

Challenges Handling Multilevels and Other Long/Cushion Equipped Cars

*Walter Rosenberger
Norfolk Southern
- Research & Tests*



Three Types or Scenarios

Dynamic Force – Slack Run-In

Steady-State Buff Force Derailments

Steady-State Force – climb guardrail



Dynamic Force Derailments

1. Result from slack run-in, can be extreme
2. Train make-up: loads behind cushion units
3. Examples:
 1. Wytheville VA & Montgomery VA – 23G
 2. Clinchfield GA – 185
 3. Altoona PA – 18N

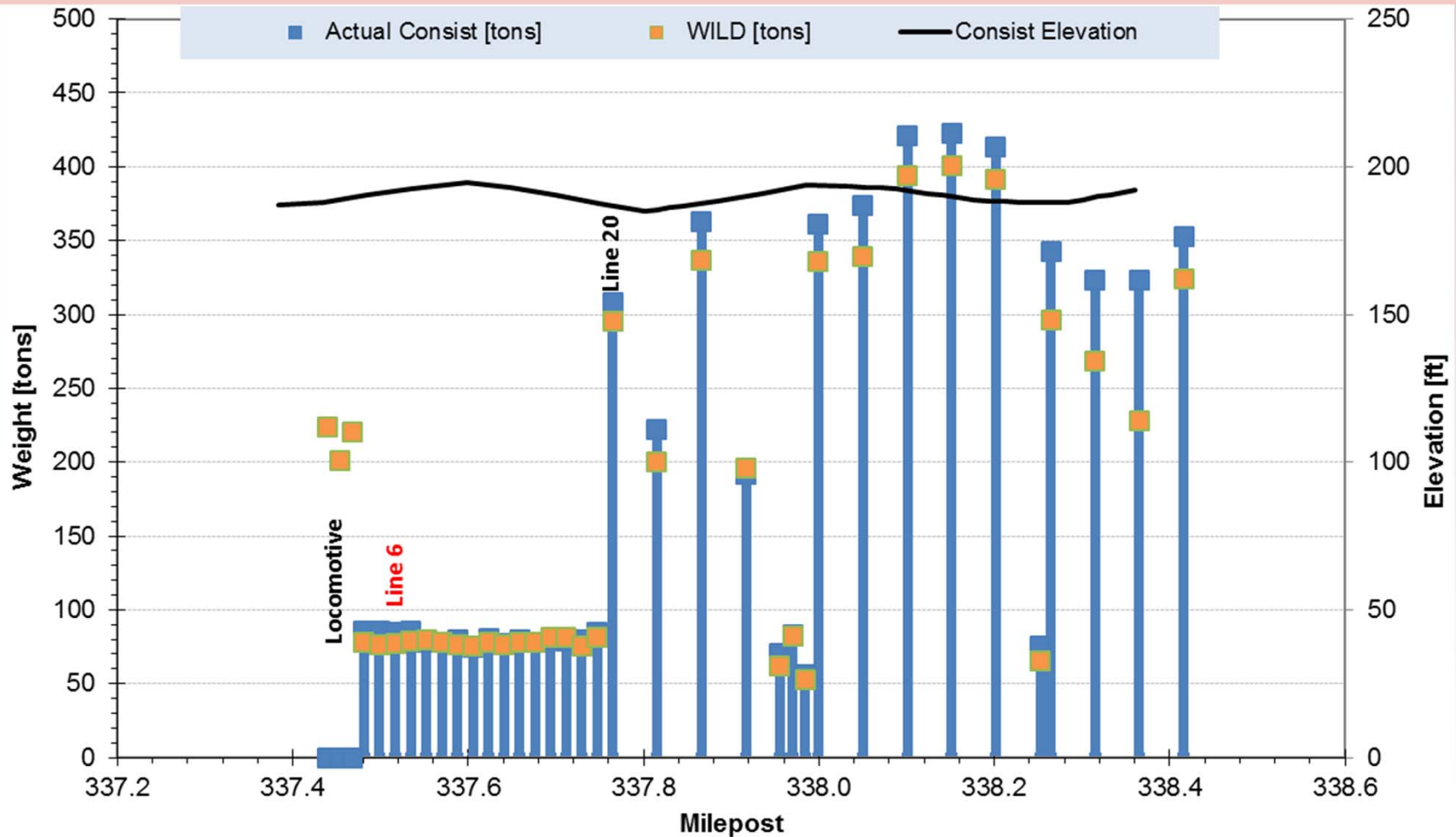


Wytheville VA - 23G

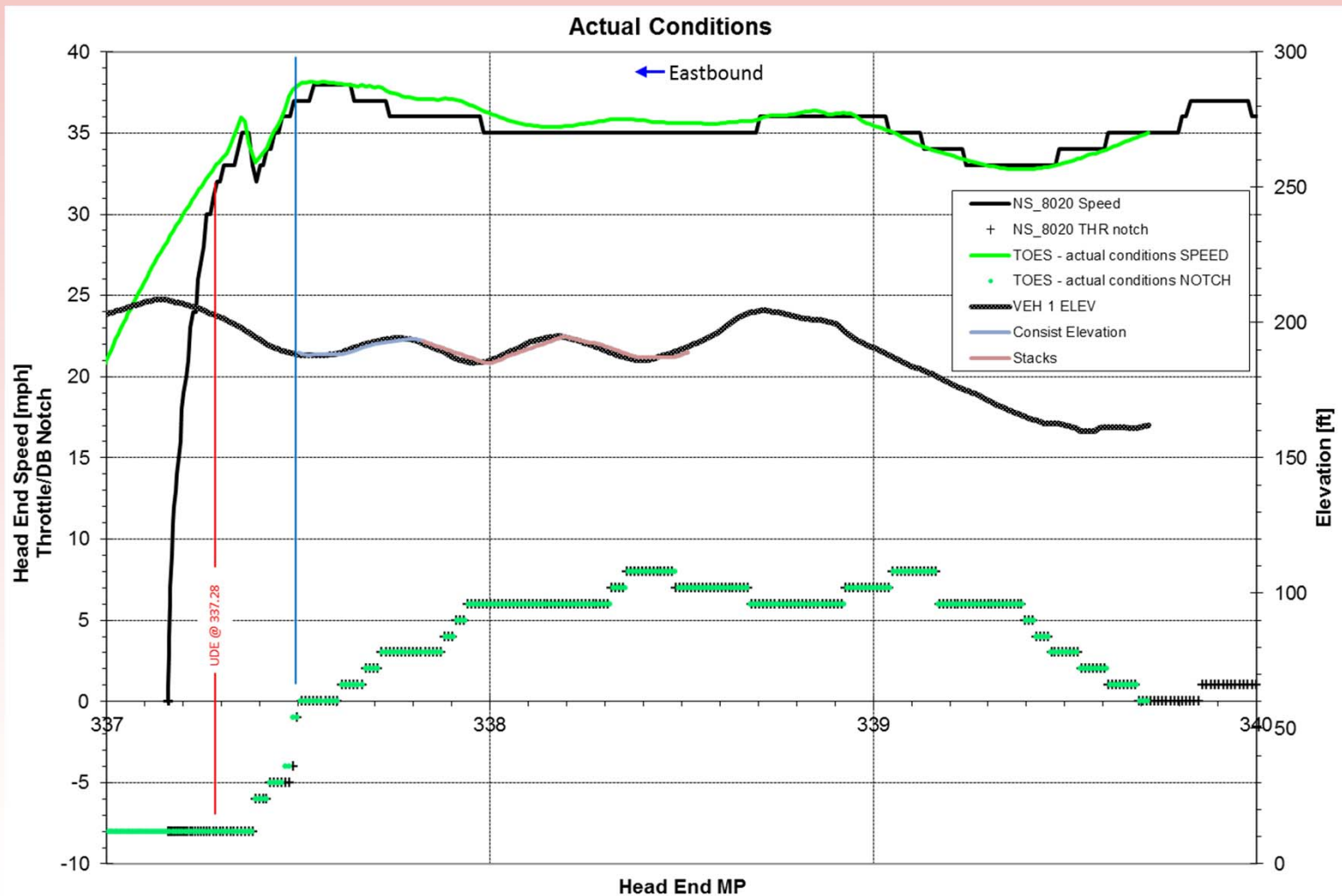
- 3x0, 16 loaded multilevels, 17 loaded doublestacks, 5996 tons and 5421 feet
- 36 mph with 12 Klbs in Dynamic 5
- Derailed 16 cars (lines 6-21)
- Normally operates 2x1 DP



