National Transportation Safety Board
Washington, D.C. 20594

Railroad Accident Brief

Accident No.:	DCA-05-FR-002
Location:	Pico Rivera, California
Date:	October 16, 2004
Time:	9:40 a.m.[1]
Railroad:	Union Pacific Railroad
Property Damage:	$2.7 million
Injuries:	None
Fatalities:	None
Type of Accident:	Derailment

Synopsis

About 9:40 a.m., on October 16, 2004, eastbound Union Pacific Railroad (UP) freight train ZLAMN-16 derailed 3 locomotives and 11 cars near Pico Rivera, California. Some of the derailed cars struck nearby residences. Small amounts of hazardous materials were released from transported cargo.[2] An estimated 5,000 gallons of diesel fuel were released from the locomotive fuel tanks when they ruptured during the derailment. About 100 people were evacuated from the area. There were no injuries to area residents, the train crew, or emergency response personnel. At the time of the derailment, the sky was overcast. The wind was from the south at approximately 6 mph. The temperature was 66° F. The UP estimated the monetary damage at $2.7 million.

The Accident

At 6:45 a.m., on October 16, 2004, a two-person crew consisting of a locomotive engineer and conductor went on duty at UP's East Los Angeles terminal to take freight train ZLAMN-16 to Yuma, Arizona. Both crewmembers were rested in accordance with Federal requirements. The train consisted of 4 locomotives and 38 loaded cars. It had a trailing weight of 4,203 tons and was 5,822 feet long. After reporting for duty, the train crew stated that they collected their work orders and then held a job briefing. UP mechanical department employees performed a successful air brake test on the train. No anomalies or defects were reported during the inspection and testing.

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[1] All times in this brief are Pacific daylight time.
[2] The cargo was resin, 18 kilograms; sulfuric acid, 6 liters; and butane lighters, 1 kilogram.

About 9:15 a.m., ZLAMN-16 departed eastbound from Los Angeles enroute to Yuma, Arizona, with a final destination of Marion, Tennessee. The engineer said that he had no difficulties with either the brakes or slack action and the train handled as expected for a train of that size. As the train approached Bartolo Junction on the single main track, a *clear*[3] signal indication was displayed. The train was traveling 57 mph when, the crew said, the lead locomotive rocked a little from a dip on the engineer's side. As the crew was talking about this event, the train air brakes went into emergency application and the lead locomotive came to a rough stop. The engineer immediately contacted the dispatcher while the conductor checked on the condition of the train. The engineer relayed information to the dispatcher from the conductor that 3 locomotives and the first 11 cars had derailed and that local residential structures appeared to be involved. The second locomotive was the easternmost piece of equipment to derail. Emergency response personnel arrived within minutes.

The derailment occurred on the UP Los Angeles Division, Los Angeles Subdivision. The UP designated the track as Class 5,[4] authorizing maximum speeds of 70 mph for passenger trains and 65 mph for freight trains. The UP timetable established train directions for this subdivision as east and west. The train involved in the accident was moving northeasterly. A residential area was adjacent to the tracks on the northwestern edge of the derailment. An embankment for the 605 Freeway curved in front of the accident site and bordered the eastern edge.

In the area of the derailment, the main track was constructed of 133-pound continuous welded rail (CWR). The rail was laid on 8 1/2- by 16-inch double shoulder tie plates. Four cut track spikes in each tie plate affixed the rail to treated timber crossties. There were 24 crossties for each 39 feet of rail. Longitudinal rail movement was controlled through base-applied rail anchors. Each tie was box anchored in the area of the initial point of derailment (POD). The anchors contacted the respective crosstie at each location. The track structure was supported by crushed granite ballast that was generally 12 inches deep and between 1 1/2 to 3 inches in diameter. The cribs were full and clean. Ballast extended beyond the ends of the ties. There was no vegetation in the ballast section or along the immediate right-of-way. It had been raining in the area before the derailment and during the on-scene phase of the investigation; however, there was no standing water near the POD.

The initial POD was at an insulated joint on the south rail at milepost (MP) 11.34. The joint was composed of two 133-pound rails and a pair of 6-hole joint bars with associated hardware and bonding material. Both joint bars were broken and the end faces

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[3] A *clear* signal indicates that a train may proceed at track speed unless otherwise restricted. Trains receiving a *clear* signal will not be diverging at the next signal location and will not have a signal more restrictive than approach at the next signal.

