





# NTSB Staff

Ron Hynes

IIC, Operations & Mechanical

Cy Gura

Track, Signals & IIC

Jim Henderson

Hazmat & Emergency Response

Tom Lasseigne

Environmental

Derek Nash

Materials Laboratory

Ruben Payan

Event Recorders

Robert Moore

Writer

Margaret Athey

Editor

Christy Spangler

Graphics

Estimated 3,100 man hours working on investigation

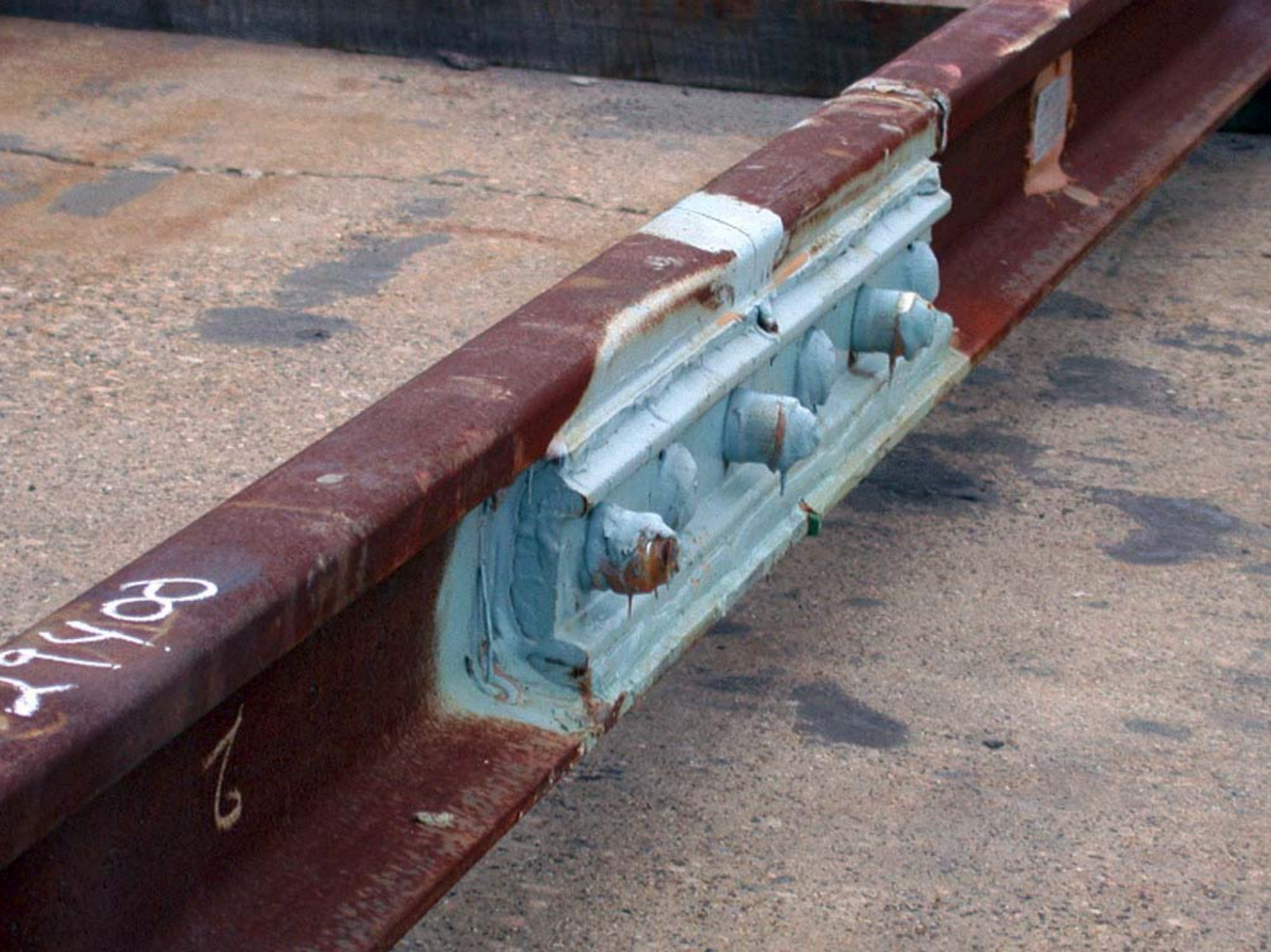


**National Transportation Safety Board**

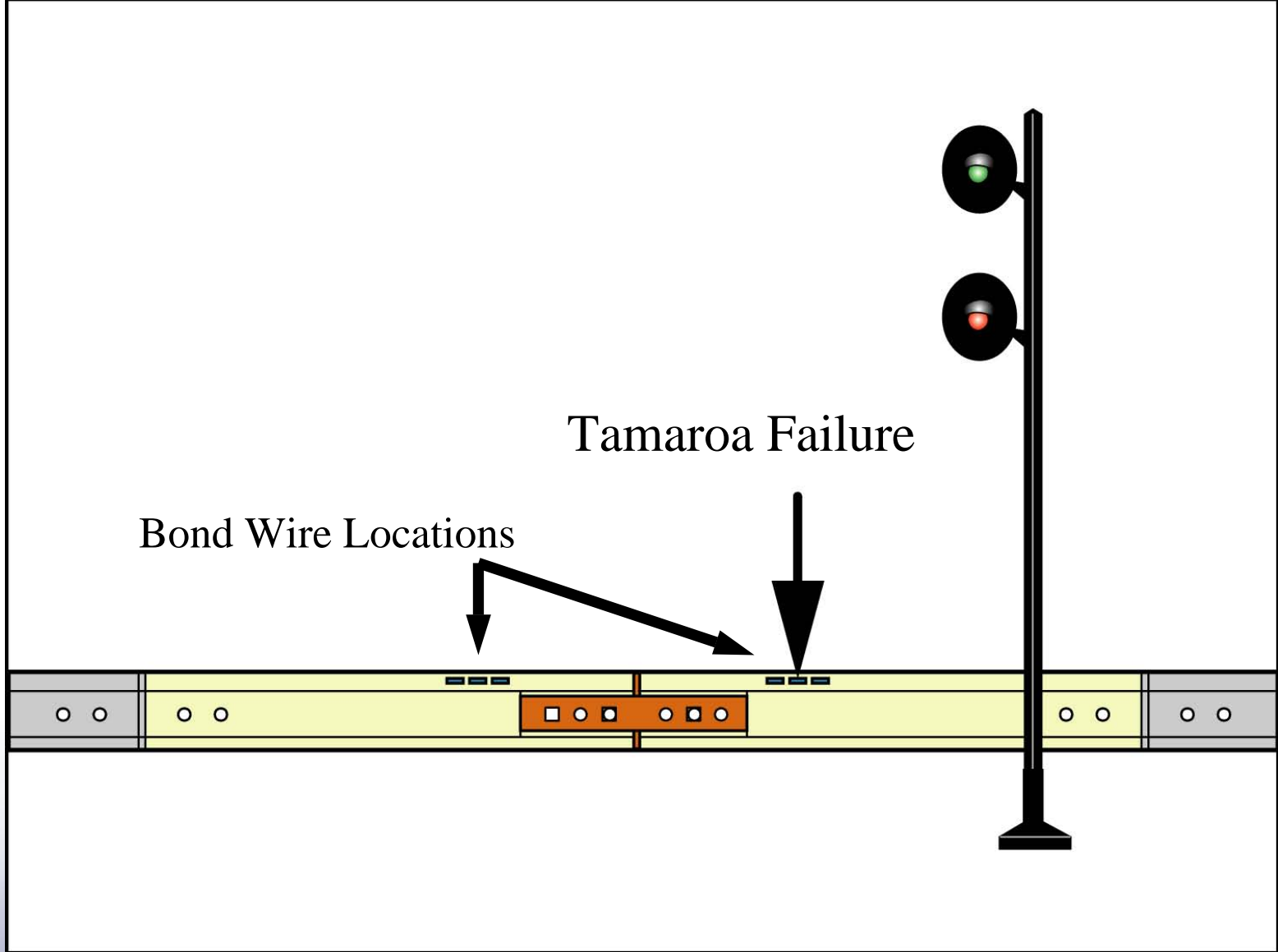
