National Transportation Safety Board
Washington, D.C. 20594

Railroad Accident Brief

Accident No.:	DCA-07-MR-007
Location:	Shepherdsville, Kentucky
Date:	January 16, 2007
Time:	8:43 a.m. eastern standard time[1]
Railroad	CSX Transportation
Property Damage:	$22.4 million
Injuries:	52
Type of Accident:	Derailment with Hazardous Materials Release

The Accident

On January 16, 2007, about 8:43 a.m., eastern standard time, northbound CSX Transportation (CSX) freight train Q502-15, traveling about 47 mph through a curve, derailed 26 of its 80 cars near Shepherdsville, Kentucky. Twelve of the derailed cars contained hazardous materials. Three of those cars breached and released significant amounts of flammable hazardous liquids, which ignited and burned. About 500 people were evacuated from the area near the accident. No one was injured during the derailment; however, 50 people and 2 emergency responders were treated at local hospitals for minor injuries related to the hazardous materials release and fire. CSX estimated the total costs associated with this accident at $22.4 million. The weather was dry and cloudy, although recent rains had left the soil well saturated. The temperature was 28° F with 14 mph winds.

Accident Sequence

CSX train Q502-15 originated in Birmingham, Alabama, on January 15 and was recrewed in Nashville, Tennessee, at 1:00 a.m. on January 16. The train, consisting of 4 locomotives and 80 cars, departed for Louisville, Kentucky, about 1:25 a.m. and operated without problems for more than 7 hours prior to the accident. According to train crew statements, the trip was unremarkable until the accident occurred.

The train was traveling at 47 mph while negotiating a curve slightly less than 1° in 1 inch of super elevation[2] in the vicinity of milepost (MP) 15 on the CSX mainline when the accident occurred. The crew stated they had felt two distinct tugs on the train just before an uncommanded emergency brake application. When the train's emergency brakes applied, the

[1] All times in this brief are eastern standard time.

[2] *Super elevation* is the difference in height between the running rails relative to the track's surface. In a curve, the inner rail is generally lower than the outer rail. Super elevation helps to counteract curving forces.

engineer looked in his side mirror and saw the fire erupt. Using the train's radio, he attempted to advise a CSX dispatcher of the emergency. Receiving no response, he used his personal cell phone to call a trainmaster at Osborn Yard (in Louisville, Kentucky) who then contacted the dispatcher in Jacksonville, Florida.[3]

The accident train separated at the 15th car behind the locomotives. The four locomotives and the first 14 cars continued north and came to a stop about 1,632 feet from the derailed cars. Twenty-six cars derailed in the accident, the 15th through the 40th. Twelve of the derailed cars contained hazardous materials. Three tank cars containing flammable liquids breached as a result of the derailment and released full loads of cyclohexane, methyl ethyl ketone, and butadiene, resulting in a large fire. (See figure 1.)

Figure 1. Aerial photo of wreckage.

The fire produced a substantial amount of dense black smoke and high flames. Heavy black smoke drifted with a moderate northwest wind. The flames reached an elevation of about 100 feet, and the fire spread adjacent the track and into an open field to the east of the wreckage.

The accident train derailed about 2 miles north of the city of Shepherdsville, Kentucky, in an unincorporated section of Bullitt County. There are several residential dwellings and small commercial facilities in the area of the accident. Interstate 65, a north-south four-lane highway less than a mile from the accident, runs nearly parallel to the CSX tracks. The Zoneton Fire Protection District (ZFD) is the principal emergency services agency responsible for fire suppression, emergency rescue, and initial response to hazmat incidents in Bullitt County.

[3] CSX maintains its operations control center in Jacksonville, Florida.

Emergency Response

After notification from the Bullitt County E911 Emergency Call Center, the ZFD responded to the scene about 8:47 a.m. The ZFD firefighters were supported by mutual aid from neighboring communities. ZFD responders arrived on scene in about 4 minutes, and soon thereafter, the additional mutual aid resources arrived.

Upon arriving on scene, firefighters reported an intense fire encompassing an area of about 35,000 square feet. As other responders arrived on scene, they observed that several of the derailed cars within the blaze were tank cars displaying hazardous materials cargo labeling. Firefighters confirmed the contents of the railcars with the CSX conductor and initiated efforts to control and suppress the fire.

A voluntary evacuation order was issued for residents within 1 mile of the accident. Because of the dense, drifting black smoke from the accident, an 8-mile section of Interstate 65 was closed from about 9:11 a.m. to about 7:54 p.m. on January 16, 2007, and vehicular traffic was detoured.

