



National Transportation Safety Board

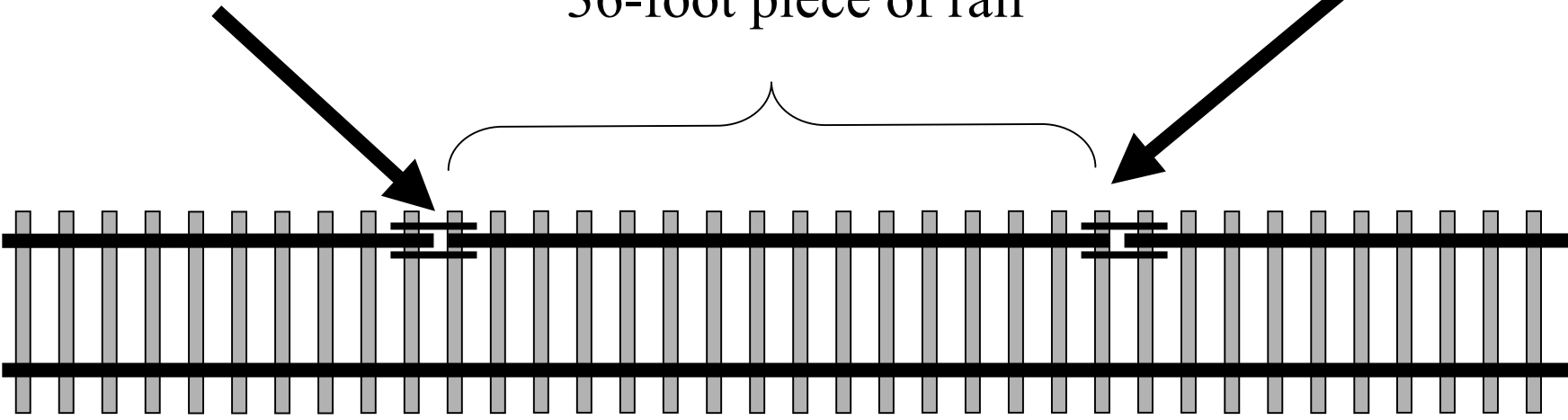


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West Joint

East Joint

36-foot piece of rail



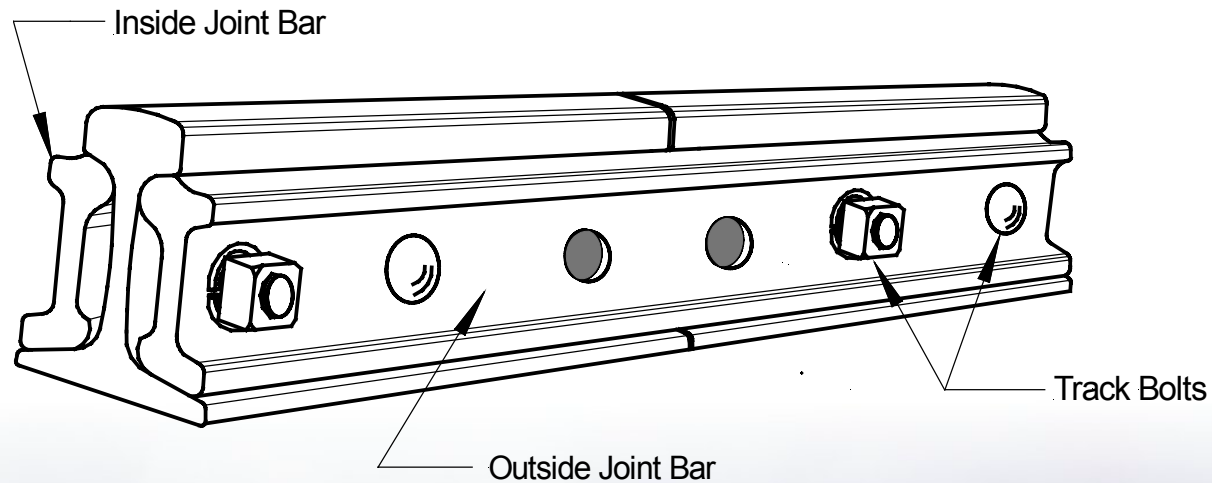
North

Minot



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Rail Joint



East Rail Joint

WEST ←

→ EAST

1

2

3

4





East Rail Joint