# Parties

- Federal Railroad Administration
- Canadian National Railroad
- ERICO Products Incorporated
- Brotherhood of Locomotive Engineers and Trainmen





60x12



# Safety Issues

- The effect of bond wire welding on rail integrity.
- Inconsistent instructions regarding the exothermic welding of bond wires.









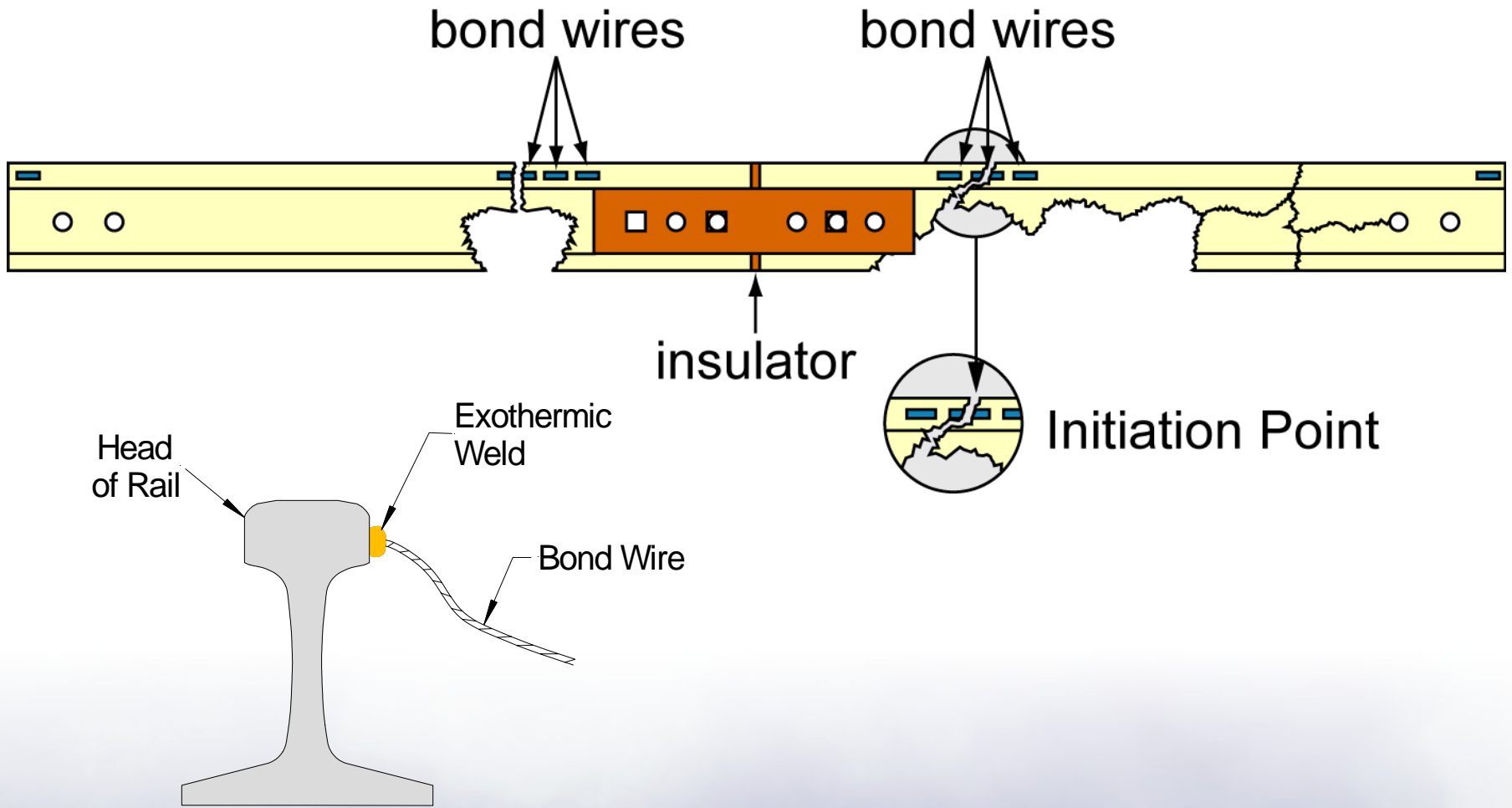
**National Transportation Safety Board**