Fire suppression and hazardous material cleanup activities concluded on January 20. On January 21, the evacuation order was lifted, residents returned to their homes, and repairs to the tracks were finished. The on-scene emergency response activities were discontinued on Monday, January 22, 2007, about 5:05 p.m.

Postaccident Observations

Twenty-six cars had derailed in the accident. The first four derailed cars, the 15th through the 18th, came to rest on their sides in a north-south orientation. The 15th car dug a long trench into the ground as it came to rest about 150 feet from the 16th car on the east side of the main track. Both mechanical coupler knuckles on the 15th car exhibited fresh overstress fractures.

The 16th car, a hazardous materials car, bore into the mud adjacent to the mainline, leaving the top two-thirds of the tank exposed, but it did not breach. However, the 17th car, another hazardous materials car, breached and caught fire. The 18th car derailed upright and came to rest leaning against the 17th car and remained in the right of way. (See figure 2.)

Figure 2. Photo showing derailed cars 16, 17, and 18.

The 19th through the 38th cars derailed and remained in the right of way. The cars were overturned, crushed, and left lying in a zigzag pattern. (See figure 1.) The last two cars, 39 and 40, derailed upright.

Of the 12 tank cars that derailed, 5 were pressure cars: 4 fully loaded tank cars containing butadiene and 1 tank car containing residue of chlorine gas. The remaining seven derailed tank cars were nonpressure tank cars carrying various hazardous liquids. All of the derailed tank cars sustained varying degrees of both mechanical and thermal damage as a result of the accident.

Postaccident Inspections

Track Structure

The track structure in the area of the accident consisted of a single main track oriented in a north-south direction. The rail was composed of 131-pound continuous welded rail. The single main track on the Mainline Subdivision where the accident occurred was owned, inspected, maintained, and operated by CSX, which had designated it as Class 4 track.[4] The maximum authorized speed for passenger and freight trains on the Mainline Subdivision was 60 mph; however, the accident train was traversing an area permanently restricted to 50 mph.

The rail was installed in 1984 and seated in double-shoulder tie plates that lay between the bottom surface of the rail and the top surface of the timber crossties. The rail was fastened through the tie plates to standard wooden crossties with conventional 6-inch cut track spikes. The investigation identified no problems with the fastening methods.

[4] Federal regulation establishes maximum train speeds for each class of track. A class 4 track has a maximum allowable speed of 60 mph for freight trains and 80 mph for passenger trains. The railroad may restrict the speed further (as was the case near Shepherdsville).

The track in the area of the derailment was last inspected on January 15, 2007, by a qualified CSX track inspector. The track inspector noted no defects between MPs 15.0 and 16.0. The investigation reviewed the previous 90 days of track inspection records. No exceptions or defects were noted within the area of the derailment. The undisturbed track in the areas to the north and the south of the accident showed no indications of exceptions or defects.

The most recent test for internal defects (cracked or broken rail) as required by Title 49 *Code of Federal Regulations* (CFR) 213.237(a) was conducted by Sperry Rail Service on October 17, 2006. This testing identified no rail defects between MPs 15.0 and 16.0.

Equipment

The accident train originated in Birmingham, Alabama, on January 15, 2007, where a predeparture Class 1 air brakes test and mechanical inspection was completed. On January 17, 2007, inspections and brake tests were performed on the underailed equipment at the accident scene. No conditions were discovered that would have caused or contributed to the derailment.

A postaccident inspection of all of the equipment involved in the derailment was completed during the on-scene portion of the investigation. The investigation identified rail burn markings on the front and rear trucks of the 18th car, AN-5696, a 70-ton box car (hereinafter referred to as the 18th car). Rail burn markings are severe gouging resulting in surface deformation caused by friction from sliding along a hard surface such as a running rail. Rail burn was not present on the first three cars in the derailment (the 15th, 16th, and 17th cars on the train).

The rail burn was observed on the underside (bottom) of the side frame on the leading (B-end) truck of the 18th car. The trailing (A-end) truck side frame was split as a result of rail burn. The location of rail burns on both trucks was consistent with a northbound movement along the east rail. (See figures 3 and 4.)