Wytheville 23G: tonnage profile



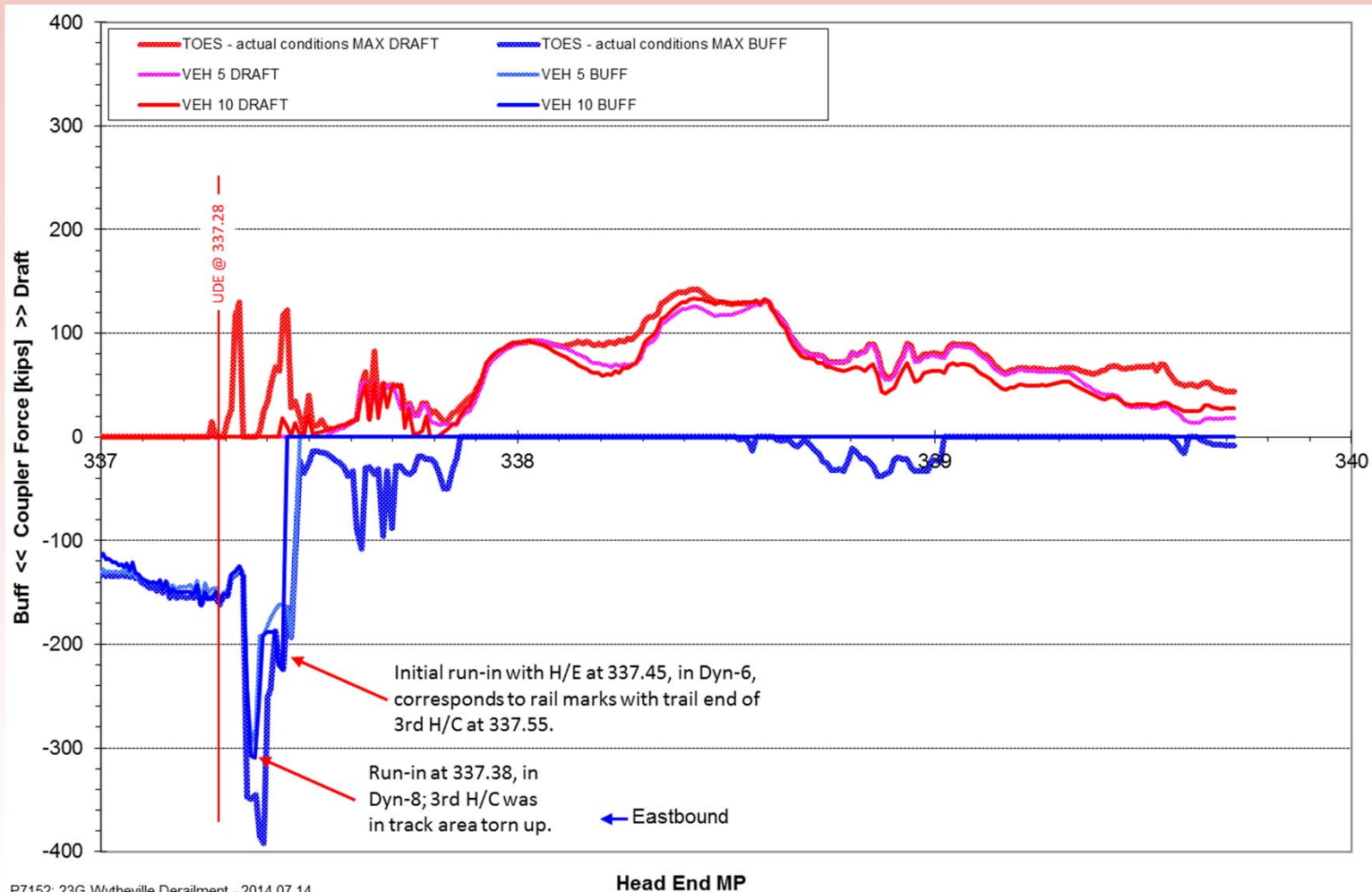
Wytheville 23G: train handling



P7152: 23G Wytheville Derailment - 2014.07.14



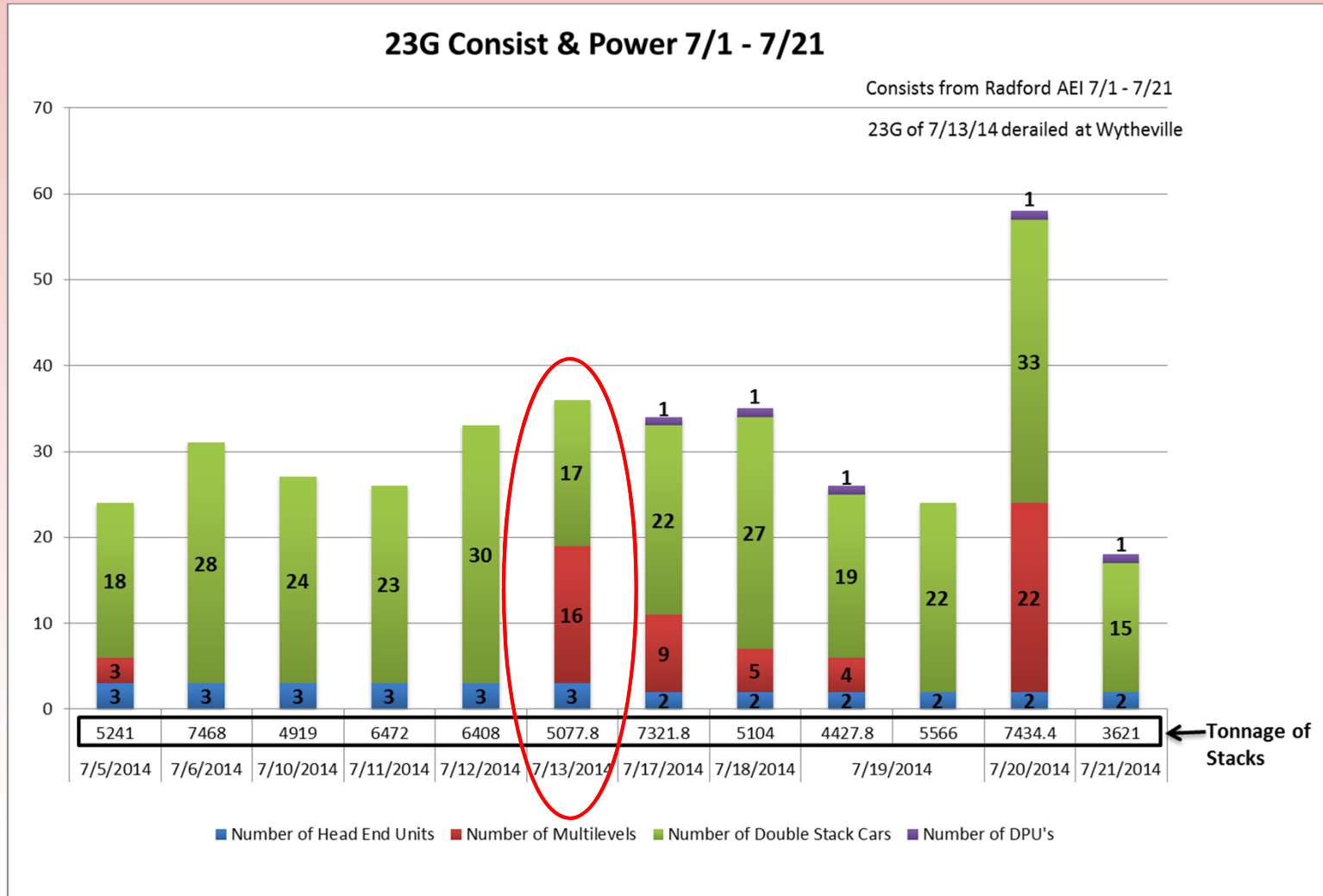
Wytheville 23G: TOES buff forces



P7152: 23G Wytheville Derailment - 2014.07.14



Wytheville 23G: consist history



Wytheville 23G: Cause Statement

- “Trail end 3rd head car/head end 4th head car (both 89 ft multilevels) jackknifed in entry spiral of 4.1° curve account aggressive dynamic braking of a train incorrectly built without DP to mitigate in-train forces of doublestacks trailing multilevels.”
- FRA Cause Code: **H519 Dynamic brake, too rapid adjustment**



Steady-State Buff Force – Pick Switch

1. Buff force and coupler angularity
2. Resultant lateral forces at truckside
3. Examples:
 1. Roanoke VA – 23G
 2. Lumberton MS – 314