WEST ←

→ EAST

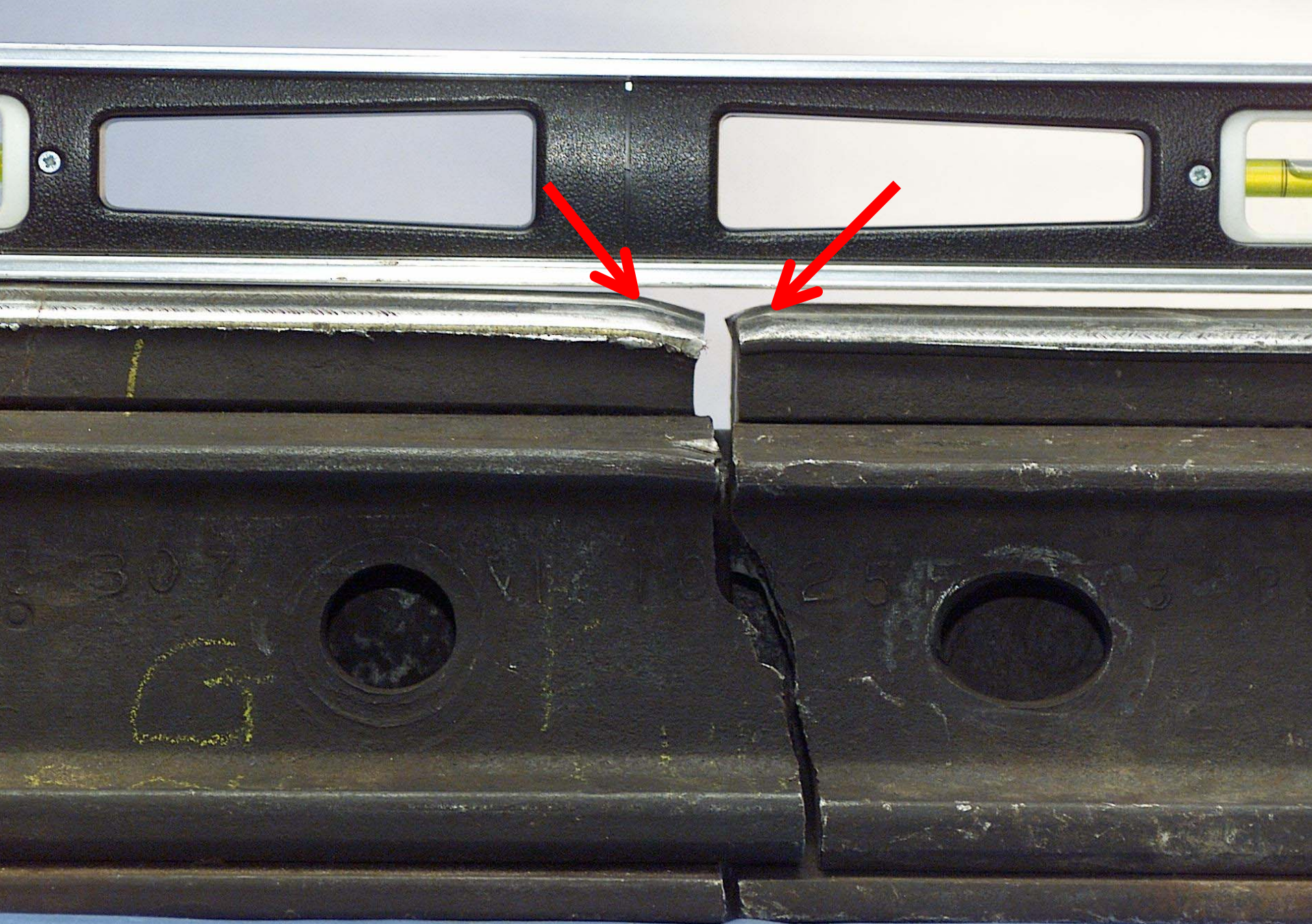
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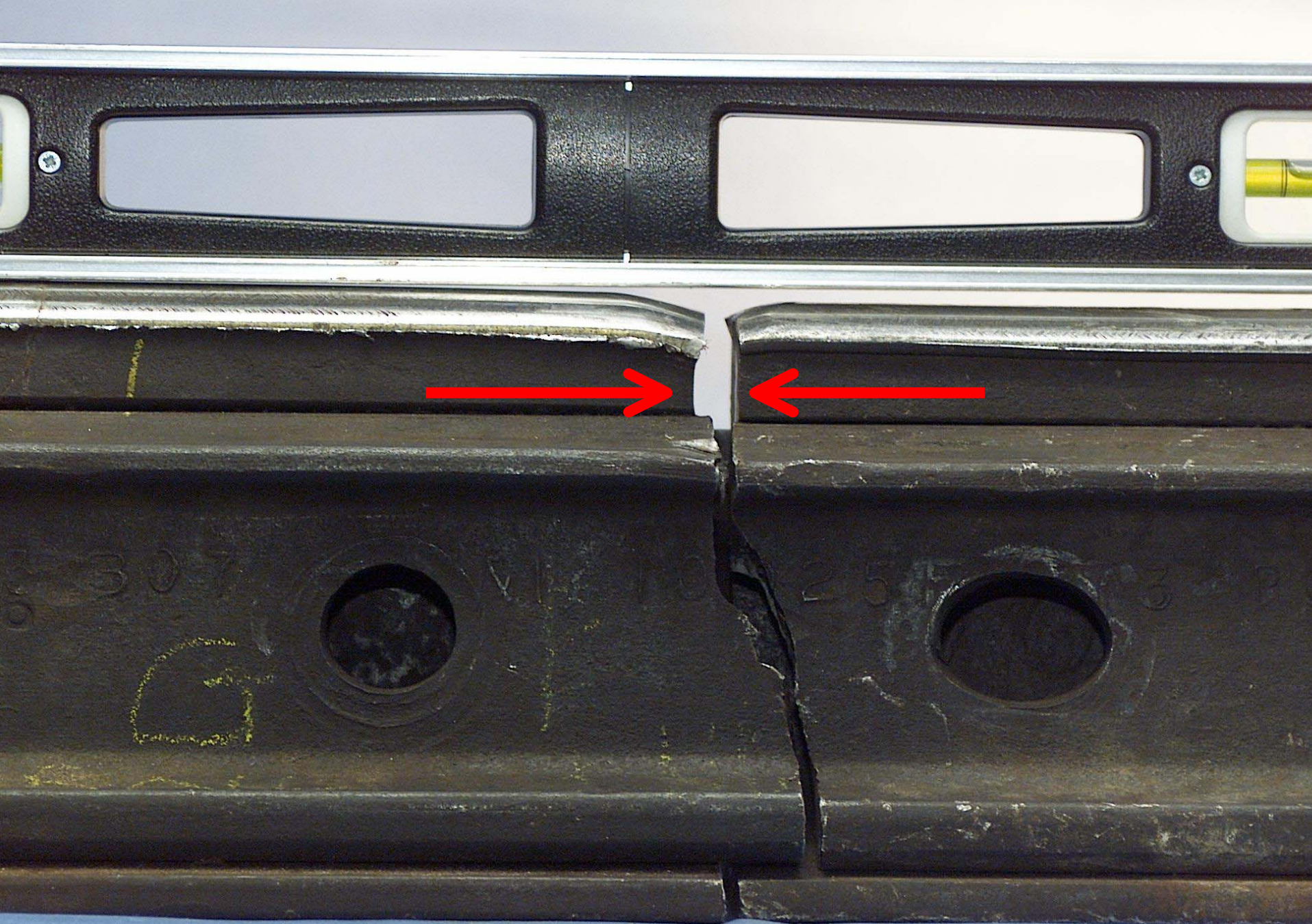
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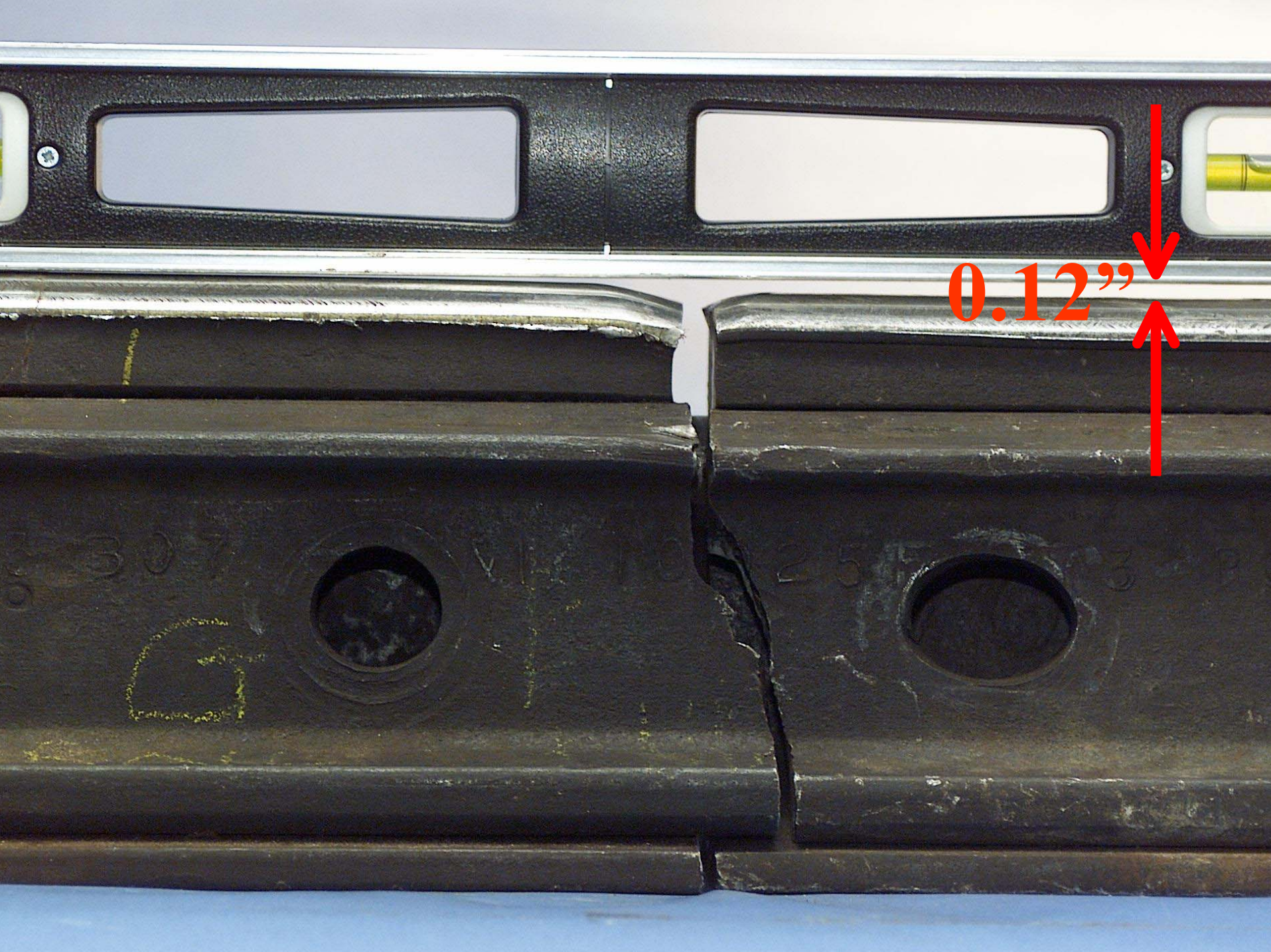
3

4









0.12''

7"

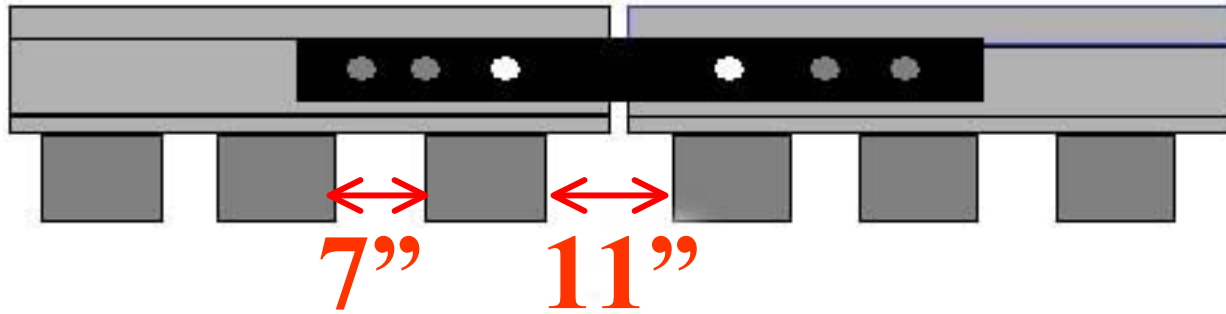
11"



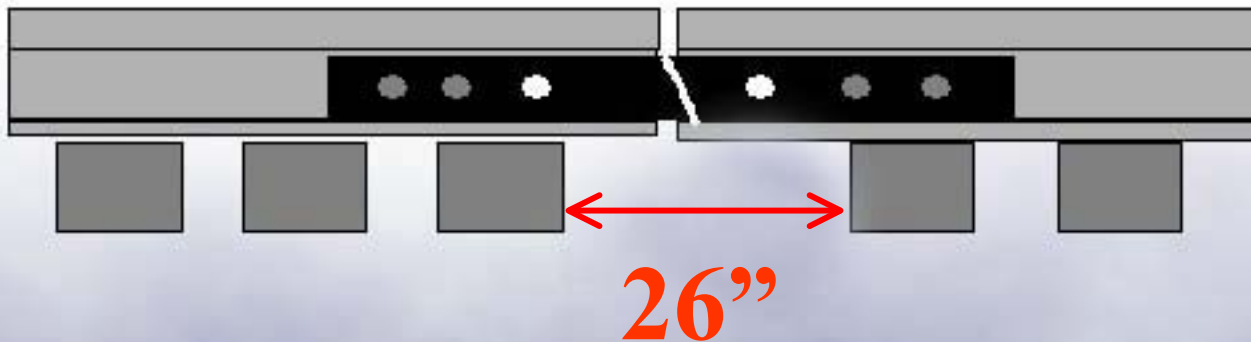
26"



