OFFICE OF RESEARCH & DEVELOPMENT

2012 R&D REVIEW

Wheel and Truck Casting Research and Development

U.S. Department of Transportation
Federal Railroad Administration

MONIQUE FERGUSON STEWART
FRA Rolling Stock Equipment & Components (RSEC) Program Manager
Office of Research and Development
Office of Railroad Policy and Development

Program Area & Risk Matrix

Wheel and Truck Casting Research and Development

Program Areas \ Risk Factors	Trespass	Grade Crossing	Derailment	Train Collision	All Other Safety Hazards
Railroad Systems Issues					
Human Factors					
Track & Structures					
Track & Train Interaction					
Facilities & Equipment					
Rolling Stock & Components			X		
Hazardous Materials					
Train Occupant Protection					
Train Control & Communications					
Grade Crossings & Trespass					

OFFICE OF RESEARCH & DEVELOPMENT

2012 R&D REVIEW

MONIQUE FERGUSON STEWART
FRA Rolling Stock Equipment & Components (RSEC) Program Manager
Office of Research and Development
Office of Railroad Policy and Development

SCOTT CUMMINGS
Principal Engineer
Transportation Technology Center Inc.

Wheel Research

U.S. Department of Transportation
Federal Railroad Administration

Acknowledgements & Stakeholders

Acknowledgements

- TTCI Engineering staff

Stakeholders & Project Partners

- Transportation Technology Center, Inc. (TTCI)
- Association of American Railroads (AAR)
- North American Freight Railroad Companies

Objectives

- Identify measures for improved wheel performance by gaining a solid understanding of the root causes of broken wheel rims and wheel tread buildup
- Inspect and analyze wheels with two of the top wheel-related accident causes: broken rim and tread buildup
- Conduct testing as appropriate for each type of wheel failure mechanism
- Attempt to re-create each of these defect types under laboratory and/or controlled track testing conditions
- Develop guidelines for reduction in train accidents due to specific wheel failure modes

Efforts are being conducted in co-operation with the AAR Wheel Strategic Research Initiative

Objective

Broken wheel rims and wheel tread buildup are two of the leading mechanical-related causes of accidents

FRA Safety Data January 2005 to February 2010 Cause of Accident = Equipment		
Specific cause	**Accident Count**	**Rank by Count**
E61C – Broken Rim	85	4
E67C – Damaged flange or tread (build up)	61	6
E62C – Broken plate	30	15

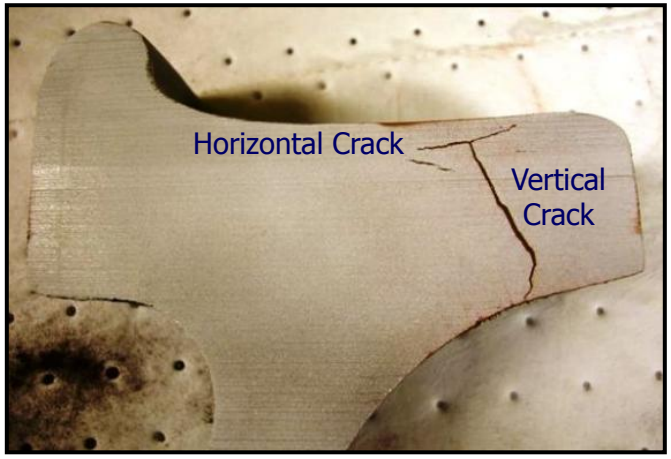

Vertical Split Rim (VSR) – Broken Rim


Tread Buildup

How the Technology Works

Investigation of Vertical Split Rim

- Shallow horizontal subsurface cracks found in many VSR wheels
- Large tensile axial residual stresses
  - Propagate vertical cracks



