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National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Adopted: 12-18-97

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In reply refer to: R-97-49 through -54

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About 6:28 a.m. on Saturday, November 23, 1996, eastbound National Railroad Passenger Corporation (Amtrak) train No. 12 derailed while crossing Portal Bridge, a swing bridge spanning the Hackensack River in Secaucus, New Jersey. When the train derailed, it sideswiped Amtrak train No. 79, which was crossing the bridge in the opposite direction on an adjacent track. All 12 cars of train No. 12 derailed, with both locomotives, 1 material handling car, and the 3 head passenger coaches coming to rest at the bottom of an embankment at the east end of the bridge. Train No. 79 sustained damage but was able to stop with the entire train intact and on the rails some distance west of Portal Bridge. No fatalities resulted from the accident, but 42 passengers and crewmembers aboard train No. 12 were injured, as was 1 passenger aboard train No. 79. Estimated cost of the damaged train, track, and signal equipment and site cleanup exceeded $3.6 million.[1]

The National Transportation Safety Board determined that the probable cause of the accident was the failure of Amtrak management to foster an environment that promoted adequate inspection, maintenance, and repair of the miter rail assemblies on Portal Bridge and to permanently correct defects in the miter rail side bars that were discovered 10 months before the accident. Contributing to the accident were (1) the failure of the Federal Railroad Administration to develop track inspection standards for special trackwork and to periodically inspect such track as part of its oversight responsibilities and (2) Amtrak's removal of the miter rail position detection circuitry without installing replacement circuitry or implementing procedures to compensate for the loss of this safety-critical system.

[1]For further information, see Special Investigation Report — *Derailment of Amtrak Passenger Train No. 12 and Sideswipe with Amtrak Train No. 79 on Portal Bridge in Secaucus, New Jersey, November 23, 1996* (NTSB/SIR-97/01).

The derailment occurred because the Portal Bridge opening and closing mechanism had malfunctioned earlier on the day of the accident. This failure caused a ramp-type elevation of track on track 1 that eventually derailed train No. 12. The Safety Board investigation uncovered numerous problems regarding the design, maintenance, inspection, and operation of this mechanism, focusing on the miter rail assembly.

The Promex miter rail assemblies used on Portal Bridge had been installed in 1992. A salient feature of the design was the joint between the miter rail and a section of running rail necessitated by the brittleness of the metal used for the miter rail. This joint was held together by side bars bolted onto each side of the two rails across the joint. As lifting force was applied to the miter rails at a point about 25 1/4 inches from the joint, the rail's dead weight exerted tensile stresses along the bottom surface of the side bars and compression stresses along the top surface. Repeated lifting and lowering of the miter rails subjected the side bars to fatigue stress cycles. Fatigue stresses were increased by the presence of a beveled notch along the bottom edge of the side bars, which represented a major, stress-concentrating change in section on the tension side of the bars. In the area immediately on either side of the rail joint gap, all of the assembly's bending tension loads were carried by the side bars; none of this load was borne by either the miter or running rails.

These stress cycles resulted in 6 of 16 side bars on Portal Bridge sustaining fatigue cracks. All of the cracks originated at the transition point to the beveled notch where the design of the miter rail assembly tended to concentrate the forces (loads) when the rails were raised. Moreover, all the cracked and broken side bars taken from the west end of the bridge were improperly machined. The beveled notch on these side bars extended from 1 to 2 inches farther than necessary, which exaggerated the stress concentration by putting the change in side bar width closer to adjacent bolt holes. The bolt holes themselves were stress concentrators, and the material that was removed to create them further reduced the load-bearing cross section at that location.

The fatigue cycles to which the side bars were subjected when they were lifted represented only a portion of the stresses the side bars were required to withstand. Added to this was the stress applied by the passage across the bridge of about 300 trains each day at an authorized speed of 70 mph. The Safety Board concluded that the design, the materials, and the operation of the miter rail system in place on Portal Bridge at the time of this accident made the side bars susceptible to fatigue cracking and led to the side bar failure that precipitated this accident.

The issue of Amtrak's maintenance of the Portal Bridge miter rail system also arose during the investigation. Cracked side bars on the movable span of Portal Bridge were first documented in January 1996, when the foreman of movable bridges noticed cracks in the bars as he was replacing missing bolts at the west end of the north rail of track 1. He notified his supervisors, who arranged an inspection and took photographs of the cracked side bars. Amtrak's solution was to replace the bars with side bars constructed of higher-strength steel.