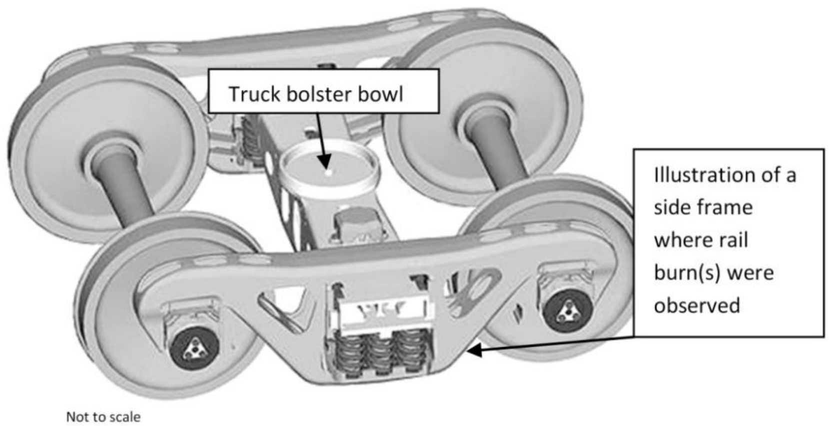

Figure 3. Illustration of truck assembly with location of rail burn on both trucks on 18th car indicated.

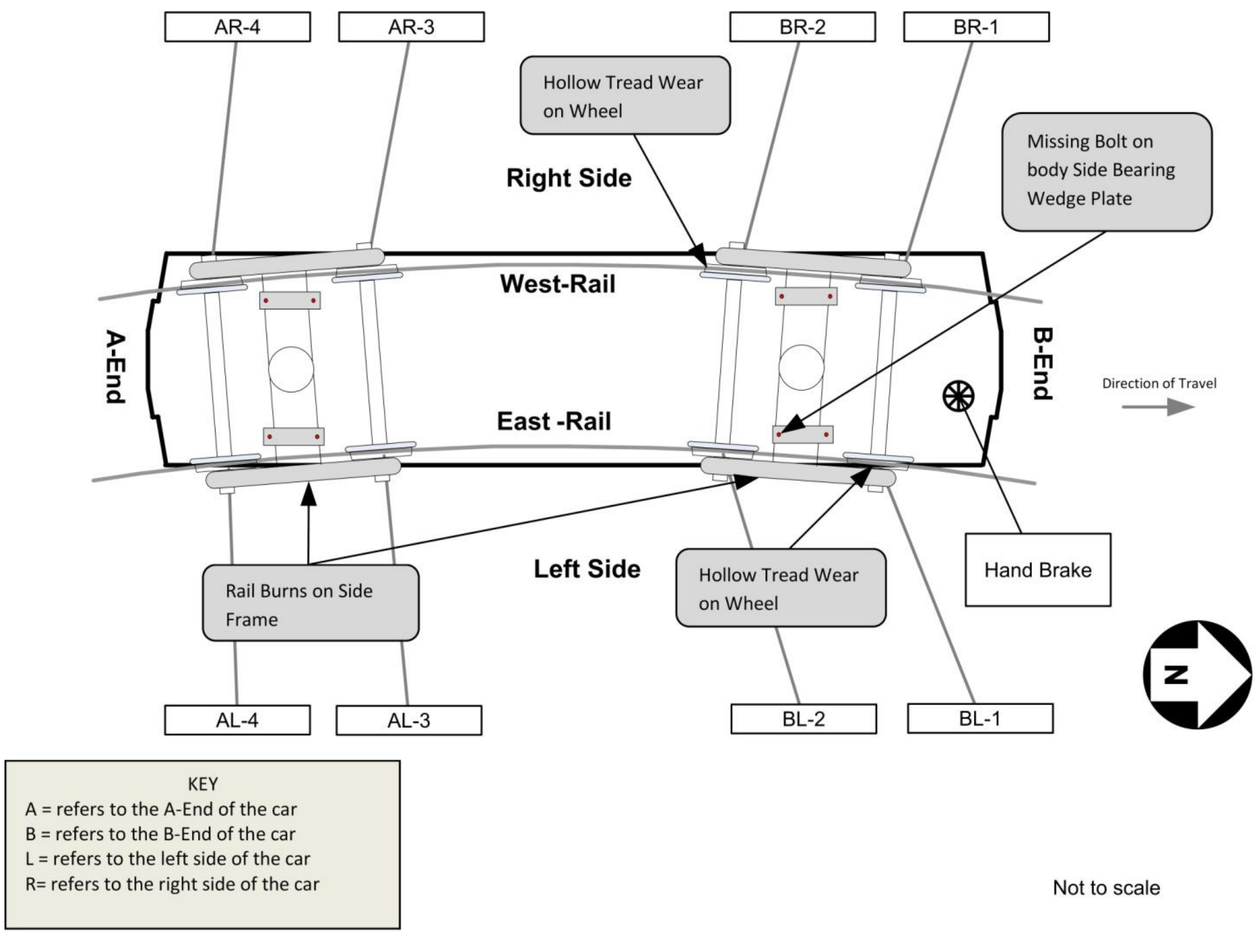

Figure 4. Illustration of car AN-5696, 18th car.