# Factors in Tamaroa Rail Failure

- Bond wire welds created brittle steel (untempered martensite)
- Decreased track support (soft ballast)
- Location of bond wire welds







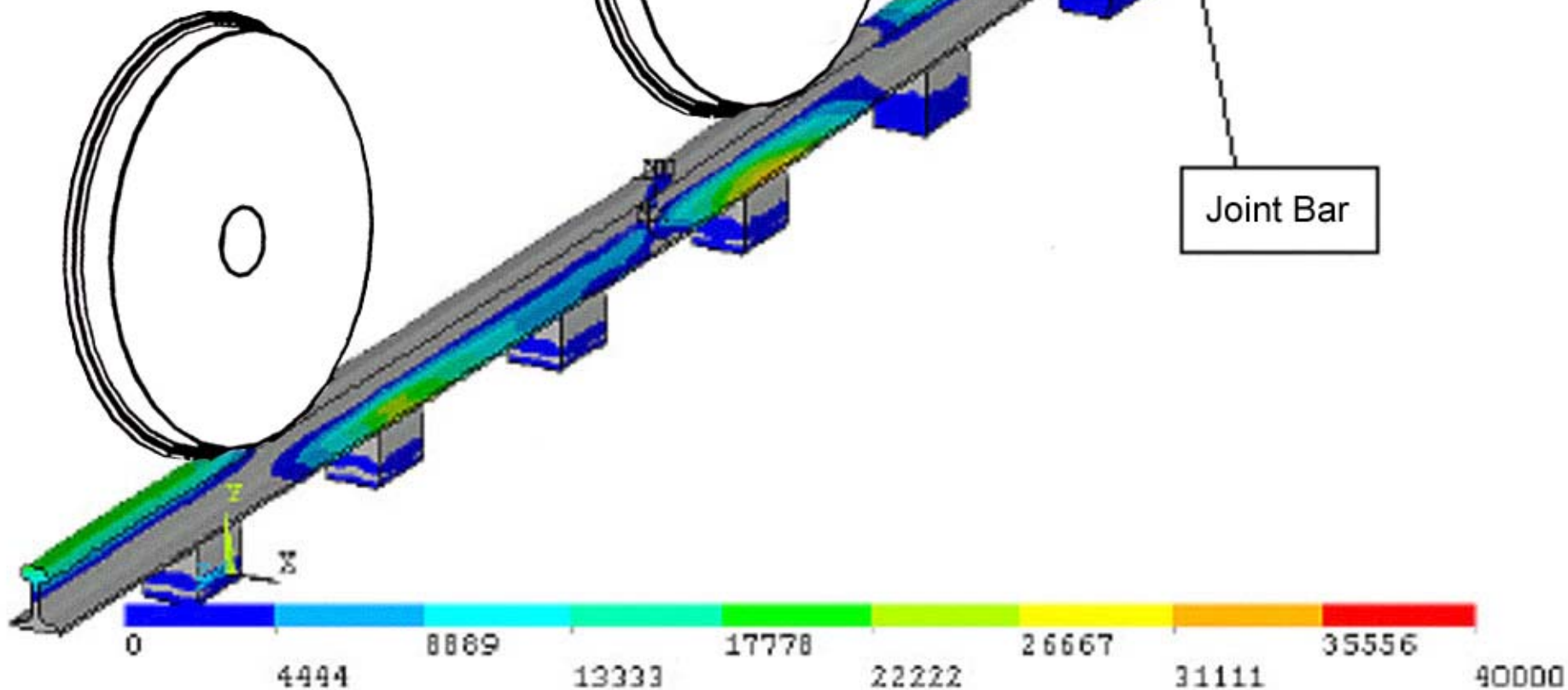
# Tamaroa Track Conditions

- Soft ballast conditions
- Increased bending stresses



High Bending Stress  
Caused by Change in  
Rail Stiffness

Joint Bar



# Conclusion

- The known soft ballast condition in the area of the insulated joint increased the amount of rail flexing in that area which, in turn, significantly increased stresses in the rail.



# Conclusion

- The increased stresses due to the flexing of the rail in the area of the insulated joint caused the propagation of the cracks that had originated in areas of untempered martensite at the rail head, causing the rail to fail only 17 days after installation.





# St. John's Insulated Joint Plug



# St. John's Insulated Joint Plug

- Failed at an exothermic bond wire weld
- The welds were made on a high stress area outside the confines of insulated joint bars





