The New Brighton, Pennsylvania, Accident and Its Influence on Rail Defect Management

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National Transportation Safety Board

The Accident

- October 20, 2006
- 23 tank cars loaded with ethanol derailed near the east end of a bridge over the Beaver River
- Area near the derailment was evacuated for 2 days
- No injuries or fatalities
- Estimated damages $5.8 million


NORTH

Track

- Class 4 track
- Owned by Norfolk Southern
- Key train route with passenger traffic
- 63.5 mgt per year
- 140RE CC continuous welded rail manufactured in 1976 installed in 1977

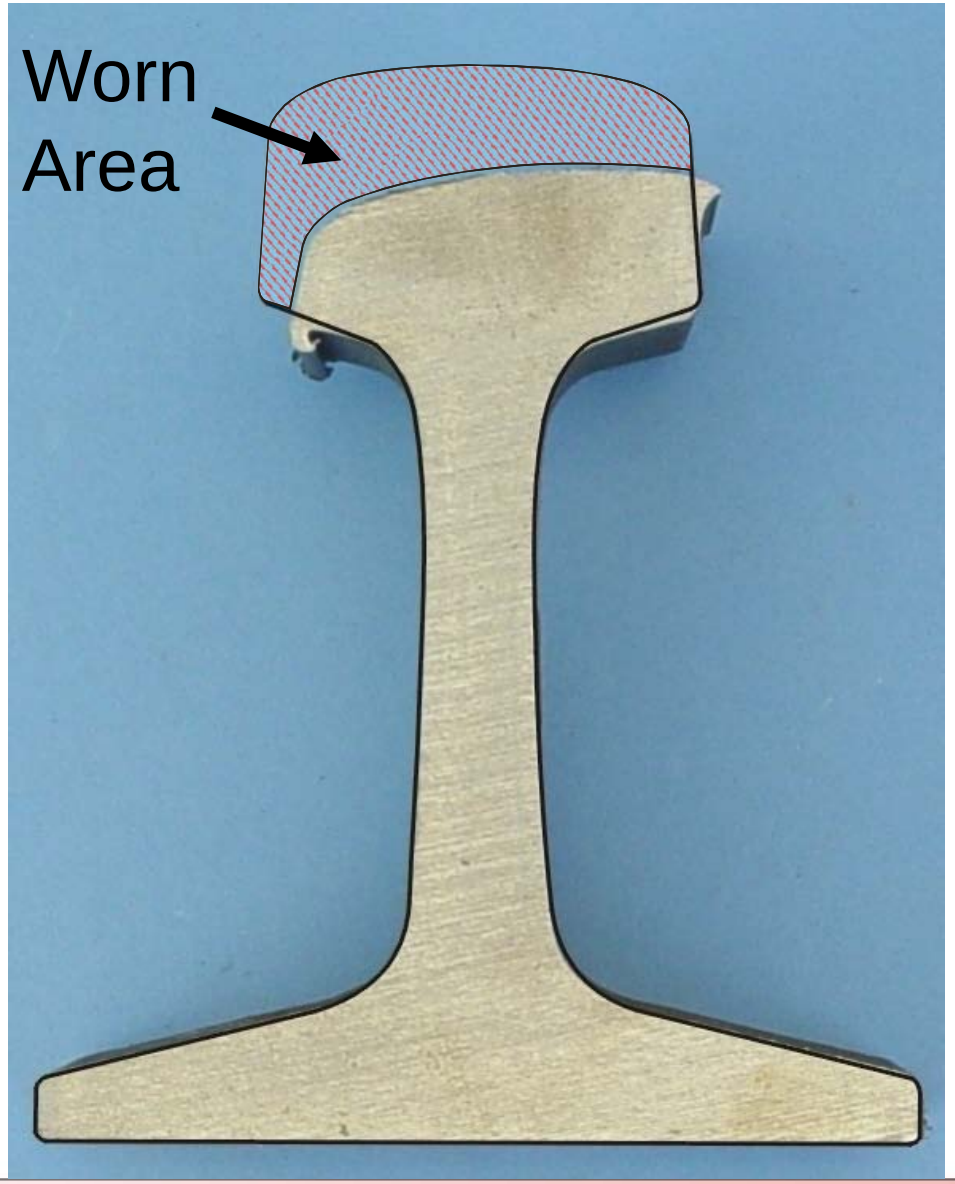
Rail Inspection History

- Inspected 4 times per year (16 mgt interval)
- Inspections in January, April, August, and next scheduled for November
  - January: no defects found
  - April: 2 transverse defects detected and repaired on the bridge just west of the derailment site
  - August: 1 transverse defect detected and repaired on the bridge just west of the derailment site