West Joint



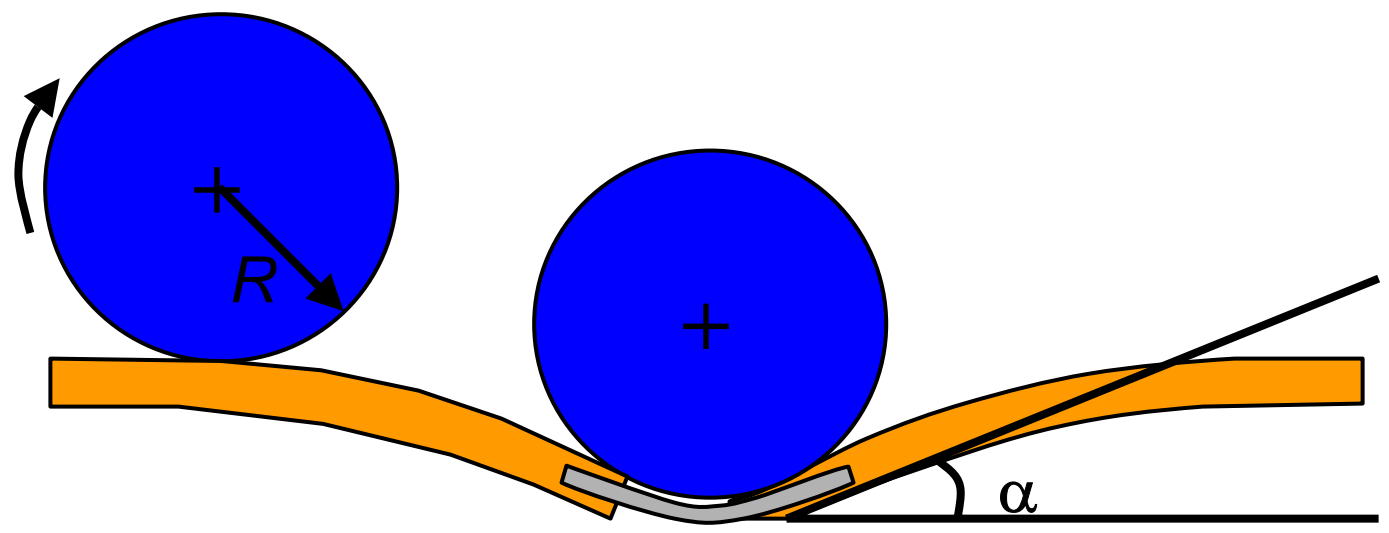
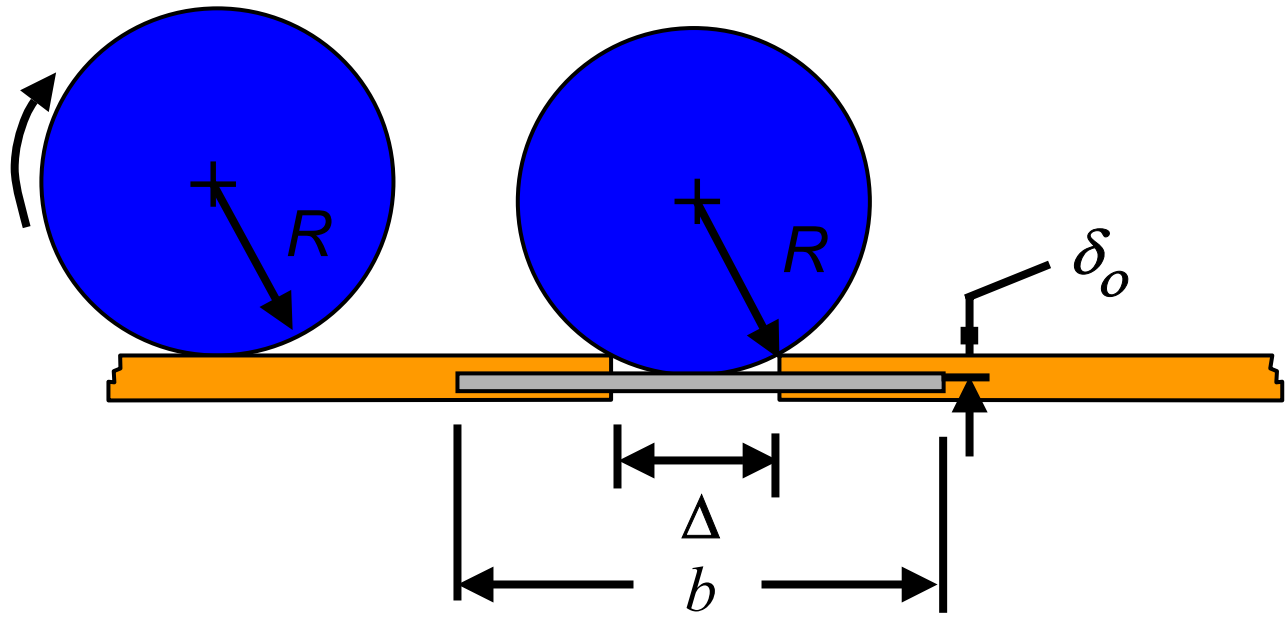
East Joint



Under Torqued Bolts



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01

03

02

CONCLUSION

The joint bars at the east end of the rail plug fractured under the previous train or as the accident train passed over the joint, and after the joint bars fractured, the rail itself also fractured and broke away, causing the train to derail.



Visual inspections from a moving vehicle are inadequate because:

- Not all joint bars are visible**
- Small fatigue cracks are not visible**
- Requires an on-the-ground inspection**





On-the-ground joint bar inspections



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Ultrasonic Joint Bar Testing

- **Devices can detect small cracks**
- **Canadian Pacific Railway used ultrasonic devices after the Burlington, ND, accident**
- **Canadian Pacific Railway ceased ultrasonic testing**



The Result:

Canadian Pacific Railway inspectors did not find the defective joint bars before the accident.



CONCLUSION

Canadian Pacific Railway inspection procedures before the accident were inadequate to properly inspect and maintain joints within continuous welded rail and that those inadequate procedures allowed undetected cracking in the joint bars at the accident location to grow to critical size.



FRA Safety Regulation

**Cracked or broken joint bars shall
be replaced**



CONCLUSION

Federal Railroad Administration requirements regarding rail joint bars in continuous welded track are ineffective because they do not require on-the-ground visual inspections or non-destructive testing adequate to identify cracks before they grow to critical size and result in joint bar failure.



FRA's CWR Program Requirements

- **Continuous welded rail program regulations effective March 1999**
- **Canadian Pacific Railway submitted its continuous welded rail program in July 1999**
- **Joint Bar inspections not addressed**



FRA Oversight

- **FRA did not review Canadian Pacific Railway's continuous welded rail program before accident.**
- **FRA inspectors did not have copy of CPR's program.**



CONCLUSION

The Federal Railroad Administration's oversight of the Canadian Pacific Railway's continuous welded rail program was ineffective because the agency neither reviewed the program nor ensured that its inspectors had copies of the program to determine if the railroad was in compliance with it.



Canadian Pacific Railway's Standard Practice Circulars Manual

- **Canadian Pacific Railway's manual contained imbedded references.**
- **Canadian Pacific Railway's manual contained conflicting instructions.**





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END OF SHOW

**EXTRA
INFORMATION**



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Identification of POD

- **Matching halves of joint bars located at west end of footprint near the east rail joint on the north rail.**
- **Rail and joint bars sent to laboratory, examined, photographed, measured, analyzed.**
- **Rail re-build eliminated consideration of broken rail cause.**



Elimination of Casual Factors

- **Inspection of trackage west of derailment eliminated mechanical causes—no loose, broken wheels, dragging equipment pre-derailment.**
- **Gage, crosslevel, alignment, and crosstie conditions were eliminated as casual factors.**
- **Secondary wheel markings were identified and eliminated as casual indications.**



Elimination of Casual Factors

- **Track inspections eliminated mechanical causes**
- **Gage, crosslevel, alignment, and crosstie conditions**
- **Secondary wheel markings were eliminated**



Casual Factors For Joint Bar Failure

- **Wider ballast crib (25” vs. 11½” in standard ballast crib)**
- **Difference in rail height (0.12”)**
- **Rail end gap (0.359” minimum to 0.659” maximum)**
- **Loose bolt gap (torque range from 54 ft/lbs to 402 ft/lbs.)**
- **Add “fly-ins” to this slide!!**



Casual Factors for Joint Bar Fatigue

- **Inadequate frequency of joint bar inspection in CWR territory.**
- **Failure to eliminate rail joint location by welding.**
- **Add fly-ins to this slide!!**



Examples of Crosstie Spacing

Insert diagram depicting crosstie spacing.



Factors Leading to Joint Bar Fatigue

- **Wider than normal tie spacing**
- **Vertical offset increases impact loading**
- **Rail end gap decreases structural strength**
- **Fatigue cracking was initiated and propagated by cyclic stress**
- **Use Dr. Jeong's diagram here??**



Small bolthole cracks

- **Bolthole cracks less than ½ inch seldom catastrophically fracture without significant stresses induced to the rail.**
- **FRA does not even require a remedial action for bolthole cracks less than ½ inch.**
- **FRA's remedial action for bolthole cracks between ½ and 1 inch is to reduce operating speed to 50 mph and re-inspect in 90 days. These type of cracks would be about 2 to four times the length measured at Minot.**
- **The current mobile internal rail detection equipment cannot consistently or accurately detect bolthole cracks less than ½ inch. No remedial action would be required.**



Materials Laboratory

- **In comparative analysis, the west joint of the same rail plug exhibited three bolthole cracks, which did not fracture under the exact same operating, tonnage, and climatic conditions.**
- **Laboratory analysis determined that the fractures faces of the rail pieces exhibited sudden rupture characteristics not typical of long term bolthole cracking.**
- **Suspect rail joint bars received separate tensile and bending, as well as, material composition testing.**
- **Material examinations met specification.**



Safety Issues Developed in this Accident

Do fly-ins--

- **Lack of uniform inspection practices for rail joints in CWR territories.**
- **FRA regulatory language for inspection of rail joint bars in CWR territory. FRA oversight into elements of CWR program minimum criteria.**
- **FRA's oversight and monitoring of railroads' CWR programs. (Reverse 2 & 3??)**
- **CPR's CWR program guidance and instruction for inspection and maintenance of CWR.**



CPR changes post-accident

- **Re-instituted ultrasonic joint bar testing.**
- **Revised OTG joint bar and ultrasonic inspection.**
- **Data forwarded to Division HQ's.**
- **Development of a 4-day training program.**
- **Implementation of a “proficiency testing.”**



Reasons for periodic OTG inspections, reporting, data collection for CWR territory

- Trains in CWR territories typically operate at higher speeds, more tonnage, greater concentrations of hazardous materials.**
- CWR territories generally carry more freight and passenger trains, commuter operations.**
- Bars generally fail under train traffic.**
- Signaled or dark territories cannot be relied upon to alert train crews or dispatcher of the presence of cracked or fractured bars (set off “red signal” or track circuit).**



Safety Hazards

- **A discontinuity of the rail is created—structural integrity is lost.**
- **Causes a situation that amounts to a broken rail scenario.**
- **Accident bars were previously cracked, grew to a critical size, fractured under train movement, which created a discontinuity in the north rail.**



