*Federal Railroad Administration*
*Office of Railroad Safety*
*Accident and Analysis Branch*

# *Accident Investigation Report*
# *HQ-2015-1024*

*BNSF Railway Company (BNSF)*
*Galena, IL*
*March 5, 2015*

***Note that 49 U.S.C. §20903 provides that no part of an accident or incident report, including this one, made by the Secretary of Transportation/Federal Railroad Administration under 49 U.S.C. §20902 may be used in a civil action for damages resulting from a matter mentioned in the report.***

U.S. Department of Transportation
Federal Railroad Administration

# FRA FACTUAL RAILROAD ACCIDENT REPORT

FRA File #HQ-2015-1024

## TRAIN SUMMARY

| 1. Name of Railroad Operating Train #1 | 1a. Alphabetic Code | 1b. Railroad Accident/Incident No. |
|---|---|---|
| BNSF Railway Company | BNSF | CH-0315-100 |

## GENERAL INFORMATION

| 1. Name of Railroad or Other Entity Responsible for Track Maintenance | 1a. Alphabetic Code | 1b. Railroad Accident/Incident No. |
|---|---|---|
| BNSF Railway Company | BNSF | CH-0315-100 |
| 2. U.S. DOT Grade Crossing Identification Number | 3. Date of Accident/Incident | 4. Time of Accident/Incident |
| | 3/5/2015 | 1:15 PM |

5. Type of Accident/Incident
Derailment

| 6. Cars Carrying HAZMAT | 7. HAZMAT Cars Damaged/Derailed | 8. Cars Releasing HAZMAT | 9. People Evacuated | 10. Subdivision |
|---|---|---|---|---|
| 103 | 21 | 13 | 9 | Aurora |

| 11. Nearest City/Town | 12. Milepost *(to nearest tenth)* | 13. State Abbr. | 14. County |
|---|---|---|---|
| Galena | 171.6 | IL | JO DAVIESS |

| 15. Temperature (F) | 16. Visibility | 17. Weather | 18. Type of Track |
|---|---|---|---|
| 25 °F | Day | Clear | Main |

| 19. Track Name/Number | 20. FRA Track Class | 21. Annual Track Density *(gross tons in millions)* | 22. Time Table Direction |
|---|---|---|---|
| Single Main Track | Freight Trains-40, Passenger Trains-60 | 117.8 | East |

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## OPERATING TRAIN #1

| 1. Type of Equipment Consist: | 2. Was Equipment Attended? | 3. Train Number/Symbol |
|---|---|---|
| Freight Train | Yes | U-ELUCXP-0-25 |

| 4. Speed (recorded speed, if available) R - Recorded E - Estimated | Code | 5. Trailing Tons (gross exluding power units) | 6a. Remotely Controlled Locomotive? 0 = Not a remotely controlled operation 1 = Remote control portable transmitter 2 = Remote control tower operation 3 = Remote control portable transmitter - more than one remote control transmitter | Code |
|---|---|---|---|---|
| 23 MPH | R | 14655 | | 0 |

6. Type of Territory

Signalization:

Signaled

Method of Operation/Authority for Movement:

Direct Train Control

Supplemental/Adjunct Codes:

Q

| 7. Principal Car/Unit | a. Initial and Number | b. Position in Train | c. Loaded (yes/no) | 8. If railroad employee(s) tested for drug/alcohol use, enter the number that were positive in the appropriate box. | Alcohol | Drugs |
|---|---|---|---|---|---|---|
| (1) First Involved *(derailed, struck, etc.)* | TILX 352174 | 9 | yes | | 0 | 0 |
| (2) Causing *(if mechanical, cause reported)* | TILX 352174 | 9 | yes | 9. Was this consist transporting passengers? | | No |

| 10. Locomotive Units (Exclude EMU, DMU, and Cab Car Locomotives.) | a. Head End | Mid Train b. Manual | Mid Train c. Remote | Rear End d. Manual | Rear End e. Remote | 11. Cars (Include EMU, DMU, and Cab Car Locomotives.) | Loaded a. Freight | Loaded b. Pass. | Empty c. Freight | Empty d. Pass. | e. Caboose |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) Total in Train | 2 | 0 | 0 | 0 | 1 | (1) Total in Equipment Consist | 105 | 0 | 0 | 0 | 0 |
| (2) Total Derailed | 0 | 0 | 0 | 0 | 0 | (2) Total Derailed | 21 | 0 | 0 | 0 | 0 |

| 12. Equipment Damage This Consist | 13. Track, Signal, Way & Structure Damage |
|---|---|
| 1963369 | 1626334 |

