[4910-06-P]

DEPARTMENT OF TRANSPORTATION

Federal Railroad Administration

[Docket No. FRA-2017-0074, Notice No. 2; Safety Advisory 2018-01]

Addressing Electrode-Induced Rail Pitting from Pressure Electric Welding

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

ACTION: Notice of Safety Advisory.

SUMMARY: FRA is issuing Safety Advisory 2018-01 to remind 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.

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: On August 16, 2017, FRA published a notice of a draft safety advisory in the Federal Register to address electrode-induced rail pitting from pressure electric welding and seeking comment on the issue. 82 FR 38989. FRA noted its investigation and research into the issue demonstrated that improper electrode contact to the rail during the welding process could result in electrode-induced pitting

that may lead to fatigue fracture and ultimately rail failure. As a result, FRA's draft safety advisory contained specific recommendations to help the industry prevent electrode-induced pitting.

FRA presented the information contained in the draft safety advisory to its Railroad Safety Advisory Committee's (RSAC) Rail Integrity Working Group. Subsequent RSAC discussions and comments submitted by the Association of American Railroads (AAR) indicated that the rail industry agrees with FRA's concern that stray arcing can result in the formation of electrode pits and that fatigue cracking can then develop from these electrode pits. AAR noted, however, that FRA's draft safety advisory did not present any information to support a finding that rail failures from electrode-induced rail pitting are a wide-spread problem. Further, AAR noted that its member railroads report they have seen no indications of a systemic problem involving electrode pitting, and that railroads and welding companies have procedures in place to prevent electrode pitting and remediate it when it does occur. Accordingly, AAR asserted that FRA should not issue any recommendations burdening the industry such as those included in the draft safety advisory.

After consideration of AAR's comments and input from RSAC discussions, FRA agrees with AAR's position that, although stray arcing during the pressure electric welding process can result in the formation of electrode burns or pits on the web, head, or base of rail, and that fatigue cracking can develop from those burns or pits, railroads and welding companies have procedures in place addressing the issue of electrode pitting. Accordingly, in issuing Safety Advisory 2018-01, FRA has not adopted the specific recommended actions listed in its draft safety advisory and instead intends Safety

Advisory 2018-01 to merely remind railroads, contractors, and the rail welding industry to be diligent in complying with existing practices and procedures designed to prevent electrode-induced pitting in rail and to mitigate the pitting when it does occur.

Safety Advisory 2018-01

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. 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 may 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. 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 the 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 recognizes that the industry already has practices and procedures in place to avoid electrode pitting during the pressure electric welding process. Therefore, FRA is issuing Safety Advisory 2018-01 to remind railroads, railroad employees, railroad contractors, and welding companies and their employees of the importance of complying with those procedures to prevent electrode pitting and, ultimately, to prevent rail failures. (FRA has posted a copy of this notice on its public website, www.fra.dot.gov, where you may view the figures below in their full resolution.)