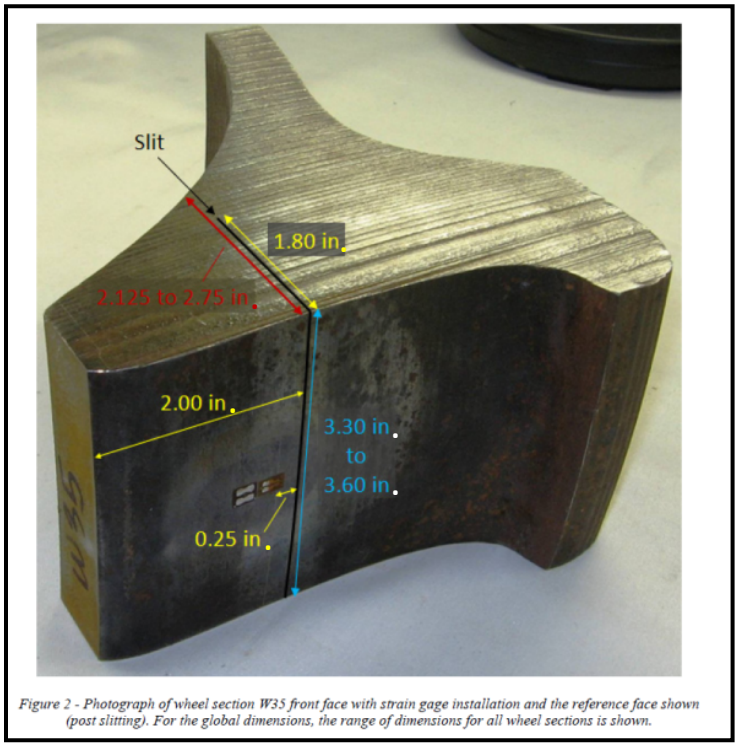
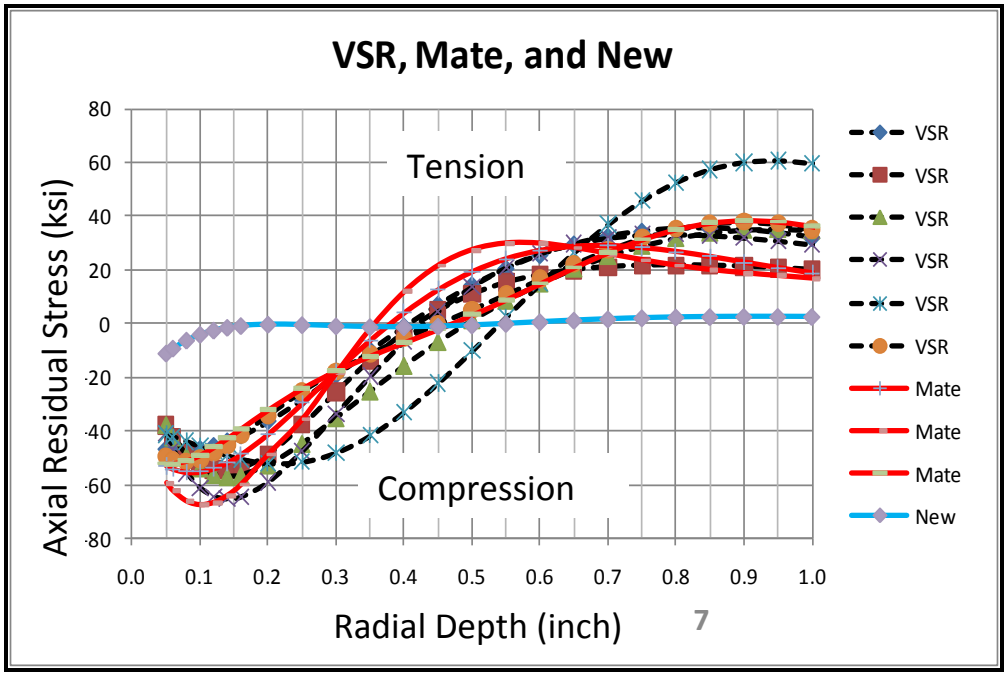
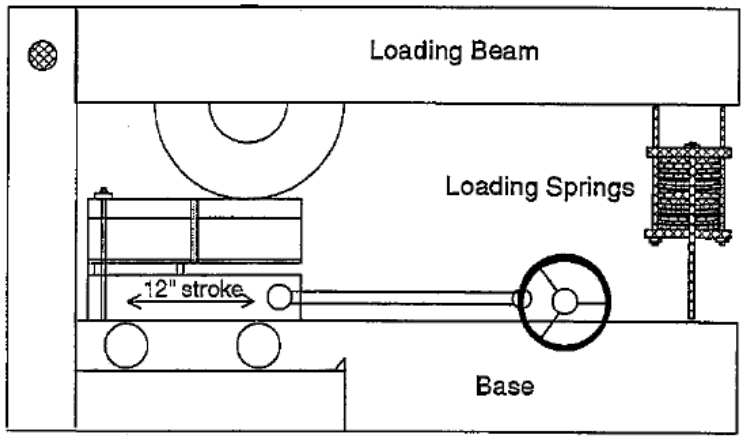


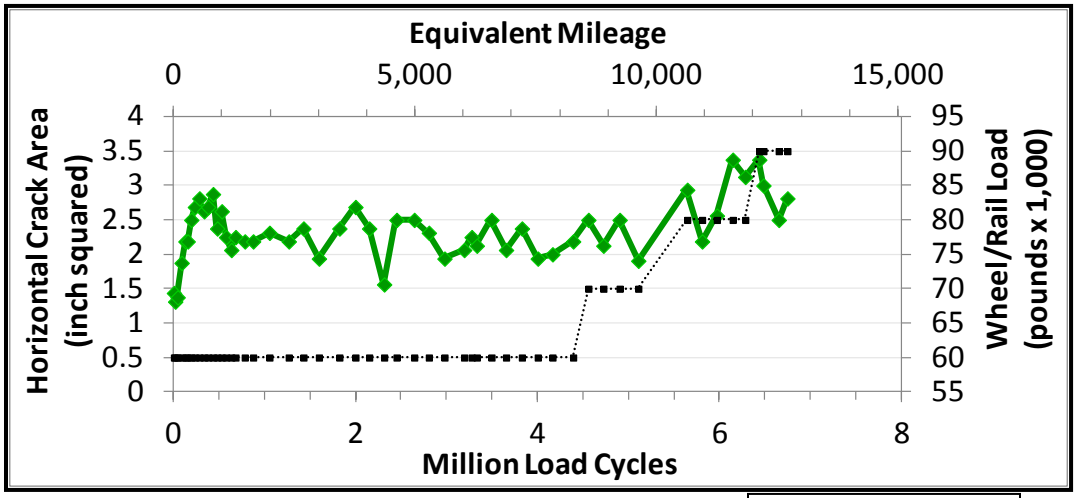
Figure 2 - Photograph of wheel section W35 front face with strain gage installation and the reference face shown (post slitting). For the global dimensions, the range of dimensions for all wheel sections is shown.