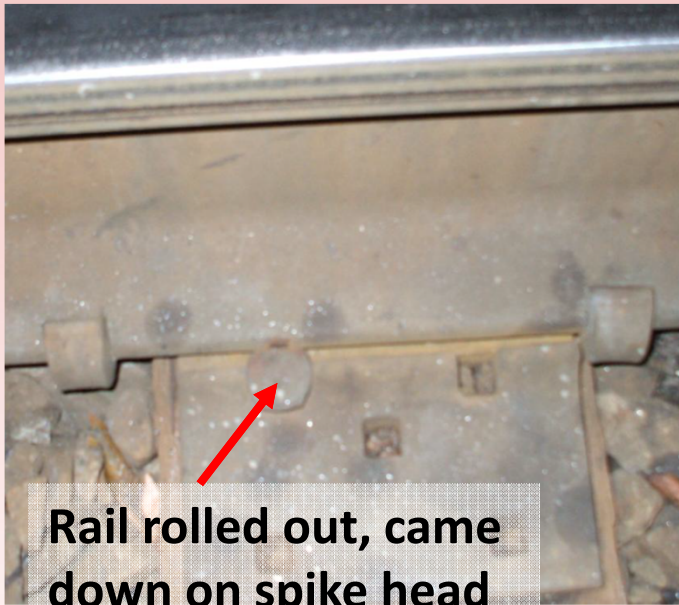


Roanoke VA - 23G

- 3x0 (one DB isolated), 36 loaded M/L's, 30 loaded doublestacks (8665 tons); 11,376 tons; 10,706 ft
- Derailed the lead truck of 20th head car, loaded 89' multilevel
- 13 mph with 920 amps of dynamic brake
- POD: point of switch, #10 turnout
- Rail began rolling out 2-1/2 stations ahead of switch
- Near bottom of a 2-mile 0.82% descending grade



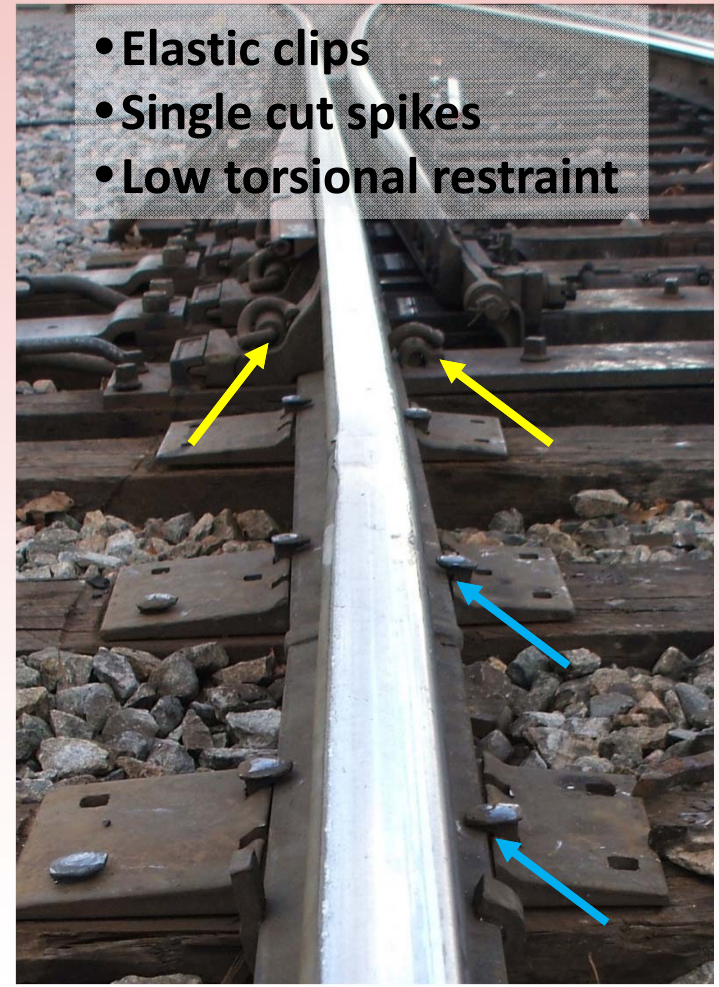
Roanoke 23G: track evidence



Rail rolled out, came down on spike head



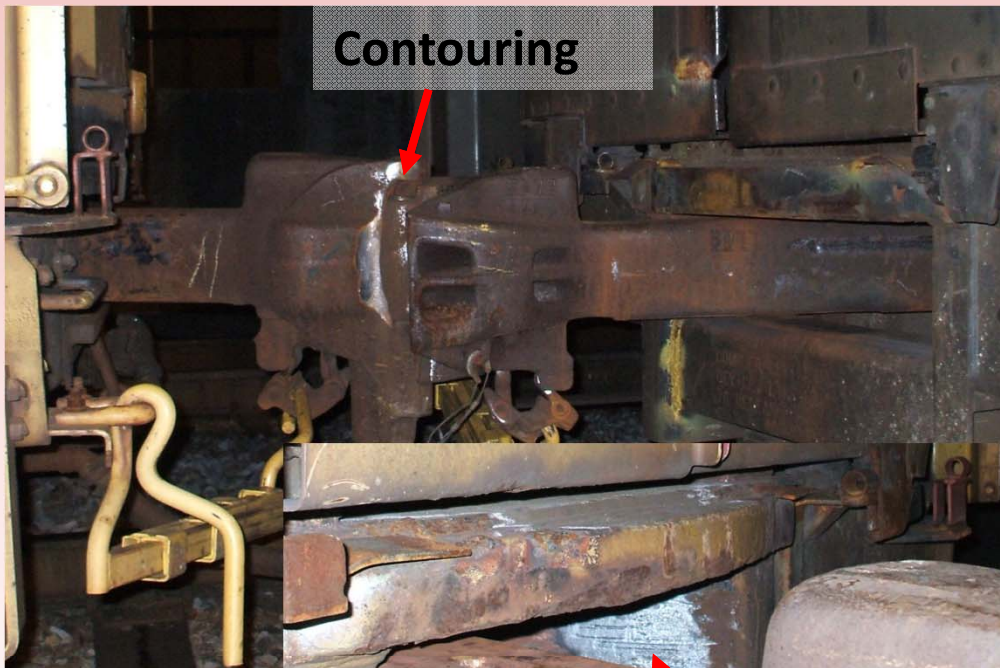
Blunted point, wheel marks back side of point