14. Primary Cause Code

E61C - Broken rim

15. Contributing Cause Code

E61C - Broken rim

Number of Crew Members

| 16. Engineers/Operators | 17. Firemen | 18. Conductors | 19. Brakemen |
|---|---|---|---|
| 1 | 0 | 1 | 0 |

Length of Time on Duty

| 20. Engineer/Operator | 21. Conductor |
|---|---|
| Hrs: 6 Mins: 56 | Hrs: 6 Mins: 56 |

| Casualties to: | 22. Railroad Employees | 23. Train Passengers | 24. Others |
|---|---|---|---|
| Fatal | 0 | 0 | 0 |
| Nonfatal | 0 | 0 | 0 |

| 25. EOT Device? | 26. Was EOT Device Properly Armed? | 27. Caboose Occupied by Crew? |
|---|---|---|
| Yes | Yes | N/A |

| 28. Latitude | 29. Longitude |
|---|---|
| 42.374843000 | -90.444164000 |

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## CROSSING INFORMATION

| Highway User Involved | | Rail Equipment Involved |
|---|---|---|
| 1. Type | | 5. Equipment |
| 2. Vehicle Speed *(est. mph at impact)* | 3. Direction *(geographical)* | 6. Position of Car Unit in Train |
| 4. Position of Involved Highway User | | 7. Circumstance |
| 8a. Was the highway user and/or rail equipment involved in the impact transporting hazardous materials? | | 8b. Was there a hazardous materials release by |
| 8c. State here the name and quantity of the hazardous material released, if any. | | |

| 9. Type of Crossing Warning | 10. Signaled Crossing Warning | 11. Roadway Conditions |
|---|---|---|
| 1. Gates 4. Wig wags 7. Crossbucks 10. Flagged by crew<br>2. Cantilever FLS 5. Hwy. traffic signals 8. Stop signs 11. Other *(spec. in narr.)*<br>3. Standard FLS 6. Audible 9. Watchman 12. None | | |

| 12. Location of Warning | 13. Crossing Warning Interconnected with Highway Signals | 14. Crossing Illuminated by Street Lights or Special Lights |
|---|---|---|
| | | |

| 15. Highway User's Age | 16. Highway User's Gender | 17. Highway User Went Behind or in Front of Train and Struck or was Struck by Second Train | 18. Highway User |
|---|---|---|---|
| | | | |

| 19. Driver Passed Standing Highway Vehicle | 20. View of Track Obscured by *(primary obstruction)* |
|---|---|
| | |

| Casualties to: | Killed | Injured | 21. Driver was | 22. Was Driver in the Vehicle? |
|---|---|---|---|---|
| 23. Highway-Rail Crossing Users | | | 24. Highway Vehicle Property Damage *(est. dollar damage)* | 25. Total Number of Vehicle Occupants *(including driver)* |

| 26. Locomotive Auxiliary Lights? | 27. Locomotive Auxiliary Lights Operational? |
|---|---|
| | |

| 28. Locomotive Headlight Illuminated? | 29. Locomotive Audible Warning Sounded? |
|---|---|
| | |

10. Signaled Crossing Warning

1 - Provided minimum 20-second warning
2 - Alleged warning time greater than 60 seconds
3 - Alleged warning time less than 20 seconds
4 - Alleged no warning
5 - Confirmed warning time greater than 60 seconds
6 - Confirmed warning time less than 20 seconds
7 - Confirmed no warning
N/A - N/A

Explanation Code

A - Insulated rail vehicle
B - Storm/lightning damage
C - Vandalism
D - No power/batteries dead
E - Devices down for repair
F - Devices out of service
G - Warning time greater than 60 seconds attributed to accident-involved train stopping short of the crossing, but within track circuit limits, while warning devices remain continuously active with no other in-motion train present
H - Warning time greater than 60 seconds attributed to track circuit failure (e.g., insulated rail joint or rail bonding failure, track or ballast fouled)
J - Warning time greater than 60 seconds attributed to other train/equipment within track circuit limits
K - Warning time less than 20 seconds attributed to signals timing out before train's arrival at the crossing/ island circuit
L - Warning time less than 20 seconds attributed to train operating counter to track circuit design direction
M - Warning time less than 20 seconds attributed to train speed in excess of track circuit's design speed
N - Warning time less than 20 seconds attributed to signal system's failure to detect train approach
O - Warning time less than 20 seconds attributed to violation of special train operating instructions
P - No warning attributed to signal systems failure to detect the train
R - Other cause(s). Explain in Narrative Description