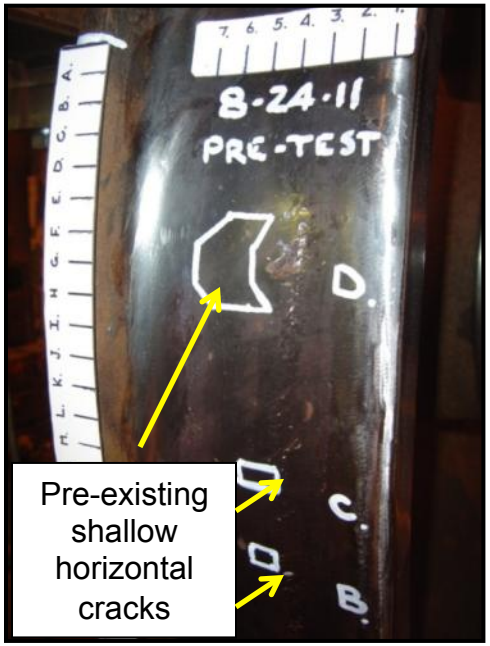
How the Technology Works

Attempt to create a VSR in the laboratory

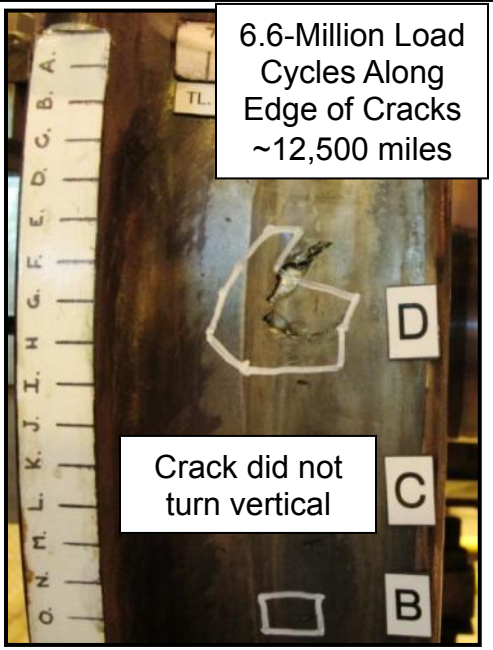




Rolling Load Machine
Up to 90 kips vertical load on service worn wheel



Pre-existing shallow horizontal cracks



6.6-Million Load Cycles Along Edge of Cracks ~12,500 miles

Crack did not turn vertical

How the Technology Works

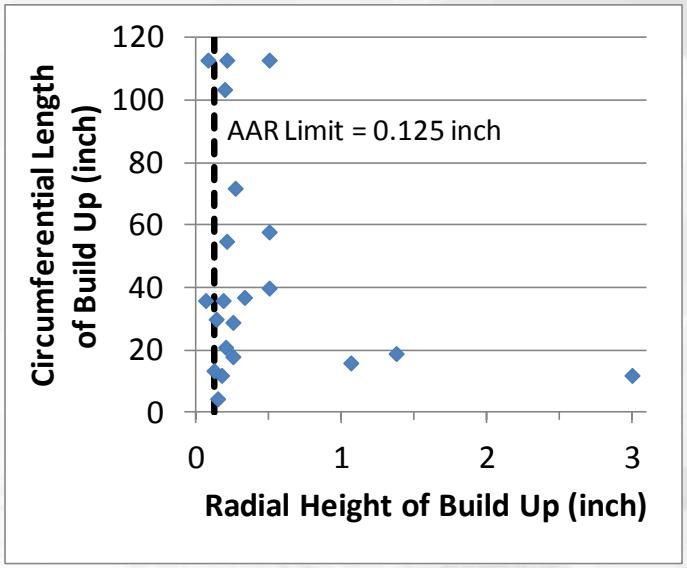
Controlled Creation of Tread Buildup

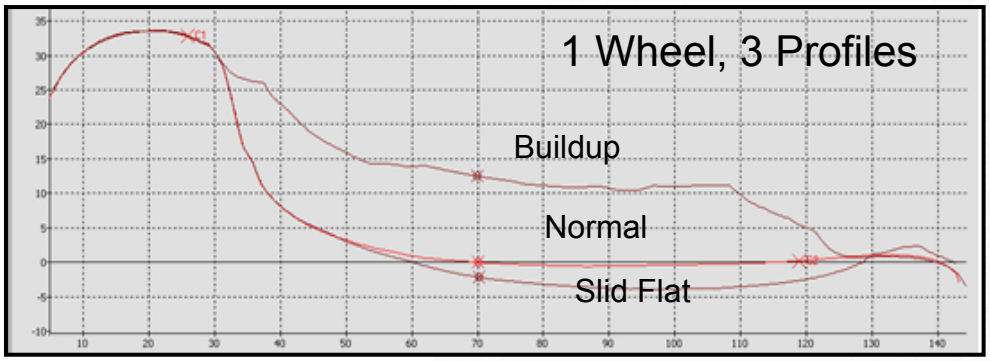
- Wheel slide tests varying speed, axle load, wet/dry
- Tests continue in 2012 including increased slide distances and brake shoes with metal pick up

25 kip Load, Dry

Results

- All wheelsets showed signs of sliding
- TBU radial height typically ½ inch or less
- Some TBU found in excess of 1 inch radial height
  - Clear indications of massive slide marks, plate discoloration near the slide
  - These are the priority TBU wheels of concern from a safety standpoint





Benefits & Disadvantages

Benefits

- Reduced accidents due to broken wheel rims and wheel tread buildup

Disadvantages

- To be determined based on recommended mitigation actions

Lessons Learned

Vertical split rim wheel cracks

- Residual stresses, increased loads are potential factors
- Loads applied to wheel in laboratory failed to turn crack in vertical direction

Tread buildup can be readily generated during wheel slides

