**U.S. Department of Transportation**

**Federal Railroad Administration**

# Office of Railroad Safety
# Summary Report

## Derailment and Subsequent Hazmat Release on CSX Transportation Freight Train # S541-01

**Maryville, Tennessee**

**July 1, 2015**

**Executive Summary**

On July 1, 2015, at 11:45 p.m., EDT, a southbound CSX Transportation (CSX) freight train, Number S541-01 ("the accident train"), originating in Cincinnati, Ohio, and consisting of two locomotives, 45 loaded, and 12 empty freight cars, derailed. The accident train was operating southbound near Maryville, Tennessee, at 34 mph, on a clear signal indication on single main track near Milepost (MP) 287.0 when the Engineer observed what he described as sparks or fire in the train. The crew notified the Dispatcher by radio, and brought their train to a stop at MP 291.2 to conduct an inspection. The Conductor walked back to approximately the tenth car from the front of the accident train, and observed a fire towards the middle of the train. Because the accident train contained hazardous material, the Conductor notified the Dispatcher about the fire, and returned to the lead locomotive.

A motorist waiting at Mt. Tabor Road grade crossing observed flames on the accident train as it passed and called 911. CSX Dispatcher also notified Emergency responders of the fire. The Maryville City Fire Department (Blount County) was first on scene. Foster and Wheeler (an environmental contractor), the United States Environmental Protection Agency, and Tennessee Environmental Services also responded to the accident scene to determine the impact to the environment. Personnel from CSX's Track, Transportation, Hazmat, and Mechanical departments responded to the accident site as well.

Only the 37th car, a tank car with car number UTLX 901717, derailed. The two lead locomotives, first 36 cars, and last 20 cars of the train remained on the track. UTLX 901717 was derailed, leaking, and on fire. UTLX 901717 contained 24,710 gallons of acrylonitrile, stabilized, a Class 3 Packing Group 1 flammable liquid. Combustion of acrylonitrile produces hydrogen cyanide gas and oxides of nitrogen. The train contents also included other hazardous materials including liquefied petroleum gas, propane (Class 2, Division 2.1 flammable gases), and elevated temperature materials.[1]

Approximately 5,000 people were evacuated for 36 hours from the affected area, which extended for up to two miles from the derailment site. The evacuation zone included the Highlands Housing subdivision, and DENSO manufacturing plant which employs over 3,000 workers and operates around the clock on a 24-hour, three-shift schedule. One hundred and ninety-seven people, including eight police officers, were treated at a local hospital; 46 were admitted for observation with symptoms associated with exposure to acrylonitrile and its combustion products (toxic oxides of nitrogen and hydrogen cyanide gas). The eight police officers who were treated at the hospital had gone door-to-door within the adjacent housing area to notify residents of the evacuation.

[1] Elevated temperature materials are defined in 49 CFR 171.8 as a material which, when offered for transportation or transported in a bulk packaging is

1. Is in a liquid phase and at a temperature at or above 100°C (212°F);
2. Is in a liquid phase with a flash point at or above 38°C (100°F) that is intentionally heated and offered for transportation or transported at or above its flash point; or
3. Is in a solid phase at a temperature at or above 240°C (464°F)."

A burned-off roller bearing from UTLX 901717 was recovered near the initial point of derailment (POD) (*Figure 1*).