Safety Hazards

- **Cracked joint bars can go undetected without close inspections.**
- **Hairline cracks exposed on surface of the bar indicate significant reduction in the strength.**
- **A failed joint bar places undue stress on the remaining bar.**



FRA Regulatory Language

- **Regulation is silent on the means and frequency of joint bar inspection**
- **Regulation does not require data collection**



FRA's CWR Program Review Process

- **FRA's was ineffective because they had not review CPR's CWR program.**
- **FRA did not ensure that their inspectors had current CWR programs.**
- **FRA did not communicate to the railroad about the CWR program issues.**



CWR Program Distribution and Compliance Issues

- **CWR programs not distributed or advise inspectors of issues with program.**
- **Local FRA inspector not provided CPR CWR program information until after incident.**
- **FRA could not monitor CWR program compliance.**
- **FRA demonstrated widespread non-compliance—mostly regarding anchor patterns.**



Imbedded References

- **SPC No. 6 refers to 5 other SPCs that refer to another 9 SPCs**
- **SPC No. 12 refers to 12 other SPCs that refer to another 8 SPCs**
- **SPC No. 28 refers to 6 other SPCs that refer to another 12 SPCs**
- **In total, the 3 SPCs refer to 19 SPCs**



Employee Interviews

- **“the old Soo Standard, the way it was done”**
- **“kind of going by both, the SPC and add a little bit—because that’s what we’re kind of used to going by.”**
- **“We talked about different topics. I can’t remember what they all were.”**





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THE END

BEGIN PHOTO BANK



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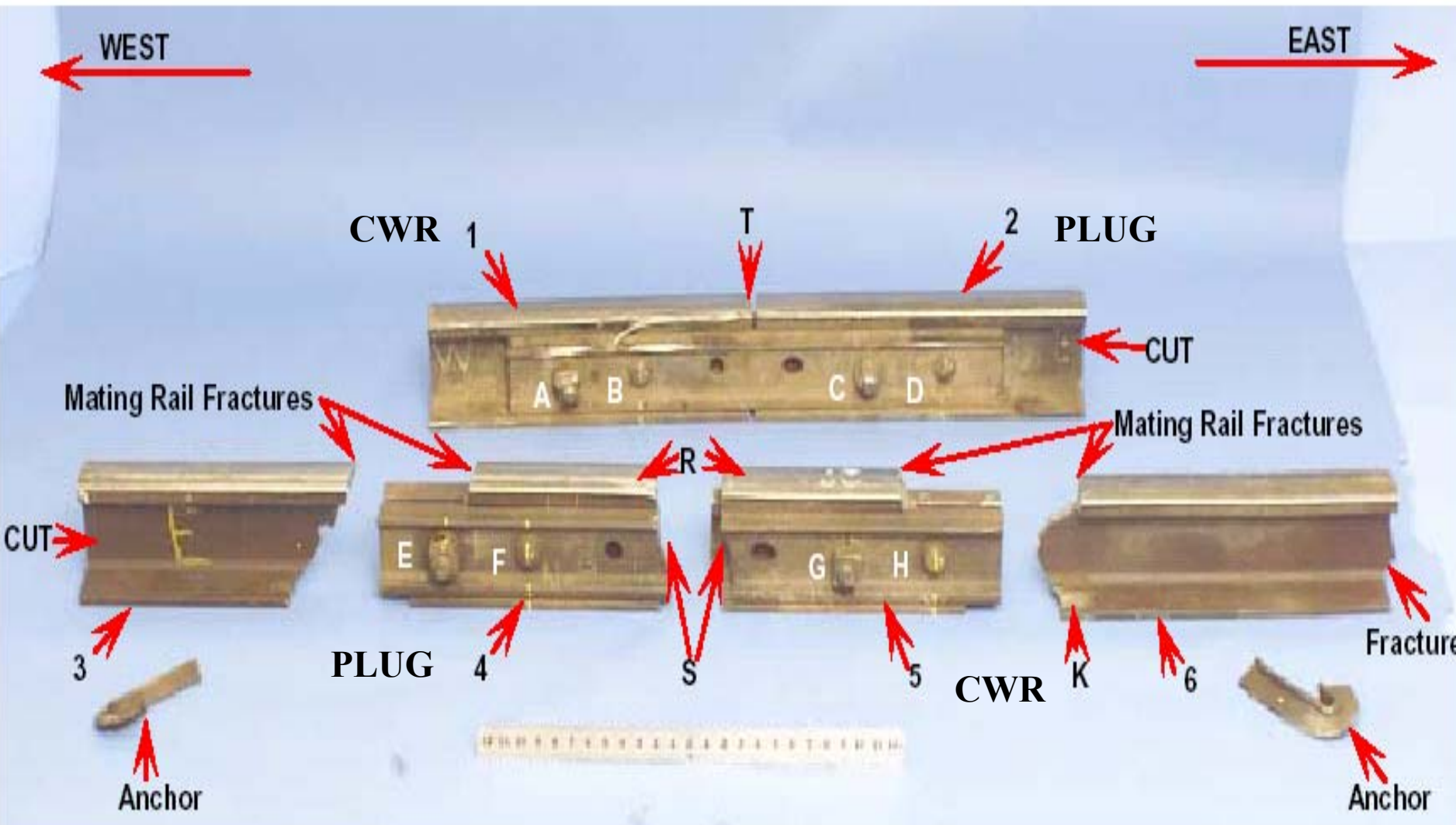
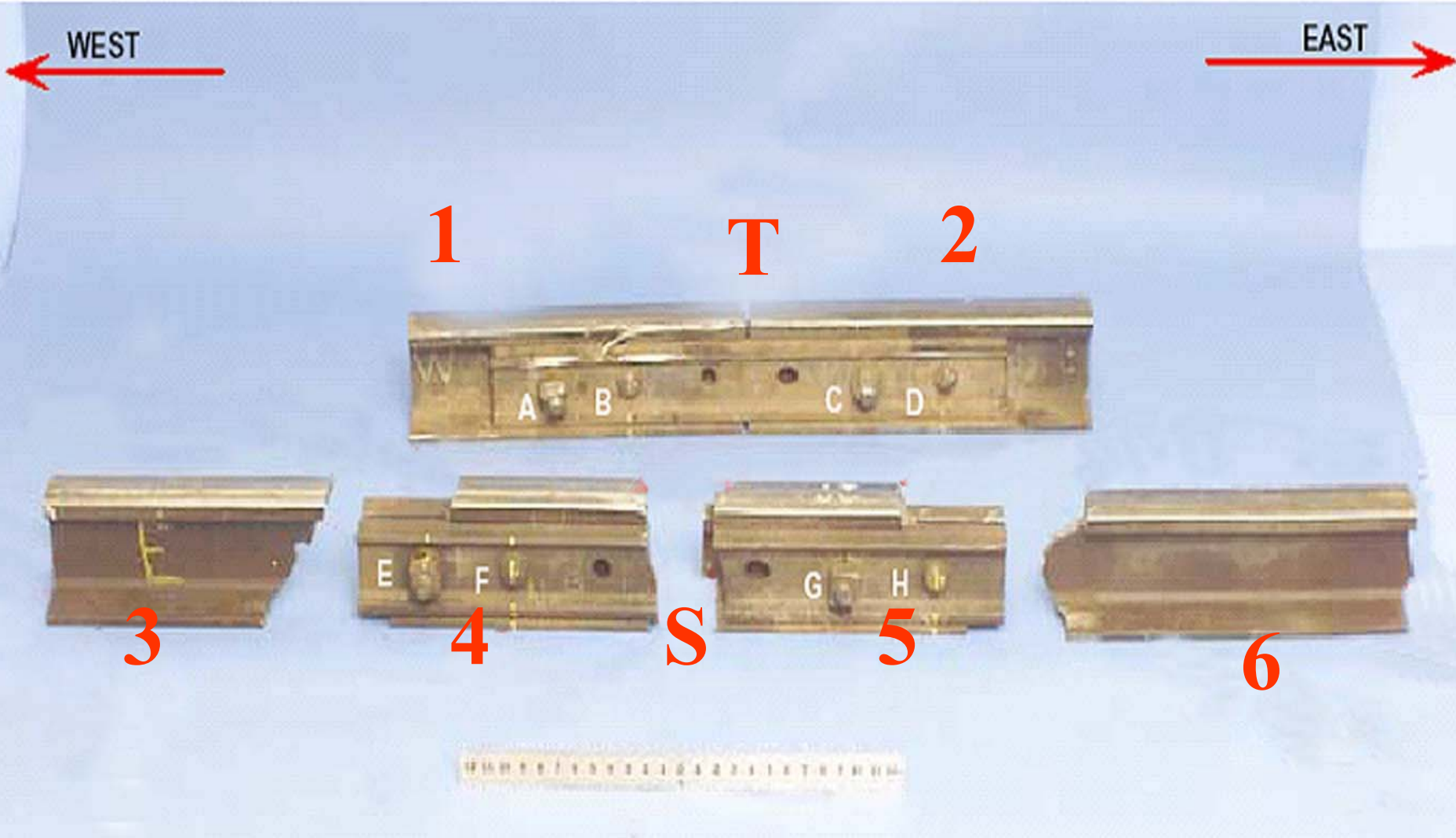


Figure 10. Recovered pieces of rail and joint bars from the north side of the track. Arrows "S" indicate the location of the fracture on the pair of joint bars from the east end of the rail plug. Arrows "R" indicate the joint between rail pieces 4 and 5. Arrow "T" indicates the joint between rail pieces 1 and 2.