[4] The Federal Railroad Administration (FRA) has established minimum inspection and maintenance standards according to various classes of track. Maximum track speeds and other requirements are based on the designated class.

of both rails exhibited visible evidence of having been deformed by impact.[5] The rail ends, attached broken bars, and the supporting tie plates were sent to the National Transportation Safety Board's Materials Laboratory in Washington, D.C. Starting on November 4, 2004, the track components from the accident were examined in the Safety Board's laboratory; representatives from the Federal Railroad Administration (FRA) and the UP were present.

The Materials Laboratory report[6] on the examination of the joint pieces is in the Safety Board's public docket. The evidence indicates that there were slowly growing fatigue cracks in both joint bars and that at least part of each fatigue crack had been visible on the lower outer portion of the bar for some time before failure. (See figures 1 and 2.)

Figure 1. West rail portion showing the fractured ends of the joint bars, a fracture between the first two bolt holes of the south joint bar, and rail batter.

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[5] "Batter" is generally used by the rail industry to describe this type of damage: a particular type of deformation that happens when wheels pass over the end face of a rail in an area where the rails are separated by a greater distance than is normal.

[6] National Transportation Safety Board's Materials Laboratory Factual Report No. 05-017 dated March 4, 2005.

The initial cracking in the south joint bar was between the first and second bolt holes from the center of the joint and was associated with an indentation in the bottom outside corner of the bar. The metallographic evaluation of the deformation could not determine whether the damage had occurred while the joint bar was being manufactured or at a later time.

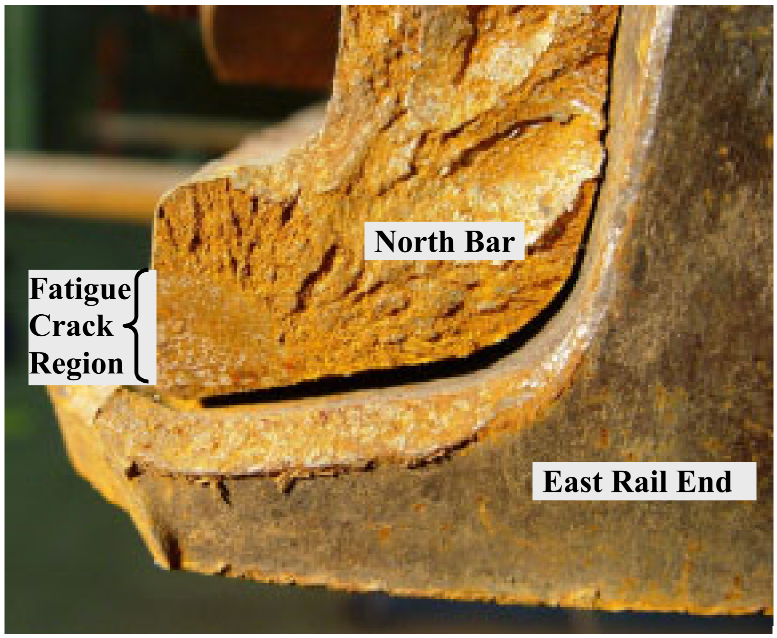

Figure 2. East rail portion showing the fractured end base of the north joint bar.

The epoxy bead along the top of the joint bars was missing from the center sections of the bars, indicating that the joint was older and was experiencing relative movement between the rail head and the bars. The joint bars were still securely bonded at the ends, indicating that the joint bars were not moving laterally, but were bending cyclically in the middle under the weight of passing trains.

Preaccident Inspections and Reports

The UP had used its track geometry car to inspect the area on September 4, 2004, and had not noted any exceptions[7] for the immediate area of what later became the POD. In a separate UP report, the crossovers at MP 11.3 had been identified in April 2004 as "Areas That Need Surfacing;" however, the area was not resurfaced before the accident. The FRA-required inspection[8] for internal rail defects was performed at the accident location on September 21, 2004. The minimum inspection requirement was once a year. However, the UP had done two other internal inspections in the previous year on January 28, 2004, and on May 20, 2004. No rail defects were reported for the area in the

[7] *Exceptions* are conditions that fall below the minimum standards defined by the FRA for the designated class of track.
[8] 49 *Code of Federal Regulations* (CFR) 213.237(a).

vicinity of the POD. Title 49 CFR 213.237 further stipulates, "(b) Inspection equipment shall be capable of detecting defects between joint bars, in the area enclosed by joint bars." This required inspection can detect internal defects in rail, but does not identify internal defects in joint bars. The UP conducted an ultrasonic test of the noninsulated joint bars in that area on July 2, 2004. No defects were reported.

