National Transportation Safety Board
Washington, D.C. 20594

Railroad Accident Brief

Accident No.:	DCA-11-FR-001
Location:	Tiskilwa, Illinois
Date:	October 7, 2011
Time:	2:14 a.m. central daylight time
Railroad	Iowa Interstate Railroad
Property Damage:	$1.6 million
Injuries:	0
Fatalities:	0
Type of Accident:	Derailment and hazardous materials release and fire

The Accident

On October 7, 2011, at 2:14 a.m. central daylight time,[1] 26 cars in eastbound Iowa Interstate Railroad (IAIS) train RI-BI-06 derailed in Tiskilwa, Illinois. Ten of the derailed cars contained ethanol, a hazardous material; ethanol released from the damaged tank cars ignited and burned. Property damage was estimated to be $1.6 million. The engineer and the conductor were not injured. No emergency responders were injured during the fire suppression and cleanup efforts.

Accident Sequence

At 11:30 p.m. on Thursday, October 6, 2011, an IAIS train crew consisting of a locomotive engineer and a conductor reported for duty at Rock Island, Illinois. The crew boarded train RI-BI-06 at the Silvis siding about 7 miles east of Rock Island at milepost (MP) 166. The train was destined for Blue Island, Illinois. The train consisted of 2 locomotives, 128 loaded cars, and 3 empty cars, accounting for 16,351 trailing tons. The train was 8,156 feet long.

The crew obtained a track warrant to proceed eastward from the siding. At 12:30 a.m., the train proceeded onto the main track. The engineer stated that the trip had been uneventful up to the point of derailment (POD) at MP 121.8.

At MP 121.8, the lead locomotive experienced a severe impact under the wheels. As the conductor was expressing his concern about this occurrence, the train went into emergency braking. The conductor looked back and saw that the cars near the locomotive were on fire, and he informed the engineer. (See figure 1.) The train (rail cars) had uncoupled from the

[1] All times in this brief are central daylight time.

locomotives. The engineer stopped the locomotives about 20 car lengths beyond where the first car of the train derailed.

Figure 1. Aerial photograph of derailment looking east.

The first 26 cars behind the locomotives had derailed. The first 15 derailed cars were covered hopper cars carrying corn mash followed by a hopper car carrying sand and 10 tank cars carrying ethanol. Nine of the derailed ethanol cars were damaged and lost product, which burned. (See figure 2.) The intense fire caused three of the tank cars to fail and erupt in massive fireballs.

Figure 2. Intense ethanol-fueled fires from several derailed tank cars.

Emergency Response

The Tiskilwa Fire Department response efforts began at 2:15 a.m. after the department had received several 911 calls from citizens reporting the train derailment and fire. About 2:16 a.m., the locomotive engineer notified the IAIS train dispatcher who notified the Bureau County Sheriff's Department. At 2:20 a.m., the IAIS dispatcher called the sheriff's department again and reported that the hazardous materials placards on the tank cars were commodity code UN 1987, which identified the material as *Alcohols, NOS* (Not Otherwise Specified), the proper shipping name for denatured fuel ethanol, a flammable liquid, Hazard Class 3. The Tiskilwa fire chief arrived at the scene at 2:21 a.m. and ordered a 1/2-mile radius evacuation as recommended in the *Emergency Response Guidebook*.[2] At 2:25 a.m., the fire chief requested assistance from a hazardous materials response team from the LaSalle Fire Department.

The immediate objectives of the fire department response team were evacuating and sheltering the residents in the vicinity of the derailment, securing the perimeter, and using portable water reservoirs and fire hoses to cool railroad cars. Five additional fire departments

[2] PHMSA (Pipeline and Hazardous Materials Safety Administration). 2012. *Emergency Response Guidebook: A Guidebook for First Responders During the Initial Phase of a Dangerous Goods/Hazardous Materials Transportation Incident*. Washington, DC: US Department of Transportation, PHMSA.

were contacted between 2:21 a.m. and 2:43 a.m. to respond to the incident: Bureau County Fire Protection District and Princeton, Buda, Malden, and Wyanet Fire Departments.