East Rail Joint Pieces



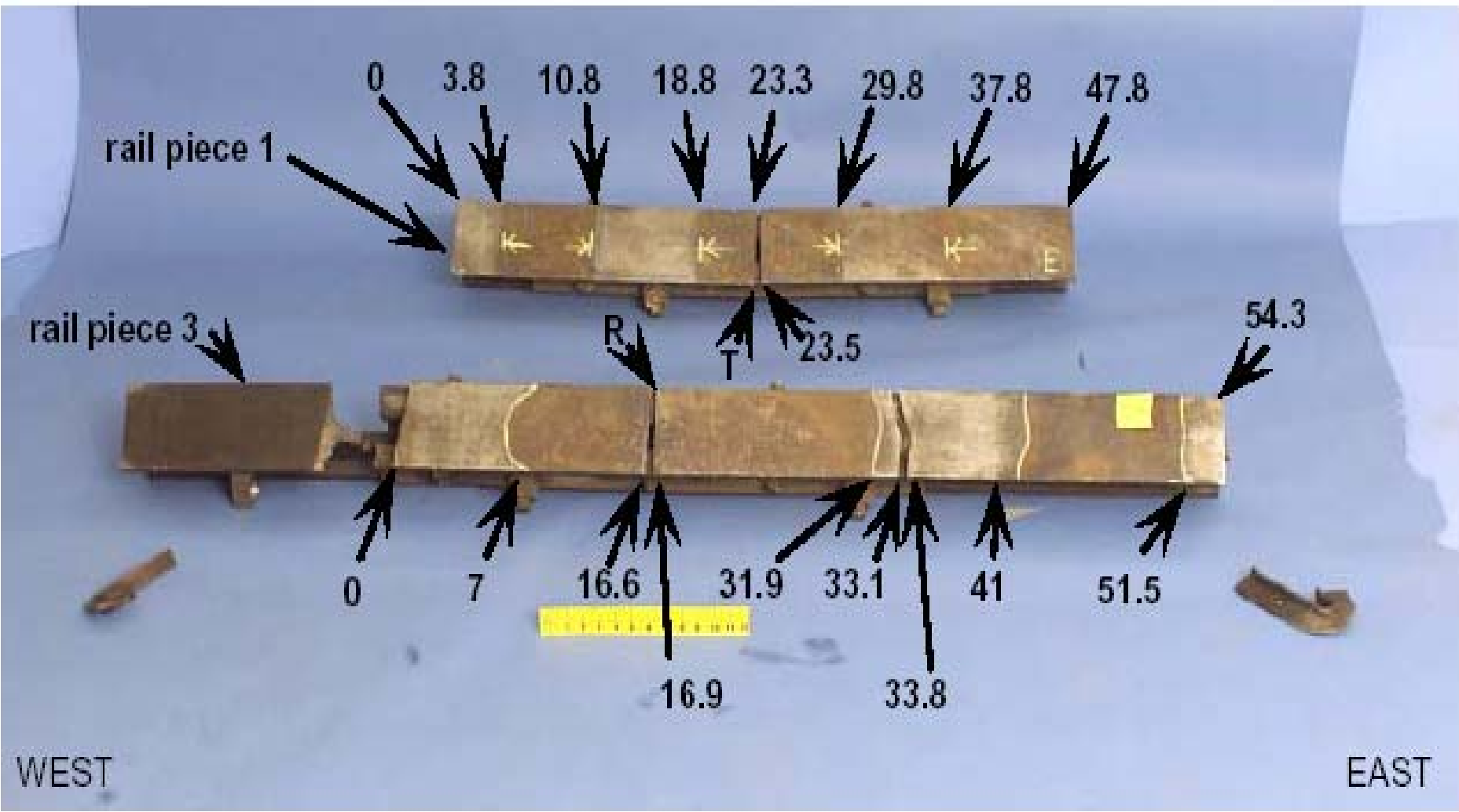
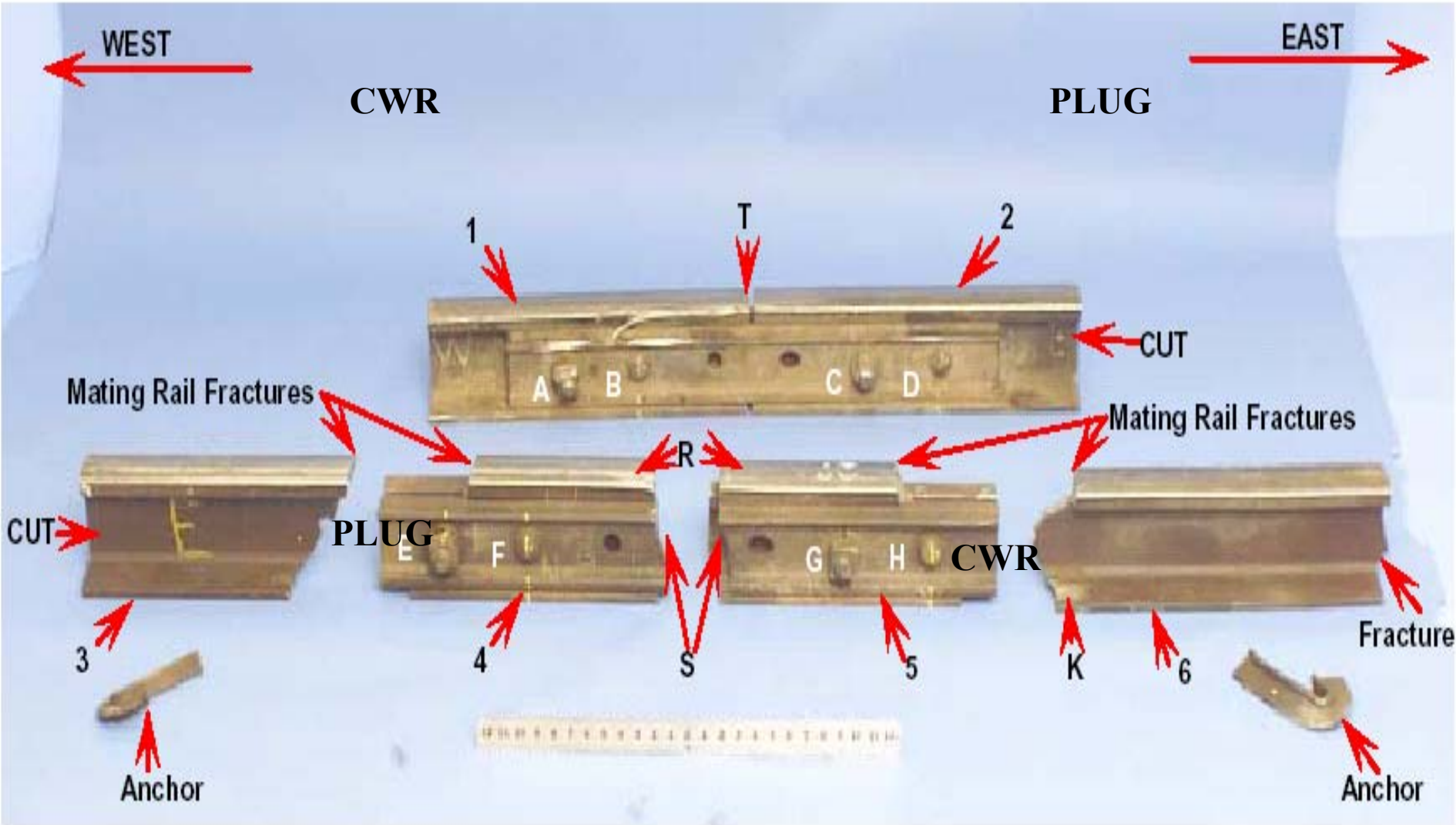


Figure 9. Underside of the recovered pieces of rail from the north side of the track. Pieces placed as they were before they were fractured. The numbers indicate the distance in inches from the “0” arrows.

East Rail Joint Pieces





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rail piece 3



WEST

EAST



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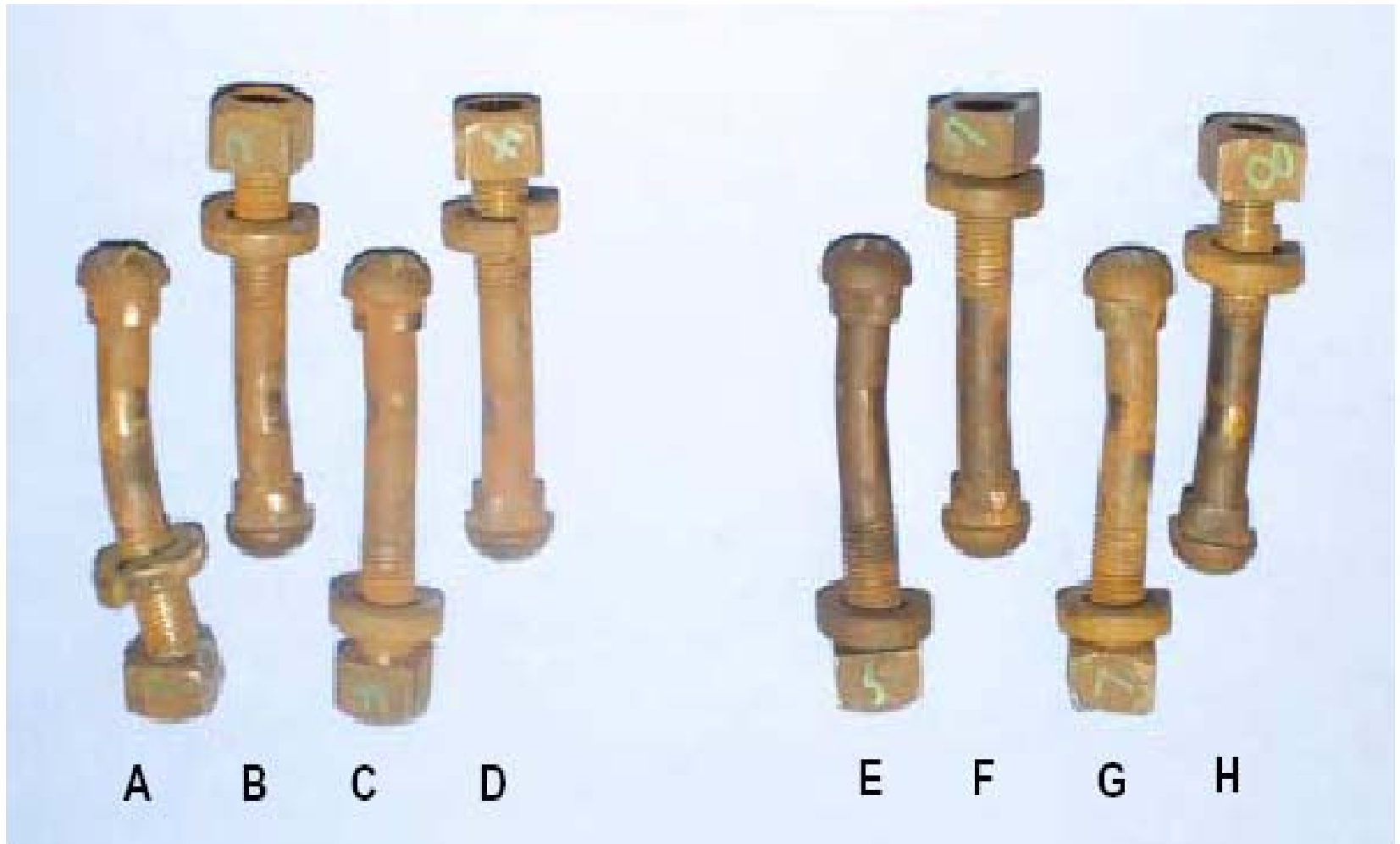


