank, terminating with three folds of metal and leaving a breach in the head that measured about 25 x 44-inches. A 32-inch long crack extended from the folded metal to the knuckle radius at about 12 o'clock. A second 6-inch long tear was located next to a 4 ½-inch wide impact mark in the lower center of the head within a circular dent that measured 42-inches wide and about 13-inches deep. Paint was scorched on the tank bottom, both heads, and the top of the B-end. The B-end stub sill partially broke away downward from its mounting pad, while the A-end stub sill had broken away at the head brace. The B-end draft gear and coupler had broken away and was laying on the edge of the culvert mid-way between this car and NATX 303504. About 28,776-gallons of product was released from this car.

**CTCX 731596** (car 68) was leaning to the right across the Mulford Road crossing with its B-end facing southwest and angled down about 10-degrees towards the A-end. The B-end head sustained an impact dent with a crease measuring about 102 x 49-inches and about 16-inches deep. At the edge of the crease was an 11 x 2-inch split in the head weld seam at about 9 o'clock. The A-end head sustained a dent, about 96 x 78-inches, 25-inches deep where it contacted car NATX 302974. The A-end head also received a 2 ¼ x ⅞ -inch puncture within a shallow 13 x 7-inch dent, near the edge at about 5 o'clock. Paint was scorched on the left side of the tank. The B-end stub sill was bent down and toward the left, and the neck of the coupler had sheared from the draft assembly. The A-end draft assembly was broken away at the head brace. About 27,000 gallons of product was released from the car.

**NATX 302968** (car 69) was oriented with the B-end facing south along the west edge of Mulford Road, perpendicular to the rail line. The B-end head was dented with a crease across its diameter from about the 2 o'clock to the 7 o'clock edges. The left half of the B-end head, along with a portion of the left shell sustained an angular tear that pedaled outward, with the edges of the flared shell portions folded inward. This tear followed approximately 100-inches of the circumferential head to shell weld. The A-end head sustained an upper right quadrant dent measuring 43 x 27-inches, 4-inches deep. Paint was scorched over the entire car surface. The total lading of 28,786-gallons was released from this car.

**NATX 303067** (car 70) came to rest west of Mulford Road roughly perpendicular across the rail line leaning to the right with its B-end facing northeast. The tank shell and heads received little damage. The top of the car sustained paint scorching centered at the manway, valve housing, and pressure relief device. The B-end stub sill was bent about 45-degrees to the left. Approximately 11,051-gallons of product were released from the car.

**NATX 303174** (car 71) was situated perpendicular and across the rail line with its B-end facing northeast. The car was tilted toward the right and sloped down about 10-degrees

toward the A-end. The A-end head sustained a dent on the left side measuring about 56 x 35-inches, 10-inches deep. Within the dent were two scores leading to a puncture on the middle right side of the head, measuring about 24 ½ x 8-inches (**Figure 5**). The length of the left side of the car exhibited paint scorching and was dented where it contacted the A-end of car NATX 303067. The bottom outlet adaptor had been sheared off at the flange, revealing a closed ball valve. The bottom outlet valve handle was also missing. The coupler was missing from the B-end draft assembly. About 25,667-gallons of product was released from this car.

**TILX 193767** (car 72) was oriented with its B-end on the track facing southwest. The car was tilted left and sloped down about 10-degrees toward the A-end. The A-end head sustained a gouge leading to a 2 x ½-inch puncture at the 9 o'clock edge, and a rectangular 6 x 2¾-inch puncture at about the 8 o'clock edge. The car sustained a 153 x 64-inch, 12-inch deep dent on the right side where it contacted car NATX 303174. Paint was scorched on the top half of the car between the A-end head and the manway. The B-end stub sill was bent downward and was cracked outboard of the head brace. The stub sill crack continued along the vertical faces of the stub sill, with the right side crack following the flange 6-inches towards the A-end. About 20,267-gallons of product was released from the car.