According to representatives from the FRA, the California Public Utilities Commission, the UP, and joint bar manufacturers, current technology will not allow an in-service joint bar to be completely inspected for internal defects. Over time, both dye penetrates and magnetic particle inspections proved ineffective in field use. Transducer applied ultrasonic imaging is generally used throughout the rail industry as the best available means of testing. However, the shape of the joint bars and rails make some areas inaccessible. Moreover, removing joint bars for testing is time consuming and it introduces new load dynamics into the system when they are reassembled.

Class 5 track requires[9] a visual inspection of the track structure by a qualified track inspector. This inspection must be performed at least twice weekly with a minimum of 1 calendar day between the inspections. Records maintained by the UP indicated that the required inspections were routinely performed and logged. Federal and State inspectors stated that they routinely observed UP track inspectors conducting these inspections.

Two days before the accident, an FRA track safety inspector, a California Public Utilities Commission track safety inspector, the local UP track inspector, and a UP manager of track maintenance inspected the Los Angeles Subdivision main track between MP 32.46 and MP 10.30. This inspection included the joint that would be involved in the accident. Portions of their inspection were done from a Hy-Rail vehicle and portions were done on foot. The inspectors reported that they stopped and did a walking inspection of the Bartolo Control Point, and then they Hy-Railed over the insulated joints at MP 11.34, the POD. As they departed, they continued their visual inspection from the moving vehicle. Minor defects[10] were noted at MP 11.40 and MP 11.50, but no defect was reported at MP 11.34. UP records indicate 102 trains passed over the track at MP 11.34 between the time of the inspection and the time of the derailment. None of these trains reported a track defect in the area.

The locomotive engineer of the last train to successfully pass over the track was interviewed after the accident. He said that he had stopped his westbound train at the end of the multiple main track to wait for the passage of an eastbound train moving from the single main track to an adjacent multiple main track. He stated that he had felt a "small bump" as he started his train moving near the west end of Bartolo Junction, but that he had not believed it was significant enough to report.

[9] 49 CFR 213.233.
[10] Loose bolts were reported.

Postaccident Testing

Postaccident track geometry measurements were made by the parties to the investigation. Fifteen stations were established at 15-foot 6-inch increments.[11] Station 1 was set at the POD. The group summarized its factual findings as follows:

- The maximum measurement allowable for gage in the FRA's Track Safety Standards (TSS) Class 5 track is 57 1/2 inches. Track notes indicate that the widest gage was 56 3/4 inches at station 11.

- The maximum allowed deviation for alignment in Class 5 track is a 3/4-inch deviation of the mid-ordinate from a 31-foot chord in curved track. Track notes show that the greatest alignment deviation for the undisturbed track was 3/8 inch at station 15.[12]

- The maximum allowable deviation for crosslevel in Class 5 track at any point on tangent track is 1 inch. Track notes recorded the greatest loaded crosslevel measurement of 5/16 inches at station 8.

- The maximum difference in crosslevel between any two points less than 62 feet apart may not be more than 1 1/2 inches for Class 5 track. Track notes recorded the greatest loaded difference in crosslevel of 1 3/16 inches between stations 11 and 15.

Joint Bar Testing and Research

The FRA and the UP report that initiatives are under way to improve standard joints and insulated joints in CWR. A project is ongoing with the Transportation Technology Center in Pueblo, Colorado, that has instrumented joints in both heavy haul revenue service[13] and at the test center. Data collected from this project are being used to better understand failure modes. Additionally, prototype joint designs are being evaluated and tested in conjunction with recently developed bonding agents and tie plates that span multiple crossties. The industry-wide Heavy Axle Load Committee[14] is studying mechanical loading and other conditions that affect insulated joints with the intent of increasing their reliability and durability. The FRA also reports that its Office of Research and Development is developing a means of inspecting joint bars with an automated vehicle-mounted photo-imaging inspection system and that industry efforts are under way to improve existing ultrasonic inspection techniques.

[11] Four stations form a 62-foot chord.
[12] Station 15 was 62 feet west of the beginning of the curve or tangent to spiral.
[13] This portion of the project is reportedly being conducted together with the Burlington Northern and Santa Fe Railway on high tonnage coal routes to accelerate the test cycle.
[14] Both the FRA and the UP state that they have representatives on this committee.

