DEPARTMENT OF TRANSPORTATION

Federal Railroad Administration

[Docket No. FRA-2017-0074; Notice No. 1]

Addressing Electrode-Induced Rail Pitting from Pressure Electric Welding

AGENCY: Federal Railroad Administration (FRA), Department of Transportation (DOT).

ACTION: Notice of draft Safety Advisory; request for comment.

SUMMARY: This document provides notice of FRA's intent to issue a Safety Advisory alerting railroads, contractors, and the rail welding industry of the potential for electrode-induced rail pitting and fatigue cracking during the pressure electric rail welding process. Based on investigation and research, FRA believes improper electrode contact to the rail during the welding process can result in electrode-induced pitting that may lead to fatigue fracture and ultimately rail failure. The draft Safety Advisory includes recommendations to help the industry prevent electrode-induced rail pitting and to inspect for and then remediate such pitting if it occurs. FRA invites public comment on all aspects of the draft Safety Advisory.

DATES: Interested persons are invited to submit comments on the draft Safety Advisory provided below on or before **[INSERT DATE 60 DAYS AFTER DATE OF PUBLICATION IN FEDERAL REGISTER]**.

ADDRESSES: Comments in response to this notice may be submitted by any of the following methods:

- Web site: The Federal eRulemaking Portal, www.Regulations.gov. Follow the Web site's online instructions for submitting comments.
- Fax: 202–493–2251.
- Mail: Docket Management Facility, U.S. Department of Transportation, Room W12-140, 1200 New Jersey Avenue, SE, Washington, DC 20590.
- Hand Delivery: Docket Management Facility, U.S. Department of Transportation, 1200 New Jersey Avenue, SE, Room W12-140 on the Ground level of the West Building, between 9 a.m. and 5 p.m., Monday through Friday, except Federal holidays.

Instructions: All submissions must include the agency name, docket name, and docket number for this notice, Docket No. FRA-2017-0074; Notice No. 1. Note that all comments received will be posted without change to http://www.Regulations.gov, including any personal information provided. Please see the Privacy Act Statement in this document.

FOR FURTHER INFORMATION CONTACT: Mr. Matthew Brewer, Staff Director, Rail Integrity Division, Office of Railroad Safety, FRA, 500 Broadway, Suite 240, Vancouver, WA 98660, telephone (202) 385-2209; or Mr. Aaron Moore, Trial Attorney, Office of Chief Counsel, FRA, 1200 New Jersey Avenue, SE, Washington, DC 20590, telephone (202) 493-7009.

SUPPLEMENTARY INFORMATION:

DRAFT Safety Advisory

FRA routinely conducts investigations of railroad accidents to determine causation and any contributing factors to help the railroad industry implement corrective

measures that may prevent similar incidents in the future. Over the past decade, FRA has investigated multiple broken rail accidents in which it found fractures in the rail web. Similarities in the fracture characteristics of the recovered rail fragments in some of these accidents have led FRA to conclude stray arcing may occur during the pressure electric welding process performed to create continuous welded rails.

Pressure electric welding is the process of using a hydraulically-operated welding head that clamps around two opposing rail ends, pressing an electrode on each rail, then hydraulically pulling the rail ends together while arcing current through the electrodes into the rails, causing them to essentially melt together to form a continuous rail. FRA believes stray arcing during this process results in the formation of electrode burns or pits on the web, head, or base of the rail. Fractures in the rail may originate from the electrode pits because they behave as stress raisers (also referred to as stress concentrations). Fatigue cracks often develop at locations of stress concentration. Once a fatigue crack initiates, the localized stress encourages the growth of the crack, which may potentially lead to rail failure. FRA believes electrode pitting may be a contributing factor, if not the root cause, in some accidents involving rail web cracking.

Figure 1 below shows a photograph of a rail with electrode pits in the web. The location of these electrode pits, when they occur, is typically four to eight inches on either side of the weld. Electrode-induced pitting from pressure electric welding may also occur in the head and base of the rail. At this time, it is unclear whether traditional ultrasonic rail testing can consistently detect electrode-induced pitting.

In 2016, FRA's Office of Railroad Safety requested technical support from The National Transportation Systems Center (Volpe) to study the fatigue and fracture

behavior of rails with pitting from electrodes used in welding. Volpe enlisted technical support from the U.S. Army's Benét Laboratories (Benét) to conduct forensic examination of three rail sections with electrode-induced pitting in the web from the pressure electric welding process. FRA obtained these rails from members of the railroad industry. Benét's examination included fractography (the science of studying fracture surfaces to identify the origin and causes of fracture), metallography (the science of studying the microstructure of metals to provide information concerning the properties and processing history of metallic alloys), and testing to determine the chemical composition and tensile mechanical properties of the rail steel. Benét confirmed FRA's hypothesis that electrode-induced web fatigue cracking is a result of pitting caused by inadequate electrode-to-rail contact.