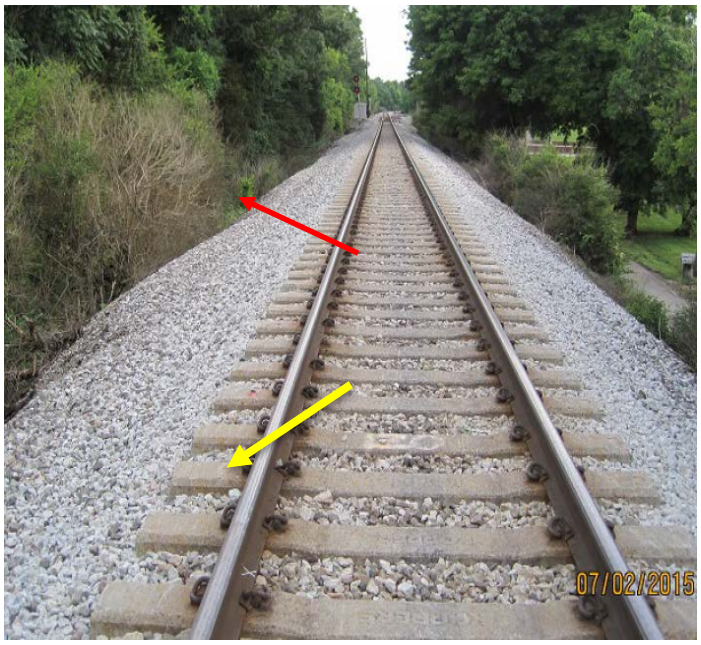


***Figure 1*: POD (yellow arrow) and location of failed roller bearing (red arrow).**

## CIRCUMSTANCES PRIOR TO THE ACCIDENT

On July 1, 2015, the accident train received a crew change in Corbin, Kentucky. The accident train crew, consisting of a locomotive Engineer and Conductor, went on duty at their away-from-home terminal at 2:30 p.m., EDT. The train crew had received the statutory off-duty rest period prior to reporting for duty. Etowah, Tennessee, is the crew's home terminal. The crew previously operated train S542-29 from Etowah to Corbin on June 30, 2015, going off duty at 8:55 p.m. EDT.

The accident train originated in Cincinnati, Ohio, and consisted of two locomotives, 45 loaded, and 12 empty freight cars. No changes were made to the accident train consist when it arrived in Corbin. All required inspections were performed before the accident train departed Corbin. The accident train departed Corbin and continued south through Knoxville, Tennessee. The Engineer stated their trip had been uneventful to that point. The accident train passed a wayside defect detector (Hot Box detector) (HBD - CSX HBD 7889 with a PRMICRO Processor and ACS Scanner) at MP 265.4. No defective conditions or excessive heat was identified and the detector provided the crew an accurate axle count.

## ACCIDENT INVESTIGATION

Federal Railroad Administration (FRA) assigned an accident investigation team consisting of Region 3 personnel from the Track, Motive Power and Equipment, and Hazardous Materials disciplines. The team arrived on site on July 2, 2015 at 4:45 a.m. EDT. Also on site were

personnel from the Maryville City Fire Department (Blount County), the Foster and Wheeler Corporation (an environmental contractor), the United States Environmental Protection Agency, the Tennessee Environmental Services, and CSX's Track, Transportation, Hazmat, and Mechanical departments. FRA's on scene investigation lasted for two days, concluding on July 3, 2015.

The track investigation found physical evidence that the lead truck of UTLX 901717 initially derailed at MP 282.6. The POD was positively identified by marks on the rail from the derailing wheel and corresponding wheel marks on the concrete railroad ties. The accident train continued until the Engineer and Conductor both observed what they described as sparks or flames and notified the dispatcher and brought the train to a safe stop at MP 291.2.

FRA's Investigators found a burned-off roller bearing near MP 282.6 on the east side of the tracks, 114 feet in the direction of travel (south) from the POD. (*Figure 2*).

***Figure 2*: Burned-off roller bearing.**

The burned-off roller bearing was from the second (trailing) axle on the lead truck (A-end) of UTLX 901717. Parts of the truck were found scattered across the 8.5 miles the tank car traveled after it derailed. The second axle of the lead truck was found at the South End Singleton switch at MP 283.8, more than one-mile south of the POD (*Figure 3*).

***Figure 3*: Second axle of lead truck**

Visible damage to the railroad ties and highway-railroad grade crossings indicates that the lead truck traveled 8.5 miles before it disengaged completely from the underframe of UTLX 901717. Damage to the roadway surface was apparent at the Mt. Tabor Road highway-railroad grade crossing in Maryville, TN, at MP 290.62 (*Figure 4*).

***Figure 4*: Mount Tabor Road grade crossing.**

The lead axle of the lead truck on UTLX 901717 was broken in half (*Figure 5*). Investigators determined that the axle broke as a result of derailment, and was not the cause of the derailment.