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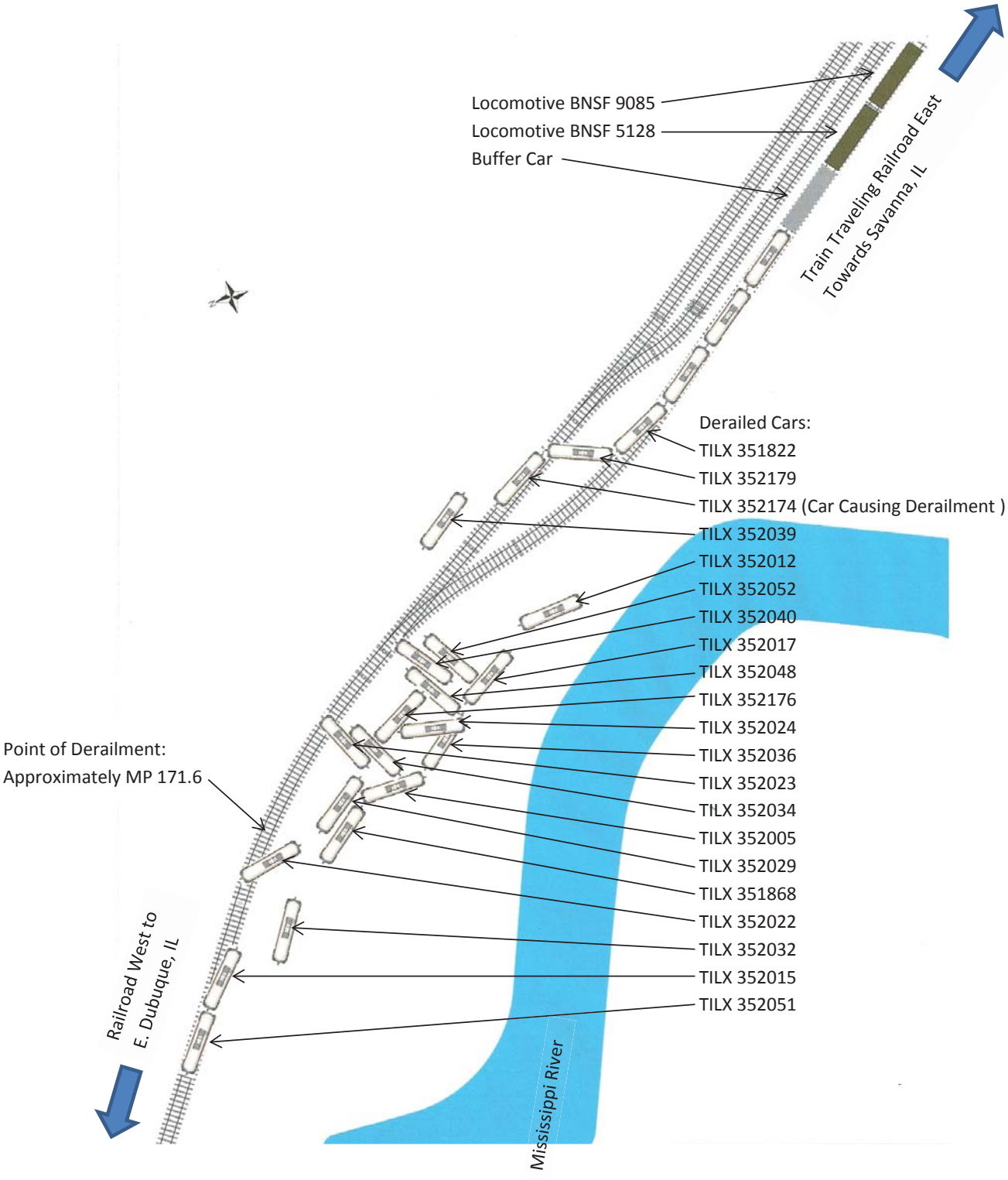
|---|---|---|

## SKETCHES

Derailment sketch Showing Car Numbers

HQ -2015-1024: BNSF Derailment near Galena, IL on May 5, 2015




*NOT TO SCALE

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## SYNOPSIS

On March 5, 2015, at 1:15 p.m., CST, eastbound Burlington Northern Santa Fe (BNSF) Train Number U-ELUCXP0-25T, derailed 21 tank cars containing hazardous materials (Bakken Crude Oil) near Galena, IL, at Milepost 171.6 on the BNSF Aurora Subdivision.