# **Materials Laboratory Examinations**

**Derek Nash**

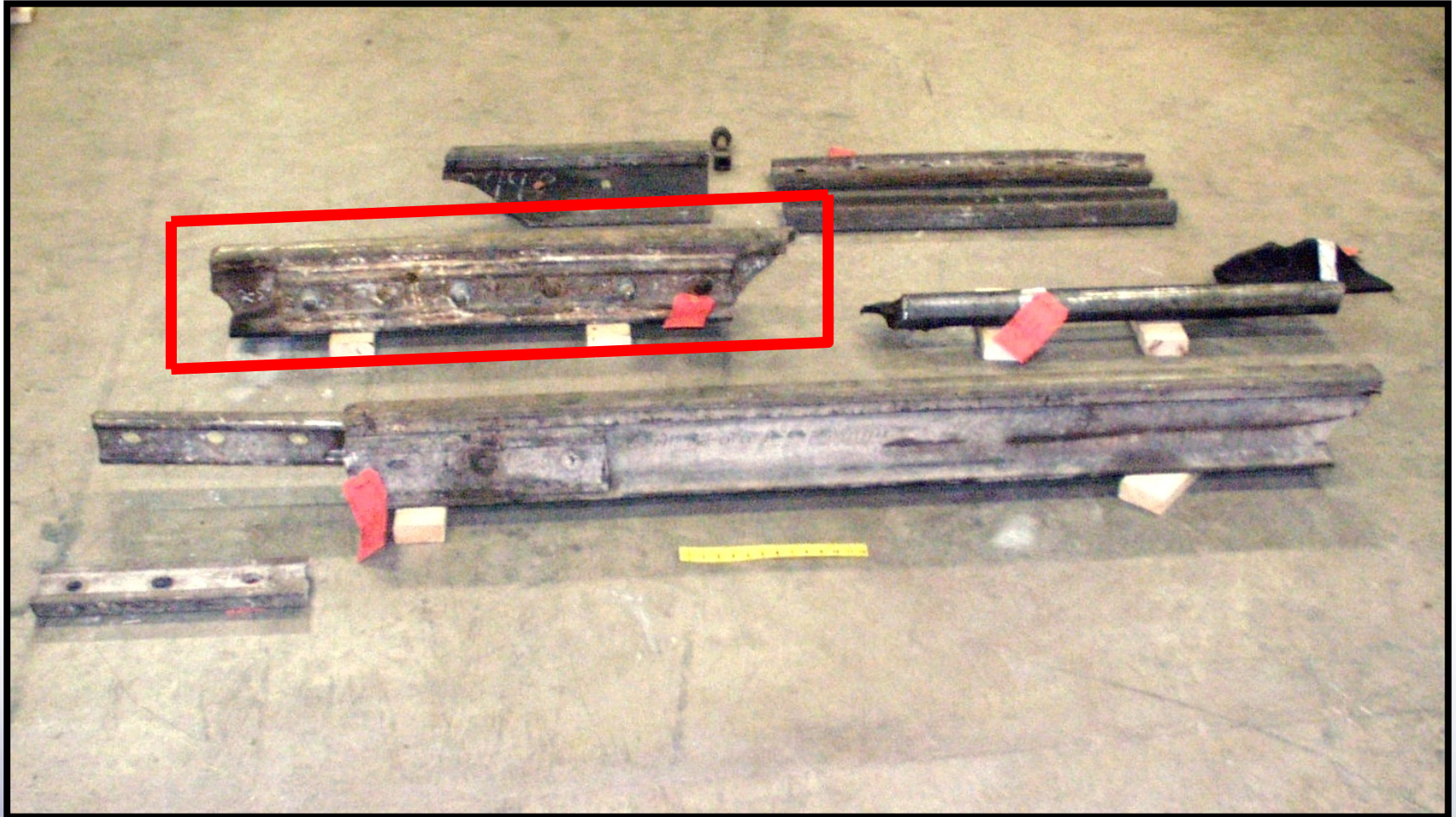


# **Tamaroa Insulated Joint**

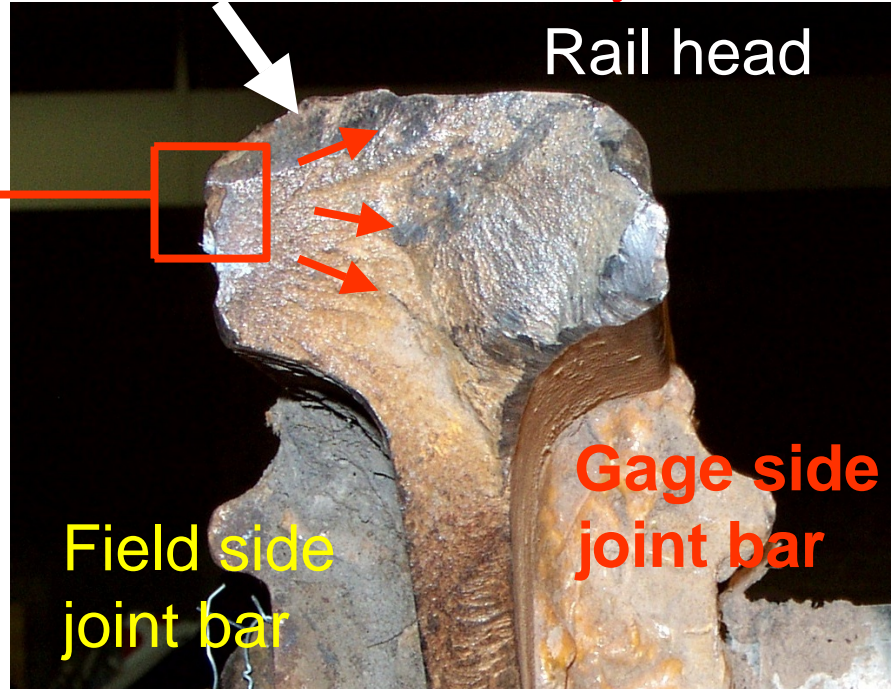
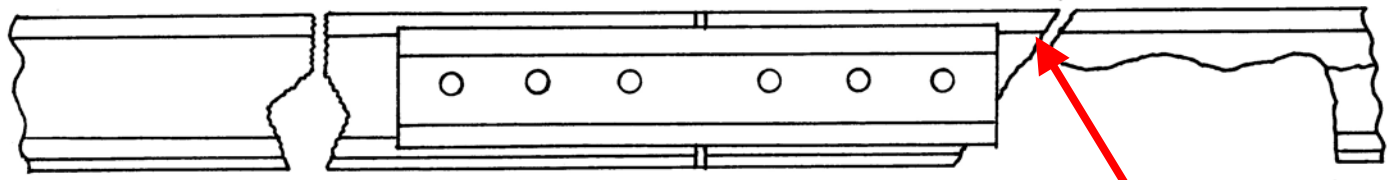