**NATX 302969** (car 73) was perpendicular to and centered on the rail line, leaning to the left with its B-end facing north. The A-end head sustained a puncture at about the 4 o'clock edge that measured 25 x 13-inches. The left side of the car received a dent measuring 43 x 14-inches, 2-inches deep, where it contacted the B-end of car TILX 193767. The bottom outlet valve adaptor and valve handle had been sheared off, exposing a closed bottom outlet ball valve. No fire damage was observed on the tank shell. The entire lading of 28,729-gallons was released in the accident.

**NATX 303125** (car 74) was the first re-railed car on the west side of the derailment. The B-end of car NATX 303125 remained attached to the west train segment, while the A-end had pulled off of the rail and was facing in a northeast direction. The A-end head sustained a gouge at about the 7 o'clock to 8 o'clock position that measured 23-inches long, ¼ to 1 ¼ -inches wide, and 0.47-inches deep. Additionally, the bottom outlet valve lever was bent. The car retained its entire lading of about 28,767-gallons.

SEE ATTACHMENTS 27, AND 29 – 31; PHOTOGRAPHS 5 – 24

***Tank Car Specimens***

The Hazardous Materials Group selected six cars from which parts and/or coupons were retained for further analysis (**Table 2)**. Each of the four tank ends retained were B-ends, cut beyond the 5-6 ring weld seams. The manway, valve and PRD assembly of car NATX 302974 that was located in close proximity to the destroyed passenger van was also sectioned and preserved. On June 26, 2009, CN transported the retained tank car parts to its Woodcrest Shops in Homewood, Illinois for storage. The tank shell coupons

were cut on June 24 and June 25, 2009 and CN shipped them to the NTSB Materials Laboratory in Washington, D.C. for metallurgical analysis.

| Car Number | Parts Retained | Shell Coupon Location |
|---|---|---|
| CTCX 730958 | | Ring 1, 12:00 |
| NATX 303504 | B end | |
| NATX 302974 | B end, and Manway/Valve/ PRD assembly | Ring 3, 12:00 |
| NATX 302968 | B end | |
| NATX 303174 | | Ring 1, 12:00 |
| TILX 193767 | B end | Ring 6, 12:00 |

TABLE 2 – RETAINED TANK CAR PARTS

A Materials Testing Group was subsequently formed with the objective of determining whether the retained samples met ASTM and AAR specifications. On January 6, 2010, the Hazardous Materials and Materials Testing Groups jointly inspected the retained tank car parts and collected additional metallurgical specimens (see Materials Group factual report for further details). Additional measurements and features noted during this inspection are summarized in Attachment 32.

SEE ATTACHMENT 32

## H. Pipeline Construction Information

Nicor Gas is one of the nation's largest gas distribution companies and maintains a network of about 34,000 miles of natural gas mains and service pipelines that deliver natural gas to more than 2-million customers in a service territory that encompasses the northern third of Illinois, excluding Chicago.

### *Pre-existing and Replacement Pipeline*

The pre-existing natural gas distribution pipeline that was damaged in this accident was constructed in 1965. The damaged segment of pipeline ran parallel to South Mulford Road about 1.5-miles between Harrison Avenue to the north and Linden Road to the south. It consisted of a welded 12-inch diameter pipeline installed into a 16-inch steel pipeline. Both pipes had a nominal wall thickness of 0.375 inches and were constructed per ASTM A-53 Grade B, 35,000 SMYS.[25] The pipe would have a minimum tensile strength of 60,000 psi and a typical elongation of 22-percent. At the time of the accident, the pipeline was operating at a pressure of 288 psig. A section of pipeline was encased inside of a 16-inch diameter 0.375-inch wall thickness steel pipe, API 5L Grade B, 35,000 SMYS. The casing was approximately 50-feet long with 2-inch diameter vents on

[25] SMYS stands for the specified minimum yield strength in pounds-per-square inch, which is used in determining allowable pipeline operating pressures.

each side of the casing. The depth of burial was approximately 11-feet at the site of the derailment. Nicor told Safety Board investigators that it submitted design calculations to the railroad before their approval was obtained, however the details of these calculations have been lost.