- Dependence on slide distance, speed, axle load

Key Success Factors

Accurate record keeping

- FRA safety data
- AAR car repair billing
- AAR MD-115 reports

Failed and unfailed parts donated by various railroads and suppliers

OFFICE OF RESEARCH & DEVELOPMENT

2012 R&D REVIEW

MONIQUE FERGUSON STEWART
FRA Rolling Stock Equipment & Components (RSEC) Program Manager
Office of Research and Development
Office of Railroad Policy and Development

SCOTT CUMMINGS
Principal Engineer
Transportation Technology Center Inc.

Improved Quality Truck Castings

U.S. Department of Transportation
Federal Railroad Administration

Acknowledgements & Stakeholders

Acknowledgements

- TTCI Engineering staff

Stakeholders & Project Partners

- Transportation Technology Center, Inc. (TTCI)
- Association of American Railroads (AAR)
- North American Freight Railroad Companies

Objective

Improve safety of train operations by reducing the number of in-service failures and derailments due to broken truck casting components

Efforts are being conducted in co-operation with the AAR Castings Strategic Research Initiative

Motivation for Project

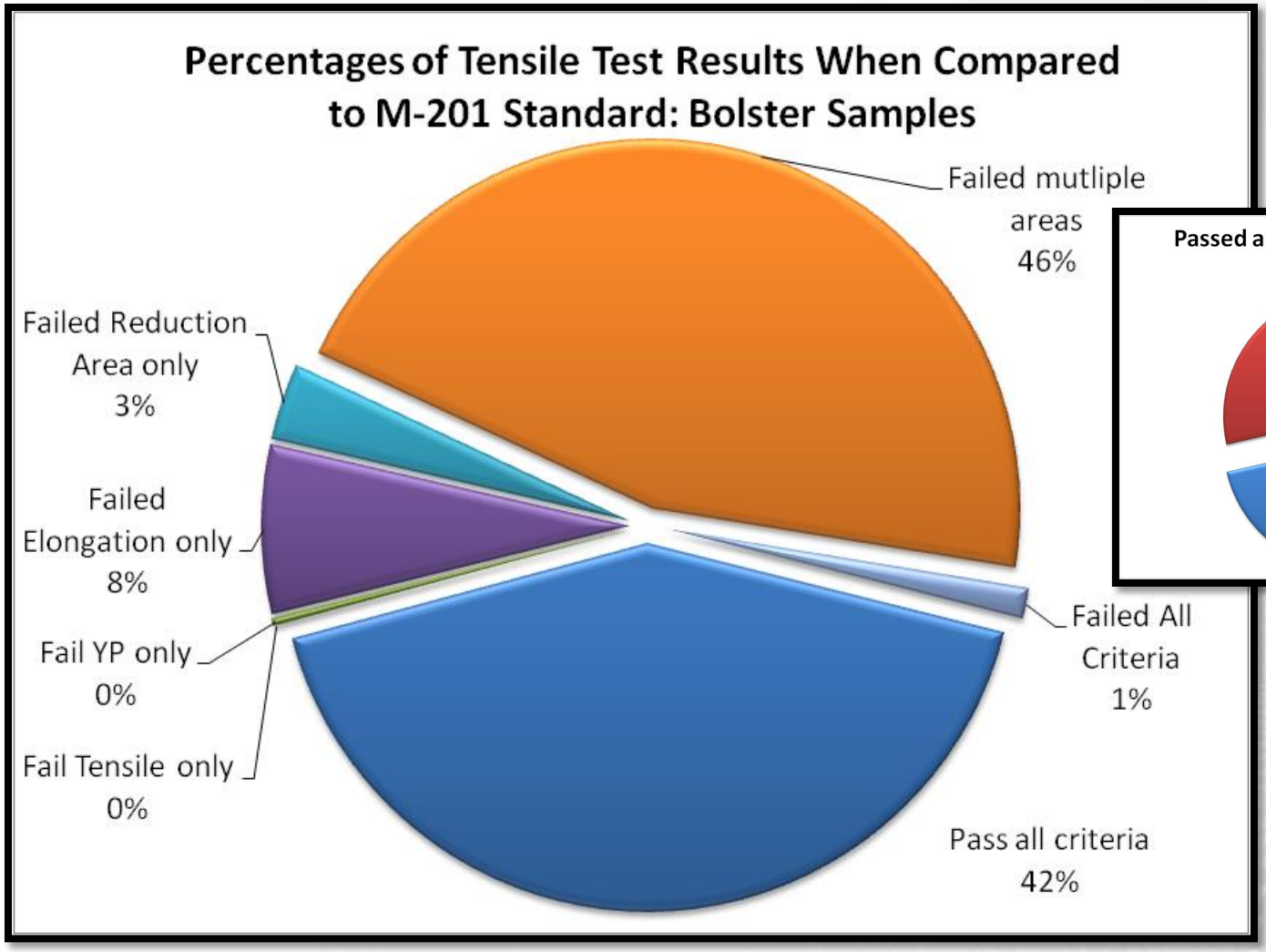
- Over $11 million in costs due to truck failures
- Re-evaluation of standards and specifications to ensure the quality, safety and reliability of the components is needed
- Comprehensive review has not been conducted for 30 years

