HAL Revenue Service Testing: 
UP and NS Mega Sites 

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Objective:

- Determine effects of HAL traffic on track infrastructure and mechanical components
  - Complement/supplement the FAST program with a range of curvatures, train speeds, subgrade conditions, and climate conditions
- Alert FRA and the industry to potential problem areas and refine economic analysis of HAL traffic
Eastern and Western Mega Sites

- Mega site concept proposed in 2003 to consolidate a wide variety of revenue service experiments
  - Improve experiment design
  - Simplify coordination and communication with host railroads
  - Foster cost efficiency for instrumentation and measurements
- Two mega sites selected in 2004, each 10-30 miles
  - Eastern mega site (NS)
  - Western mega site (UP)
- Funded by AAR and FRA with donations and participations of many suppliers
HAL Revenue Service Testing - UP Mega Site

- Limits of test
  - South Morrill Subdivision
    - MP 30 to MP 60
  - Martin Bay, NE to Lewellen, NE
- 35-135 coal trains/day
  - Coal bound from Wyoming to southern and eastern power plants
- Annual tonnage 220 MGT
**UP Mega Site - Track Characteristics**

- Concrete tie track, premium rail, premium turnouts with movable point and spring frogs
- Ballast deck bridges
- Curvature 1° - 2°
- Grades < .5%
- Time Table speed 60 mph
- Loaded coal train speed 50 mph
**Objective**
- Define load environment and failure modes
  - Longitudinal force, rail temperature, vertical impact force, joint bar bending stress
- Measure effectiveness of two different joint supports

**Status**
- Instrumented four pairs of IJs in July 2004
  - Three pair 141# with 48” bars – all joints supported
  - One pair 133# with 36” bars – one joint supported and one joint suspended
Results

- Longitudinal tensile forces up to 530 kips at -10 deg. F
- IJ’s installed at a relatively high neutral temperature (> 100°)
- Isolated impact forces above 80 kips
- Magnitude of bending stresses in joint bars not a concern
- Isolated hairlines in the epoxy have been seen
- Still performing well after 300 MGT
UP Mega Site - Bonded Insulated Rail Joint Test

Site 1 - North Rails

Total Forces

Total Longitudinal Force (kips)

Rail Temperature (deg)
UP Mega Site - Bonded Insulated Rail Joint Test

Site 1, North Rails - Adjusted Force

Thermal Forces

Rail Temperature (deg)
Supported joint – mainly in compression; Suspended joint – mainly in tension; Stresses relatively low
**Objective**
- Measure wear and surface performance of new 141# premium rails on low-degree curve

**Status**
- Test rails installed in Sept. ‘05
  - MP 42.85 2,200’ 1° curve
  - MP 44.64 1,700’ 2° curve
  - MP 47.00 1,100’ 2° curve
### 1° Curve (2200') MP 42.85

**High Rail**

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<th>HCHH1</th>
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**Curve = 2200'**

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### 2° Curve (1700') MP 44.65

**High Rail**

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**Curve = 1700'**

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### 2° Curve (1100') MP 47

**High Rail**

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**Curve = 1100'**

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**Seven premium rails from six suppliers**

**Nippon HE-X is the control**
**Objective**
- Measure longitudinal force/rail neural temperature behavior
  - At IJs
  - Rail repair (rail cutting)
  - Traffic effect after installation of new rails
  - Seasonal effect

**Status**
- Measuring longitudinal force at four IJ locations since July 2004
- Stress modulus installed in Sept. 2005 to measure the effects of rail repair, traffic and season variation
UP Mega Site - Concrete Ties on Concrete Bridge

◆ Objective

- Quantify the load environment of concrete tie/concrete bridge and their approach
- Solve concrete tie cracking problems on ballast deck concrete bridges
- Three phases:
  - Concrete ties, ballasted deck bridge and approach
  - Concrete ties with rubber tie pads
  - Ballast mat
**UP Mega Site - Concrete Ties on Concrete Bridge**

- **Status**
  - Instrumentation and test site commissioning completed Sept. 2005
**UP Mega Site - Concrete Ties on Concrete Bridge**

- Surface strain gauge on ties
- Vertical load circuits on rails (multiple of wheel circumference)
- AEI reader

East, direction of main traffic
Rail defect records
- Review and analyze rail defect and service failure records

Track geometry records
- Review and analyze track geometry records for geometry degradation rates

Analyze 286k vehicle/track interaction test conducted in July 2004
UP Mega Site - Summary

- Test program started in 2004
- Several tests just underway:
  - Instrumented IJs
  - Premium rails
  - Longitudinal forces
  - Concrete tie/bridge and approach
  - Past and current testing records for the mega site
- Tests planned for the near future:
  - Slot welds
  - Rail pad degradation
  - TOR friction management
Norfolk Southern
Mega Site
HAL Revenue Service Testing – NS Mega Site