The pipe used to replace the damaged section of pipeline is welded 12-inch diameter steel pipe with 0.250-inch wall thickness, API 5L Grade X-42, 42,000 SMYS. In agreement with CN, Nicor installed approximately 700-feet of replacement pipe parallel to the west side of Mulford Road, about 350-feet north and 350-feet south of the CN Railroad crossing, adjacent to the existing main that was retired in place. The replacement pipeline was installed by directional boring at a depth of 22-feet below the centerline of the tracks.

Yellow fiberglass pipeline markers indicting the presence of a natural gas line along with owner name and emergency contact number were installed prior to the derailment on the north and south side of the tracks. The nearest pipeline marker on the south side of the grade crossing was mounted against a utility pole about 50-feet south of the tracks and was destroyed in the post accident fire. A second legible pipeline marker was situated about 250-feet south of the tracks along Mulford Road within a tuft of vegetation. The nearest pipeline marker on the north side of the derailment was located about 525-feet from the grade crossing on the west side of Mulford Road and was not damaged in the accident.

SEE ATTACHMENTS 15, AND 33

***Pipeline Construction Standards***

The applicable industry standard in 1965 was ASME B31.8 Gas Transmission and Distribution Piping Systems.[26] ASME B31.8 standard 841.14, Cover, Clearance, and Casing Requirements for Buried Steel Pipelines and Mains states that buried mains shall be installed with cover of not less than 24-inches. The standard requires 36-inches of cover in normal soil for transmission pipeline railroad crossings and 24-inches of cover in rock excavation. The standard notes that additional protection shall be provided in areas subject to erosion, or in locations where future grading is likely such as at road and railway crossings. The standard provides pipeline design factors that allow for increased pipeline operating pressure for pipeline crossings installed with casing.

The current applicable state construction standard is contained in Title 83, Part 590 of the Illinois Administrative Code, in which as of January 1, 2009 the Illinois Commerce Commission adopted the standards contained in 49 CFR Parts 191.23, 192, 193 and 199 as its minimum safety standards for the transportation of gas and for gas pipeline facilities.

[26] The American Society of Mechanical Engineers ASME B31.8 code is an American national standard of engineering requirements deemed necessary for safe design and construction of pressure piping.

The current applicable Federal construction standard for railroad pipeline crossings is contained in 49 CFR 192.327, which requires cover of 36-inches in normal soil for transmission pipeline crossings. The regulation requires a minimum of 24-inches of cover distribution pipelines. An exception to the minimum cover standard is authorized in situations where an underground structure prevents installation at the required depth, in which case additional protection, such as casing, must be provided to withstand the anticipated external loads. The regulation also provides that a distribution pipeline may be installed with less than 24-inches of cover if the State or municipal law establishes a minimum cover of less than 24-inches, requires that gas mains be installed in a common trench with other utility lines, or provides adequately for the prevention of damage to the pipe by external forces.

When designing and installing pipelines across railroad tracks, Nicor conforms to railroad owner specifications, which typically have incorporated American Railway Engineering and Maintenance of Way Association (AREMA) specifications as a standard. Prior to 1993, the American Railway Engineering Association[27] Manual for Railway Engineering recommended that pipelines carrying flammable gas and liquids under railroad track be encased in a larger steel pipe. The use of casing addressed concerns about train loads crushing pipelines installed beneath the rail beds. The depth of the cased pipe would be determined using design methods developed by Professors Marston and Spangler of Iowa State University.[28] The pipeline industry has experienced several problems associated with the use of casing, including; ground settlement causing the carrier pipe and casing to move differentially and shorting the cathodic protection system; moisture condensation within the interstitial space that promotes corrosion; and shielding of the carrier pipe from cathodic protection. In 1985, the Gas Research Institute solicited Cornell University to study alternatives to casing pipes. The American Petroleum Institute participated in the study and concluded that the perceived added factor of safety provided by casing pipe does not outweigh the negative effects that a casing has on the overall reliability of the carrier pipe. The design criteria that Cornell developed resulted in new standards that were incorporated into the 1993 AREMA manual to reflect the use of uncased pipelines under railroads as an acceptable alternative, provided that wall thickness and burial depth met conservative minimum standards.