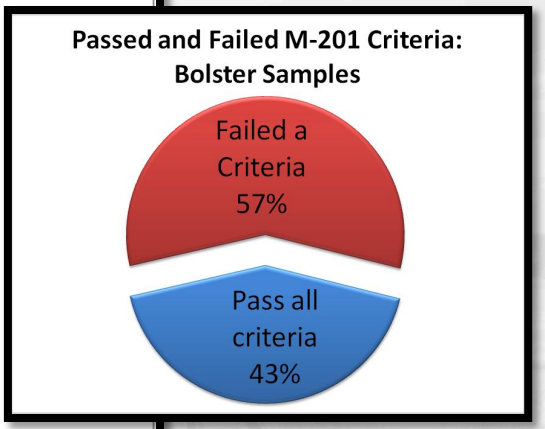
How the Technology Works

Mechanical testing of Grade B+ bolster castings from seven AAR approved foundries

- Tensile (material strength in tension)
  - Keel blocks vs. samples from the bolster
- Charpy (toughness, ability to absorb energy)
  - AAR standard test conditions vs. range of temperatures
- Dynamic Tear (resistance to rapid progressive fracture)
  - AAR standard test conditions vs. range of temperatures

Results
Mechanical Test Results
Tensile Test Samples from Bolster



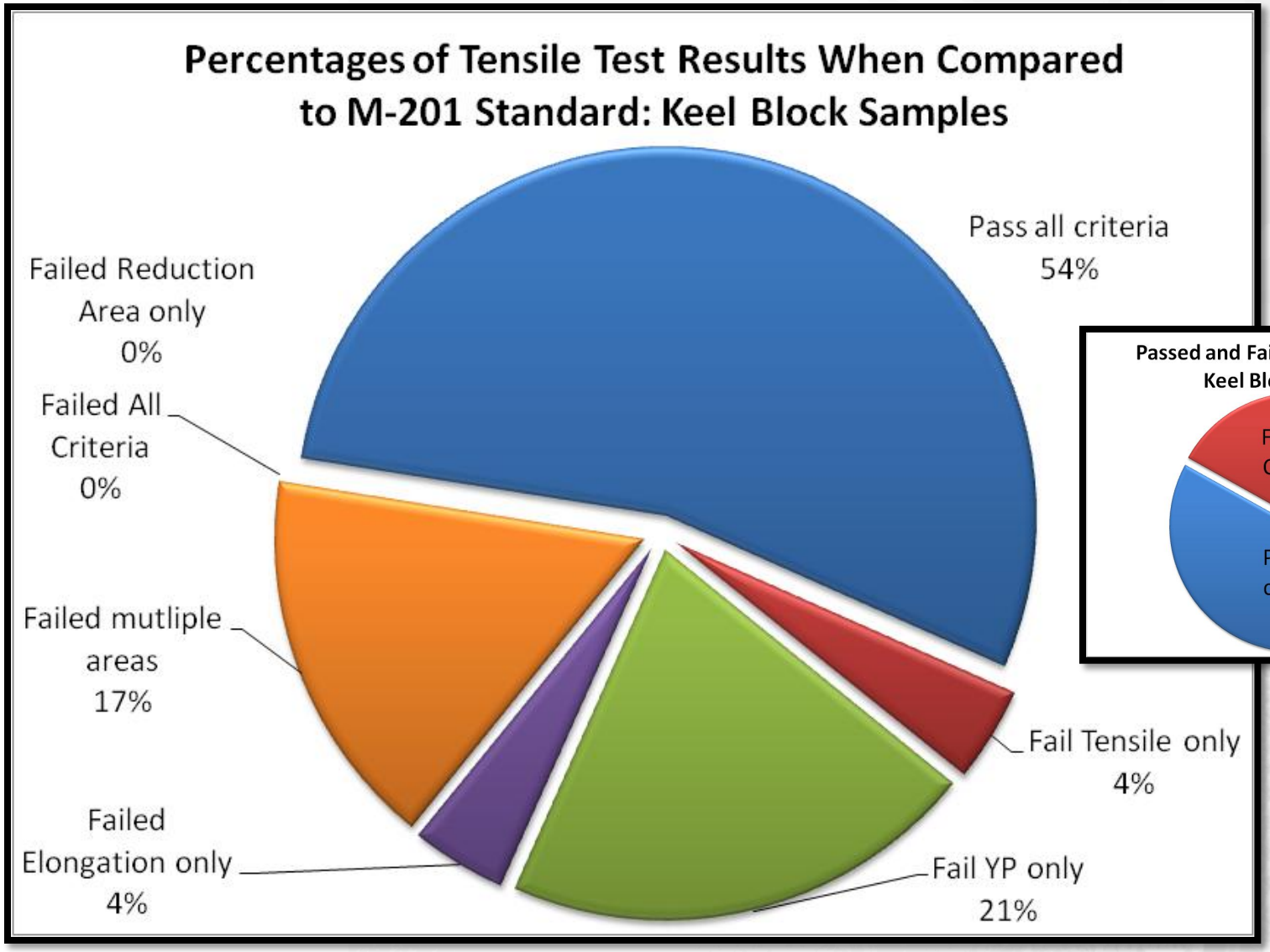


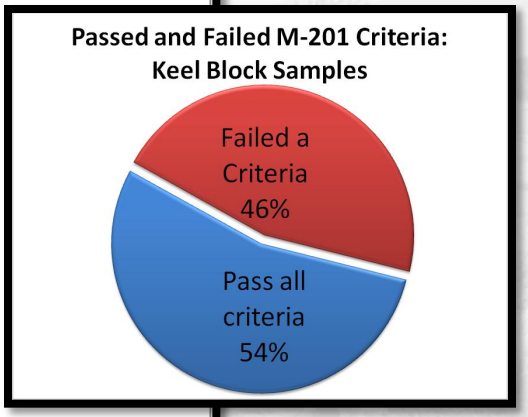
Comparison values taken at 80% of standard values to reflect proper comparison for M-201