Flaking
End batter
Railhead checking
Shell Crack
Preexisting defect

Rail Wear

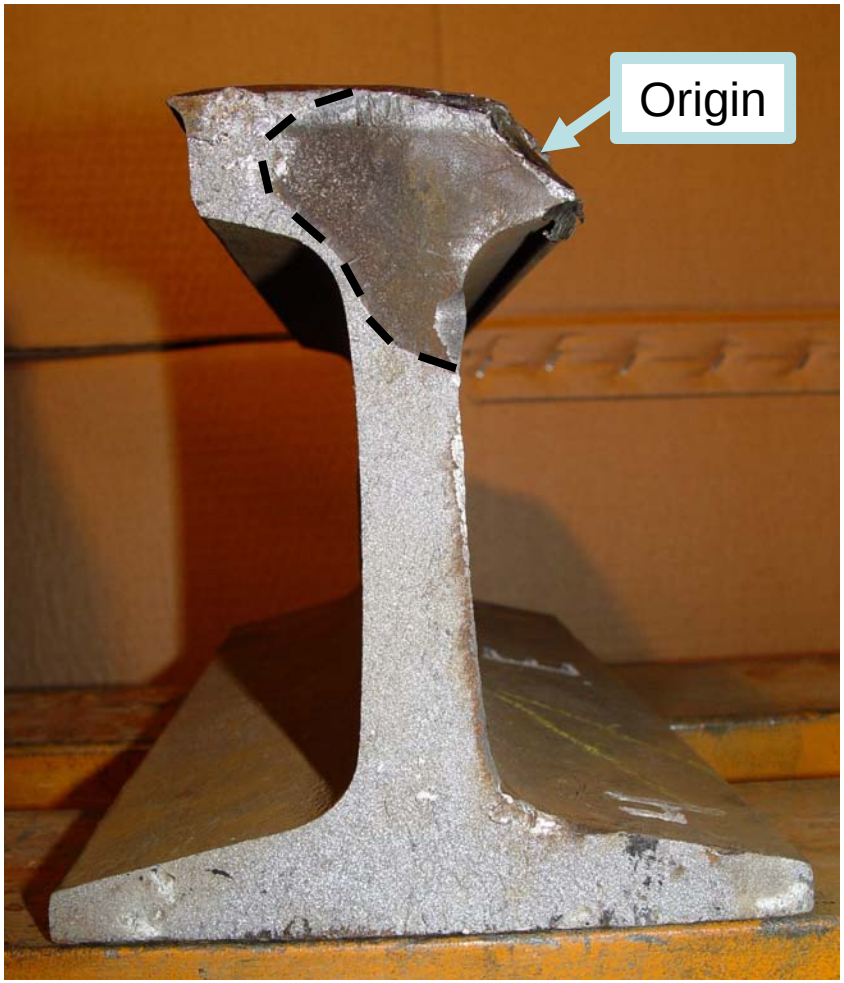
- 40% head wear
- Sufficient to list the rail for replacement
- Not yet reached the level at which NS would implement speed restrictions



Primary Fracture

- Detail fracture covering 78% of the remaining head area

- Initiated at shell crack in gage corner

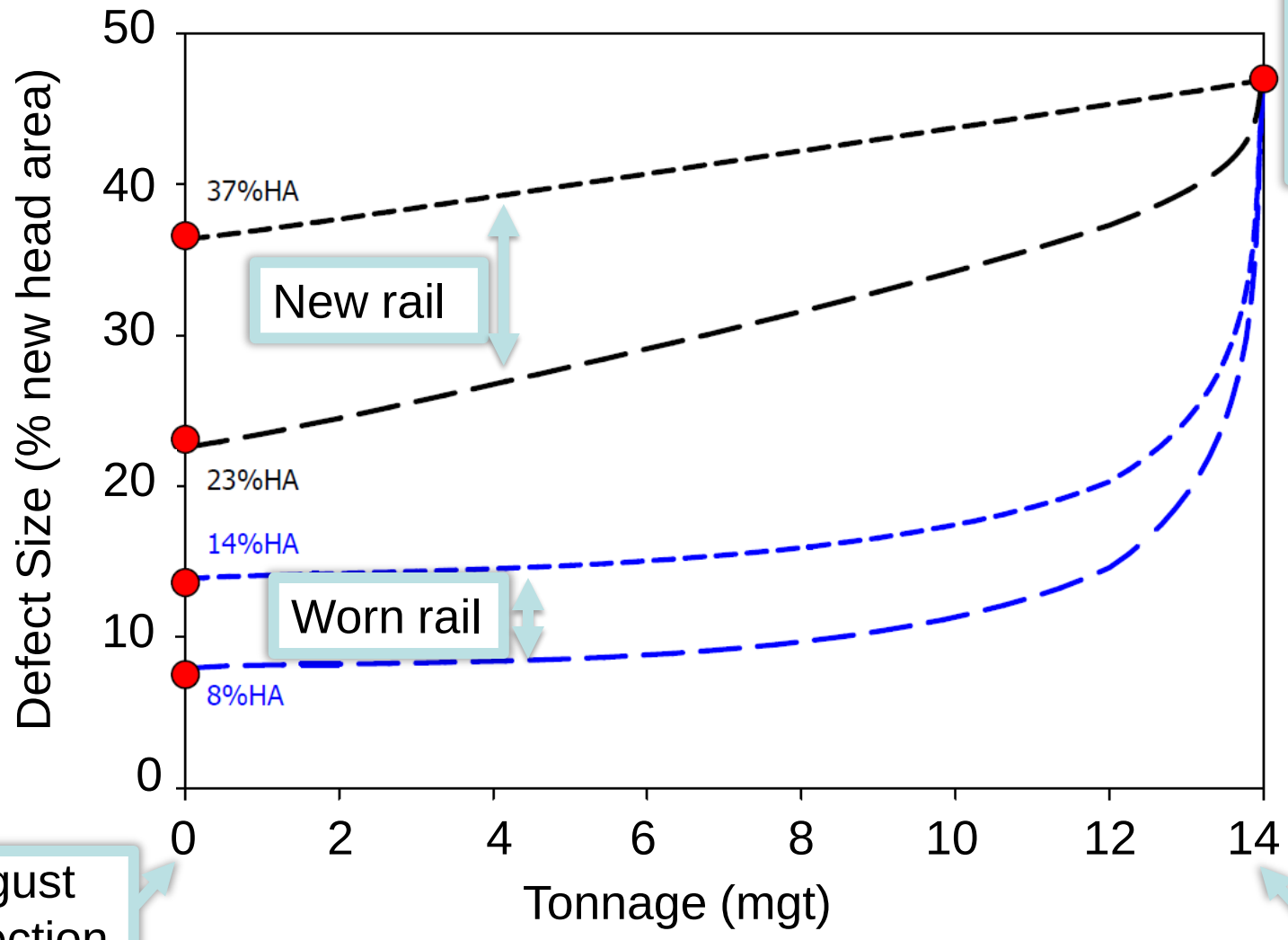


Back-Calculation of Defect Size

- What was the size at last inspection?
- Volpe Center[1] model for crack growth
- Calculated using defect size relative to new head area
  - Lab measurement: 78% of *remaining* rail head area
  - Defect size equaled 47% of *new* rail head area
- Assumed values for average wheel load and temperature differential were varied
- Crack size at last inspection was estimated to be between 8% and 14% of new head area