There were no injuries; however, there was a release of approximately 125,217 gallons of Bakken crude oil and a voluntary evacuation of nine local residents. Thirteen hazardous material tank cars lost product. Ten of the derailed hazardous materials tank cars were breached, allowing product to leak and burn.

The estimated total monetary damage was $1,963,369 to equipment and $1,626,334 to track and signal.

At the time of the accident, the weather was reported as sunny and clear. The temperature was 25 degrees Fahrenheit. The Timetable directions are east and west on BNSF's Aurora Subdivision. Timetable direction is used throughout this report

The probable cause of the derailment was the broken wheel tread/flange of the L1 wheel of tank car TILX 352174 allowing the wheel to fall inside the gage of the rail.

## NARRATIVE

Circumstances Prior to the Accident

The crew of BNSF Train U-ELUCXP0-25T consisted of a locomotive engineer and a conductor. They reported for duty at 6:30 a.m., CDT, on March 5, 2015, at BNSF's Yard Office in La Crosse, Wisconsin. The crew members received more than the statutory off-duty period prior to reporting for duty. The Engineer had been off duty for 14 hours prior to the assignment and the Conductor had been off for 29 hours and 42 minutes. The Timetable directions are east and west on BNSF's Aurora Subdivision. Timetable direction is used throughout this report.

Train U-ELUCXP0-25T was a unit Bakken crude oil train consisting of two head-end locomotives, 103 loaded CPC-1232, non-jacketed tank cars with half height end shields, two buffer freight cars, and one distributed power unit (DPU) at the rear of the train. The total length of the train was 6,120 feet with 14,655 trailing tons. The train received a 1,500 mile extended haul Class 1 air brake test at the Bakken Oil Express LLC facility in Eland, North Dakota, at 5:30 a.m. on March 3, 2015.

Train U-ELUCXP0-25T departed La Crosse in an eastbound direction at 7:15 a.m. Immediately preceding the accident, the train was operating eastbound under Track Authority 303-17, which gave Train U-ELUCXP0-25T authority to proceed from Centralized Traffic Control (CTC) Graf (Milepost (MP) 296.3)) to CTC Control Point (CP) 1462 (milepost MP 146.2) on the Aurora Subdivision.

Train U-ELUCXP0-25T was operated by the Locomotive Engineer, who was seated at the controls on the right side of the cab. The Conductor was seated in the conductor's seat, behind the desk, on the left side of the locomotive cab throughout the trip.

On the approach to the derailment area, the grade is slightly ascending between 0.1 percent and 0.18 percent and is tangent track for approximately 0.5 miles. The track then enters a 3.0 degree left-hand curve at the derailment site where the grade gradually descends between 0.1 percent and 0.38 percent.

The approach to Galena from the west is single main track and double main track to the east of Galena Junction. There is also a siding track between the two main tracks which begins at Galena Junction and continues to the east. A total of two switches are located within the limits of Galena Junction.

The Accident

Train U-ELUCXP0-25T was being operated at a recorded speed of 23 mph when the accident occurred. This speed was recorded by the event recorder on the controlling locomotive. The maximum authorized speed was 35 mph, as designated in BNSF Chicago Division Timetable Number 8; however, the train was restricted to 25 mph because a portion of the train was still within the limits of a temporary slow order between MPs 171.6 and 171.8 as designated in General Track Bulletin Number 39476.

After traveling eight car-lengths through the switch at Galena Junction taking them from the single main track to Main Track 2, Train U-ELUCXPO-25T experienced an unintentional emergency brake application. The Engineer of westbound train SLPCSE3-05, which was located on Main Track 1 approximately 500 feet east of Galena Junction, observed the derailment and announced on the radio that Train U-ELUCXP0-25T had derailed.

A total of 21 cars derailed, positions 5-25, all of which were loaded crude oil tank cars. Fourteen of the cars were derailed accordion style. Thirteen of the tank cars lost product. Ten of the cars were breached (three cars lost lading on account of being consumed by fire and 7 cars developed heat tears).

First responders were dispatched from the Jo Daviess County Sheriff's Office and the Galena Fire Department. Approximately 125,217 gallons of crude oil was released and a total of 9 residents voluntarily evacuated for approximately 40 hours. The crude oil release was contained to the extent that it did not enter nearby waterways.