The CN Railroad has adopted these specifications for pipelines under railroad tracks or across or along railroad right-of-way, which specify that pipelines carrying flammable products under pressure must be buried a minimum of 5-feet 6-inches beneath main tracks.[29] The standard further requires that pipelines carrying flammable products located within 25-feet of the centerline of any track, or where there is a danger of damage from leakage to any bridge, building or other important structure, must be encased, or of special design approved by the railway chief engineer. The standard allows the use of

[27] The American Railway Engineering Association is the predecessor of AREMA.
[28] The Marston-Spangler theory of pressure on buried conduit resulted from research starting in 1906 and extending into the 1940's, and is the basis for most current buried pipe design.
[29] CN pipeline crossing specifications state that if laws or orders of public authority prescribe a higher degree of protection than specified by the American Railway Association Specifications, then CN will adhere to the specified higher degree of protection.

uncased natural gas pipe if the pipe is constructed of steel and installed a minimum of 10-feet below the rail ties.

SEE ATTACHMENTS 33 – 34, AND 37

***History of Pipeline Accidents at Railroad Crossings***

The Pipeline and Hazardous Materials Safety Administration (PHMSA) conducted a search of its pipeline incident records since 1984 and found that for gas transmission and gathering systems, train derailments accounted for 2 of 121 total incidents at railroad crossings. During the same time period, train derailments accounted for 3 of 342 incidents involving hazardous liquid pipelines at railroad crossings.

SEE ATTACHMENT 38

## I. Previous NTSB Investigations

Among its numerous investigations of accidents involving the DOT-111 tank car, the Safety Board conducted a 1991 safety study in which it examined the performance of 84 DOT-111 tank cars in accidents that occurred between March 1988 and February 1989.[30] The study found that 54-percent of the DOT-111 cars involved in these accidents released products, with head and shell punctures accounting for 22-percent of the releases. The study found that the rate at which the DOT-111 tank cars experienced head or shell puncture or failure was double that of the DOT-105, -112, and -114 pressure tank cars. The Safety Board concluded that the DOT-111 tank cars, which are frequently used to transport hazardous materials that pose a potential threat to public safety, have a high incidence of failure when involved in an accident. NTSB issued safety recommendations to RSPA, FRA, the Association of American Railroads (AAR), the Chemical Manufacturers Association (CMA), the American Petroleum Institute (API), and the National Fire Protection Association (NFPA) that included a recommendation that these organizations work together to improve the packaging of the more dangerous products (such as those that are highly flammable or toxic, or pose a threat to health through contamination of the environment) by developing a list of hazardous materials that should be transported only in pressure tank cars with head shield protection and thermal protection (if needed), and to establish a working agreement to ship the listed hazardous materials in such tank cars. The safety recommendations issued to RSPA and FRA are classified as Closed – No Longer Applicable as a result of rulemaking activities that required the use of better protected tank cars for transporting certain classes of hazardous materials, such as those designated as poisonous by inhalation.[31] The CMA reported that

[30] *Transport of Hazardous Materials by Rail*, Safety Study NTSB/SS-91-01 (Washington, DC: National Transportation Safety Board, 1991).

[31] RSPA, in cooperation with the FRA published regulations under dockets HM-175A and HM-201 in September 1995 that require stronger and better-protected tank cars for certain classes of hazardous materials. Under these regulations, a wider variety of hazardous materials (non-flammable compressed gases, thermally reactive material, ethylene oxide and materials designated as poisonous by inhalation) must be transported in pressure tank cars that have head and shield protection and thermal protection as applicable and enhanced puncture protection for tank cars used to transport halogenated organic compounds that pose environmental hazards.

some of its members had made voluntary equipment modifications and implemented operating practices to enhance the performance of their DOT-111 tank cars, such as increased head and shell thickness, head shields, elimination of bottom outlets where feasible, and removal of unused fittings and valves.