Findings/Results

Mechanical Test Results

Tensile Test Samples from Keel Blocks

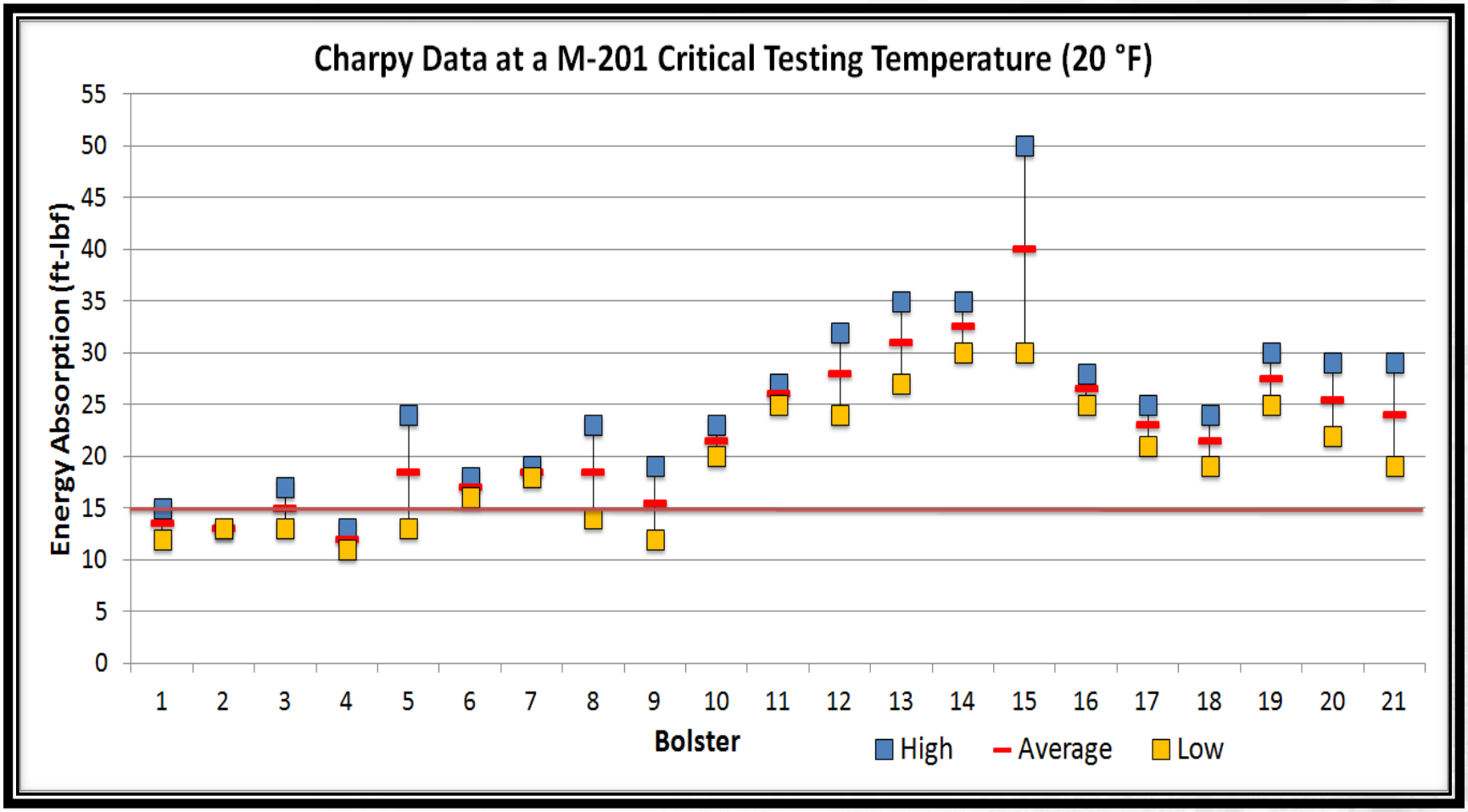




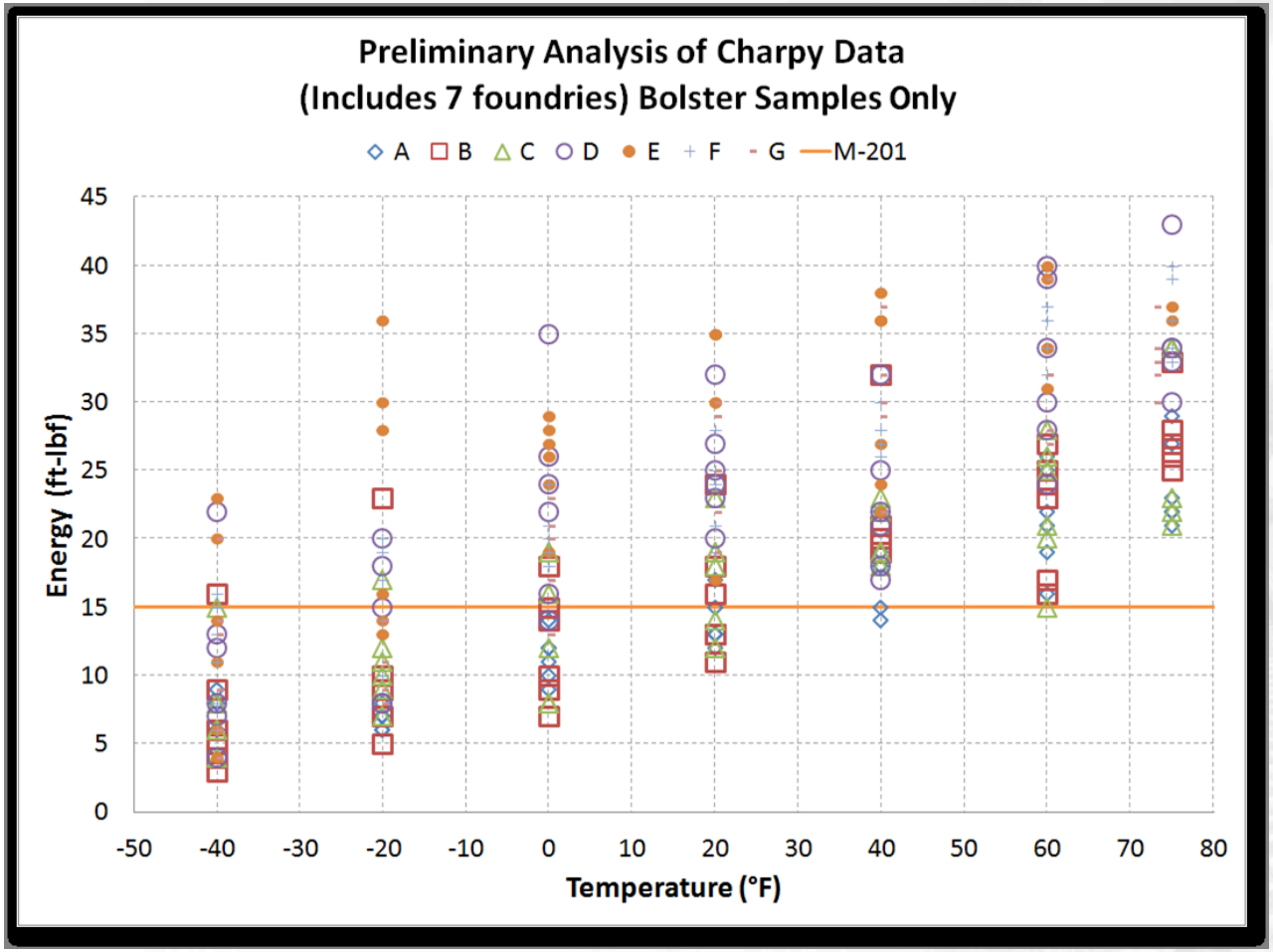
Results

Mechanical Test Results

Charpy Test Samples from Bolster



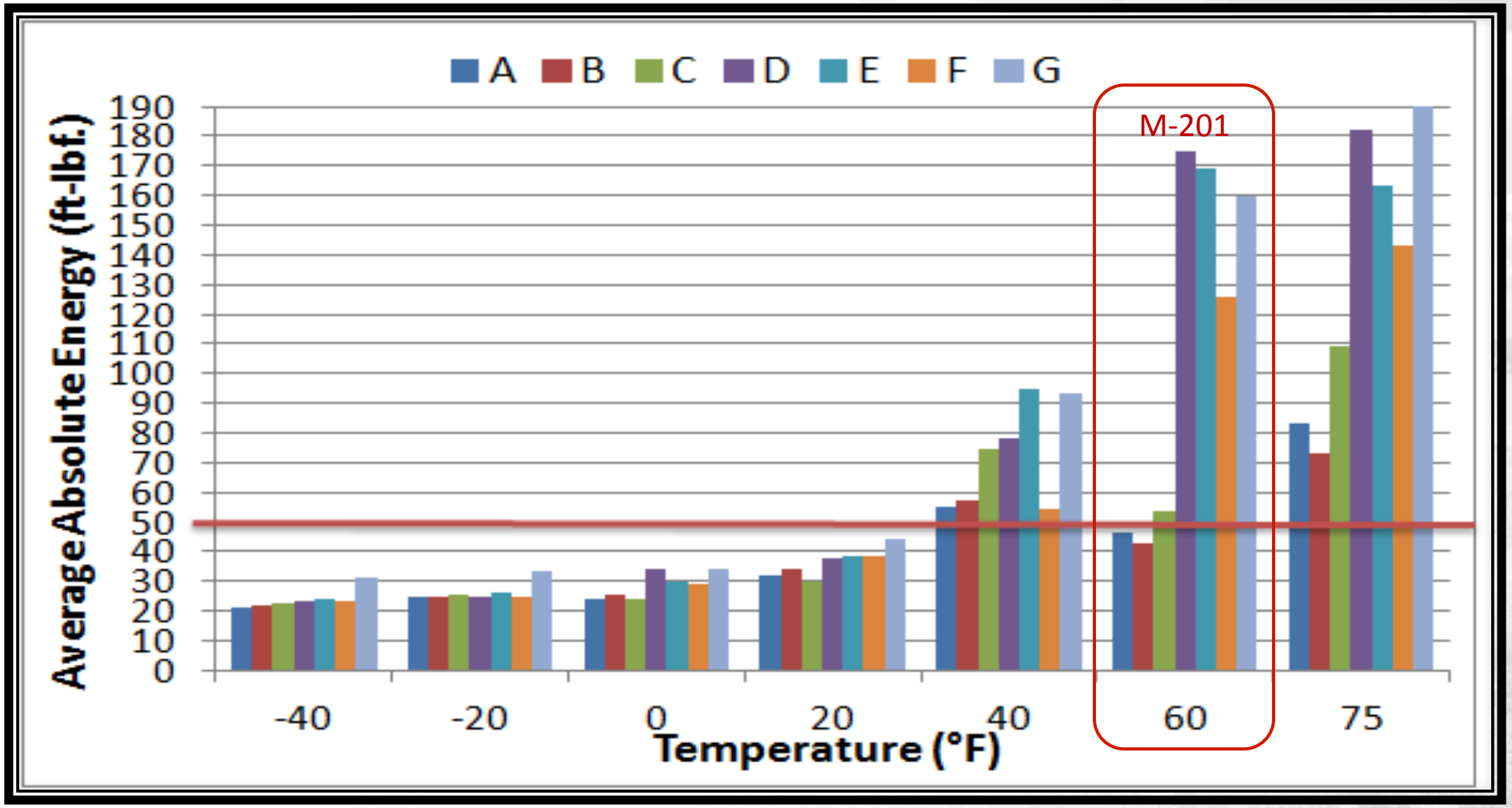
Results
Mechanical Test Results
Tensile Test Samples from Bolster



Results

Mechanical Test Results

Dynamic Tear Samples from Bolster



Benefits & Disadvantages

Benefits

- Reduced accidents due to truck casting failures
- Improved quality and increased life of truck castings

Disadvantages

- Potential for increased manufacturing cost

Lessons Learned

- Mechanical properties strongly related to temperature
- Sample size may need to be increased
- Mechanical test results indicate modifications to current AAR specifications may be necessary to address brittle failures

Key Success Factors

- Accurate record keeping
  - FRA safety data
  - AAR car repair billing
- Failed and unfailed parts donated by various railroads and suppliers