



National Transportation Safety Board

Washington, D.C. 20594

Safety Recommendation

Date: February 3, 2005

In reply refer to: R-05-03

Mr. William Roj
President
ERICO Products, Inc.
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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 recommendation in this letter. The Safety Board is vitally interested in this recommendation because it is designed to prevent accidents and save lives.

This recommendation addresses the effect of bond wire welding on rail integrity and inconsistent instructions regarding the exothermic welding of bond wires. The recommendation is derived from the Safety Board's investigation of the February 9, 2003, derailment of northbound Canadian National (CN) freight train M33371 in Tamaroa, Illinois, and is consistent with the evidence we found and the analysis we performed. As a result of this investigation, the Safety Board has issued four safety recommendations, one of which is addressed to ERICO Products, Inc. Information supporting this recommendation 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 recommendation.

About 9:04 a.m. central standard time on February 9, 2003, northbound Canadian National freight train M33371, traveling about 40 mph, derailed 22 of its 108 cars in Tamaroa, Illinois. Nineteen of the 22 derailed cars were tank cars that contained hazardous materials or hazardous material residues. One pressure tank car was punctured, and seven general service tanks were breached. About 850 residents were evacuated from the area within a 3-mile radius of the derailment, which included the entire village of Tamaroa. No one was injured during the derailment, although one contract employee was injured during cleanup activities. Damages to track, signals, and equipment, and clearing costs associated with the accident totaled about \$1.9 million.¹

¹ For more information, see National Transportation Safety Board, *Derailment of Canadian National Freight Train M33371-08 and Subsequent Release of Hazardous Materials in Tamaroa, Illinois, February 9, 2003*, Railroad Accident Report NTSB/RAR-05/01 (Washington, D.C.: NTSB, 2005).

The National Transportation Safety Board determined that the probable cause of this accident was CN's placement of bond wire welds on the head of the rail just outside the joint bars, where untempered martensite² associated with the welds led to fatigue cracking that, because of increased stresses associated with known soft ballast conditions, rapidly progressed to rail failure.

ERICO provides the equipment, supplies, and guidance for the Cadweld[®] exothermic welding process that CN used at the site of the derailment. The company also provided the equipment used for making Cadweld bond wire welds at St. Johns, the site of a previous CN insulated joint plug rail failure that the Safety Board evaluated as part of this accident investigation.

A review of ERICO guidance documents applicable to bond welds revealed some omissions and contradictions that, if the instructions in these documents were used to direct the welding process, could affect the integrity of the weld or the steel at the weld site.

For example, effective bond welding requires that the rail be dried before application of the bond wires. However, ERICO's Cadweld instructions for rail head bonds do not contain the rail-drying requirement found in its Cadweld instructions for rail web bonds, even though both applications require the same pre-weld preparation. The American Railway Engineering and Maintenance-of-Way Association's (AREMA's) *Communication and Signal Manual*, Part 8.6.40, Section C5, also recommends that bonding not be performed when moisture or lubricants are present on the molds, weld metal, or rail surface. Further, ERICO's Cadweld rail web bond instructions do not contain a requirement that molds be clean and dry, although ERICO provides such a requirement in its instructions for bonds at rail heads, and such a requirement is appropriate for all applications.

To reduce stresses in the weld areas, bond welds at the rail head must be placed above the joint bars. The Cadweld rail head bond instructions, however, illustrate the fixture on a rail head without any reference to the joint bars. In contrast, the AREMA *Communication and Signal Manual*, at Part 8.1.30, figure 1, properly illustrates a bond wire on a rail head directly above a joint bar. Thus, the Safety Board concluded that ERICO's exothermic bond wire welding application literature is not entirely consistent with recommended industry practices.

ERICO's Cadweld instructions do not warn against placing a rail head bond outside the confines of a joint bar, despite the fact that ERICO's own May 10, 1999, list of items the company provided for possible inclusion by AREMA in its exothermic welding guidance documents included the statement that "bonds are to be exothermically welded to the head of the rail only within the confines or limits of the splice plate or joint bars." ERICO's Cadweld instructions also do not specifically warn against putting a bond weld outside the confines of the joint bar on the rail base, even though in its May 10, 1999, guidance to AREMA, ERICO stated that "bonds welded to the rail outside the confines of the splice plate or joint bars shall be welded

² *Martensite* is a hard and brittle crystal structure that occurs as a result of very rapid cooling (quenching) of heated steel (at about 1000° C or 1832° F per minute). Subsequent reheating of the steel to about 400° C (752° F) and holding it at this temperature for a time (tempering) produces a strong and tough steel with lower hardness and brittleness.

to the web of the rail at the neutral axis.” (In the case of the broken St. Johns insulated joint plug that was replaced in January 2003, the exothermic bond wire welds were made both outside the confines of the joint bar and on the rail base with equipment supplied by ERICO.)

The Safety Board’s document review also revealed that some ERICO guidance literature contains statements that were proven inaccurate by the results of the demonstration welds that ERICO made as part of the accident investigation. Specifically, although the Cadweld process literature states that the Cadweld process produces a quenched and tempered thermal cycle that tempers the steel and reduces its hardness sufficiently to result in reduced brittleness, Safety Board examination of eight bond wire welds from Tamaroa and three welds from St. Johns found heat-affected zones with structures consistent with untempered martensite. Analysis of a failed CN Cadweld weld performed for CN by a metallurgical testing laboratory also revealed a martensitic structure beneath the weld. Finally, the hardness of the heat-affected zones in the demonstration welds that ERICO produced for the Safety Board was found to be near the maximum hardness associated with untempered martensite, indicating that little or no tempering was accomplished during the production of the weld. A re-bonded weld on the St. Johns rail did show a reduction in hardness and therefore a tempered martensite structure, suggesting that only a second heating process will truly temper the steels at exothermic welds.

The National Transportation Safety Board therefore makes the following safety recommendation to ERICO Products, Inc.:

Revise the instructions for your Cadweld welding systems to address the proper placement of exothermic bond wire welds, especially in the vicinity of joint bars, and to make users aware that these welds create untempered martensite that could, under certain conditions, lead to fatigue cracking and rail failure. (R-05-03)

The Safety Board also issued safety recommendations to the Federal Railroad Administration and the American Railway Engineering and Maintenance-of-Way Association. In your response to the recommendation in this letter, please refer to R-05-03. If you need additional information, you may call (202) 314-6177.

Chairman ENGLEMAN CONNERS, Vice Chairman ROSENKER, and Members CARMODY, HEALING, and HERSMAN concurred in this recommendation.

By: Ellen Engleman Connors
Chairman