Most recently, the Safety Board investigated an October 20, 2006 accident in New Brighton, Pennsylvania in which a Norfolk Southern Railway denatured ethanol unit train derailed 23 tank cars.[32] Twenty of the twenty-three derailed specification DOT-111A100W1 cars lost an estimated 485,278-gallons of denatured ethanol following the derailment and subsequent fire. In that accident, twelve tank cars lost full loads, eight tank cars lost partial loads and three cars were not breached. Eight of the twelve cars that received extensive shell damage fell from an elevated bridge following the derailment and lost their entire contents.

## J. Accuracy of CN Train Consist Information

Title 49 CFR 174.26, Notice to Train Crews, requires that a train crew must have a train consist that reflects the current position in the train of each rail car containing a hazardous material. The train consist must be maintained onboard the occupied locomotive of every train. The train crew must update the train consist to indicate changes in the placement of a rail car within the train. When changes to the train consist occur en route as a result of pickups or set outs, the regulation states that a train crew must update the train consist by handwriting on it or by appending or attaching another document.

In the investigation of the July 10, 2005 collision of two CN freight trains in Anding, Mississippi,[33] the Safety Board noted that the original consist of one of the trains was destroyed and the consist CN subsequently delivered did not accurately reflect the actual makeup of the train because it did not indicate the cars the crew had set out and picked up prior to the accident. The Safety Board concluded that because CN did not have the capability to provide an accurate consist for the train after the on-board document was destroyed, emergency responders were unable to promptly identify all of the hazardous materials and their locations on the train. The Safety Board also concluded that to ensure the safety of emergency responders and the public, railroads must have the ability to quickly provide emergency responders complete information about the specific hazardous materials being transported on a train and their location within it, regardless of the availability of the on-board consist. The Safety Board issued Safety Recommendation R-07-02 to the FRA recommending that it should assist PHMSA in developing regulations to require that railroads immediately provide to emergency responders accurate, real-time information regarding the identity and location of all hazardous materials on a train. On October 25, 2007, the FRA responded that although

[32] *Derailment of Norfolk Southern Railway Company Train 68QB119 with release of Hazardous Materials and Fire, New Brighton, Pennsylvania October 20, 2006*, Accident Report NTSB/RAR-08/02 (Washington DC: National Transportation Safety Board, 2008).
[33] *Collision of Two CN Freight Trains Anding, Mississippi July 10, 2005*, Accident report NTSB/RAR-07/01 (Washington DC: National Transportation Safety Board, 2007).

the development of a national system that could electronically track tank car shipments of hazardous materials is being considered, the current practice of requiring hand-off of train consists remains the most accurate method of providing hazardous materials information to emergency responders when an event occurs. On July 31, 2009, as a result of FRA's position that federal regulations are not needed to implement this recommendation, the Safety Board reclassified it as: Open - Unacceptable Response.

In its 2006 National Hazardous Materials Audit, the FRA focused on the level of Class I railroad compliance with the requirements for train placement of hazardous materials shipments and accurate hazard communications information on train consists in the train crews' possession.[34] The audit findings indicated that the rail carriers had an overall 13.2 percent defect ratio for train car placement and 6.6 percent defect ratio for hazard communications. FRA determined that 22.3 percent of the 76 CN trains that it audited had improper hazardous materials car documentation, consist errors, train crews failing to update the train consist to reflect actual car placement, or trains dispatched with erroneous consist information. FRA noted that significant change was required of the Class 1 railroads in order to stem the level of noncompliance and ensure adequate levels of protection for train crews, emergency responders, and the general public. FRA recommended that the AAR facilitate a best practices review of the Class I railroad industry to assist members in improving train consist accuracy. FRA also recommended that the Class I railroads take immediate actions to raise the compliance levels within the railroad system.

As a result of the discrepancy in the accident train consist; FRA issued a July 28, 2009 inspection report directing CN to develop a transportation action plan to identify operational procedures and requirements of CN trains transporting rail cars containing hazardous materials. FRA indicated that the action plan should address efficiency testing of train crews for hazardous materials consist compliance, and announced that it would monitor CN's efficiency tests by conducting its own unannounced train consist inspections to determine compliance with 49 CFR 174.26.