Virginia Division
Christiansburg District
MP N350 – 360
Main 1

52 annual MGT
50% HAL
Coal traffic moving east
NS Mega Site – Track Characteristics

- Standard 136 lb rail
- Wood ties, cut spikes, spring anchors, 8” x 18” rolled steel plates in curves,
- Majority of track in 2-12° curves
- 0.47% to 1.15% grade
- Elevations up to 3 inches
- 25 mph track speed
- Open deck bridges
- Main 1 traffic traveling downhill from west to east, usually with dynamic and air brakes
- Average annual precipitation 41 inches
- Temperatures between -15°F and 95°F during the year
NS Mega Site – Composite Tie Test

- **Objective** - Determine performance of composite ties in medium to high-degree curves

- **Installation**
  - November 17, 2004
  - 6.8 degree curve
  - 2.5” elevation
  - 0.8% grade
  - 75 each of
    - Polywood
    - TieTek
    - New wood control
  - 8” x 18” rolled steel plates
  - No pilot holes
  - Cut spikes
NS Mega Site – Composite Tie Test

◆ Results

- Some cracking at tops and sides of ties
- Material flowed up and out of some spike holes resulting in raised plates
- As plates settled, spikes appear raised, not from spikes moving upward, but from plates moving down
- All ties were inspected April 2005 by vendors, TTCI, and NS
- 9 ties replaced in June 2005
  ♦ Predrilled with 3/8” x 3” pilot holes
  ♦ No cracks and better seating of plates
  ♦ No significant additional cracking after installation
NS Mega Site – Composite Tie Test

Gage-Spreading Strength after 30 MGT

Static Gage-Spreading Strength Measurements
June 2005 – after 30 MGT
Static load 9 kips with Light Track Loading Fixture
More cant in composite tie zones
**Objective**

- Measure wear rates and rolling contact fatigue in medium and high degree curves

**Materials**

- 8 premium rails from 4 suppliers
- 141 RE rail
- RMSM DH as control
NS Mega Site – Premium Rail Test

◆ Status

- Rails installed August 2005
- Initial profiles measured
- Initial surface hardnesses measured
NS Mega Site – Elastic Fastener Test

◆ **Objective**
  - Determine performance of new generation of elastic fasteners using cut spikes as control

◆ **Status**
  - Elastic fasteners installed at HAL satellite site east of Roanoke, June 2005
  - 200 each (100 ties) of
    - AirBoss
    - NorFast
    - With high strength screws
  - Control 90 ties of 8” x 18” plates with cut spikes
NS Mega Site – Wide Gap Welds

- **Objective**
  - Monitor performance of wide gap welds on premium rail in medium and high degree curves

- **Status**
  - 16 locations selected
  - In spirals, high and low rails of 4 test rail curves
  - 141 RMSM DH
  - Materials en route to site
  - Installation scheduled for first week of October
NS Mega Site – Bridge Approach Stability

Objective
- Investigate new remedy methods for surface and alignment problems associated with open deck bridges in curves or spirals

Status
- 2 bridges selected with local maintenance supervision
  - Skewed backwalls, alignment problems, broken spikes, frequent tamping
- AAR Track Loading Vehicle tested for track modulus and subsurface strength with cone penetrometer in May 2005
- Data being evaluated
NS Mega Site – Additional Tests

- FRA’s GRMS (T18) provides testing twice a year for mega site
  - Curving force measurements
    - Instrumentation installed
    - Data being collected and analyzed
  - Top of rail friction management
    - Wayside dispensers installed
    - Data being collected and analyzed
  - Slot welds
    - Depends on results of tests at TTCI
  - Rail failure history analysis
    - Data analysis in progress
  - Circular entry guardrail
    - Potential turnouts selected
    - Materials being assembled
  - Elastic fasteners on bridges
    - In initial planning stage
NS Mega Site – What is Next?

- Continue HAL revenue service monitoring at the mega sites
  - On-going experiments
  - Add new tests, addressing key issues of the industry
  - A research and testing program for many years to come
Acknowledgements

◆ Special thanks to:
  - FRA and AAR for funding the research
  - Host railroads:
    ◆ UP - Bill Wimmer, Bill Ge Meiner, Sam Atkinson
    ◆ NS - Gary Woods, Bob Blank
  - Rail Manufacturers
    ◆ Nippon
    ◆ RMSM
    ◆ JFE
    ◆ MITTAL
    ◆ Corus
    ◆ Voest Alpine
  - Tie Suppliers:
    ◆ CXT
    ◆ TieTek
    ◆ Polywood
  - Fastening Systems:
    ◆ NorFast
    ◆ AirBoss
    ◆ Lewis Bolt and Nut