[1]John A. Volpe National Transportation Systems Center, Dept. of Transportation

Back-calculation of Defect Size

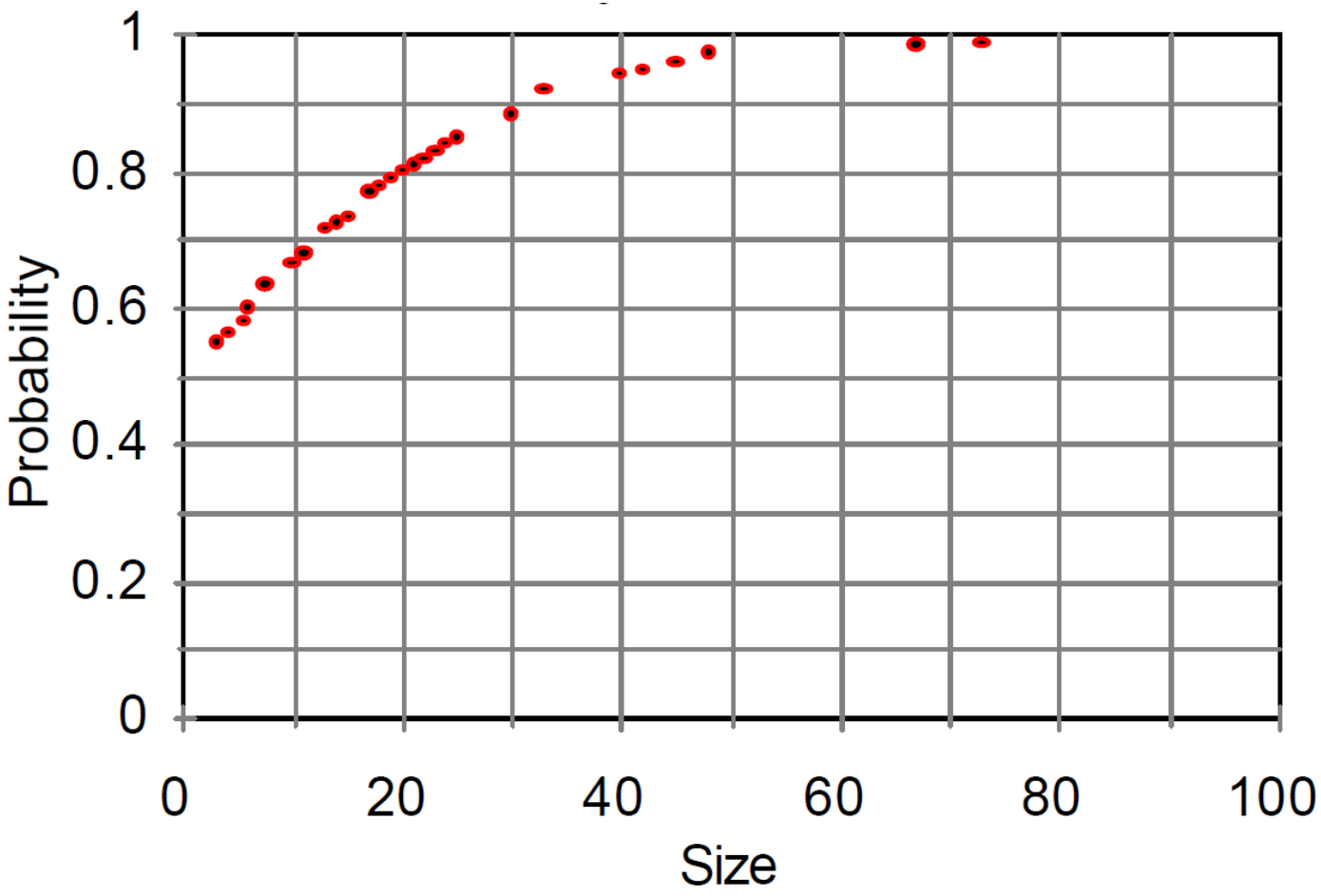


47% of new head area

August inspection

October accident

Probability of Detection



B.D. Jeffrey and M.L. Peterson, *Assessment of Rail Flaw Inspection Data*, Colorado State University, August 1999

NTSB Finding

NS did not conduct internal rail inspections frequently enough to reliably detect an internal defect before it could grow to critical size in the significantly worn rail.