On August 10, 2009, CN responded to FRA's directive by establishing a "Hazardous Materials Action Plan" for its Iowa Subdivision. This plan specifies that cars carrying hazardous materials must not be handled unless a crew member has all of the proper documents showing the current position of all hazardous material shipments in the train. The plan requires that when picking-up or setting-out cars, the documents are to be updated before the train departs the location. The plan states that CN will perform efficiency test on a 24/7 operation and directs every transportation officer in CN's Iowa Zone to perform a minimum of 5 hazardous materials placement tests per month on trains or locals that pick-up or set-out en route, and 3 hazardous materials placement tests per month on trains leaving the initial terminals. The plan specifies follow-up testing for employees that have failed within 10-days of a violation.

[34] *2006 National Hazardous Materials Audit*, (Washington DC: U.S. Department of Transportation, Federal Railroad Administration, 2007).

On October 8, 2009, FRA reported that CN found no defects during 16 efficiency tests that it conducted of train crews transporting hazardous materials. These efficiency tests included train consist documentation after setting-out and picking-up rail cars en route.

SEE ATTACHMENT 36

## K. Post Accident Actions

### *AAR Tank Car Committee Task Force Activity*

On July 22, 2009, in response to this accident and others involving the DOT-111, the American Association of Railroads (AAR) Tank Car Committee formed a task force and opened docket T87.5 to consider head and shell protection for non-pressure tank cars transporting Packing Groups I and II. The task force mission statement is to review the performance of DOT-111 tank cars transporting hazardous materials in Packing Groups 1 and II, investigate possible changes in design, use of existing types of protective systems, or changes in operations related to performance, and determine the benefits of making changes to new cars, existing cars, or operations. The AAR director of tank car safety reported that the task force is considering enhancements for general service tank cars, such as head shields, side shields or energy absorbing tank jackets, thermal protection, and eliminating the use of bottom outlet valves. Another task force docket, T94.27, is concerned with top fittings protection for general service tank cars. At its October 14, 2009 meeting, the effective date for inclusion of top fittings protection was proposed to be for cars ordered after April 1, 2010.

SEE ATTACHMENT 35

### *DOT Hazard Communications Initiative*

On October 13-14, 2009, PHMSA hosted a public meeting to solicit input for an upcoming proof-of-concept study on the use of electronic data sharing in lieu of paper hazardous materials shipping papers.[35] The initiative is titled HM-ACCESS (hazardous materials – automated cargo communications for efficient and safe shipments). The goal of HM-ACCESS is to define regulations and guidelines to allow the electronic communication of shipping paper information, and to evaluate the feasibility and potential benefits of allowing the use of electronic shipping papers. The proposed benefits of this program include improving the availability and accuracy of hazard and response information for shipments and packages which are tracked electronically and improving the speed by which information is available to emergency responders when accidents occur. PHMSA notes that rail transport organizations are prepared to begin utilizing electronic shipping paper technology, subject only to regulatory authorization.

[35] Notice of Public Meeting, Hazardous Materials - Automated Cargo Communication for Efficient and Safe Shipments, *Federal Register*, vol. 74, no. 172 (September 8, 2009), p. 46292. U. S. Department of Transportation, Pipeline and Hazardous Materials Safety Administration.

***Nicor Gas Emergency Responder Communications***

Nicor maintains two 24-hour response and dispatch centers as well as schedules for on-call personnel throughout the service territory to respond to events that occur after normal business hours. When initial information reported to the dispatch centers indicates that pipeline equipment may be damaged, Nicor dispatches the appropriate field personnel to the location to determine the extent of the damage and take such actions as necessary in accordance with its operating practices.

Since this accident, Nicor has made improvements to communication and notification protocol to ensure that dispatch personnel review pipeline maps and corroborate their findings concerning the location of pipelines with the field duty supervisor to avoid providing erroneous information to emergency response agencies.

SEE ATTACHMENT 14

*Paul L. Stancil*
*Hazardous Materials Accident Investigator*

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