About 2:56 a.m., responding state and local police departments began a precautionary evacuation of the town's 745 residents. The evacuees were sheltered at Princeton High School.

About 4:00 a.m., responders at the scene reported that one of the tanks had ruptured.

About 5:00 a.m., the IAIS chief transportation officer reported three tank cars were venting and flames could be seen above the pressure-relief devices. Shortly before 7:00 a.m., the incident command ordered the back end of the train (nonderailed cars) separated and removed from the scene to prevent it from becoming involved in the fire.

About 8:00 a.m., using thermal imaging cameras, the hazardous materials team measured the fire temperatures at more than 1000°F. The incident command ordered continued cooling of the derailed cars. By 10:00 a.m., only one tank car was venting and on fire. The Bureau County Fire Protection District continued the cooling operations until about 11:00 a.m., at which time its employees were relieved by firefighters contracted by the railroad. The incident command coordinated with the contract firefighters to cool the tank cars to reduce the risk of tank rupture.

After the fires were extinguished and the equipment cooled, transloading of the tank car contents began. (See figure 3.) This process took several days and mitigated the release of ethanol into the surrounding environment.

Figure 3. Crews pumping remaining ethanol from derailed tank car.

The Investigation

National Transportation Safety Board (NTSB) investigators reviewed the event recorder data and determined that the crew was operating the train within the authorized speed for the territory. The crew had correct track warrants and track authority. Investigators also reviewed the crew's work history and determined the crew had sufficient off-duty time before reporting for work.

Equipment

Nonderailed Cars

From the original consist, 105 cars were uncoupled and moved to the Atkinson siding. On October 8, 2011, NTSB investigators observed an airbrake test and performed a mechanical inspection of the cars. No exceptions were identified.

Locomotives

On October 8, 2011, investigators inspected the two locomotives: IAIS 513 (leading) and IAIS 504. Investigators found fresh transverse batter[3] marks on the wheel treads of the wheels on the right side of both locomotives at wheel positions 1 through 6. The batter appeared more pronounced on the first three wheels. The forward main spring located on the right side of locomotive IAIS 504 at wheel position 1 had new impact marks on the inner portions of the coil, indicating that it recently had bottomed out. The Federal Railroad Administration (FRA) Class 1 brake test and the air leakage test were completed with no exceptions. A review of the maintenance and inspection records for both locomotives indicated all of the required FRA and IAIS mechanical inspections were current with no defects recorded.

Video recordings from outward-facing cameras on both locomotives were reviewed. The trailing unit recording system captured video from its rear-facing camera. The lead unit recording system (facing forward) was inoperable, and no video was recorded. Both recordings contained audio from microphones mounted outside the locomotive cabs and some parametric data similar to that recorded by the locomotive's event recorder.

The trailing locomotive video was illuminated by the rear-facing headlight. The audio captured a loud bang as the video showed the first trailing car dropping and rotating to the south side of the track. The video also shows a fire in the distant background.

Previous Train Traffic

The last train to operate through Tiskilwa before the accident went through about 6 hours before. The engineer and the conductor of that train told NTSB investigators that they did not see or feel anything unusual. In response to a request from investigators, IAIS maintenance personnel inspected the rear car of the 2-locomotive, 26-car train for lateral markings on the

[3] *Batter* is deformation of the wheel that is perpendicular to the wheel tread.

wheel tread, which would indicate that the train had encountered a broken rail. No lateral markings were visible.

Track and Engineering

The IAIS inspects and maintains the single main track on the portion of Subdivision 1 where the accident occurred to the FRA Track Safety Standards for Class 3 track, which allows for a maximum operating speed of 40 mph. The subdivision carries an average of four trains in a 24-hour period—about 9 million gross tons annually.