NS Rail Inspection Frequency

- Risk-Based Approach
  - Track Speed
  - Annual Tonnage
  - Hazardous Materials Route
  - Signaled Territory
  - Rail Weight
  - Rail Age
  - Curvature
  - Rail Defect/Failure History
- 4 times per year (~16 mgt between inspections)

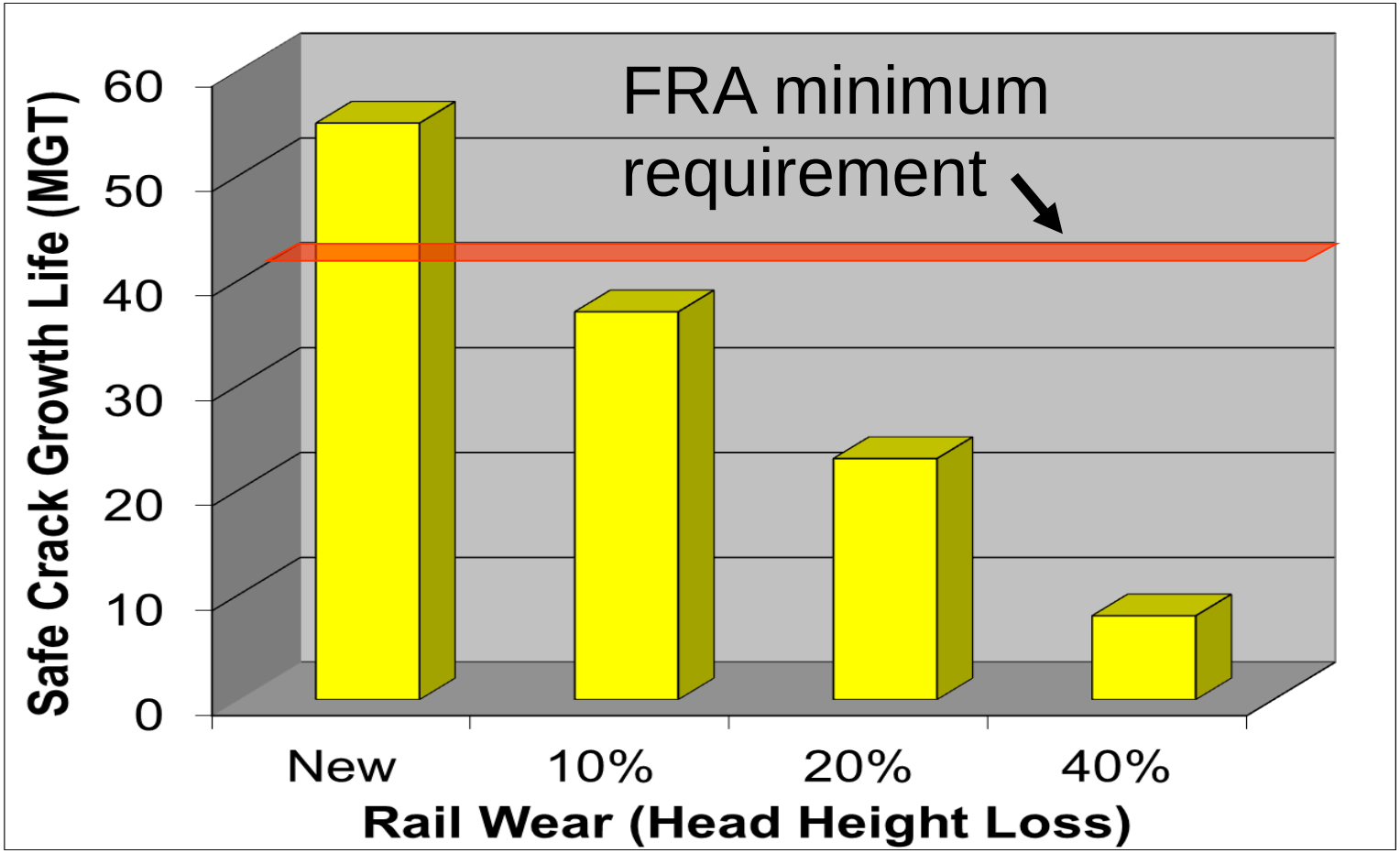
FRA Rail Inspection Requirements

- A continuous inspection of the rail is required
  - At least once every 40 mgt; or
  - Once a year whichever interval is shorter
- If a continuous inspection cannot be conducted
  - Conduct another inspection before time & tonnage requirements expire
  - Reduce operating speed to 25-mph
  - Remove the rail from service

Intervals Exceeded FRA Requirements

- NS rail inspection intervals exceeded FRA minimum standards based on time and tonnage
- FRA regulations did not compel track owners to identify and remediate areas more likely to produce a rail failure from an internal defect

Defects Grow Faster in Worn Rail



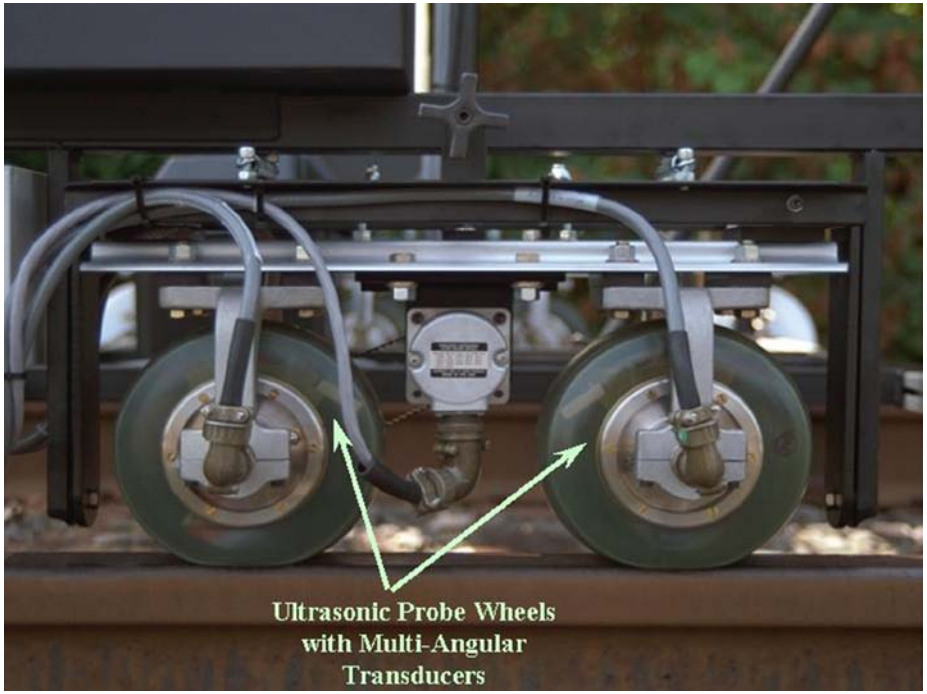
Data from D.Y. Jeong, Y.H. Tang, O. Orringer, and A.B. Perlman, *Propagation Analysis of Transverse Defects Originating at the Lower Gage Corner of Rail*, DOT/FRA/ORD-98/06, US Dept. of Transportation (1998).