Figure 13. The eight bolts that fastened the joint bars. The disassembled bolts, washers, and nuts are positioned as they were when in place. Note that the shank portion of the bolts that are bent away from their rail joints. West is on the left side of photograph.

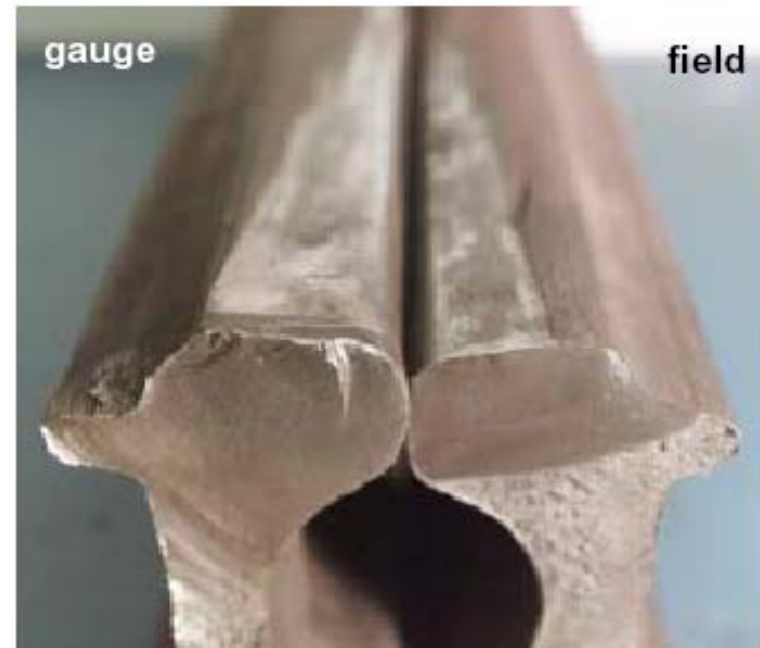
Importance of Non-destructive Testing

The bar on the left, two halves of same bar, shows fatigued area very similar to fatigued area of accident bars (2).

Post-accident “missed defect”



Accident Joint Bar





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28 12:5



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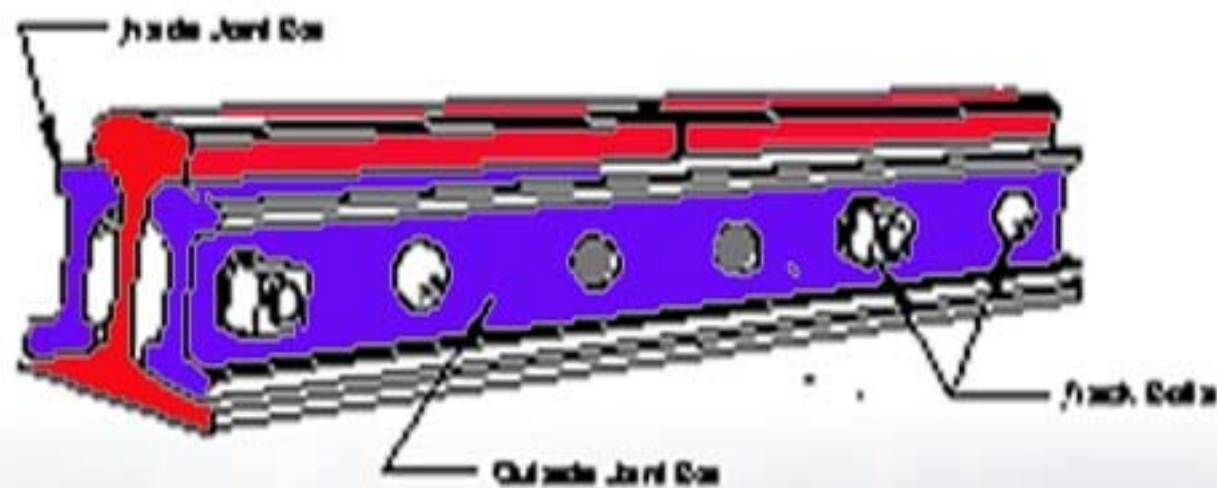
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March 3, 2004 at
10:00 p.m.**



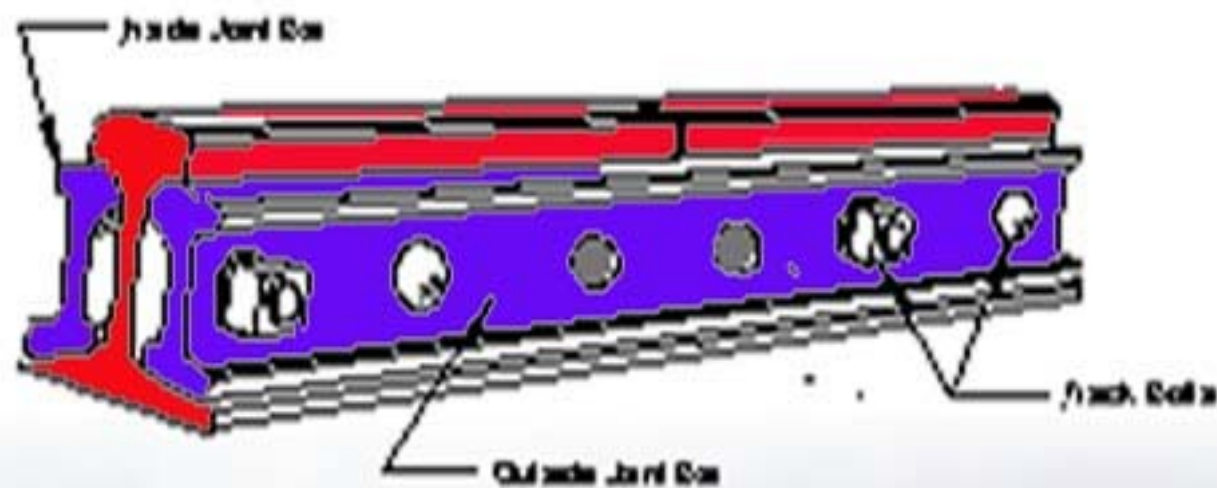


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Rail Joint



Rail Joint

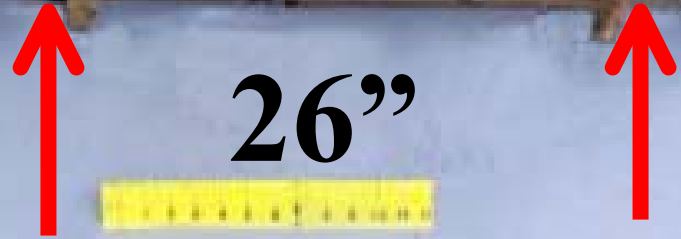


7 7"

11"



26"