The day before the accident, October 6, 2011, an IAIS maintenance crew repaired fouled ballast[4] at locations west and east of Tiskilwa. The work began west of Tiskilwa at MP 123.8, and the crew worked eastward. After working west of Tiskilwa, the crew worked three short spots of fouled ballast east of Tiskilwa: one west of the derailment area, one within the limits of the derailment area, and one east of the derailment area.

NTSB investigators took no exceptions to the ballast conditions, anchoring pattern, and rail restraint effectiveness. Two locations were noted where new ballast had been applied to the track structure: one west of and outside the derailment area and one near the 3/4-mile marker post east of the derailment area. These findings were consistent with the information from interviews of the regulatory inspector and the maintenance personnel. Additionally, the IAIS geometry test data, ultrasonic records, and test frequency were reviewed; no exceptions were noted from those examinations.

Rail Recovery and Rebuild

On October 8, 2011, NTSB investigators assembled pieces of rail recovered from the derailment. Investigators measured, documented, and inventoried each piece of recovered rail. The entire north side rail was recovered; all except 2 feet 7 inches of the south rail was recovered.

The markings and conditions of the recovered rails indicated that the POD was a section of the south rail at MP 121.76.

About 100 feet into the derailment area[5] in the direction of train travel, the rail exhibited severe receiving rail end batter.[6] Fifty-seven inches east of the severely battered rail end, investigators found wheel flange markings on top of the rail that trailed into the gage side, or the inside, of the rail head.

The area of the north rail opposite the POD had markings consistent with corresponding derailment marks on the opposite rail. The south rail was bent outward to the southeast of the

[4] *Fouled ballast* is the accumulation of material (generally dirt and cemented mud) within the limits of the rails or at the outside edges of the crossties where the track structure is supported by the ballast section. Typically, areas with fouled ballast do not drain properly, which adversely affects the track geometry.

[5] As measured from the west end of the derailment footprint

[6] *Rail end batter* is deformation of the rail face and running surface that results from contact with a wheel at a gap or misalignment in the rail that allows the wheel to drop below the running surface of the rail. Severe batter is indicative of a heavy load hitting already broken rail. Two types of rail end batter can occur: receiving and trailing.

severe rail end batter about 100 feet into the derailment area. The north rail bowed outward to the north across from the south rail's outward bend, creating an area of wide gage that caused subsequent cars to derail at that point. Both rails had multiple rail fractures east of the severe rail end batter noted about 100 feet into the derailment area. No rail defects were found in the rail fractures east of the severe rail end batter.

All fractures east of the POD were overstressed or new breaks in the rail. This is consistent with a scenario in which an axle set of wheels derailed from its normal wheel-rail relationship and caused damage as the train continued eastward.

Rail pieces adjacent to the severely battered rail end about 100 feet into the derailment area were sent to the NTSB Materials Laboratory in Washington, DC, for detailed documentation, examination, and analysis. The running surface adjacent to the severely battered fracture face was flattened and deformed downward, and the upper portion of the fracture in the rail head had been obliterated by receiving rail end batter. (See figure 4.) The field side[7] of the head had an overall downward deformation near the fracture face. No evidence of preexisting cracks was observed.