Specifically, Benét's metallurgical analyses concluded the cracking in the rail web originated from the pitting created by inadequate electrode-to-rail contact during the pressure electric welding process. The fractographic and metallographic examinations revealed evidence of fatigue cracking originating from the pitting and fast fracture once the fatigue crack reached a critical length. Figure 2 below shows three photographs of the fracture surface of a crack found in one of the rails Benét examined. These photographs support the metallurgical evidence indicative of three stages of fatigue fracture: (1) Crack initiation or formation originating from the pitting; (2) crack propagation or growth by metal fatigue; and (3) final rupture or fast fracture. Figure 3 below shows photographs of the microstructure near the electrode pits in each examined rail, providing further evidence the cracking originated from the pitting created by improper electrode contact during welding.

The results from the metallurgical analysis also suggested premature and sudden rail failure may result from high wheel-impact load (e.g., flat wheel), especially in cold-weather environments when the longitudinal rail force is tensile. Results from the chemical analysis and mechanical testing indicated the chemistry and mechanical properties of the rails selected for evaluation were within specifications the American Railway Engineering and Maintenance-of-Way Association (AREMA) published, except for the hardness measurements in one rail, which were slightly lower than the AREMA minimum. Hardness is a measure of the resistance of a material to surface indentation produced by a carbide indenter applied at a given load for a given length of time. The lower hardness in that rail, manufactured in the 1950s, may be attributed to lower concentrations (compared to the other two rails) of alloying elements, specifically carbon, silicon, and chromium, which were still within AREMA tolerances. Testing of the chemistry and the mechanical properties revealed all three rails were made from standard quality steel containing no other defects except the electrode-induced pitting.

FRA presented its concerns about electrode-induced rail pitting and fatigue cracking to the Railroad Safety Advisory Committee's Rail Integrity Working Group. FRA also advised the Working Group that FRA was considering issuing a safety advisory to ensure all parties are aware of the potential for electrode-induced pitting and fatigue cracking (as identified in the figures below) and the pressure electric welding process is performed properly. (FRA has posted a copy of this notice on its public Web site, www.fra.dot.gov, where you may view the figures below in their full resolution.)