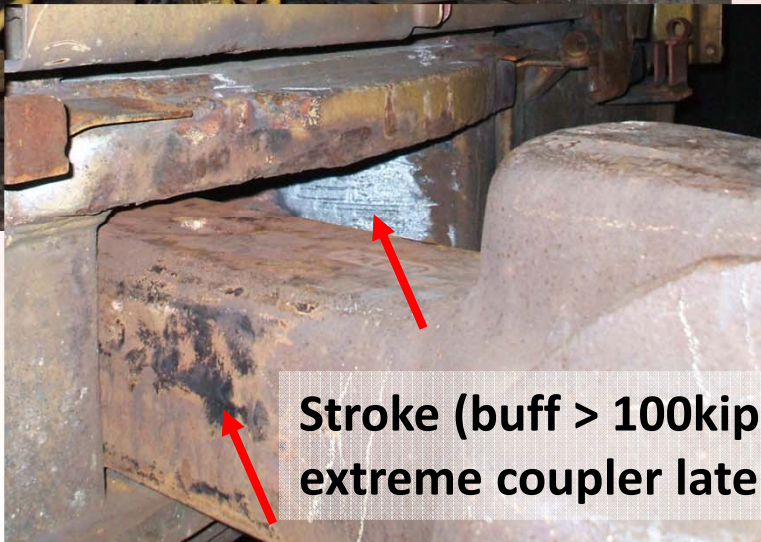
- Elastic clips
- Single cut spikes
- Low torsional restraint