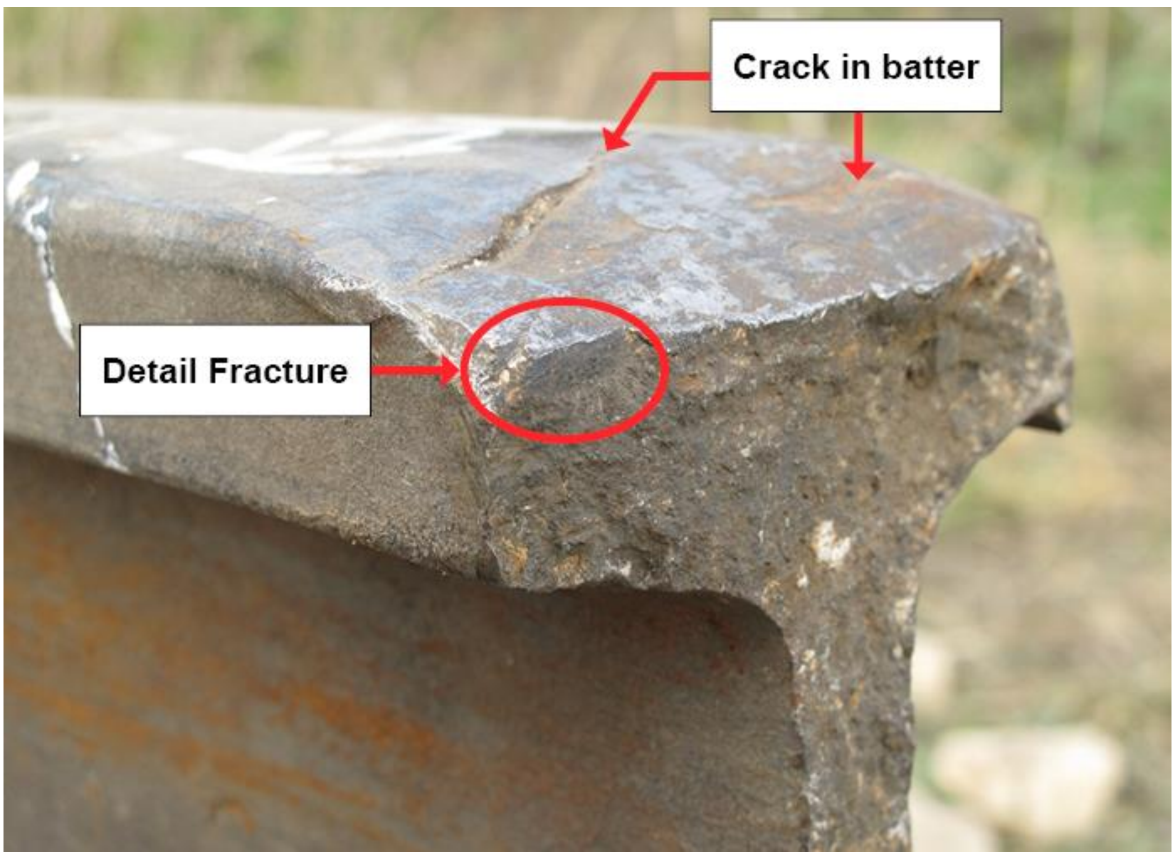

Figure 4. Rail head at east end of west rail fracture showing severe rail end batter and detail fracture.

[7] The field side refers to the outside of the rail head towards the "field" as opposed to the running side or gauge side of the rail where the wheels or the equipment make contact with the inside if vertical face of the rail head.

Investigators found a detail fracture[8] that measured about 3 percent of the original head area. Because a small section of the rail in the POD area was missing, investigators could not determine whether this rail defect caused the derailment; however, the other physical evidence points to a broken rail as the initiating factor. Also, it is unlikely that a detail fracture of only 3 percent of the original head area would cause a derailment.

The rail pieces from the POD were inspected using an ultrasonic flaw detector. The inspection revealed no indications of features that would suggest the presence of an internal rail flaw within either of the rails.

The train crew's experience of a severe impact under the lead locomotive wheels, the locomotive recordings, the physical evidence of lateral markings on the lead locomotive wheels, and the presence of severely battered rail all indicate that the rail broke prior to the derailment.

Tank Cars

The 10 tank cars that derailed were general service specification DOT-111A-100W1 (DOT-111) noninsulated stub sill design cars manufactured by American Rail Car, Trinity Tank Car, or Union Tank Car. Each car was fitted with a bottom outlet valve, top fittings within a protective housing, a hinged and bolted manway, and safety valves (pressure relief devices). None of the tank cars had head shields, jackets, or thermal protection.

Current design requirements for specification DOT-111 tank cars are found in Title 49 *Code of Federal Regulations* (CFR) Part 179 Subparts B and D. The minimum head and shell thickness authorized for DOT-111 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.[9] The 10 tank cars derailed in this accident were in compliance with this specification requirement in effect at the time of their construction.