**National Transportation Safety Board**

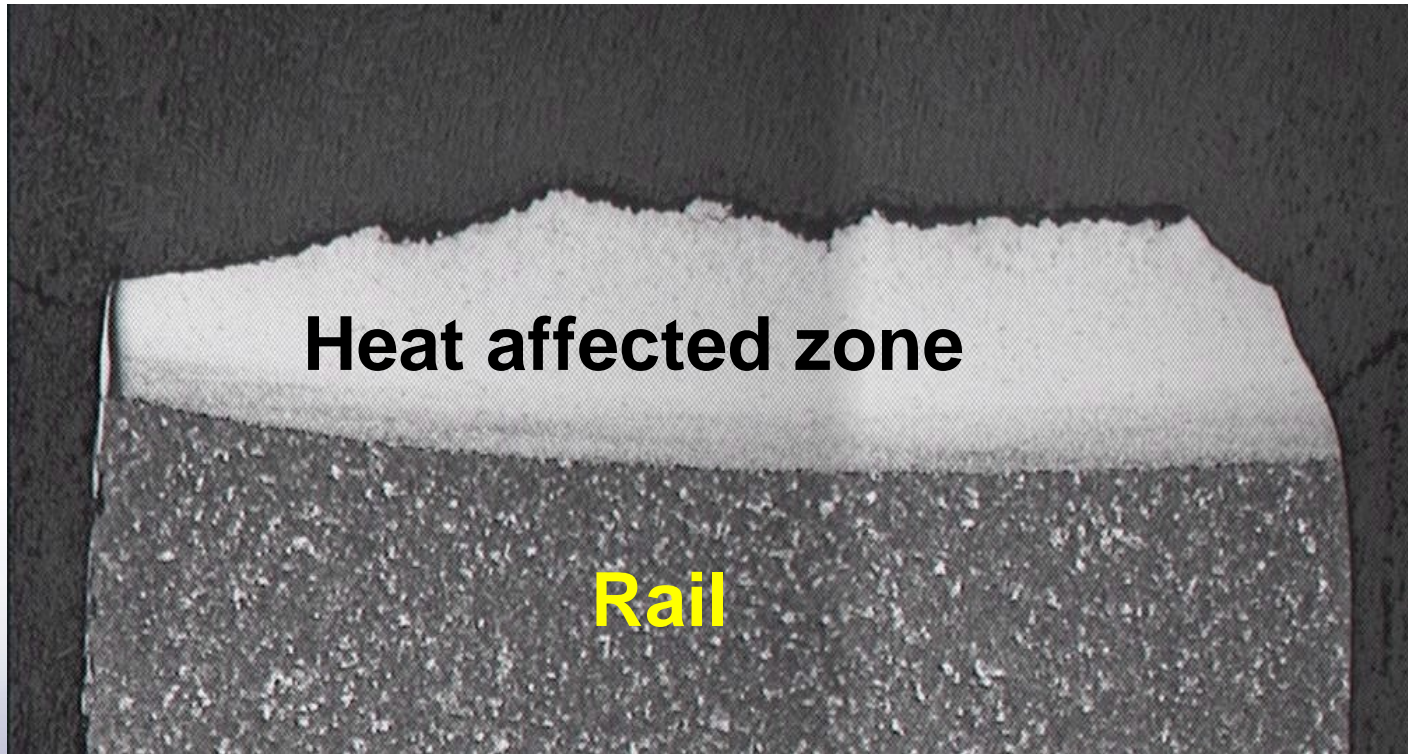
# Tamaroa Insulated Joint Pieces (Field Side View)