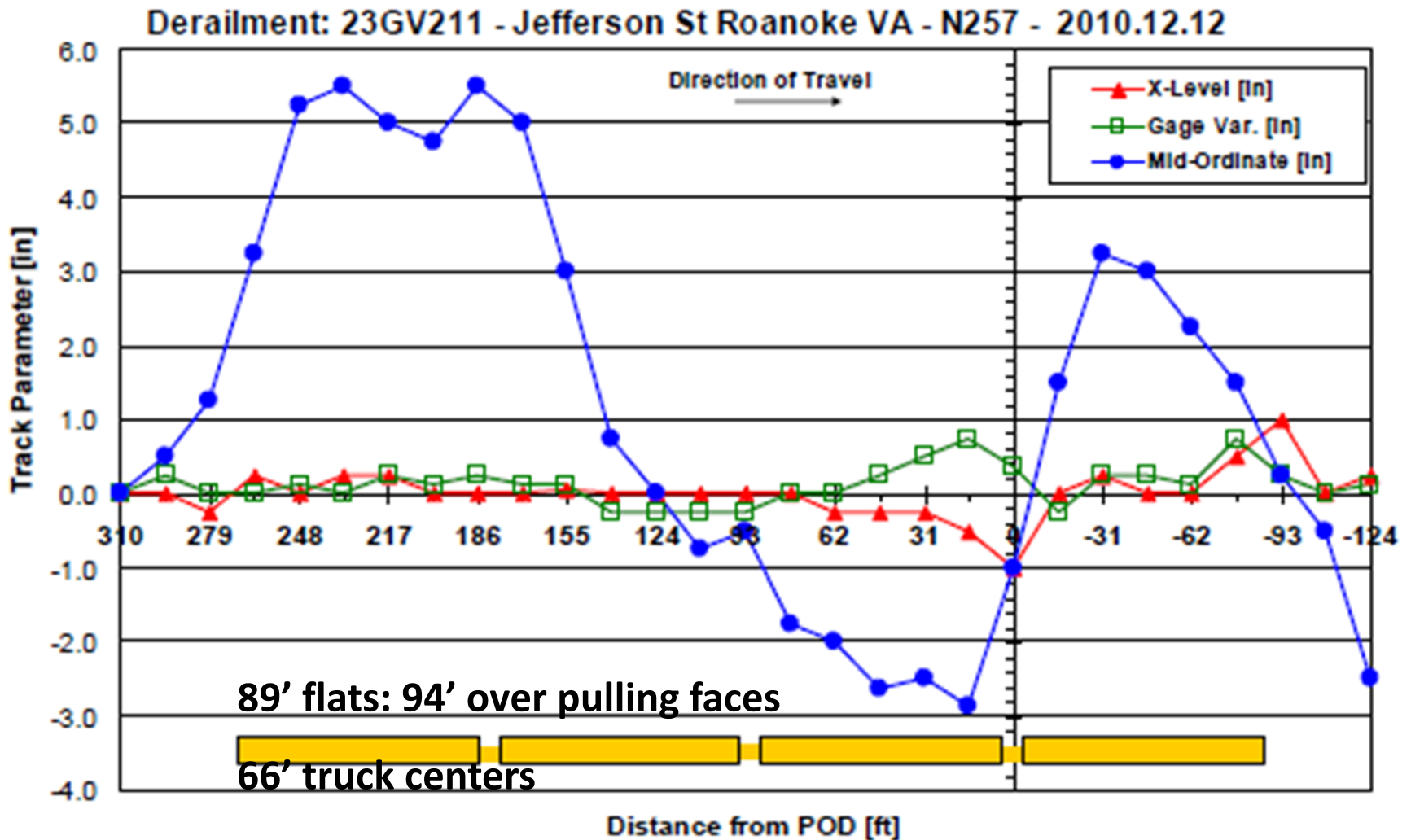
Roanoke 23G: coupler evidence



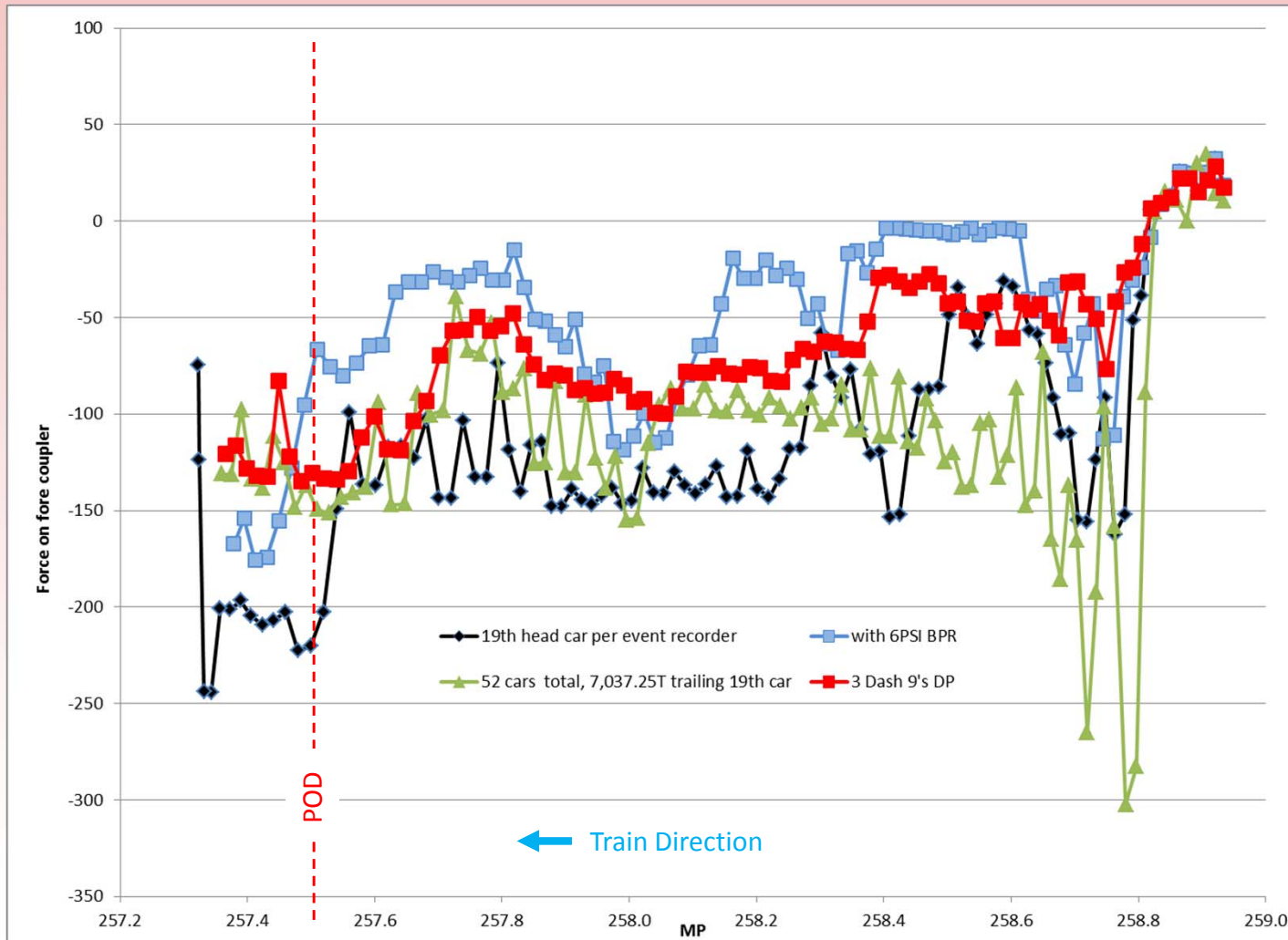
- Long car
- Long coupler overhang
- Long shank couplers
- High degree of coupler angularity



Roanoke 23G: cars on curves



Roanoke 23G: in-train forces



Roanoke 23G: Cause Statement

- “Lead wheels, lead truck of 20th head car (loaded multilevel CN 710905) partially rolled north rail and passed behind switch point account resultant lateral forces associated with improper train makeup.”
- FRA Cause Code: **H501 Improper train make-up at initial terminal**