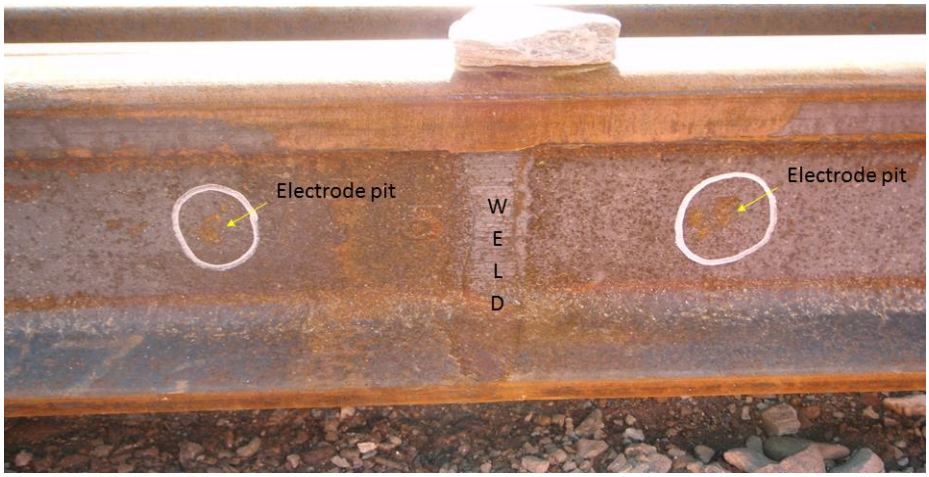

Figure 1: Electrode-Induced Pits in a Rail

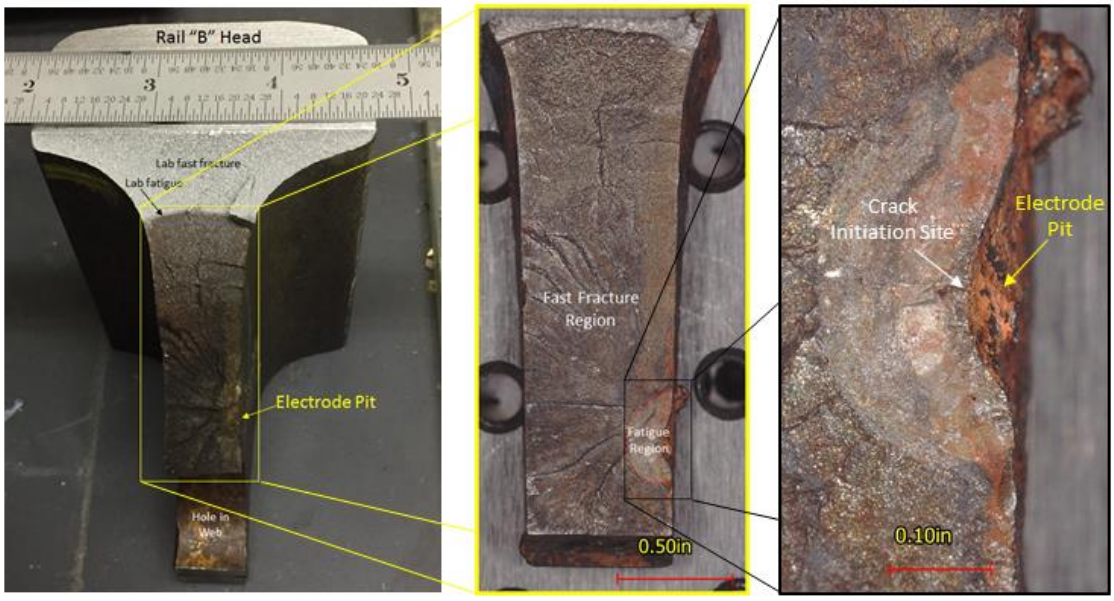

Figure 2: Photographs of Crack Fracture Surface in Examined Rail

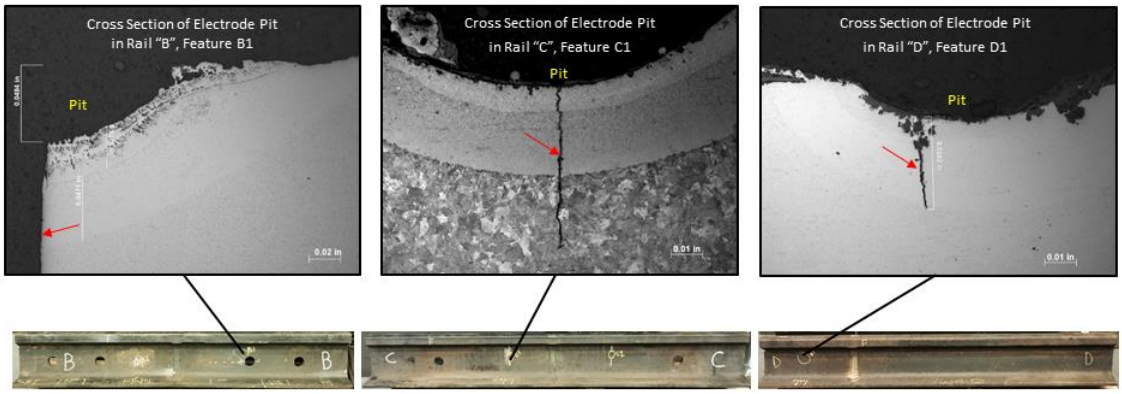

Figure 3: Photographs of Rail Cross Sections

Recommended Action: Based on the discussion above, and to prevent future electrode-induced pitting and fatigue cracking which may lead to premature rail failure, FRA recommends railroads, contractors, and the rail welding industry develop and apply appropriate methods to:

1. Prevent electrode-induced rail pitting from occurring by:
    a. Reviewing proper pre- and post-weld procedures to avoid the development of electrode pitting;
    b. Improving welder training programs to ensure consistency in welding procedures, especially for the pressure electric welding process; and
    c. Developing and scheduling appropriate pressure electric welding maintenance and rail testing programs.
2. Identify electrode-induced rail pitting by:
    a. Inspecting the rail upon completion of welding, and reviewing the documentation in the weld report to help identify if pitting occurred;
    b. Visually inspecting existing welds for electrode-induced pitting during routine track inspections; and

c. Considering alternative methods of identifying electrode-induced pitting, such as ultrasonic testing, machine vision, etc.

3. Remediate any identified electrode-induced pitting by:

    a. Removing the section of rail containing electrode-induced pitting and re-welding the rail; or

    b. Developing and applying possible alternative methods to remove electrode-induced pitting, such as drilling, if electrode-induced pitting is found and the section of rail cannot be readily removed or re-welded.

FRA requests public comment on all aspects of this draft Safety Advisory.

Privacy Act Statement: Anyone can search the electronic form of all comments received into any of DOT's dockets by the name of the individual submitting the comment (or signing the comment, if submitted on behalf of an association, business, labor union, etc.). You may review DOT's complete Privacy Act Statement in the *Federal Register* published on April 11, 2000 (65 FR 19477), or you may visit http://www.regulations.gov/#!privacyNotice.

Issued in Washington, DC on August 10, 2017.

Patrick Warren,

Executive Director.

BILLING CODE 4910-06-P

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