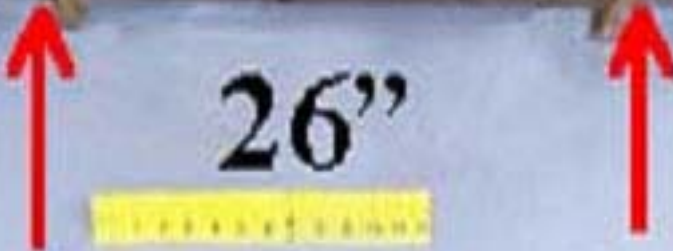


WEST

EAST

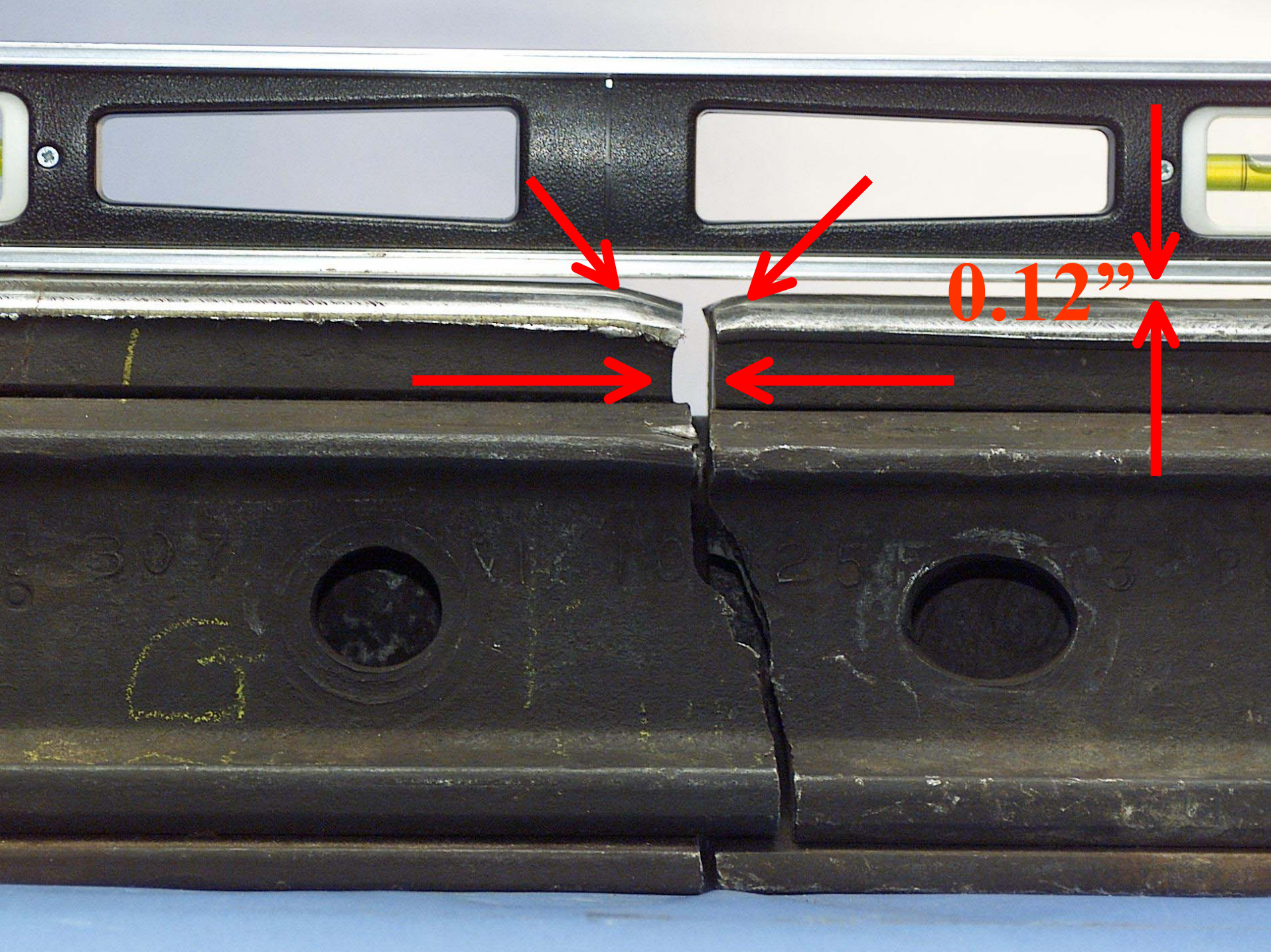
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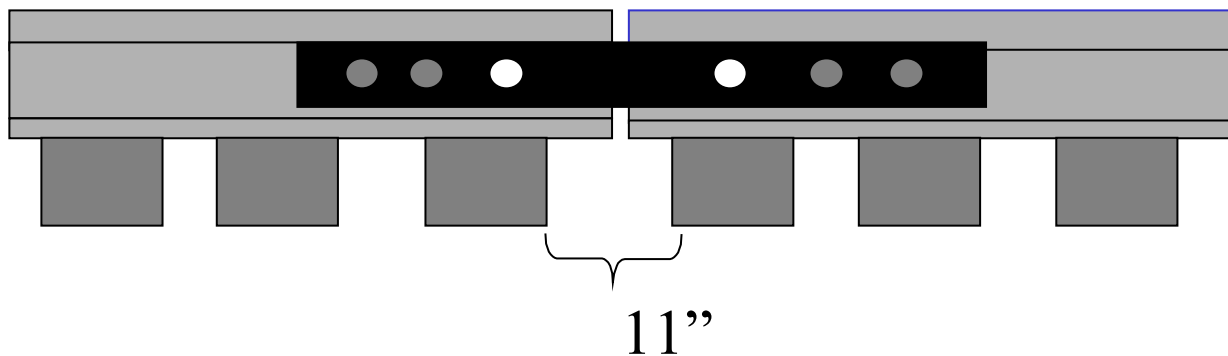
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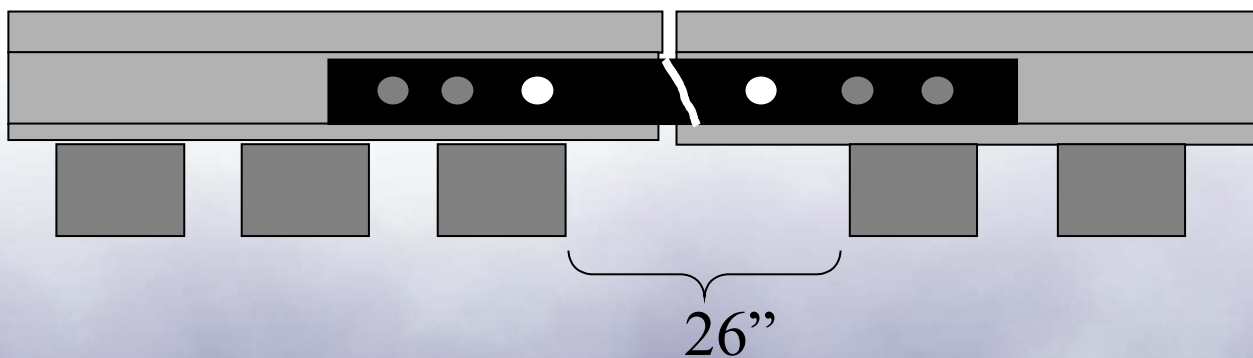


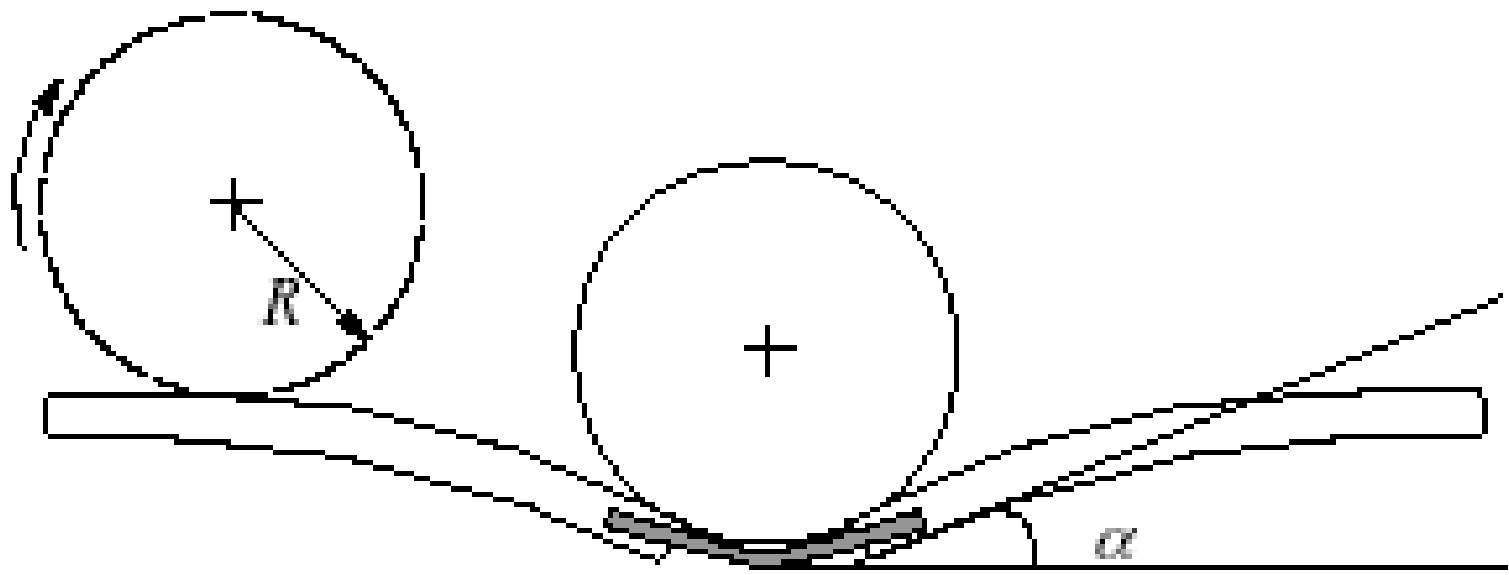
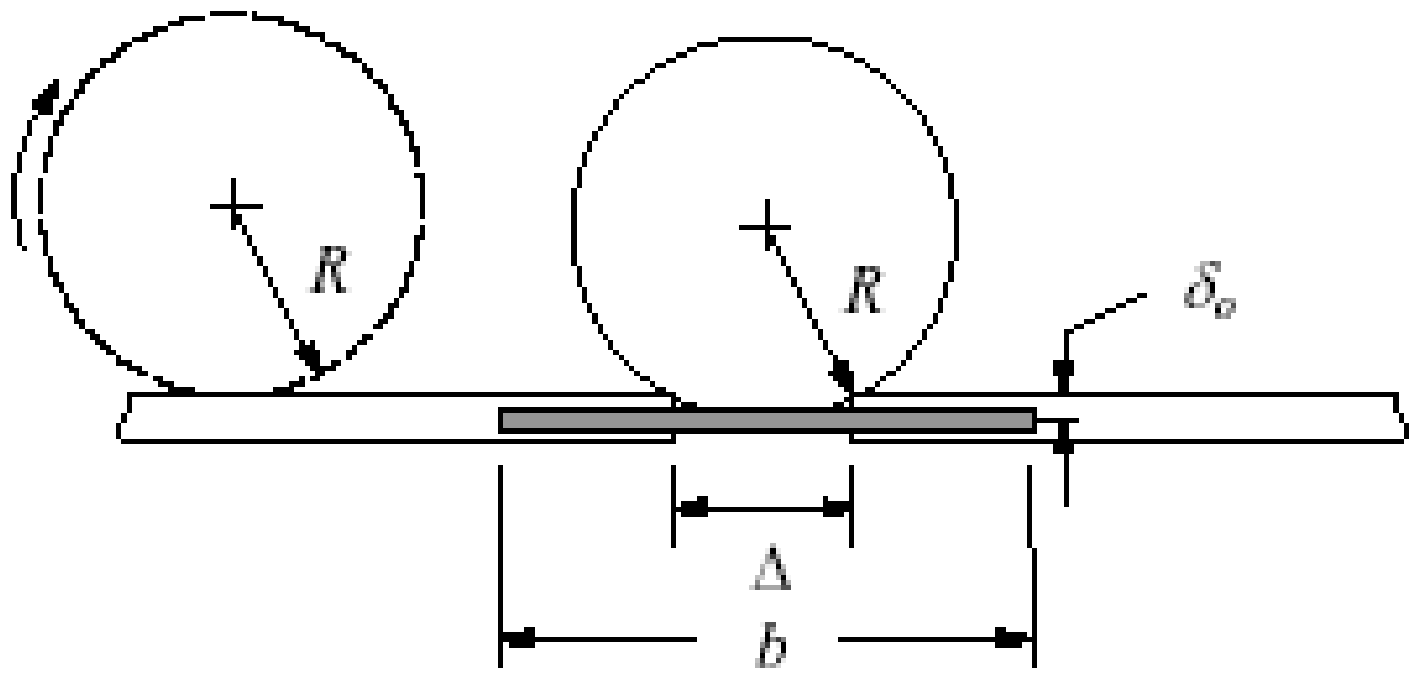
0.12"