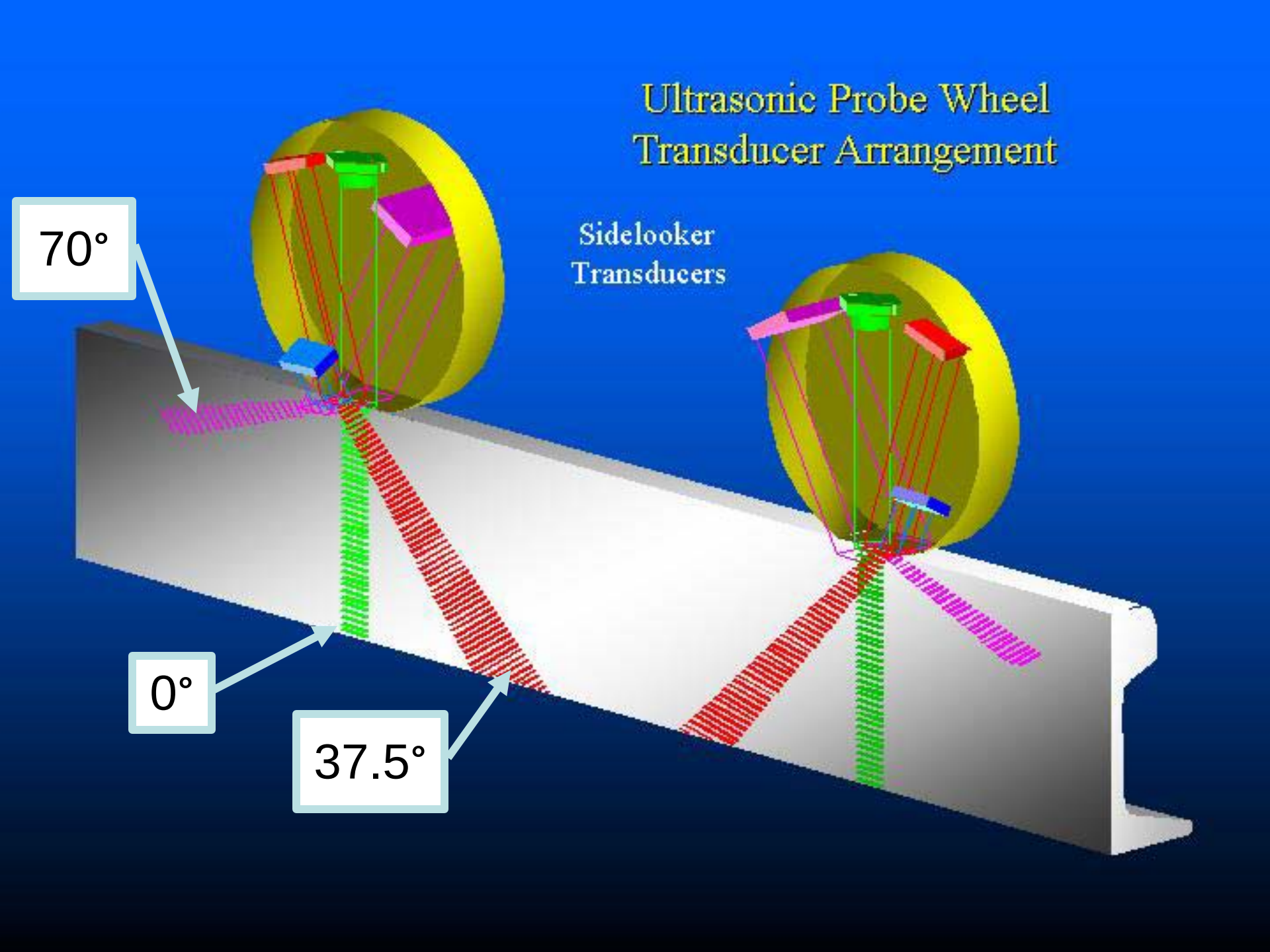
NTSB Finding

The FRA's minimum inspection intervals were inadequate because they did not take into account the effect of rail wear, which can allow undetected internal rail defects to grow to critical size between required inspections.