***Figure 5*: Lead axle of lead truck on UTLX 901717**

Because the axle broke in half, the wheels came in contact with the tank shell, and friction caused the wheels to burn through the underside of the tank car's shell (*Figure 6* and *Figure 7*).

***Figure 6*: Burn through of tank shell located at the outboard A-end right side of draft sill.**

***Figure 7*: Burn through of tank shell on the outboard A-end, left side of draft sill.**

These breaches allowed the acrylonitrile to leak. Sparks or excessive heat buildup from the steel on steel contact likely ignited the substance resulting in the fire (*Figure 8).*

Over the course of approximately 20 hours, approximately 24,710 gallons of acrylonitrile ignited as it leaked onto the ground where UTLX 901717 came to rest. Due to environmental concerns, Emergency Responders made the decision to let the fire burn and consume the liquid, acrylonitrile, to prevent it from soaking into the ground rather than extinguishing the fire. The trailing truck of UTLX 901717 did not derail (*Figure 9*). UTLX 901717 and the adjacent leading tank car were both impinged upon by the fire resulting from the ignition of the acrylonitrile.

***Figure 8*: The A-end of UTLX 901717 and B-end of the adjacent car UTLX901708.**

***Figure 9*: The B-end of UTLX 901717.**

## INVESTIGATION FINDINGS AND ANALYSIS

FRA's field investigation concluded on July 3, 2015. A timeline of precursor events, the derailment, and FRA's investigation are provided in *Table 1*. The following is a summary of the findings and analysis of the findings related to the cause of the derailment.

***Table 1*: Precursor, accident, and investigation timeline**

| Date & Time | Location | Event |
|---|---|---|
| 6/28/15 @ 6:40 AM | Cincinnati, OH | Pre-departure inspection (Cincinnati, OH) |
| 6/30/15 @ 8:55 PM | Corbin, KY | Accident Train crew goes off duty (Corbin, KY) |
| 7/1/15 @ 2:30 PM | Corbin, KY | Accident Train crew goes back on duty |
| 7/1/15 @ 10:45 PM | 17.8 miles from derailment site | Hot Box detector records no defective roller bearings on Accident Train |
| 7/1/15 @ 11:48 PM | Mt. Tabor Road grade crossing | Motorist waiting at Mt. Tabor Road observes sparks/fire on Accident Train and calls 911 |
| 7/1/15 @ 11:45 PM | Vicinity of Maryville, TN | Accident Train derails |
| 7/2/15 @ 4:00 AM | Vicinity of Maryville, TN | FRA accident investigation 1st responder arrives on-site |
| 7/3/15 @ 6:00 PM | Vicinity of Maryville, TN | FRA accident investigation concludes |

### *Track*

FRA Investigators measured the geometry of the track leading up to and at the point of derailment and reviewed CSX's track inspection and maintenance records. Investigators did not identify any track conditions that could have caused or contributed to the accident.

### *Operating Practices*

The locomotives were equipped with event recorders and speed indicators. The event recorder data was downloaded by CSX's Road Foreman of Engines at the accident site and reviewed by FRA and CSX.

Investigators interviewed the Engineer and Conductor of the train. The interview included discussions of train handling, crew work histories, crew rest cycles, crew experience, and crew training. The Engineer's statement describing how he handled the train was compared to the event recorder readout and the track charts.

FRA obtained operating crew information from CSX, including the 10-day work history, for the Engineer and Conductor of the accident train. Both crew members were also tested for alcohol and drug usage, and all tests were negative.

FRA found that the operating crew was qualified, rested, and fit for duty. There was no evidence that the qualifications or actions taken by the operating crew caused or contributed to the accident.

### *Motive Power and Equipment*

An FRA Motive Power and Equipment Investigator performed an inspection of available non-derailed cars and locomotives of the accident train after they had been placed in a secure location. No defects were observed.

A burned-off roller bearing was located near the POD. The roller bearing was from the second axle of the lead truck, which happened to be the A-End of the car. Therefore, in railroad nomenclature, the failed roller bearing was on the L-3 axle of UTLX 901717.