Wheels from the 18th car were recovered and examined. The BL-1 wheel exhibited hollow tread wear that exceeded Association of American Railroads (AAR) condemning limits. (See figure 4.) Hollow tread wear is defined as the vertical difference between the outside wheel radius and the midpoint of the tread as seen in figure 5. Title 49 CFR Part 215 contains no criteria for hollow tread wear.

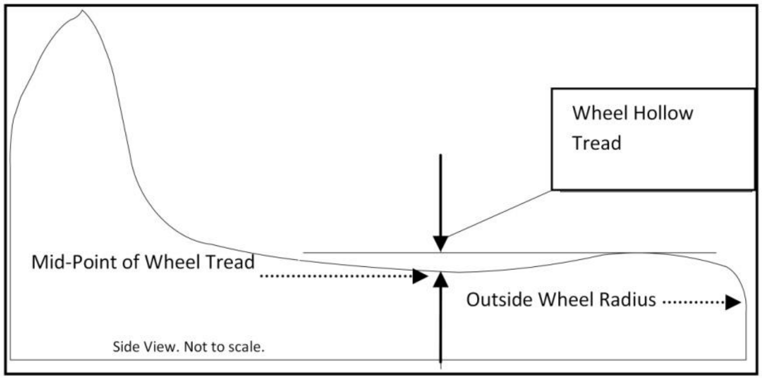

Figure 5. Illustration of hollow worn wheel profile.

The BL-1 wheel also exhibited thin wheel flange width and high vertical flange nearing the AAR condemning limits. An example of a thin wheel flange and high wheel flange profile is illustrated against an unworn wheel profile in figure 6. The BR-2 wheel was also found to have hollow tread, but it did not exceed the AAR condemning limit. Title 49 CFR, Part 215 contains condemning criteria for thin wheel flanges, and the BL-1 flange was within the allowable limits.

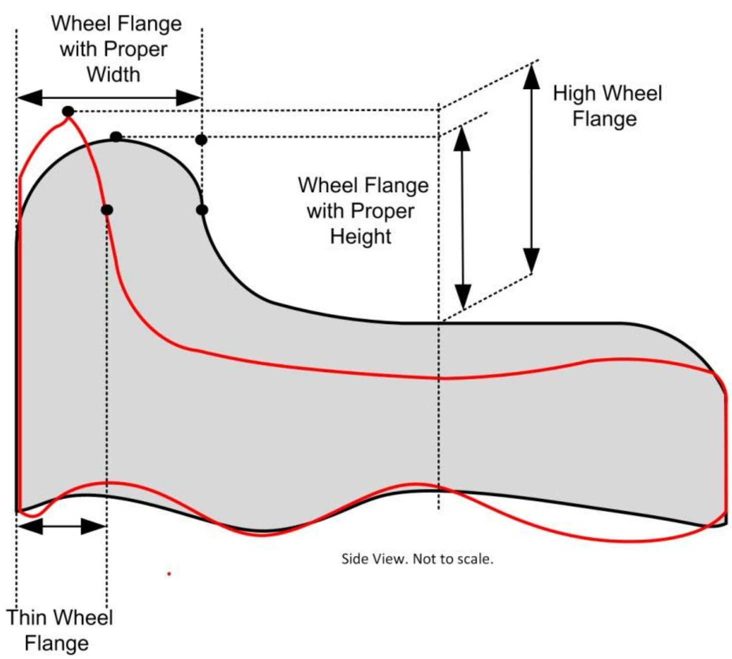

Figure 6. Illustration of a thin flange wheel profile shown with an unworn profile.

Inspection of the B-end truck assembly from the 18th car revealed engagement wear patterns on the truck bolster bowl rim. (See figure 7.[5]) The engagement wear patterns matched the carbody center plate wear patterns. AAR rules require a clearance of 1 1/16 inch be maintained. Postaccident wreckage of the B-end truck assembly precluded obtaining any clearance measurements during the on-scene portion of the accident.