Eventually, new side bars of stronger material were ordered; in the meantime, however, Amtrak took no steps to repair the cracks, to slow trains crossing the bridge, to step up

inspections of the miter rail assemblies, or to modify bridge operating procedures. Despite the critical function of the side bars, Amtrak officials did not consider the cracked side bars a safety issue. Only in April 1996, when the cracked side bars on the west end of the north rail of track 1 had broken completely through, did Amtrak undertake to replace the entire miter rail assembly. Unable to effect the replacement because the spare miter rail assembly could not be made to fit, Amtrak officials decided to weld the side bar cracks. Even then, however, the broken side bars were allowed to remain in place for a full week before a weld repair was attempted. According to the Amtrak welder, he told his supervisor that the side bars could not be properly welded while they remained attached to the miter rail assembly, but he was told to weld them in place. Safety Board laboratory examination bore out the welder's concerns, revealing that the weld repairs were poorly carried out and should, at best, have only been considered a temporary fix.

The weld repairs were most likely made by shielded metal arc welding and, while this is an acceptable process for this material, the fact that the side bars were not removed for welding meant that the welds were partial joint penetration groove welds that extended only part of the way through the thickness of the bars and left residual fatigue cracks. Evidence from one Amtrak official indicated that even Amtrak did not consider welding to be an approved repair method for the side bars, although several officials concurred in its use.

The weld repairs left the bars with significantly reduced cross-sectional areas, along with the remains of the cracks and the original notch ends, which acted as stress concentrators. The commentary on the Structural Welding Code-Steel[2] states, in part, "A partial penetration groove weld has an unwelded portion at the root of the weld....These unwelded portions constitute a stress raiser having significance when fatigue loads are applied transversely to the joint." The side bars had obvious fatigue loads applied when opening and closing. The Safety Board therefore concluded that the welding that was performed on the side bars was inadequate and inappropriate as a permanent repair and served to concentrate stress on the already fractured areas of the side bars. The Safety Board further concluded that the weld repairs could have been adequate as a temporary fix had a detailed and repetitive inspection program been established to ensure continued safe operation until permanent repairs or replacements could be made.

In July 1996, the first set of new, higher-strength steel side bars was delivered, but Amtrak made no effort to replace any of the existing side bars, even those that had already broken through and had been welded. The Safety Board concluded that Amtrak management was aware of failures in miter rail side bars at least 10 months prior to the derailment, but because the company erroneously considered cracked or broken side bars to be a maintenance issue rather than a safety issue, it did not make replacements or permanent repairs that could have prevented this accident.

The Safety Board also took exception to the method of inspection used for the miter rail system on Portal Bridge. A review of periodic track inspection reports from September 2, 1996, through November 21, 1996; monthly bridge inspections from January 19, 1993, through

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[2]American National Standards Institute/American Welding Society D1.1-86.

October 2, 1996; a Sperry Rail Track Geometry Report dated May 13, 1996; and the annual miter rail and expansion joint inspection on June 13, 1996, disclosed no defects in any of the side bars on any of the miter rails on Portal Bridge. On November 22, 1996, the day before the accident, an Amtrak track inspector made a walking inspection of the tracks on the bridge and reported finding no defects regarding the miter rails or their components.

The day after the accident, Safety Board investigators found that both side bars on three miter rail assemblies (six side bars total) were cracked. The Safety Board considers it unlikely that these cracks developed within a single day of the accident. More likely, the cracks had originated weeks or months before the accident and progressed slightly with each stress cycle. The Safety Board is concerned that repeated Amtrak inspections failed to reveal the presence of the cracks.

In the view of the Safety Board, Amtrak inspection procedures on Portal Bridge did not adequately address the special circumstances created by the Promex miter rail assemblies. The inspection procedures did not require that the miter rails be lifted to be inspected, even though the most critical components of the assembly were almost completely hidden when the rails were seated. At least as early as January 11, 1996, Amtrak became aware that a nut had fallen off a bolt in the toe of a miter rail, allowing the bolt to work out of its bolt hole and hang in the adjacent stationary miter rail. A short time later, on January 22, 1996, the movable bridges foreman found bolts missing from the side bars on the west end of the north rail of track 1. When he had the miter rails raised, he found that the remaining bolts were loose. These nuts and bolts had obviously loosened gradually over time, but no inspection procedure had detected the problem before a potentially hazardous situation developed.