West Joint



East Joint

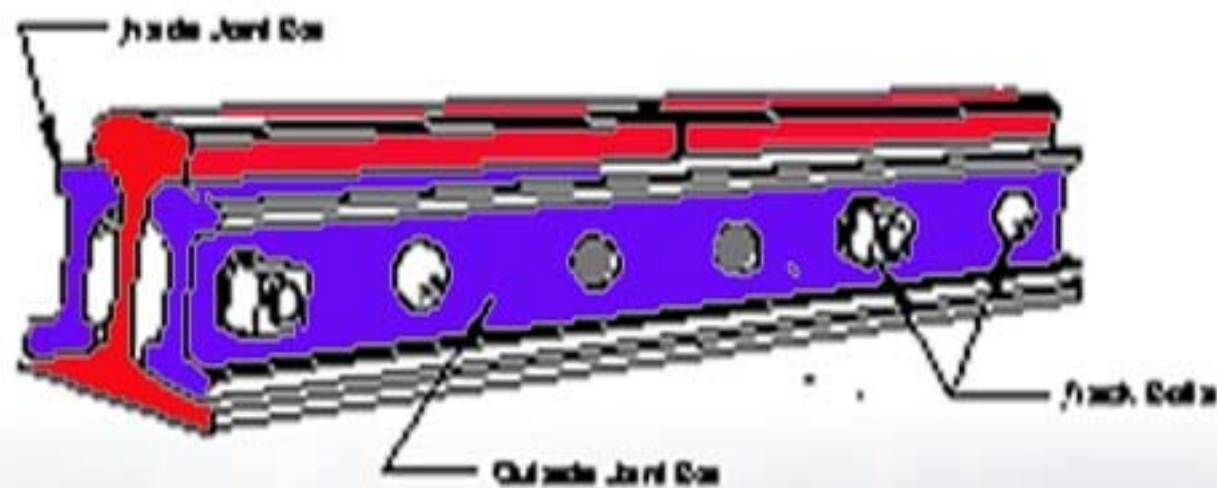






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Rail Joint



Identification of Point of Derailment

- **Matching halves of joint bars**
- **Rail and joint bars sent to Material Laboratory**
- **West joint eliminated as casual**
- **Broken rail cause eliminated**



Importance of Non-destructive Testing

Post-accident “missed defect”



Accident Joint Bar



Canadian Pacific Railway had:

- **Inadequate inspections from Hy-rail**
- **Once a year on-the-ground non-recorded inspections**
- **Ceased non-destructive testing**

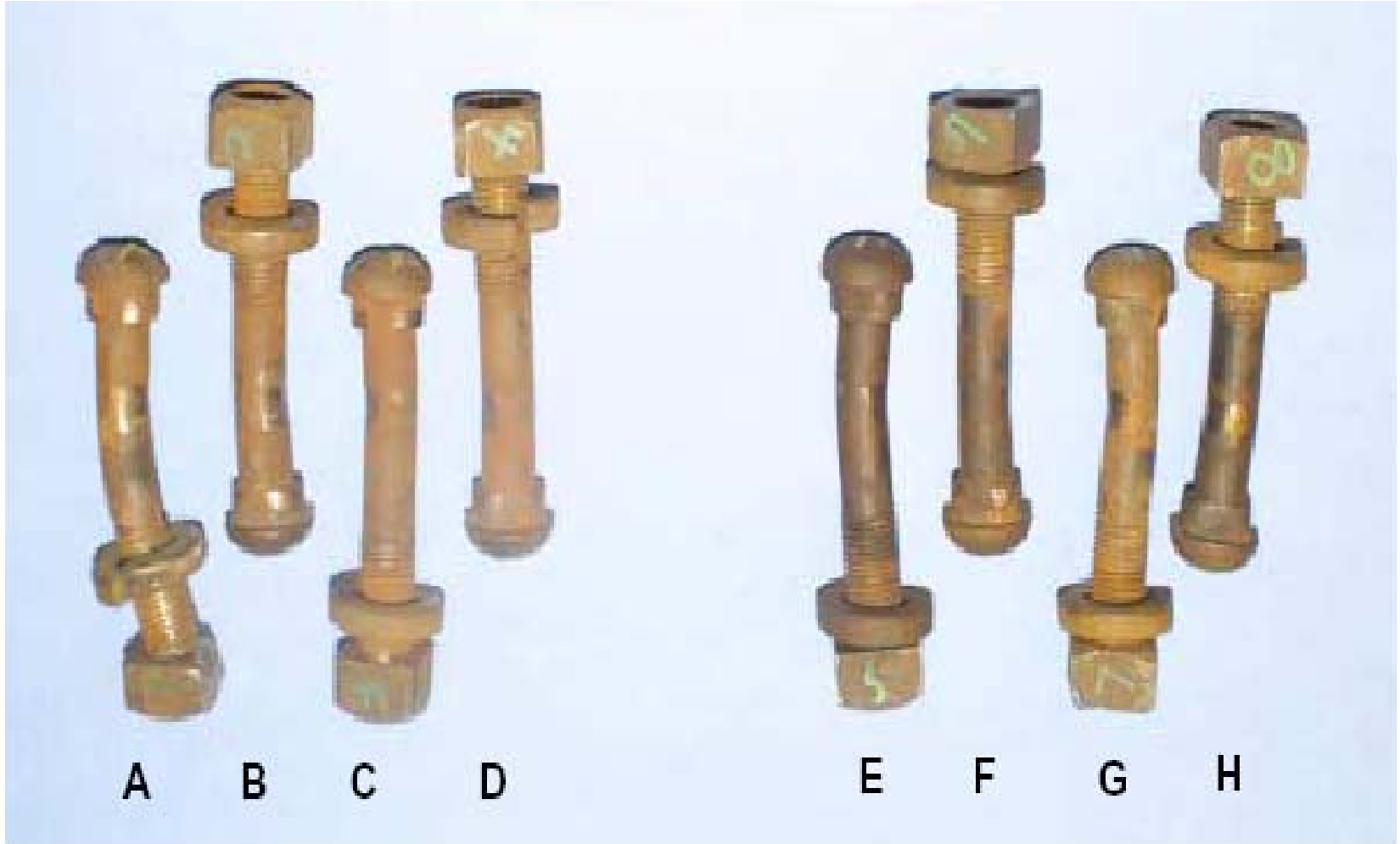


FRA's Continuous Welded Rail Program Review Process

- **FRA reviewed the major railroads**
- **FRA did not review CPR's CWR program**

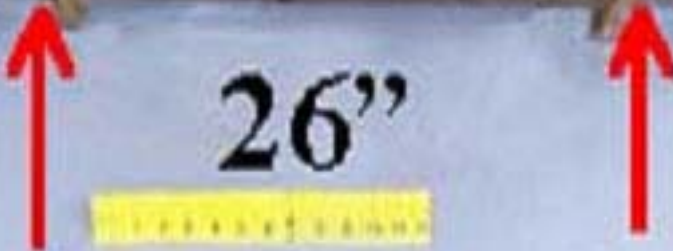


Bolt Conditions



7"

11"



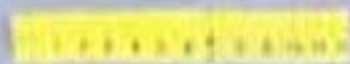
26"



7"



26"



East Rail Joint

WEST ←

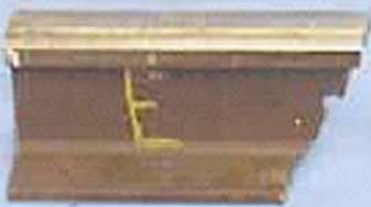
→ EAST

3

4

5

6



S



East Rail Joint

WEST ←

→ EAST

3

4

5

6



S



Imbedded References

- **Canadian Pacific Railway's continuous welded rail program consists of four Standard Practice Circulars**
- **The Standard Practice Circulars referred to many other Standard Practice Circulars**
- **For example, Standard Practice Circular No. 12 refers to 12 other procedures that refer to another 8 procedures**



CONCLUSION

Canadian Pacific Railway's track procedure manual was confusing and thus did not provide employees with clear guidance on the practice to be followed in installing and maintaining continuous welded rail.



Conflicting Instructions

- **Some Canadian Pacific Railway employees were trained under Soo Line and Canadian Pacific Railway Standards.**
- **One example of conflicting instructions are the anchor pattern for repair rails.**
 - **SPC No. 12 stated “every other tie”**
 - **SPC No. 19 stated “every tie for 195 feet.”**