An examination of inspection records showed the required pre-departure mechanical inspection for the accident train was conducted at CSX's facility in Cincinnati, OH, by CSX mechanical personnel. The inspection was completed on June 28, 2015, at 6:40 a.m. EDT. The only noted defect was a missing hazardous materials placard which was replaced prior to departure. The Class 1 train air brake test was also conducted in Cincinnati, OH, by CSX mechanical personnel. This test was complete on July 1, 2015, at 1:00 a.m. EDT. No defective cars were noted during this test.

A review of records of previous repairs made to UTLX 901717 on CSX's property indicate no repairs or issues related to the roller bearings or axles on UTLX 901717.
There are no Federal regulations limiting a roller bearing mileage, age, or number of times wheel sets are rebuilt. Roller bearings are inspected and changed out if there are signs of oil

leakage or loose fasteners. Roller bearings are sealed when remanufactured or rebuilt and do not require field lubrication.

The Hot Box detector located at MP 265.4 gave no indication of an impending failure on the second axle of the lead truck of UTLX 901717. CSX confirmed in a post-accident investigation that the detector was working properly as the train passed at 11:15 p.m. EDT. Hot box detectors are wayside defect detectors designed to identify overheating of truck components and/or wheels. Overheating is an indication of an improperly engaged brake and can result in the degradation of the mechanical properties of the steel wheel. The Hot Box detectors notify crew of a passing train of defective conditions that may require immediate repairs or set off railcars at the next siding. Across CSX-owned and operated territory, Hot Box detectors are placed at an average interval of about 17 miles. On the subdivision where the derailment occurred, Hot Box detectors are spaced at 23 miles. The derailment occurred 17.8 miles from the last Hot Box detector it passed at MP 265.4, where no indication of overheating was recorded.

The roller bearing is being held by CSX subject to its evidence preservation obligations in ongoing litigations. CSX reports that the roller bearing has been visually inspected, but has not been subjected to physical or destructive testing and based on the visual inspection, they determined that it does not appear useful information will be obtained from physical or destructive testing.

Once UTLX 901717 derailed, the forces from the derailed truck likely caused the lead axle to break. When the axle broke, the friction from wheel contact burned through the tank shell. These openings allowed the flammable lading to leak, and sparks from the excessive friction heating or steel on steel contact ignited the substance and created the fire.

In support of the field investigation, FRA reviewed 15 years of data for reportable derailments, focusing on derailments caused by roller bearing failures. An analysis of the data indicates that industry as a whole and CSX individually experienced a decline in derailments caused by roller bearing failure (*Figure 10* and *Figure 11*). This decline coincides with the installation of Hot Box detectors.