The loose or missing bolts and nuts in the miter rail assemblies should have prompted Amtrak management to amend its inspection procedures to include raising the miter rails for inspection to detect cracked or broken side bars, loose or missing track bolts, displaced track bolt heads, lifting arm mechanism cotter pins, etc. Experience with the amended procedures would have allowed Amtrak to determine an optimum inspection schedule that would have ensured miter rail integrity with the least adverse effect on train schedules. Instead, Amtrak management continued the inspection procedures that had proven to be completely ineffective in detecting problems with the miter rail assemblies. The Safety Board concluded that Amtrak management did not develop and implement miter rail inspection procedures that were adequate to identify defects in all components of the miter rail assemblies on Portal Bridge. The Safety Board further concluded that, had Amtrak, when it first learned about the cracked side bars on the miter rails, revised its miter rail inspection procedures to include raising the miter rails for inspection, the accident may have been prevented.

Only in January 1997, after the second incident in which a loose bolt jammed a miter rail and created a potentially hazardous situation, did Amtrak establish short-term procedures to ensure a thorough inspection of the miter rail assemblies while in the raised position. In March 1997, more than 1 year after problems with the miter rails had initially been detected, Amtrak issued new instructions for the inspection and protection of miter rail assemblies and established new training standards for inspectors.

The Safety Board is also concerned that in 1987 Amtrak chose to remove, and did not subsequently replace, a safeguard feature — the position detection circuits — from the miter rail assembly on Portal Bridge. Although Amtrak purchased a new type of heavy duty circuit controller to replace the limit switches, the devices were never installed on the miter rails. When the rails were replaced in 1992 by miter rails of Promex design, no detection circuitry was installed, even though the mechanism had provisions for such devices.

The rail position detection circuitry reported to the bridge operator when the rails were properly lifted before an attempt was made to open the bridge and firmly seated again after the bridge was closed. In fact, the bridge interlocking mechanisms would not allow a bridge opening or closing operation to proceed unless (1) the system received a safe indication from the detection circuitry, or (2) the bridge operator used a bypass switch to allow the operation to continue without a safe indication. With no detection circuitry in place, bridge operators always used the bypass switch, even though, absent a visual inspection of the rails before and after each opening, the bridge operator had no way of knowing whether the attempt to raise or lower the miter rails had been successful.

If Amtrak management understood the important safety function served by the rail position detection circuitry, it did nothing to compensate for the removal of the system. An appropriate course may have been to require a visual inspection of the miter rails to confirm that they were completely lifted before opening and completely seated afterward. This practice could have been continued until the detection circuitry could be replaced. In a January 30, 1997, memorandum to Portal Bridge operators (and Spuyten Duyvil Bridge signal maintainers), Amtrak instituted such visual inspections. The Safety Board is concerned, however, that for almost 10 years, Portal Bridge operators were allowed to assume that a critical procedure in the opening or closing of the bridge would always be successful and that no confirmation, electronic or visual, was required before using a bypass switch. The Safety Board concluded that if Amtrak management had had in place on Portal Bridge a functioning rail position detection system or procedures that required visual confirmation of the proper positioning of all miter rails, this accident probably would not have occurred.

Emergency response is another area in which the Safety Board believes Amtrak can make improvements. In the Portal Bridge accident, emergency response was delayed because of confusion about the accident location. The problem can be traced to the Amtrak police dispatcher who called the appropriate agency, the Secaucus Police Department, but relayed the accident location as "Portal Tunnel' instead of "Portal Bridge." The dispatcher further confused the issue when he called the North Bergen Police Department and reported the accident location as "Portal Tunnel Bridge." It was only when a construction worker flagged down a Secaucus police cruiser that had been sent out to investigate and check known bridges in the area that the actual accident location became known.

As a result of this confusion about the accident location, the first ambulance did not arrive at the accident scene until 47 minutes after the initial notification. The Safety Board concluded that, had this accident resulted in more serious injuries, the confusing communication of the accident location by the Amtrak police dispatcher and the resulting delay in emergency response could have resulted in additional risks to train occupants.

Investigation of the Portal Bridge accident indicated to the Safety Board that Amtrak could also benefit from changing some of its requirements regarding locomotive event recorders. According to information provided by Bach-Simpson, the manufacturer of the event recorders installed on the accident locomotives, when a cab signal aspect changes, the traction motor current (TMC) signal is interrupted, and a record of the cab signal is inserted in the data record. The signal activation and aspect are distinguishable within the recorded data by their high relative current levels. However, according to Amtrak, TMC values as high as 1,800 to 2,000 amps can be reached during normal operation of an AEM-7 locomotive. Thus, the range of TMC values overlaps the range of values assigned to specific cab signals, making it difficult, if not impossible, to determine whether the value depicted for the TMC channel reflects the current draw of the traction motor alone or the additional current draw that results from activation of a cab signal. For example, if the traction motor is operating at about 1,700 amps when the locomotive receives an approach cab signal (also 1,700 amps), the event recorder data provide no means of identifying the source of the current draw. Moreover, an approach signal will not always be recorded at 1,700 amps; the readings could be 1,684, 1,712, 1,690, or another value, making it even more difficult to identify cab signal data.