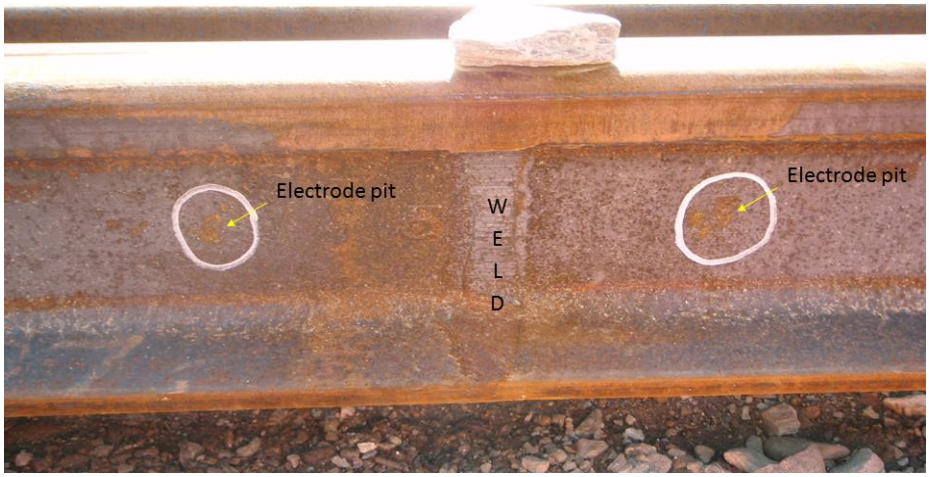

Figure 1: Electrode-Induced Pits in a Rail

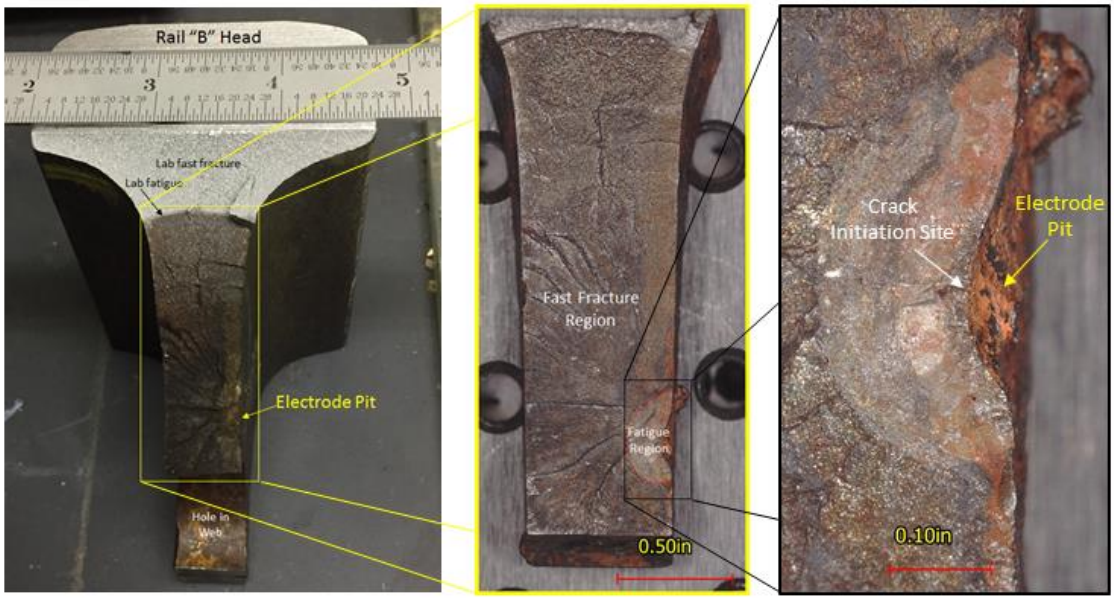

Figure 2: Photographs of Crack Fracture Surface in Examined Rail

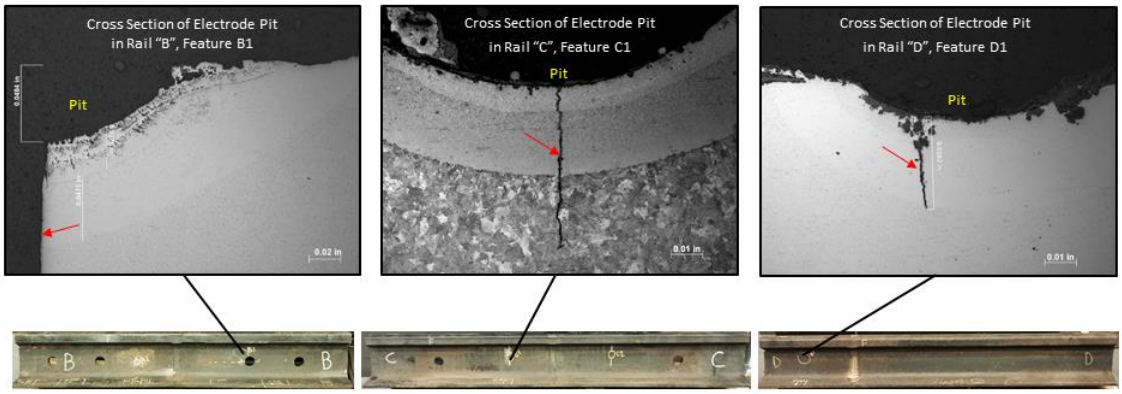

Figure 3: Photographs of Rail Cross Sections

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Administrator.
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