Damage to seven of the nine tank cars that were damaged included four head punctures, three shell punctures, and three shell tears. The head punctures were caused by car-to-car coupler strikes or contact with a rail or another object. The shell punctures resulted from car-to-car impact, and the shell tears resulted from the high temperatures of the pool fire. The damage to these DOT-111 tank cars is similar to the tank car damage that has occurred in several derailments over the years. (See "Previous NTSB Investigations," below.)

Tank car ADMX 31172 exhibited significant head damage, front sill pad weld fractures, and a circumferential shell fracture. The breach to tank car ADMX 31172 appears to have had a

[8] Title 49 *Code of Federal Regulations* Part 213 defines *detail fracture* as a progressive fracture originating at or near the surface of the rail head. These fractures should not be confused with transverse fissures, compound fissures, or other defects that have internal origins. Detail fractures may arise from shelly spots (where small shell-like pieces have become detached from the top surface or side of the railhead), head checks, or flaking.

[9] Title 49 CFR 179.200-7, *Materials*, The maximum allowable carbon content must be 0.31 percent when the individual specification allows carbon content greater than this amount. The plats may be clad with other approved materials: . . . .

failure mode consistent with other accidents examined by the NTSB and the FRA in Cherry Valley, Illinois,[10] and in Arcadia, Ohio.

The B-end[11] draft sill and attachments and the breached area of tank car ADMX 31172 were examined in detail. In each instance, the end of the tank with the sill pad separation also had significant tank head damage. The stub sill exhibited a downward deformation, and in the process the front sill pad fractured from the shell. As the draft sill was pulled further down relative to the tank, the tank appears to have breached with a transverse fracture that followed the fillet weld along the edge of the body bolster pad. The fracture surfaces in the B-right side and the B-end draft sill to head assembly were subjected to metallurgical testing and comparison to ADMX 30847, which did not sustain impact damage to the B-end head as a result of the accident. This draft sill exhibited downward deformation, and the draft sill broke free from the car without separating the head pad or fracturing the tank. The welds in this area were compared to those in ADMX 31172.

Previous NTSB Investigations

The NTSB has investigated a number of accidents in which DOT-111 tank cars have been damaged and subsequently released hazardous materials. Previous NTSB investigations identified the poor performance of DOT-111 tank cars include a May 1991 safety study[12] as well as the following NTSB investigations: June 30, 1992, derailment in Superior Wisconsin;[13] February 9, 2003, derailment in Tamaroa, Illinois;[14] October 20, 2006, derailment of an ethanol unit train in New Brighton, Pennsylvania;[15] and June 19, 2009, derailment of 19 tank cars carrying ethanol in Cherry Valley, Illinois.[16] In addition, on February 6, 2011, the FRA investigated the derailment of a unit train of DOT-111 tank cars loaded with ethanol in Arcadia, Ohio, which released about 786,000 gallons of product.

The poor performance of DOT-111 general specification tank cars in derailments suggests that DOT-111 tank cars are inadequately designed to prevent punctures and breaches and that catastrophic release of hazardous materials can be expected when derailments involve DOT-111.

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[10] National Transportation Safety Board. 2012. *Derailment of CN Freight Train U70691-18 With Subsequent Hazardous Materials Release and Fire, Cherry Valley, Illinois, June 19, 2009*. RAR-12/01. Washington, DC: NTSB. <www.ntsb.gov/>

[11] Because rail cars have no front or rear, for descriptive purposes, the ends of the cars are designated “A” and “B.” The “B” end of a car is the end equipped with the wheel used to manually set the car‘s brakes. The end without the brake wheel is the “A” end. As trains are assembled, either end of a tank car may be placed in the front or rear position.