Joint Bar Inspections

Joint bars are subject to routine visual inspections only as part of an overall track structure inspection. The FRA allows visual inspections to be conducted from a moving vehicle, as in the case of this accident. The Safety Board addressed the need for periodic on-the-ground inspections of rail joint bars during its investigation of the derailment of a Canadian Pacific Railway freight train on January 18, 2002, near Minot, North Dakota:[15]

> Visual inspection from a moving vehicle is inadequate because, for example, a track inspector checking the accident location from a vehicle traveling west to east would be able to see only the tops of the joint bars on the north rail, and the outside joint bar on the south rail would not be visible at all. Even those joint bars that can be partially seen by an inspector may have small fractures or fatigue cracks that are extremely difficult, if not impossible, to see from a moving vehicle. Instead, to adequately visually inspect joint bars, an inspector must dismount the vehicle and conduct an up-close, on-the-ground inspection of both the field- and gage-side bars for small hairline cracks. The joint bar fatigue cracks that eventually fractured and led to the Minot derailment were externally visible over a length of 1.9 inch on the gage-side bar and 0.8 inch on the field-side bar. An on-the-ground, visual inspection of this joint bar would almost certainly have detected the larger crack, which should have led to replacement of the joint bar before it failed and caused a derailment. A secondary benefit of on-the-ground rail joint inspection in CWR territory is that the inspector could assess the rail joint gap as well as look for evidence of bent or loose bolts.
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> The FRA's regulations regarding CWR are silent on inspections of joint bars. Although, by definition, CWR joints are welded rather than being bolted with joint bars, in practice, a length of CWR can have numerous joint bars where rail plugs have been added to replace defective rail sections. Although FRA regulations state that cracked or broken joint bars shall be replaced, they do not provide any guidance on finding such joint bars. Defects such as fatigue cracks develop and grow over time until, as in this accident, the bar can no longer support the load and fractures. With the proper frequency and type of joint bar inspections—specifically, on-the-ground visual inspections—these defects can be detected, and the defective bars can be repaired or replaced before their minor defects lead to complete failure and a possible derailment. Moreover, as noted previously, on-the-ground visual inspections can detect rail gaps, loose bolts, poor joint support, or other conditions that can be corrected before

[15] National Transportation Safety Board, *Derailment of Canadian Pacific Railway Freight Train 292-16 and Subsequent Release of Anhydrous Ammonia Near Minot, North Dakota*, January 18, 2002, Railroad Accident Report NTSB/RAR-04-01 (Washington, DC: NTSB, 2004). Paragraph excerpts are from pages 55 and 56.

cracking develops. Unfortunately, a railroad can meet existing FRA CWR regulations without an effective joint bar inspection program.

As a result, the Safety Board concluded in the same report, "FRA requirements regarding rail joints in CWR track are ineffective because they do not require on-the-ground visual inspections or nondestructive testing adequate to identify cracks before they grow to critical size and result in joint bar failure." On March 15, 2004, the Safety Board made two recommendations to the FRA on this issue:

> R-04-01
> Require all railroads with CWR track to include procedures (in the programs that are filed with the FRA) that prescribe on-the-ground visual inspections and nondestructive testing techniques for identifying cracks in rail joint bars before they grow to critical size.
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> R-04-02
> Establish a program to periodically review CWR rail joint bar inspection data from railroads and FRA track inspectors and, when determined necessary, require railroads to increase the frequency or improve the methods of inspections of joint bars in CWR.

The CWR track involved in the Pico Rivera accident had all the inspections required by the UP and the FRA. In some instances, the inspections were done more frequently than required. Nevertheless, the inspections failed to detect the developing problems and prevent the ultimate failure. Additionally, during the 2 days after the last inspection, more than 100 trains passed over the insulated joint bars without either discovering or reporting a defect. Trains traversed the area after the insulated joint bars were completely broken, as evidenced by the rail batter in both directions.[16]

Several indications of an imminent or actual defect were present before this accident, which the inspection from a moving vehicle did not discover:

- The epoxy bead was missing from the center section of the insulated joint bar, indicating vertical movement.

- The joint bars cracked before they completely fractured. Part of each crack was visible on the lower outer portion of the bar for some time before its failure.

- Rail end batter developed when the joint bars completely fractured and trains continued to pass over them in both directions.

These indications developed over time, and a close visual inspection from the ground would have likely uncovered the emerging problem and allowed corrective action to be taken to avoid the accident.

[16] Rail signal systems are designed to provide broken rail protection, but because the break was within an insulated joint, the safeguard was not activated.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the derailment was the failure of a pair of insulated joint bars due to fatigue cracking. Contributing to the accident was the lack of an adequate on-the-ground inspection program for identifying cracks in rail joint bars before they grow to critical size.

Adopted: May 31, 2005