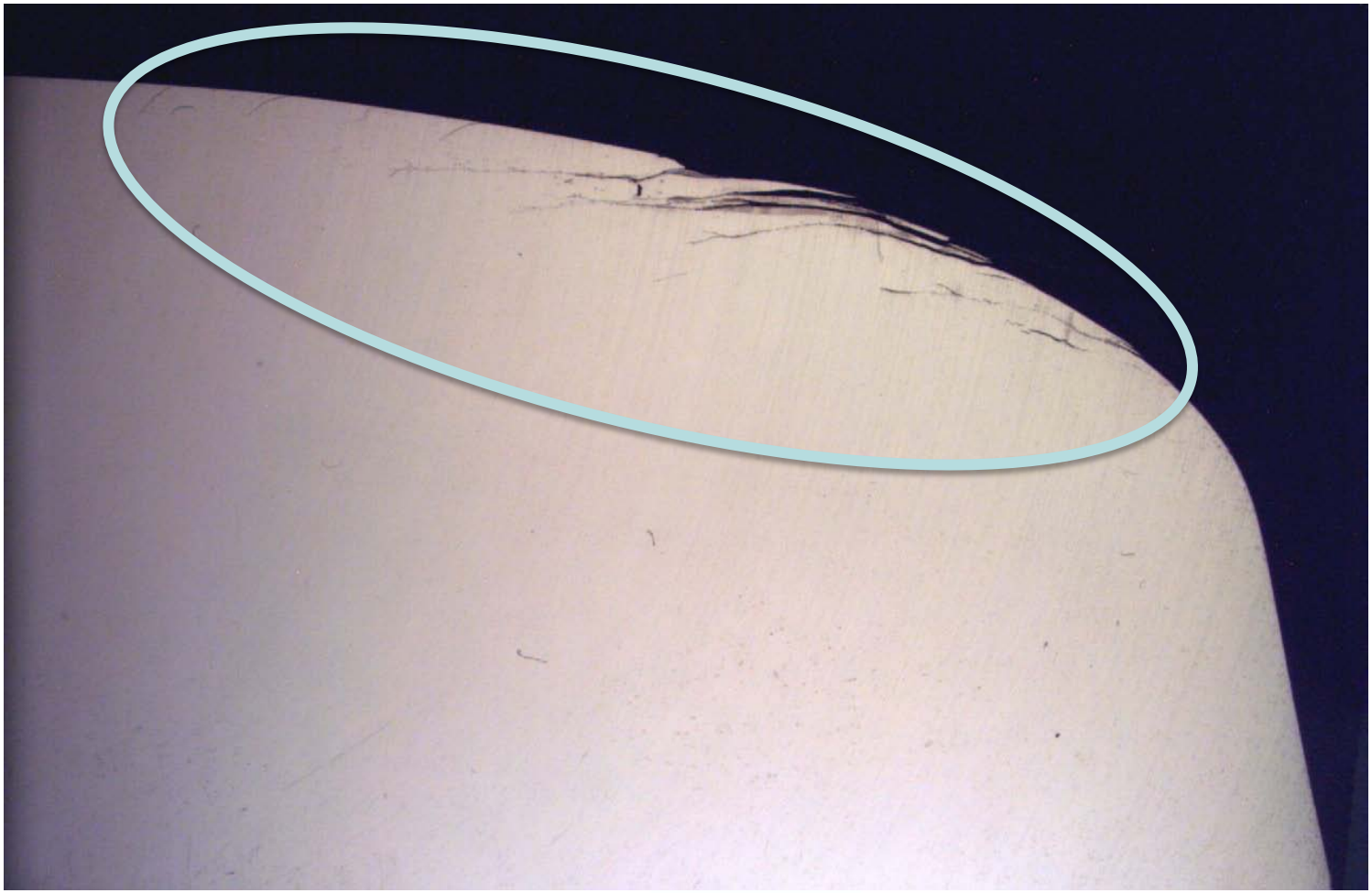
Search for Internal Defects

- August rail inspection
  - Test vehicle was equipped with ultrasonic and induction inspection equipment



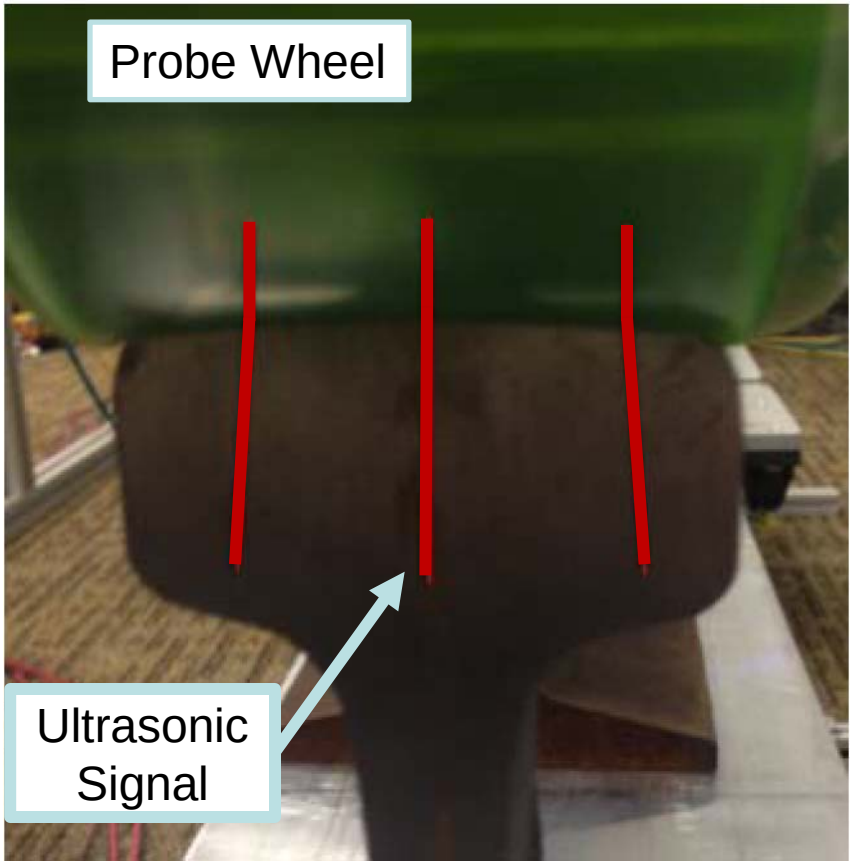

Ultrasonic Probe Wheel
Transducer Arrangement
Sidelooker
Transducers
70°
0°
37.5°