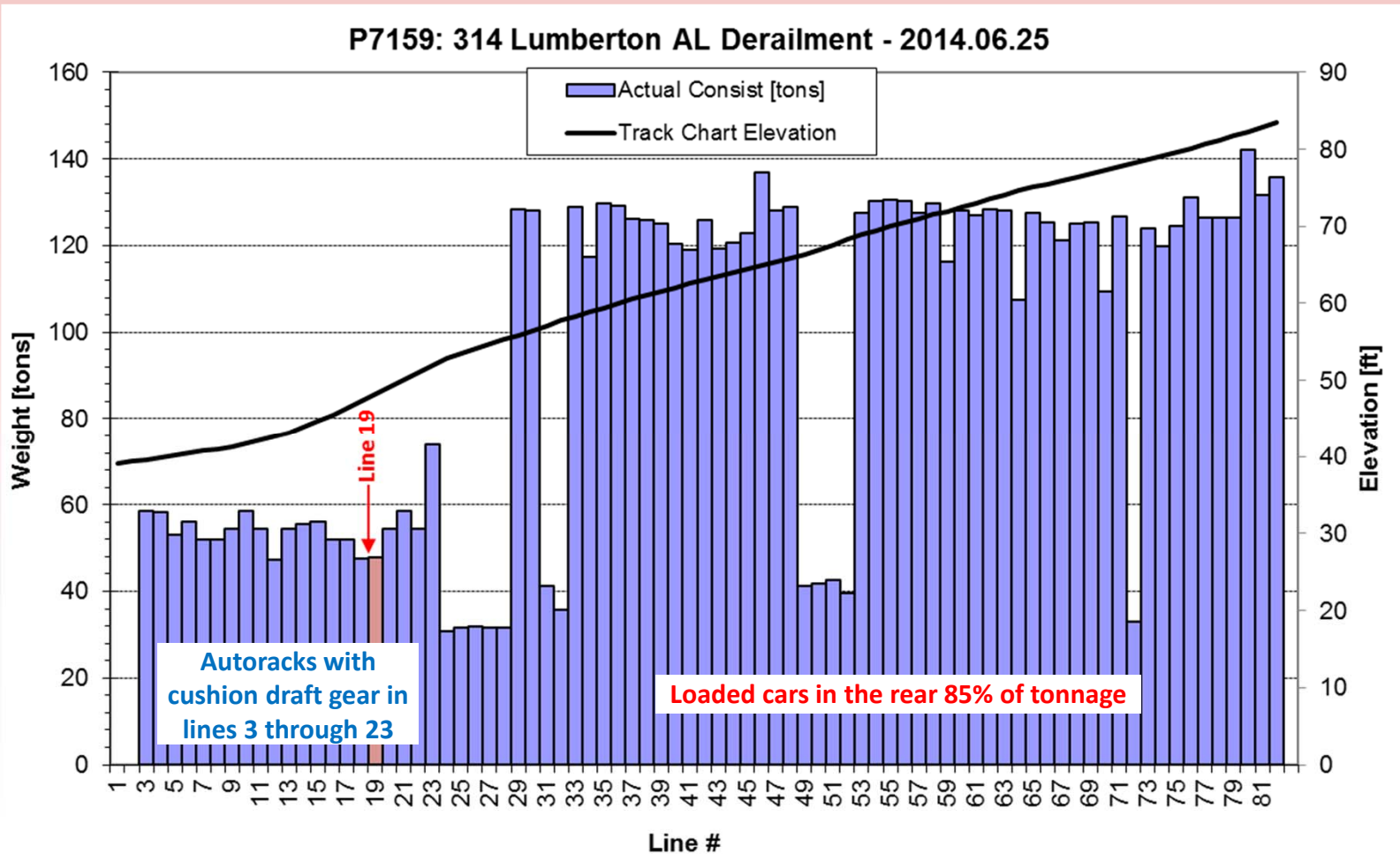


Lumberton MS – 314

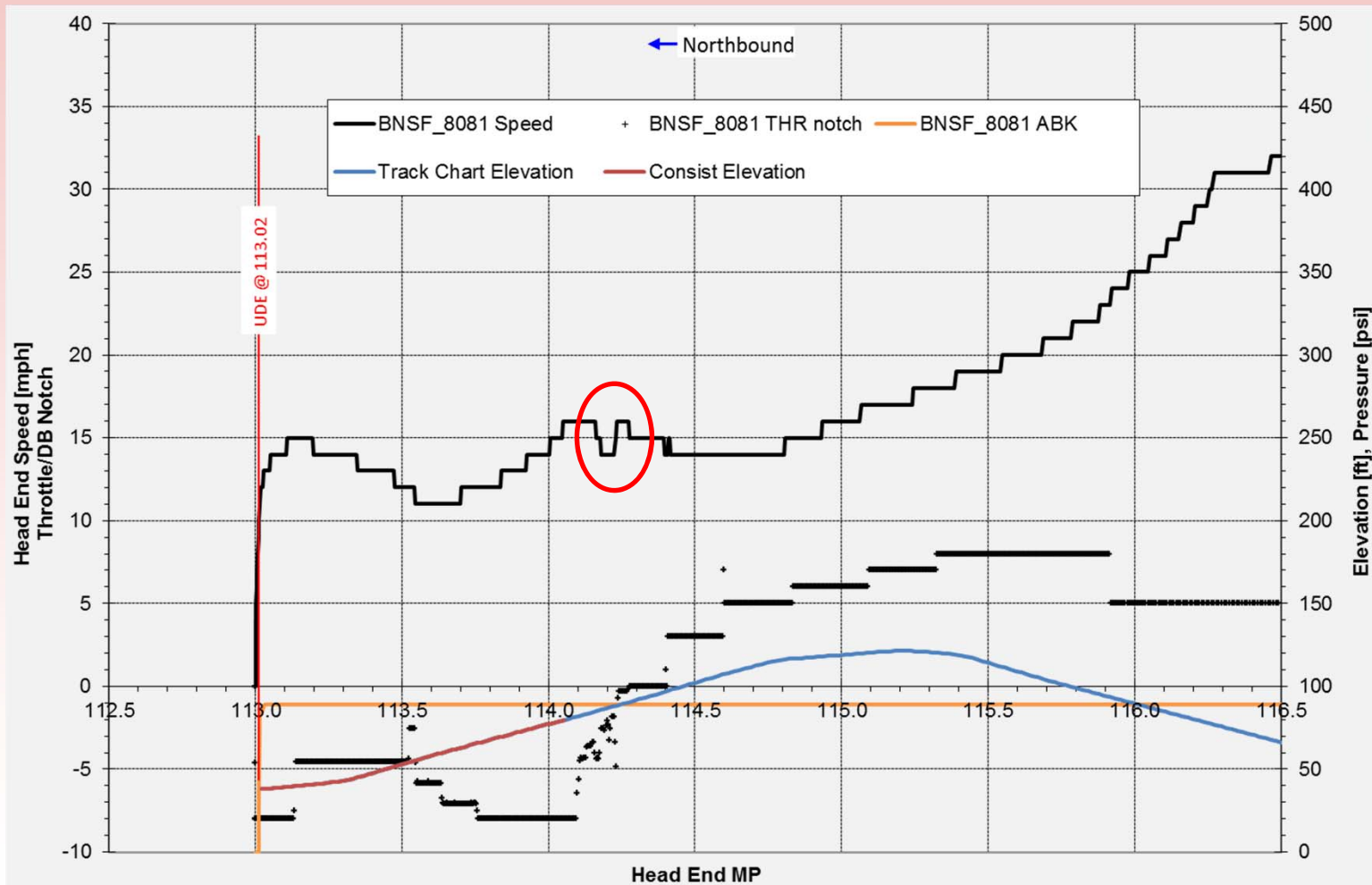
- 2x0, 48 loads, 32 empties, 7513 tons; 5533 ft
- 21 M/L's ahead of 6354 tons
- Derailed trail truck of 17th head car, empty 89' multilevel
- 15 mph in full dynamic brake
- POD: point of switch, #10 turnout
- Near bottom of a 2-mile 0.9-1.0% descending grade



