



# National Transportation Safety Board

Washington, D.C. 20594

## Safety Recommendation

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**Date:** December 20, 2007

**In reply refer to:** R-07-23 through -28

Mr. John Catoe  
General Manager  
Washington Metropolitan Area Transit Authority  
600 Fifth Street, N.W.  
Washington, D.C. 20001

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The National Transportation Safety Board is an independent Federal agency charged by Congress with investigating transportation accidents, determining their probable cause, and making recommendations to prevent similar accidents from occurring. We are providing the following information to urge your organization to take action on the safety recommendations in this letter. The Safety Board is vitally interested in these recommendations because they are designed to prevent accidents and save lives.

These recommendations address wheel-truing procedures, mitigating measures for wheel climb derailments, and interdepartmental coordination. The recommendations are derived from the Safety Board's investigation of the January 7, 2007, derailment of a Washington Metropolitan Area Transit Authority (WMATA) Metrorail train near the Mt. Vernon Sq. 7th St.-Convention Center (Mt. Vernon Square) station in Washington, D.C.,<sup>1</sup> and are consistent with the evidence we found and the analysis we performed. As a result of this investigation, the Safety Board has issued six safety recommendations, all of which are addressed to WMATA. Information supporting these recommendations is discussed below. The Safety Board would appreciate a response from you within 90 days addressing the actions you have taken or intend to take to implement our recommendations.

On January 7, 2007, about 3:45 p.m. eastern standard time, northbound WMATA Metrorail train 504 derailed one car (car 5152) as the train traversed a crossover from track 2 to track 1. The accident occurred in an underground tunnel on the Metrorail Green Line near the Mt. Vernon Square) station at chain marker E2 23+28. The train was traveling about 18 mph as it approached the station.

The train consisted of six cars. The fifth car from the head end of the train derailed. About 80 passengers were on board at the time of the accident. Twenty-three passengers were transported to local hospitals for treatment and released. Emergency response personnel from Washington, D.C., provided the on-scene treatment and transportation of the injured passengers.

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<sup>1</sup> For more information, see <http://www.nts.gov/publictn/2007/RAR0703.pdf>. National Transportation Safety Board, *Derailed of Washington Metropolitan Area Transit Authority Train near the Mt. Vernon Square Station, Washington, D.C., January 7, 2007*, Railroad Accident Report NTSB RAR-07/03 (Washington, DC: NTSB, 2007).

The contact damage at the tunnel wall and track damage accounted for about \$1,000 in damages. The cost to replace the damaged vehicles was estimated at \$3.8 million.

The National Transportation Safety Board determined that the probable cause of the January 7, 2007, derailment of Washington Metropolitan Area Transit Authority train 504 as it traversed a standard turnout track near the Mt. Vernon Square station in Washington, D.C., was a wheel climb on car 5152 that was initiated by a rough wheel surface created when the wheel was trued with a milling machine, the lack of quality control measures to ensure that wheel surfaces were smoothed after truing, the lack of a guard rail on the No. 8 turnout, and Washington Metropolitan Area Transit Authority's failure to have an effective process to implement safety improvements identified following similar accidents and related research projects.

The investigation examined factors and conditions that may have contributed to the wheel climb derailment and actions that can reduce the likelihood of a wheel climb.