Surface Conditions Can Interfere with Ultrasonic Signals

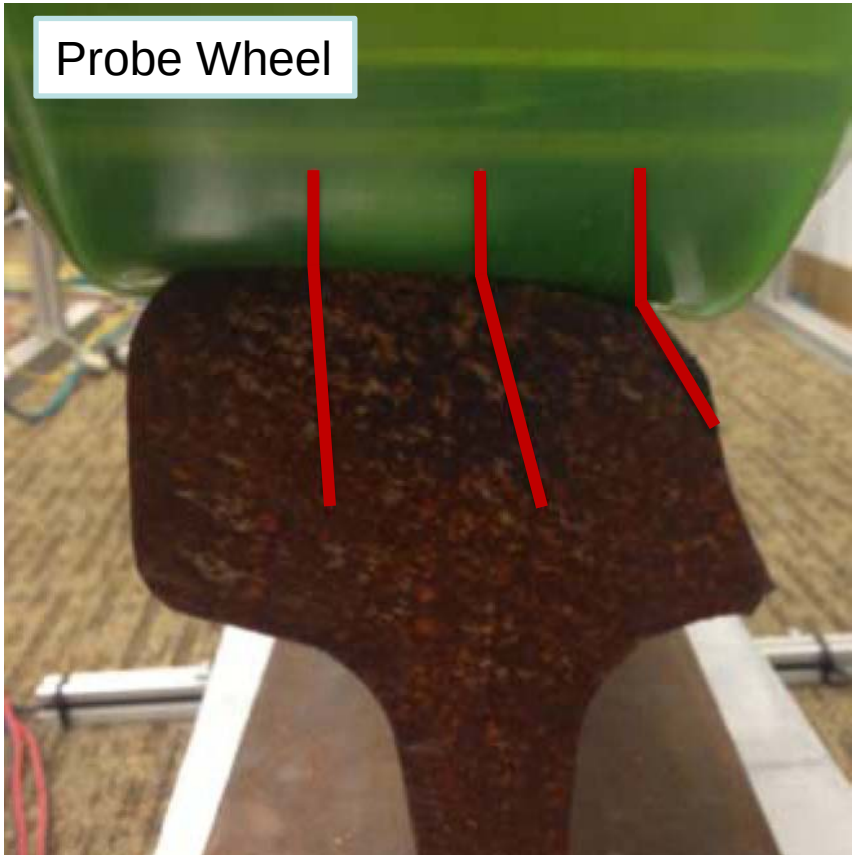


Head Profile Affects Ultrasonic Signal

New Rail Head



Worn Rail Head



Images used with permission.

August Rail Inspection

- Intermittent loss of bottom signal during first pass through accident area, initially thought to be the only pass
- Operator stated that retest or hand inspection was not completed because NS instructions did not require it
- Later review of the August test data showed subsequent passes on the same day through the accident area with no loss of bottom signal
- No defect was detected in any of the passes – confirmed during post-accident data review

NS Special Instructions

- NS instructions to test equipment operators regarding longitudinal defects
  - "Any rail tested that…produces a Zero Degree Ultrasonic Loss of Bottom equipment response exceeding five feet in length or greater…is to be repeated (rerun) by the detector car operator."
- Intended to enhance performance in detection of vertically oriented rail head defects
  - Vertical split head
  - Shear break

- May have had unintended consequences in detection of transverse oriented defects

FRA Oversight

- FRA was not aware of the rail inspection procedures implemented by NS that could be interpreted to allow a discontinuity of a continuous search
- Other railroads had implemented similar procedures
- Did not typically monitor rail test operator's performance
- Typically inspected for frequency compliance and remediation of found rail defects

NTSB Finding

The FRA's oversight of the NS's and other railroad's internal rail inspection process was inadequate.

Probable Cause

- Norfolk Southern's inadequate rail inspection and maintenance program that resulted in a rail fracture from an undetected internal defect.
- Contributing factor: Federal Railroad Administration's inadequate oversight of the internal rail inspection process and its insufficient requirements for internal rail inspection.

Recommendations

- FRA
  - R-08-09: Review internal rail defect detection procedures and eliminate exceptions to the requirement for an uninterrupted, continuous search for rail defects
  - R-08-10: Require railroads to develop rail inspection and maintenance programs based on damage tolerance principles
- NS
  - R-08-14: Revise ultrasonic rail inspection procedures to eliminate exceptions to the requirement for an uninterrupted, continuous search for rail defects

Eliminating the Exceptions: FRA Action

- FRA established the Rail Integrity Group to review all railroads' internal rail defect detection procedures
- Proposed rule includes qualified operator requirements and clarifies responsibility for ensuring a continuous search
- Open – Acceptable Response

Eliminating the Exceptions: NS Action

- NS disagreed that the special instructions were an exception to the rule for continuous search
- NS modified the instructions, including the following statement: “In areas where a loss of bottom less than five feet in length is encountered, the operator must still satisfy himself that he has conducted a valid search for internal defects in accord with 49 C.F.R. § 213.237.”
- Closed – Acceptable Action

FRA Rulemaking Activity

- Rail Safety Advisory Committee (RSAC)
  - Collaborative process for developing regulatory standards
- Rail Integrity Task Force Tasks
  - Rail inspection frequency
  - Rail flaw testing improvements
  - Remedial action requirements
  - Effect of rail head wear, surface conditions and other relevant factors on the acquisition and interpretation of internal rail flaw test results
  - Inspection of plug rail