# Fracture Face North of Insulated Joint



# Section Through Rail Head Fracture

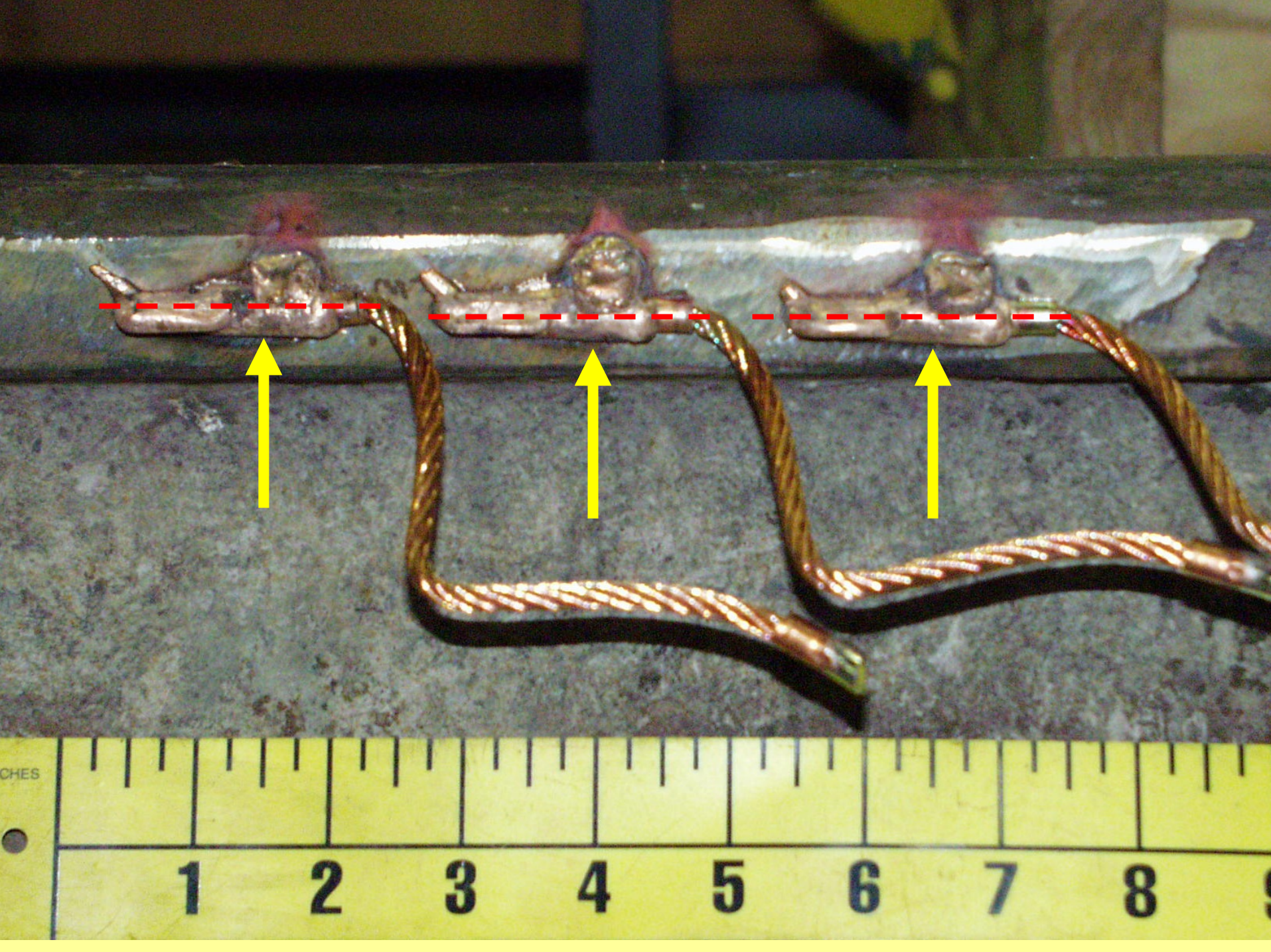




# **CADWELD Demonstration Welds**



**National Transportation Safety Board**



-----



CHES

1

2

3

4

5

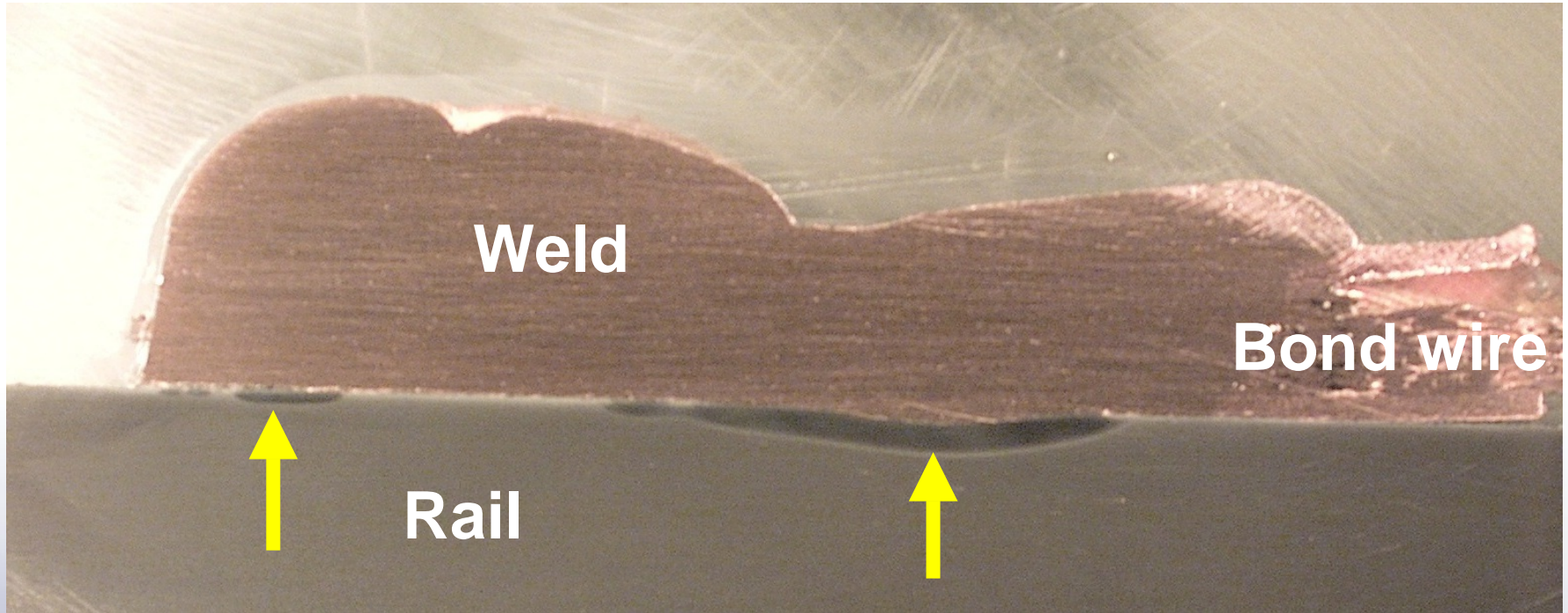
6

7

8

9

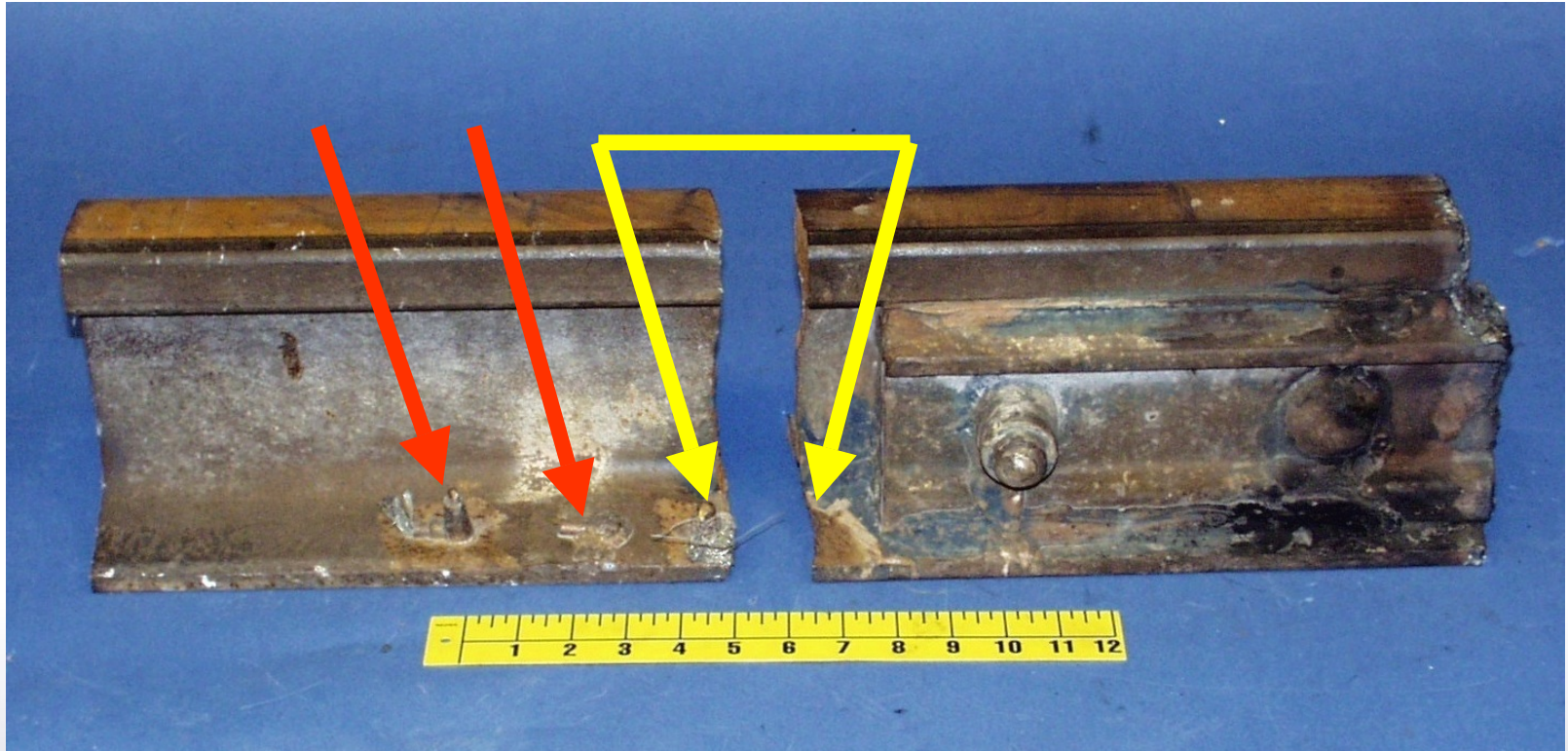
# Section of a Demonstration Weld



# St. Johns Rail



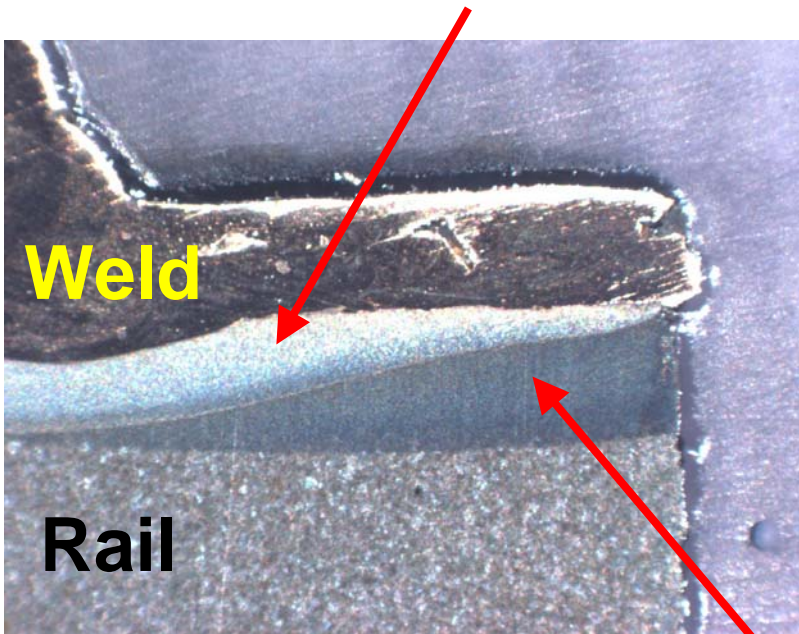
**National Transportation Safety Board**



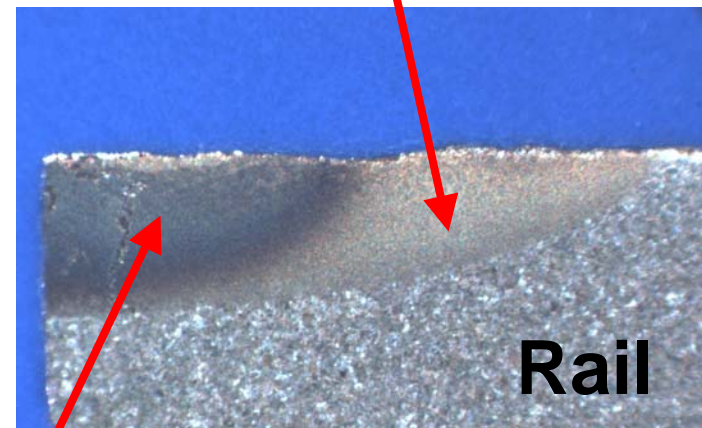
**National Transportation Safety Board**

# St. Johns Rail Sections

Heat affected zone A



Heat affected zone C



Heat affected zone B

# Materials Laboratory Observations

- Bond wire welding produced untempered martensite.
- Fatigue cracks developed from areas of untempered martensite.
- The bond wire welds had been located at a high stressed portion of the insulated joint.
- The bond wire at the fracture initiation of the St. Johns rail had been installed on top of a previous bond wire weld.