### **Wheel-Truing Procedures**

The wheels on the fifth car had been trued at the WMATA Greenbelt maintenance facility 2 days prior to the derailment using a milling machine, and the car had been returned to train service the day of the accident. The surface of the wheel that climbed the rail displayed a "fish scale" appearance and had pronounced ridges. The only smooth, polished area was about a 1/4-inch-wide line in the center where the wheel tread most frequently made contact with the rail head. WMATA milling machine operators did not polish wheel surfaces after truing operations. In August 2005, the Transportation Research Board's Transit Cooperative Research Program (TCRP)<sup>2</sup> published *Report 71, Track-Related Research, Volume 5: Flange Climb Derailment Criteria and Wheel/Rail Profile Management and Maintenance Guidelines for Transit Operations*.<sup>3</sup> This report discussed flange climb derailment factors for transit vehicles and practices to reduce the risk of wheel climb, such as quality control of wheel-truing procedures, lubrication of rails, and installation of guarded turnouts. The TCRP report indicates that a rough wheel surface finish from wheel truing increases the probability of a wheel climb derailment. The report further indicates that wheel surface conditions may be improved by addressing the final wheel surface. Addressing the final wheel surface can involve a light finishing cut, with no significant material removed, to smooth the roughness of the wheel tread surface. Newly trued wheel surfaces can also be polished by running the cars through curved yard tracks and turnouts until the rough finish is smoothed over the entire tread surface. The Safety Board concludes that WMATA's lack of measures to smooth wheel surfaces after truing increases the potential for a wheel climb derailment. WMATA has no explicit guidelines concerning the final surface texture. The Safety Board therefore believes that WMATA should develop a standard for maximum allowable wheel roughness and develop and implement post-wheel-truing procedures to meet that standard.

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<sup>2</sup> The TCRP was established under Federal Transit Administration sponsorship in July 1992 and provides a forum where transit agencies can cooperatively address common operational problems.

<sup>3</sup> This report was one of seven on track-related research. The research for this report was conducted "to improve wheel/rail interaction in transit systems by introducing flange climb derailment criteria and wheel/rail profile management and maintenance guidelines that can be applied to transit operations."

Transit industry research indicates that wheel surface conditions are improved by frequently inspecting the cutting tools, especially on wheel-milling machines. However, WMATA did not have a standard schedule for inspecting and indexing the milling machine cutting heads; instead, indexing was done on an “as needed” basis. From discussions with another transit agency (the Bay Area Rapid Transit District [BART]) that uses milling machines, investigators learned that it requires its milling machines to be indexed every day.

The investigation found irregularities in the dimensions of recently trued wheels at WMATA, including the wheel that derailed in this accident. Although the overall profile of the wheel was accurate, measurements indicated that more material was being removed during the truing operation than was necessary. The cutting head on the milling machine that was used on the wheel was found to be out of alignment. The milling machine’s internal bearings were replaced, and the alignment was corrected. The Safety Board concludes that although the misalignment of the milling machine used in WMATA’s wheel truing operation did not contribute to the wheel climb, it does indicate inadequacies in WMATA’s quality assurance process. The Safety Board therefore believes that WMATA should implement quality assurance procedures to ensure accurate wheel truing, including the regular alignment and indexing of cutting heads on wheel milling machines.

### **Car-Leveling System**

Problems with the car-leveling system on the 5000-series cars were identified soon after WMATA began taking delivery of the cars in 2001. Initially, adjustments were made to the linkage between the leveling valve and the truck. When this proved unsuccessful, modifications were made to the linkage. The modifications did not resolve the situation, so replacement valves were considered. Investigators found that concerns with the car-leveling system appeared to be common knowledge, and while varied attempts have been made, the car imbalance problem has not yet been resolved.

The American Public Transportation Association (APTA) Technical Review Panel that was convened at the request of WMATA reviewed the seven prior low-speed derailments that involved the 5000-series cars. The panel found that up to 98 percent of the fleet of 5000-series cars failed a car-leveling check that was made during routine preventative maintenance procedures. Further, wheel loading could be 25 percent on one corner of a car and 75 percent on the diagonally opposite corner, an imbalance that could lead to a low-speed wheel climb derailment.

The APTA panel expressed concern that the same Knorr leveling valve in the 5000-series cars was also specified in the new 6000-series of WMATA Metrorail cars. The panel further noted its concern that WMATA interdepartmental communication was inadequate, stating that car maintenance personnel input was either not solicited or listened to during the design and engineering process for new cars, and there was no comprehensive process to include all relevant departments in the specification review process for new cars and equipment.