[12] NTSB (National Transportation Safety Board). 1991. *Transport of Hazardous Materials by Rail*, SS-91-01, Washington, DC: NTSB, <http://:www.ntsb.gov>

[13] NTSB (National Transportation Safety Board). 1994. *Derailment of Burlington Northern Freight Train No. 01-142-30 and Release of Hazardous Materials in the Town of Superior, Wisconsin, June 30, 1992*, HZM-94/01. Washington, DC: NTSB. <www.ntsb.gov/>

[14] NTSB (National Transportation Safety Board). 2005. *Derailment of Canadian National Freight Train M33371 and Subsequent Release of Hazardous Materials in Tamaroa, Illinois, February 9, 2003*, RAR-05/01. Washington, DC: NTSB, <www.ntsb.gov/>

[15] NTSB (National Transportation Safety Board). 2008. *Derailment of Norfolk Southern Railway Company Train 68QB119 With Release of Hazardous Materials and Fire, New Brighton, Pennsylvania October 20, 2006*. RAR-08/02. Washington, DC: NTSB. <www.ntsb.gov/>

[16] RAR-12/01.

About 40,000 tank cars are dedicated to transporting ethanol, and recently industry has dramatically increased the number of DOT-111 tank cars used to transport crude oil to US refineries. About 10,000 new DOT-111 tank cars are expected to be manufactured in 2013 to meet the increase in demand.

In the Cherry Valley accident, 13 of 15 tank cars that were involved in the derailment, lost about 324,000 gallons of product from head and shell breaches or through damaged valves and fittings, or a combination of the two, The NTSB concluded that tank car design standards for the attachments of draft sills to sill pads and of sill pads to the tanks are insufficient to protect the integrity of the tanks in accidents in which the draft sills are subjected to significant downward deformation. The NTSB recommended to the Association of American Railroads:

> Review the design requirements in the Association of American *Railroads Manual of Standards and Recommended Practices C-III, "Specifications for Tank Cars for Attaching Center Sills or Draft Sills*," and revise those requirements as needed to ensure that appropriate distances between the welds attaching the draft sill to the reinforcement pads and the welds attaching the reinforcement pads to the tank are maintained in all directions in accidents, including the longitudinal direction. (R-12-9)

Environmental Cleanup Activities

The Environmental Protection Agency (EPA) was responsible for environmental monitoring, wreckage clearing, and contaminated soil remediation.

Site Cleanup and Waste Disposal

The IAIS and its contractor, SWS Environmental Services (SWS), delayed clearing the wreckage until the transloading of the hazardous liquid was complete. Between October 8 and October 10, SWS recovered about 97,000 gallons of ethanol, which was about 37 percent of the original 259,000 gallons of lading from the nine damaged tank cars. The 162,000 gallons of unrecovered ethanol was consumed by the fire, absorbed into the soil, or evaporated

Environmental Monitoring and Remediation

The EPA conducted air monitoring in the surrounding community and surface water monitoring in the vicinity of the accident scene to either prevent or minimize releases to navigable waterways. The EPA assisted in drafting a plan for sampling residential wells, surface water, groundwater, surface and subsurface soils, and waste materials. The Center for Toxicology and Environmental Health, LLC (CTEH) was contracted by the IAIS to monitor releases of hazardous materials to air and water. The EPA oversaw the excavation of about 100 cubic yards of contaminated soil underlying the incident footprint following the CTEH October 9, 2011, work plan.

Monitoring wells installed close to the accident scene were sampled three times between November 7 and 14, 2011. The samples revealed the presence of ethanol and denaturant constituents. In accordance with the interim remedial action plan, on November 10, 2011, the

IAIS contractors installed two groundwater recovery wells at the center of the accident scene to remove ethanol-affected groundwater and reduce the pollutant concentrations. On November 11, about 60,000 gallons of groundwater was pumped from the wells into containers for transport. According to the plan, additional groundwater recovery or treatment will continue if sampling of monitoring wells detects additional pollutants.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was a broken rail. Contributing to the large quantity of hazardous materials released was inadequate puncture resistance of the tank heads and shells of the DOT-111A-100W1 general service tank cars and the failure of draft sill attachments.

Adopted: August 14, 2013