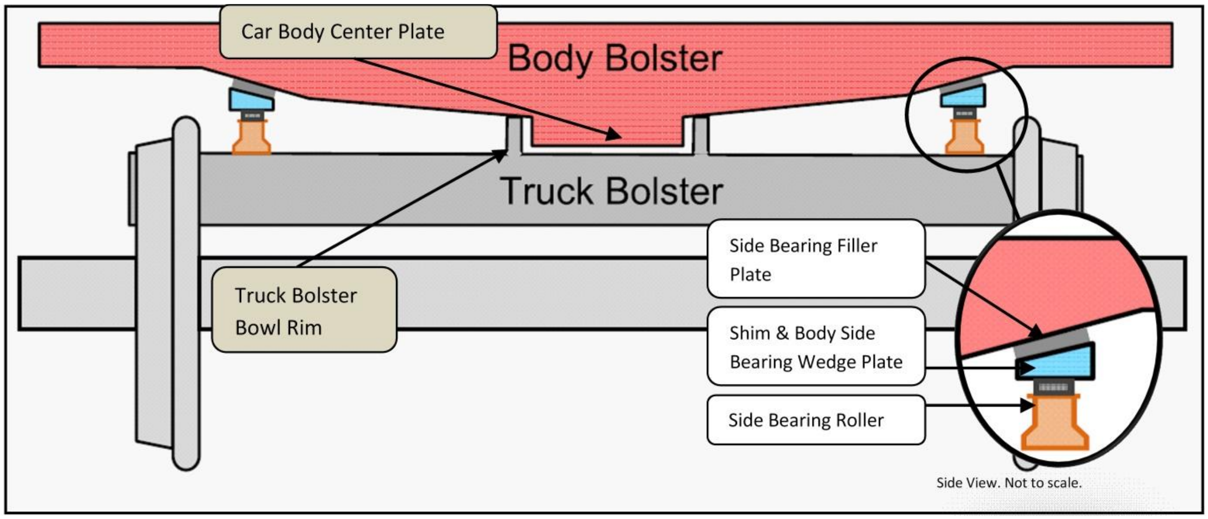

Figure 7. Side view of car-body and truck connection.

The 18th car was equipped with side bearing rollers mounted on the truck bolster. The side bearing rollers are designed to support the underside of the car body bolster in the event the car leans to one side or the other. The body side bearing arrangement consisted of a filler plate that was welded to the body bolster, a shim, and a body side bearing wedge plate. (See figure 7.) The body side bearing wedge plate and shim were secured through the filler plate and body bolster with two bolts and nuts at each end of the plate.

One of two B-end body side bearing plate attachment bolts was found broken on the left side of the 18th car. (Refer to figure 4.) The broken bolt allowed the partially attached body side bearing wedge plate to rotate inward toward the center of the car. The bearing surface of the B-end left side wedge plate was heavily worn and damaged from contact with the side bearing roller. Side bearing clearance is specified by AAR rules[6] and must be maintained between a minimum of 3/16 inch and a maximum of 5/16 inch.

Track Damage

The track in the derailment area was heavily damaged from the accident and fire; the rails in the area of the pileup were destroyed. The individual pieces were recovered and reassembled end to end in a linear fashion as they were originally oriented in the track. In total, about 600 feet of rail was recovered.

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[5] Also see figure 3 for an illustration of a truck bolster bowl.

[6] Association of American Railroads Interchange Rule 62, Truck Side Bearings.

In the area of MP 15.1, investigators identified a gouge on the west rail starting at the gage, or inside, face of the rail and extending northward 5 inches along the top of the rail. An abrasion on the east rail adjacent the gouge on the west rail was also observed. This was an abrasion mark that extended northward on the gage face about 22 inches. Investigators observed no other indications similar to those identified in the area of MP 15.1.

All of the fracture surfaces of the recovered rail were examined. The fractures were all determined to have resulted from overstress as a result of the derailment. The fracture surfaces of the sections were covered with orange oxide, consistent with postfracture oxidation. The fracture surfaces were rough and irregular and showed no signs of wheel impact marks from recent train movement.

Investigation

The investigation did not reveal any operational or track condition as having caused or contributed to the derailment. The train operations were in compliance with CSX operating rules. The gouging and scraping identified on the east and west rails in the area of MP 15.12 are consistent with a loss of the wheel-rail interface. Investigators determined the point of derailment was MP 15.12, a location where distinctive marks on the west and east rails indicated that a wheel had climbed the rail.