Amtrak initially informed the Safety Board that cab signal aspect was recorded properly for the accident locomotives, and that cab signal records were contained within the TMC data. After consultation with Safety Board staff, however, Amtrak agreed that cab signal indications were not recorded in a way that made it possible to determine the cab signal that each train was operating under at the time of the accident. The Safety Board concluded that Amtrak's use of a multiplexer to monitor and record both TMC and cab signal on a single channel of the event recorder is inappropriate and ineffective. As a result, Safety Board investigators found it impossible to determine cab signal indications in this accident.

In conclusion, the circumstances of this accident indicate that Amtrak's oversight policies may be lacking. Amtrak management did not take sufficient action to address the ineffectual inspection practices, delays in installing safety-critical miter rail assembly components, and unsuccessful repair procedures that preceded the Portal Bridge derailment. It appears that Amtrak management may not have emphasized safety as strongly as possible, at least with regard to the inspection, maintenance, and repair of the Portal Bridge miter rail assemblies. Therefore, the Safety Board concluded that Amtrak management failed to foster an environment that promoted adequate inspection, maintenance, and repair of the miter rail assemblies on Portal Bridge and to permanently correct defects in the miter rail side bars that were discovered 10 months before the accident.

While this investigation found that those employees who carried out inspections and maintenance on the bridge followed Amtrak guidance, it also indicated that the guidance was not

always appropriate and forceful. The circumstances of this accident, which could have had far greater consequences in terms of injury and loss of life, point out significant deficiencies in the Amtrak response to safety issues.

Based on the foregoing information, the National Transportation Safety Board recommends that the National Railroad Passenger Corporation (Amtrak):

> Perform a comprehensive stress analysis of the design of any miter rail assembly currently in use or intended for use on Portal Bridge to identify critical areas of high cyclic stress. Ensure that the miter rail design adequately accommodates these cyclic loads. (R-97-49)
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> Continue to monitor the safety of special trackwork on your movable bridges and ensure that your special inspections are adequate and of sufficient frequency to detect failures or potential failures involving all components of all your special trackwork. Develop and put procedures in place to ensure that any failures or potential failures that are noted during these inspections are corrected before they develop into safety hazards. (R-97-50)
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> Ensure that current or future miter rail installations on Portal Bridge are equipped with a miter rail position detection/indication system that provides the maximum protection possible and that is interlocked with other bridge systems to prevent the bridge from being opened or cleared for train traffic until the position of the miter rails can be confirmed to be safe. (R-97-51)
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> Review the training of your police dispatchers and ensure that dispatchers are trained to correctly identify all Amtrak locations to emergency response agencies. (R-97-52)
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> Perform a thorough test of the entire recording system on every locomotive equipped with an event recorder to ensure that cab signal data records can be easily and positively identified and evaluated. (R-97-53)
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> Conduct a comprehensive internal management review of the circumstances of this accident to determine why several layers of Amtrak management failed to act in a timely fashion to correct a known hazardous condition on Portal Bridge. Make the management or procedural changes necessary to ensure that conditions affecting the safety of rail operations are given the highest priority. (R-97-54)

Also, the Safety Board issued Safety Recommendations R-97-55 through -58 to the Federal Railroad Administration, R-97-59 to the Association of American Railroads, and R-97-60 to the American Short Line Railroad Association.

The National Transportation Safety Board is an independent Federal agency with the statutory responsibility "to promote transportation safety by conducting independent accident investigations and by formulating safety improvement recommendations" (Public Law 93-633).

The Safety Board is vitally interested in any action taken as a result of its safety recommendations. Therefore, it would appreciate a response from you regarding action taken or contemplated with respect to the recommendations in this letter. Please refer to Safety Recommendations R-97-49 through -54 in your reply. If you need additional information, you may call (202) 314-6488.

Chairman HALL, Vice Chairman FRANCIS, and Members HAMMERSCHMIDT, GOGLIA, and BLACK concurred in these recommendations.

By: Jim Hall
Chairman