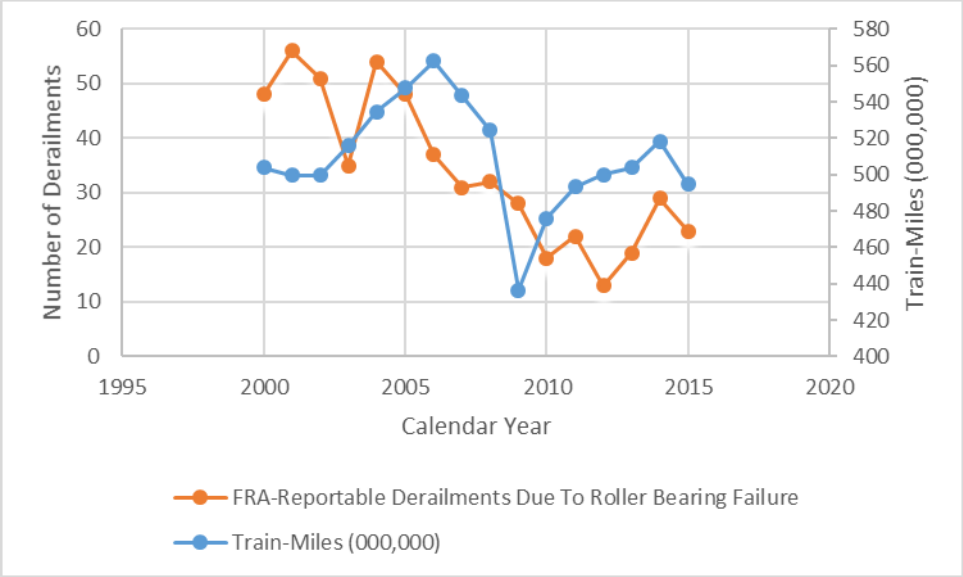


***Figure 10*: Reportable derailments due to roller bearing failures for all railroads.**

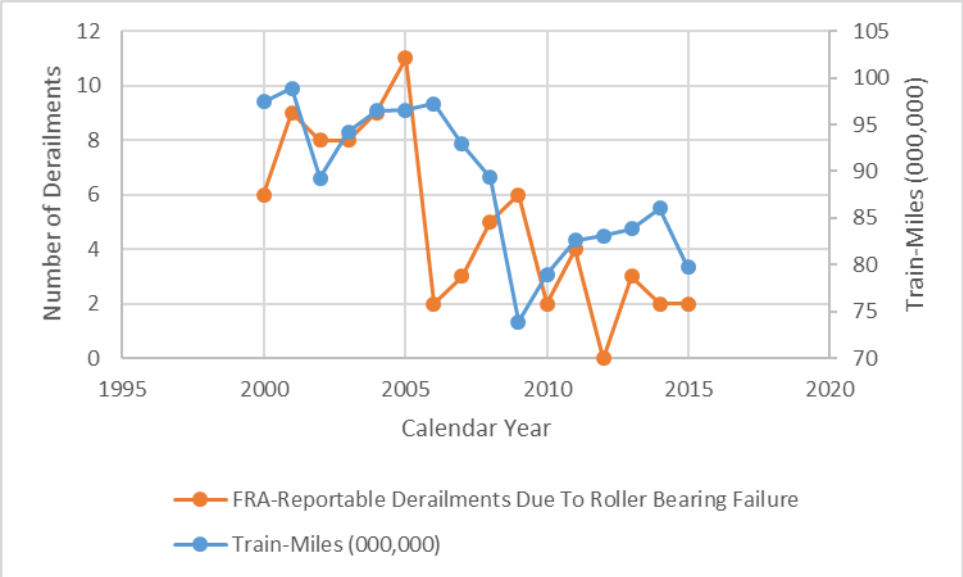


***Figure 11*: Reportable derailments due to roller bearing failure for CSX.**

## CONCLUSIONS

1. Track condition did not cause or contribute to the accident.
2. The operating crew of the accident train was qualified, rested, and fit for duty.
3. Post-accident drug and alcohol tests conducted on the Engineer and Conductor were negative.
4. Train operations as described by the Engineer and confirmed by the event recorder were appropriate, and neither caused nor contributed to the accident.
5. A burned-off roller bearing from UTLX 901717 was found near the initial POD.
6. Subsequent to the derailment, CSX verified the Hot Box detector located at MP 265.4 was functioning properly when the last reading was taken prior to the derailment.

7. The burned-off roller bearing overheated and failed suddenly without a gradual heating process detectable by deployed Hot Box detectors.
8. The wheels on a derailed, and subsequently, broken axle burned through the underside of UTLX 901717.
9. Sparks or excessive friction heating from the steel on steel contact ignited the acrylonitrile which fueled the fire.

## PROBABLE CAUSE

The probable cause of the derailment was the sudden overheating and failure of a roller bearing on the second axle of the lead truck of UTLX 901717.

## FRA ACTIONS

FRA developed guidance for regional personnel to improve FRA investigations of failed roller bearing-caused accidents. This guidance will provide consistent information suitable for trending and analysis. Specifically, the investigative guidance requires investigators to:

- Identify the type of truck, and type of damping (constant damped or variable damped);
- Inspect the bearing adaptor for manufacturing or installation flaws:
- Identify the roller bearing manufacturer;
- Identify the type and describe the condition of the mate wheel's roller bearing;
- Identify the wheel shop that installed the bearings and from the records;
- Identify the press pressures used when installing bearings;
- Note any anomalies described in the records;
- Determine mileage on the wheel set;
- Determine from the car history if the car was involved with a flood or stored in a rainy or wet environment;
- Identify if the acoustic bearing detector records exist for this car;
- Identify temperature trending data if available;
- Identify trending records from another railroad if the car was interchanged.