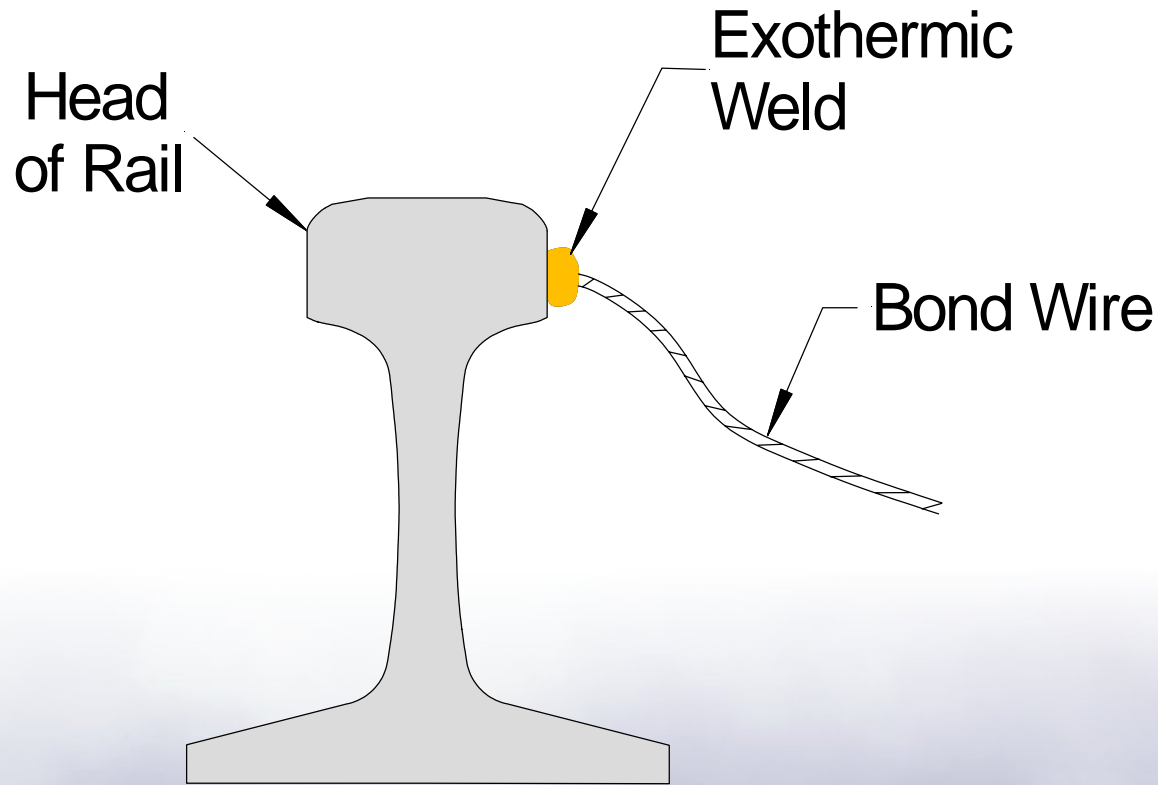


# Bond Wire Welding Locations

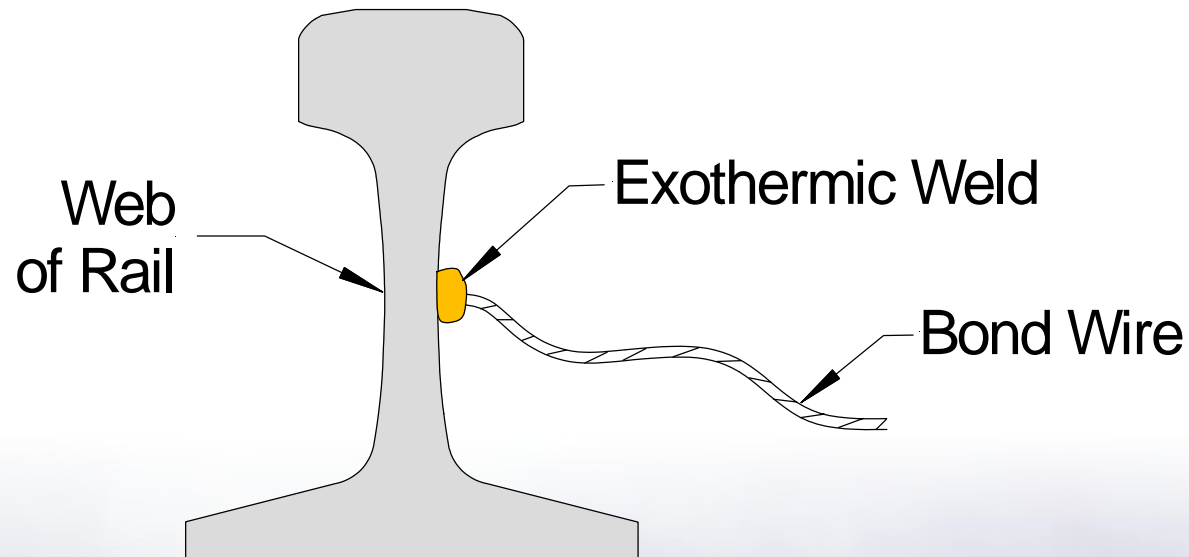
- Applied to the rail head, web, or base



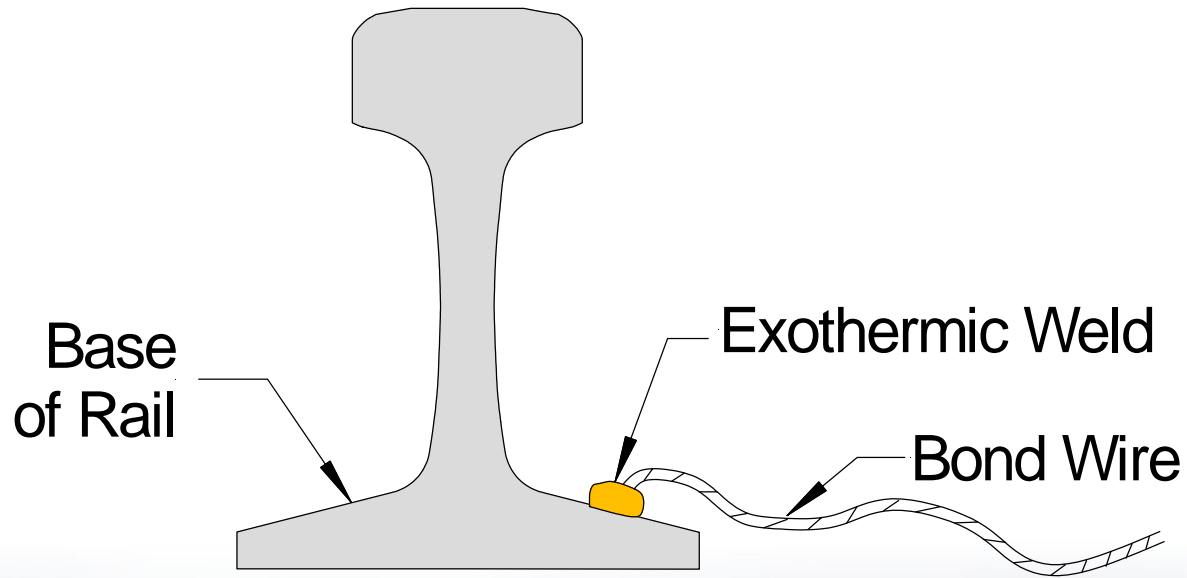
# Bond Wire on Rail Head



# Bond Wire on Rail Web



# Bond Wire on Rail Base



# American Railway Engineering and Maintenance-of-Way Association (AREMA)



**National Transportation Safety Board**

# Bond Wire Welding Locations

- AREMA allows placing welds at rail head
- ERICO instructions recommend welds at rail web
- UP reports problems from welds at rail web
- Further study is needed to develop guidance on placement of bond wire welds



# Discrepancies Found in ERICO's Cadweld Literature

- States that untempered martensite would not be produced in the welding process
- All welds examined during the investigation contained untempered martensite
- Other inconsistencies were also found in Cadweld bonding instructions



# Rail Defects from Exothermic Bond Wire Welding

- About 64,000 rail defects found during rail inspection
- 327 rail defects from exothermic bond wire welding
- CN has a defect code for data entry





# Rail Defects from Exothermic Bond Wire Welding

- An undetermined quantity on the Long Island Rail Road, BNSF, UP, & CSX
- UP has reported split-web defects in heavy haul territory



# Federal Railroad Administration

- No defect code for rail defects caused by bond wire welding in 49CFR213.113, Defective Rails
- No derailment cause code in the FRA Guide for Preparing Accident/Incident Reports