BART has passenger cars similar to the 5000 series cars used by WMATA. However, BART uses the Westcode leveling valve, which has a broader dead band than the Knorr valve, and BART also polishes newly trued wheel surfaces by running the cars through curved yard

tracks until the wheels are smoothed across the tread surface. It is difficult to assess the performance of specific leveling valves in different transit systems and operating environments. Additionally, the leveling valve and associated linkage were damaged in the accident and could not be tested after the accident. Consequently, the extent to which the leveling system and/or valves may be a factor that increased the possibility for a wheel climb derailment at Mt. Vernon Square could not be determined.

WMATA has informed the Safety Board that it has recently installed instrumentation to collect on-board data to further examine and identify the problems with the leveling system on 5000 series cars. Nevertheless, the Board is concerned that inadequate communication between car maintenance department personnel and vehicle engineering design personnel may have delayed bringing this issue to resolution. The Board is also concerned that WMATA has taken delivery of more than 100 new 6000-series cars with car leveling systems equipped with Knorr valves and is in the process of preparing design specifications for a new 7000-series car, with the unresolved issues still associated with these valves. The Safety Board therefore believes that WMATA should establish procedures to ensure that there is appropriate coordination between all departments responsible for car maintenance and engineering design to ensure that problematic issues are identified, examined, and resolved before new equipment is ordered.

### **Wheel Climb Derailment**

WMATA was aware of the wheel climb derailment problem with the 5000-series cars before this accident. Transit industry research and discussions with WMATA management indicate WMATA was aware of work done by the Transportation Research Board for the National Academy of Science and National Academy of Engineering on flange climb derailments in transit operations. Additionally, WMATA commissioned, participated in, and received the final *Wheel-Rail Interface Study* from the Transportation Technology Center Incorporated (TTCI). Extensive testing to determine the cause of these relatively similar derailments in the 5000-series cars failed to produce a solid answer. Also, the APTA panel concluded that there was no single cause in the seven derailments it examined; however, the panel did identify several specific factors and made recommendations for WMATA to consider to prevent future derailments. Nonetheless, after requesting reviews by industry experts and funding related research work, WMATA failed to effectively address the proposed safety recommendations before this accident. The Safety Board therefore believes that WMATA should establish a process, including a single point of responsibility, to prompt timely evaluation and action on proposed safety improvements that are identified as a result of accident and derailment investigations and related research projects.

### **Rail Lubrication**

Although the turnout where the accident occurred was adequately lubricated, the study of the previous yard derailments identified the application of rail lubrication on unguarded No. 8 turnouts as an important strategy to minimize the possibility of a wheel climb derailment. Proper rail lubrication on standard No. 8 turnouts, whether in a yard or on main track, reduces the coefficient of friction as a train maneuvers through a turnout, thereby reducing the potential for a wheel climb.

On October 25, 2005, WMATA sent a memorandum to track inspectors that requires them to assess the lubrication at all switches during routine track inspections. Track inspectors typically apply lubrication at turnouts, as needed, in accordance with the training and instructions detailing where to apply the lubrication. The memorandum emphasizes proper lubrication at crossovers and turnouts to ensure safe single-tracking operations.

Single tracking can occur at any time for a variety of reasons during normal operations and on days when routine track inspections are not conducted. Operating department personnel responsible for planning single-track operations determine the particular turnouts that will be utilized. Track engineering department personnel are responsible for lubricating switches as required during each inspection to ensure that the turnout remains adequately lubricated during a single-tracking operation. However, engineering personnel are not automatically notified when single-tracking operations are initiated. Because more trains are operated through lubricated switches utilized in single tracking, lubrication is depleted faster, which could eventually lead to an undesirable “dry rail” condition that increases the coefficient of friction and thereby increases the potential for a wheel climb derailment.

WMATA’s October 25, 2005, memorandum does not contain requirements for coordination between the operating and track engineering departments. In addition, although WMATA has drafted a written standard operating procedure and a written track maintenance procedure that expand on the instructions in the memorandum and provide technical guidance regarding the location, application procedures, and frequency of rail lubrication, these procedures also do not address the need for interdepartmental communication and coordination when single-tracking operations are planned.