The investigation determined that the 18th car was the first car to derail because it was the first car to display rail burn. The overstress fractures on both mechanical coupler knuckles on the 15th car strongly indicated that it was pulled off the track during the derailment. This car, along with cars 16 and 17, did not exhibit any indication of rail burn.

The rail burn on the 18th car observed on both side frames on the leading (B-end) truck and trailing (A-end) truck was consistent with a northbound movement along the east rail. The investigation determined the B-end right side wheel (R-1) climbed the west rail at MP 15.12 and fell into the track.

Wheels recovered from the B-end truck of the 18th car were examined. The BL-1 wheel exhibited hollow tread wear that exceeded AAR condemning limits. The BL-1 wheel exhibited thin flange width and high vertical flange nearing the AAR condemning limits. The BR-2 wheel was also found to have hollow tread but did not exceed the AAR condemning limit.

The B-end truck assembly revealed engagement wear patterns on the truck bolster bowl rim. The engagement matched the engagement patterns on the B-end car-body center plate of the 18th car. Investigators determined this undesirable engagement could directly affect the steering performance of the B-end truck assembly.

The B-end body side bearing plate attachment bolt found broken on the left side of the B-end of the 18th car allowed the partially attached body side bearing wedge plate to rotate inward toward the center of the car. The bearing surface of the B-end left side wedge plate was heavily worn and damaged from prior contact with the side bearing roller, strongly suggesting the condition was preexisting.

Investigators determined that these three conditions, hollow worn wheels, engagement wear on the truck bolster bowl rim, and the partially attached side bearing wedge plate created a condition that severely diminished steering and maneuverability of the B-end truck assembly.

The 18th car received several types of inspections prior to the accident. The car was inspected by qualified CSX mechanical inspectors and automatic inspection technology.[7] The records did not reveal any entries related to the hollow tread wear on the wheels, truck bolster bowl rim engagement wear, or an out-of-position body side bearing wedge plate.

Postaccident Actions

Automatic Inspection Technology

Since the accident, CSX and other major railroads have continued to invest in automatic inspection technology in an effort to improve safe operation on their railroads. The AAR began to implement changes to the Interchange Rules[8] in 2004 to use data from automatic inspection systems to notify rail car owners of maintenance problems.

Automatic inspection technology is used by many railroads. This technology monitors vehicle performance based on predetermined failure conditions, allowing railroad owners to identify poorly performing equipment before it fails. These condition-monitoring systems are mounted on the right of way along the sides of the track or within the running rails.

The systems fall into two categories; reactive and predictive. Reactive systems include dragging equipment detectors, wheel impact load detectors, hot wheel detectors, and hot bearing detectors. Predictive systems include truck performance detectors, truck hunting detectors, wheel profile detectors, and acoustic bearing detectors. Most of the condition-monitoring systems for railroad vehicles are focused on wheels and trucks.

CSX has developed a network of automatic inspection systems that actively monitor the performance of vehicles operating on its railroad. Included in this network are "Super Sites," each of which is an automatic inspection site that consists of a wheel impact load detector, a truck performance detector, an acoustic bearing detector, and a truck hunting detector, all at a single location. CSX has developed 11 of these sites, including one that has an automated wheel measurement system.

In January 2007, at the time of the accident, the CSX automatic inspection network contained only two Super Sites: one in Florida and one in West Virginia. CSX's 5-year plan was to install these sites along all major routes, maximizing the exposure of trains to automated inspection. Because the accident train originated in Birmingham, Alabama, it was not routed through one of the existing Super Sites.

Automatic inspection technology has been shown to provide an additional layer of safety, because poorly performing vehicles can be removed from train consists before they affect

[7] Automatic inspection technology is explained in the next section of this brief.

[8] *Interchange Rules* refer to the interchange rules that govern the mechanical requirements for freight cars.

operations. In the case of the 18th car in the accident train, existing technology could not have detected an out-of-position body side bearing wedge plate; however, the Super Site network would have identified performance issues related to out-of-position components and hollow worn wheels and would have alerted the railroad.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was the failure of the 18th rail car to properly negotiate a curve because of the inadequate side bearing clearance of the B-end truck assembly, likely due to a broken side bearing wedge plate attachment bolt, which caused a wheel to climb the rail, which derailed the car. Contributing to the derailment was (1) the undesirable contact of the truck bolster bowl rim with the car body center plate and (2) the hollow worn wheels on the 18th car, which further diminished the steering ability of the truck assembly.

Adopted: March 30, 2012