Analysis and Conclusions

Analysis – Toxicological Testing: The accident met the criteria for Title 49 Code of Federal Regulations, Part 219 Post-Accident Toxicological Testing. The train crew members were tested under this authority. The test results for the two crew members were negative.

Conclusion: Impairment of the crew was not a causal factor in this accident.

Analysis – Fatigue: The Federal Railroad Administration (FRA) used a fatigue analysis software program to create an analysis model for each crew member's overall effectiveness rate at the time of the accident. This model was produced through calculations made using collected work/rest data from each of the crew members. FRA uses an overall effectiveness rate of 77.5 percent as the baseline for fatigue analysis, which is considered equivalent to blood alcohol content (BAC) of 0.05. At or above this baseline, FRA does not consider fatigue as probable for any employee. Software sleep settings vary according to information obtained from each employee. If an employee does not provide sleep information, FRA uses the default software settings. FRA obtained fatigue related information, including a 10-day work history, for two employees involved in this accident, including the locomotive engineer and conductor of BNSF Train UELUCXP0-25T. Information for these two employees follows:

Fatigue Conclusions:

1. Locomotive engineer of BNSF Train UELUCXP0-25T
Sleep setting - excellent
Overall effectiveness = 81.83% Lapse Index = 2.7
Reaction Time = 121% Chronic Sleep Debt = 6.75
Hours of Continuous Wakefulness = 8.27
Time of Day 13:15
BAC Equivalent = < 0.05
Conclusion: Fatigue was not probable for this employee

2. Conductor of BNSF Train UELUCXP0-25T
Sleep setting - Excellent
Overall effectiveness = 86.11% Lapse Index = 2.0
Reaction Time = 116% Chronic Sleep Debt = 5.35
Hours of Continuous Wakefulness = 8.27
Time of Day 13:15
BAC Equivalent =< 0.05
Conclusion: Fatigue was not probable for this employee

Conclusion: Fatigue of the crew members was not a causal factor in this derailment.

Analysis – Event Recorder: FRA analyzed the event recorder data provided by BNSF for Lead Locomotive BNSF 9085. The event recorder data prior to the derailment suggested that train handling was in accordance with proper train handling procedures.

The maximum authorized speed at the derailment location was 35 mph; however, there was a 25 mph temporary slow order at this location due to a defective tie condition. The lead locomotive was being operated with gradual changes in throttle position between "Throttle Off" and "Throttle Position 2" for 10 minutes prior to the derailment. At the time of the unintentional emergency application of the air brakes, the train was travelling at 23 mph.

Conclusion: Improper train handling was not a causal factor in this derailment.

Analysis – Mechanical: A proper 1500 mile extended haul air brake test was performed at 5:30 a.m., on March 3, 2015, by BNSF mechanical inspectors at Bakken Oil Express LLC in Eland, ND. One defect was noted on the inspection report. The defect was for a defective brake shoe on a car not involved in the derailment.

FRA reviewed the relevant records for the equipment involved in the incident and took no exceptions; however, during the on-site investigation of the derailment, the L1 wheel of tank car TILX 352174 was found to have a significant portion of the tread broken off. Upon further investigation, two pieces of the wheel tread were found at locations prior to the Point of Derailment (POD). A 6-inch piece was found at MP 172.3 at a switch on Main Track 1 at the Portage CP. A second, 3 ¼ inch piece of wheel tread was found on the north side of the single main track, 74 feet west of the POD. These two pieces of wheel tread could be fit together and looked to be consistent with the damaged L1 wheel of tank car TILX 352174. The L1 wheel of tank car TILX 352174 had a considerable portion of its tread broken off. Nearly one quarter of the circumference of the wheel tread showed damage. Portions of this damage were in areas of considerable shelling and the broken off tread locations had signs of darkening and rust which indicates that a defect had been developing for some time.

Poor wheel steel cleanliness and tensile residual stress fields are two potential root causes for broken treads and flanges. Oxides and sulfide inclusions and voids in the steel structure can act as stress risers and are generally undesirable. Tensile residual stresses can increase the mechanical stresses that occur during wheel-to-rail contact and increase the probability for crack initiation and propagation. Compressive residual "hoop" stresses are developed in the wheel rim both during manufacturing and when wheels contact the rail while in service. Heat input from braking can relieve the hoop stress or cause an undesirable tensile state of residual hoop stress in some cases.