Because more frequent lubrication will likely be needed on turnouts used for single-track operations due to increased train traffic, when track department personnel are aware that a single-track operation is scheduled between track inspections, they can make arrangements for additional inspections to assess the adequacy of lubrication during the operation. The Safety Board concludes that although rail lubrication was not a factor in this accident, because a lack of rail lubrication can significantly increase the potential for wheel climb derailments, comprehensive rail lubrication procedures and interdepartmental coordination are needed that take into account both operational and track engineering demands. The Safety Board believes that WMATA should establish written procedures for rail lubrication that include close coordination between the operating and track engineering departments to ensure timely and appropriate rail lubrication is applied in normal and single-track operations.

### **Guarded Turnouts**

The seven prior WMATA derailments, beginning in 2003, involved empty trains traveling at low speeds on yard tracks. Three of the derailments involved trains traversing standard (unguarded) No. 8 turnouts; the other four derailments occurred when a train maneuvered through a curve with a radius of less than 500 feet. Some of these derailments also involved cars that had recently had at least one set of wheels trued at a WMATA maintenance facility.

Guarded turnouts have an additional guard rail system that physically restrains the wheel sets from climbing the rail when a change in the wheel/rail interface occurs as a train traverses a

turnout. Therefore, if an increased coefficient of friction from a rough wheel surface or a car imbalance occurs in a guarded turnout, the possibility of a wheel climb derailment is eliminated. The Safety Board concludes that had a guarded turnout been installed, it would have prevented the wheel climb and derailment of the fifth car as the accident train traversed the curved track.

The TTCI, APTA, and TCRP reports found that there is an increased risk of a wheel flange climb derailment when a transit car operates through a standard No. 8 turnout. Further, the TTCI report recommended in 2005 that WMATA replace standard No. 8 turnouts with guarded turnouts. WMATA has informed the Safety Board that it is replacing all standard No. 8 turnouts with guarded turnouts on its main track. Currently, WMATA is replacing an average of about 30 turnouts per year.

As of September 2007, WMATA had 101 guarded No. 8 turnouts and 72 standard (unguarded) No. 8 turnouts on the main tracks of the Metrorail system. Although the Safety Board recognizes that WMATA is making progress in replacing standard turnouts with guarded turnouts, the Board believes that WMATA should expedite and complete by 2009 the replacement of all No. 8 standard turnouts with guarded turnouts on main track.

Therefore, the National Transportation Safety Board makes the following recommendations to the Washington Metropolitan Area Transit Authority:

Develop a standard for maximum allowable wheel roughness and develop and implement post-wheel-truing procedures to meet that standard. (R-07-23)

Implement quality assurance procedures to ensure accurate wheel truing, including the regular alignment and indexing of cutting heads on wheel milling machines. (R-07-24)

Establish procedures to ensure that there is appropriate coordination between all departments responsible for car maintenance and engineering design to ensure that problematic issues are identified, examined, and resolved before new equipment is ordered. (R-07-25)

Establish a process, including a single point of responsibility, to prompt timely evaluation and action on proposed safety improvements that are identified as a result of accident and derailment investigations and related research projects. (R-07-26)

Establish written procedures for rail lubrication that include close coordination between the operating and track engineering departments to ensure timely and appropriate rail lubrication is applied in normal and single-track operations. (R-07-27)

Expedite and complete by 2009 the replacement of all No. 8 standard turnouts with guarded turnouts on main track. (R-07-28)

In your response to the recommendations in this letter, please refer to Safety Recommendations R-07-23 through -28. If you need additional information, you may call (202) 314-6177.

Chairman ROSENKER, Vice Chairman SUMWALT, and Members HERSMAN, HIGGINS, and CHEALANDER concurred in these recommendations. Member HIGGINS filed a concurring statement, which is attached to the Railroad Accident Report.

*[Original Signed]*

By: Mark V. Rosenker  
Chairman