Proposed Changes to the Rule

- Notice of Proposed Rulemaking (NPRM) issued October 19, 2012
  - Added minimum qualification requirements for flaw detection equipment operators
  - Changes in rail flaw detection frequencies, remedial action requirements, and rail inspection record requirements
  - Added requirements for inspecting plug rail

Qualified Operator

- Documented training program
- Authorized by track owner to
  - Conduct search using specified equipment
  - Determine that a search is continuous and has not been compromised due to environmental contamination, rail conditions, or equipment malfunction
  - Training and supervised experience requirement

Remediation Table

- Transverse defects combined into one category
- Reduced size limit requiring most restrictive action
- Reduced time to repair certain transverse defects
- Added crushed head defect
- Key change: Defects to be sized as percent *remaining* head area

Risk-Based Approach

- Alternate to damage tolerance approach
- Must meet a performance target
- Key aspect to this approach is the method for measuring performance
  - Performance measured in terms of number of service failures per track mile per year
  - Segment length
  - No consensus on definition of segment length
- Maximum 30 mgt or 1 per year, whichever is less

Segment Length

- Length of track over which performance is measured to determine if track owners had met their performance target for the year
- If too short, 1 service failure within that length of track would cause a track owner to miss the performance target
- If too long, isolated problem areas could be masked by many miles of good track
  - Areas with chronic problems could remain unaddressed

Variability in Rail Strength and Load

- Strength of the rail varies through a territory
  - Rail size
  - Wear conditions
  - Surface condition/defect development
- Load varies
  - Track bed condition
  - Curvature
  - Temperature

Finding the Area of Weakness

- Trains will find the areas of weakness
- Track should be evaluated in small enough segments that weak areas will be identified and promptly remediated

Plug Rail - Nodaway, Iowa

- March 17, 2001
- BNSF track
- 78 injured, 1 fatality
- Probable cause: Rail fracture due to undetected internal defects in a replacement (plug) rail
- Contributing factor- lack of a comprehensive method for ensuring that replacement rail is free from internal defects

Recommendations - Plug Rail

- FRA
  - Require railroads to conduct ultrasonic or other appropriate inspections to ensure that rail used to replace defective segments of existing rail is free from internal defects (R-02-5)
- Similar recommendations to conduct inspections (R-02-6 and R-02-7) were made to Class I and passenger railroads

BNSF Actions

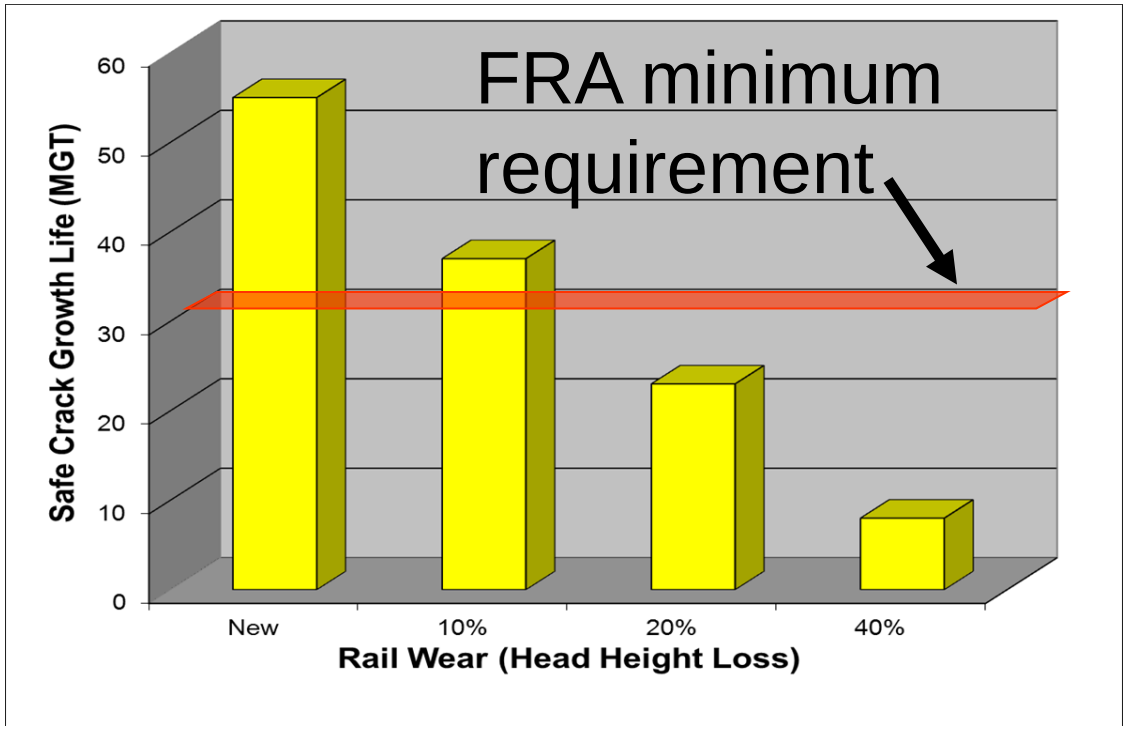
- *BNSF Engineering instructions, revised March 1, 2001*
  - *Poor quality rail used for defect removal may itself become defective. One survey found that 17 percent of defects during the month measured were in rails installed to remove previous defects.*

BNSF Policy for Inspecting Plug Rail

- Soon after the accident
  - BNSF estimated 53,335 rail segments received an ultrasonic inspection before redistribution as replacement rail
  - Of those tested, 685 defective rails were found with internal defects

Proposed Rule

- New requirement for plug rail
  - Accumulated tonnage less than 30 mgt before retest



Recommended Practice

- Don’t set yourself up for failure by installing defective rail
- Inspect your rail before relaying it on main line track
- Improve safety (and save time and money)

Questions?