Tank car TILX 352174 had no actionable Wheel Impact Load Detector (WILD) or Hot Box detector (HBD) alarms in the 90 days prior to the accident. The highest WILD reading for the L1 wheel was 85.15 kips on February 2, 2015, on the CSX Transportation Railroad in Springfield, PA. At the time of the accident, BNSF policy was to remove wheels from service with kip readings of greater than 90.

The L1 wheel of tank car TILX 352174 was manufactured in July 2013, at Bessemer, AL and was mounted at Trinity Industries in Dallas, TX on September 4, 2013. Tank car TILX 352174 had been in service for approximately 70,000 miles, according to Trinity Industries.

A large enough portion of the wheel tread was broken off to allow the L1 wheel to fall to the inside of the south rail at the POD. This is consistent with the facts, as tank car TILX 352174 was found upright, east of the Galena Junction CP, with its wheels to the north side of their corresponding rails. After the L1 wheel of the tank car TILX 352174 fell into the gage of the single main track, it failed to negotiate the turnout which was lined for Main Track 2 at Galena Junction. It continued on the ground for approximately 150 feet past the turnout towards Main Track 1 and, due to the shelf style couplers, pulled the two cars to the east of it off the track. When tank car TILX 352174 failed to negotiate the turnout, it destroyed the turnout which made the track to the west of it impassable for the trailing cars.

The lab report for the L1 wheel of tank car TILX 352174 was unavailable at the writing of this report.

Conclusion: The post-accident investigation revealed that the significant portion of missing tread on tank car TILX 352174's L1 wheel allowed it to derail and subsequently damage the track structure to the extent that it became impassable for the remaining portion of the train.

Analysis – Tank Car Performance: All 21 of the tank cars involved in the derailment were constructed by Trinity Industries to a 30,000- gallon nominal capacity. The cars were CPC-1232, non-jacketed tank cars with half height end shields. Ten of the cars (TILX 352017, TILX 352024, TILX 352052, TILX 352040, TILX 352048, TILX 352176, TILX 352034, TILX 352029, TILX 352036, and TILX 352023) were breached as a result of the derailment, releasing all or part of their contents. Three lost lading which was attributed to being consumed by fire. Eight of the derailed cars retained their entire lading. All of the cars contained Petroleum Crude Oil, Class 3, UN 1267, PG I. The amount of lading lost was calculated by comparing the original bills of lading from Mercuria Energy Trading with the amounts recovered by Sunpro Environmental. The total amount of lading consumed by fire or otherwise lost to soil or air was approximately 125,217 gallons.

Conclusion: The loss of product came primarily through heat tears in the tank cars.

Analysis – Track Structure: Track measurements taken after the derailment showed the track geometry to be in compliance for the class of track. FRA's post-accident inspection of the track noted no FRA Part 213 deficiencies approaching the POD. Approximately 1000 feet of track at the derailment site was completely destroyed, including the power switch at the Galena Junction CP.

The last track inspection prior to the accident was performed by a qualified BNSF track inspector on March 5, 2015, approximately two hours prior to the derailment and no defects were noted. Track on this portion of the Aurora Subdivision is inspected four times per week, which exceeds the FRA's minimum requirement of twice weekly.

The last BNSF geometry test car prior to the derailment operated over this portion of the Aurora Subdivision on February 12, 2015, with no defects noted. BNSF operates its Geometry Car over the Aurora Subdivision at approximately 120-day intervals.

The most recent ultrasonic rail defect test was conducted on March 4, 2015, with no defects found in the area of the derailment. BNSF conducts Ultrasonic Rail Detection tests at approximately 39-day intervals. Examination of the rail breaks at the derailment site revealed that the breaks were stress breaks due to the derailment and there was no evidence of internal defects.

The track leading up to and at the derailment site was constructed of wood cross-ties spaced at approximately 20 inch centers and 141-pound continuous welded rail (CWR) manufactured by EVRAZ USA in August 2008. The rail is held in place with conventional cut spikes and the addition of curve blocks in the area of the 3-degree curve east of the bridge.

Conclusion: Track structure was not a causal factor in this accident.

Analysis – Signal: The area of the derailment was CTC territory. FRA analyzed the signal system test records between the Portage CP at MP 172.3 and the Galena Junction CP. No deficiencies were noted in BNSF testing of its signal system at the derailment location.

Conclusions: Signal equipment was not a causal factor in this derailment.

Probable Cause and Contributing Factors

The probable cause of the derailment was the broken wheel tread/flange of the L1 wheel of tank car TILX 352174 allowing the wheel to fall inside the gage of the rail.