Lumberton 314: tonnage profile



Lumberton 314: train handling



Lumberton 314: track evidence



- Elastic clips
- Single cut spikes
- Low torsional restraint



Lumberton 314: Cause Statement

- “Trail truck of 17th head car, in a block of 21 autoracks trailed by 6323 tons, picked the switch point at 15 mph in full dynamic braking, account lateral force due to long car coupler angle sufficient to deflect stock rail.”
- FRA Cause Code: **H506 Lateral drawbar force on curve excessive, train make-up**



Steady-State Force – Climb Guard Rail

1. Multilevels or 89' flats

1. Roanoke 8-1/2 Street – 192
2. Allentown Hump – H45

2. Not 89' or multilevels (in order of frequency):

1. empty centerbeam flat
2. empty bulkhead flat
3. long boxcar
4. empty covered hopper



Roanoke 8-1/2 Street – 192

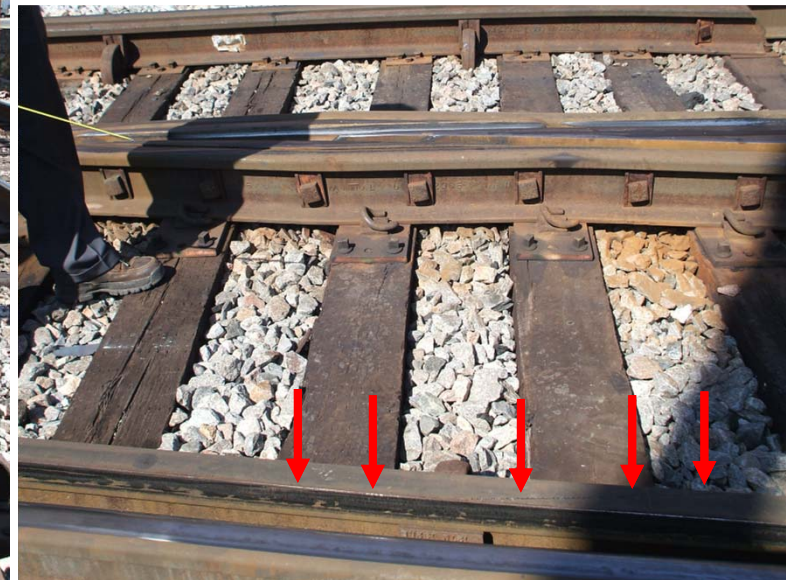
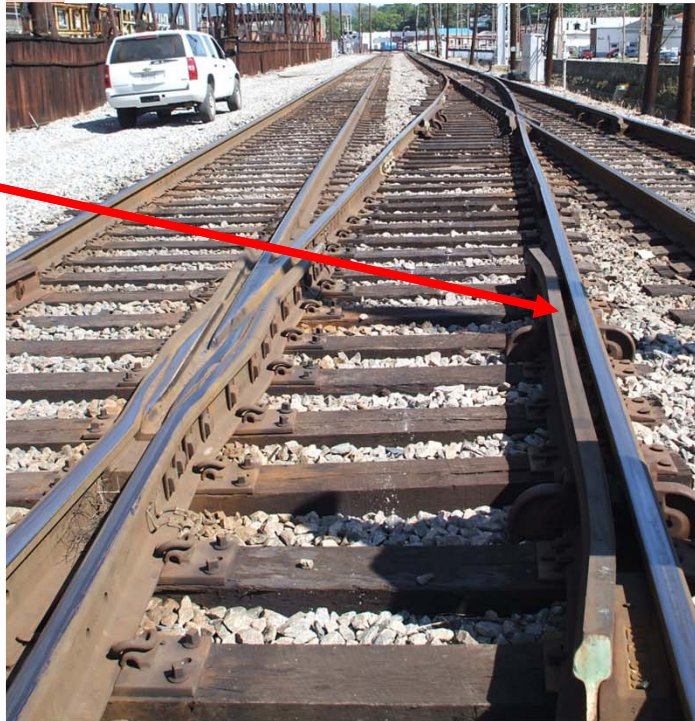
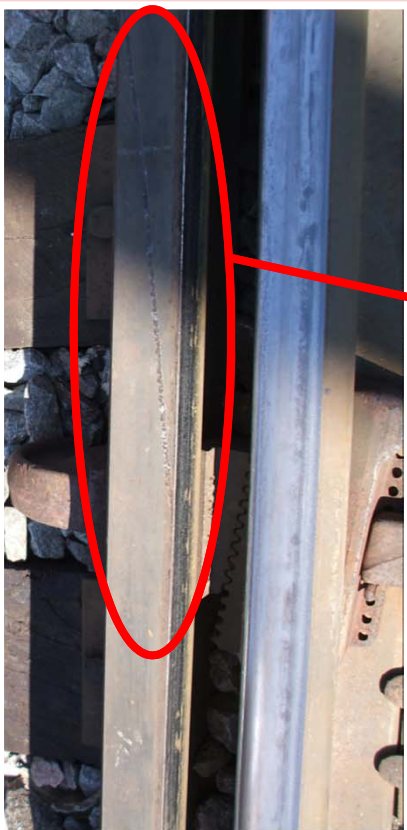
- 3x0 (1 isolated), 12,653 tons, 9120 ft
- 9 mph in DB-8, 670 Amps
- Derailed trail truck of 39th H/C, empty 89' flat
- Car ahead was an empty 73' bulkhead flat, car behind was another empty 89' flat; ahead of 83% of train's tonnage
- Climbed guard rail of #10 frog in crossover
- Near bottom of a 2-mile 0.82% descending grade



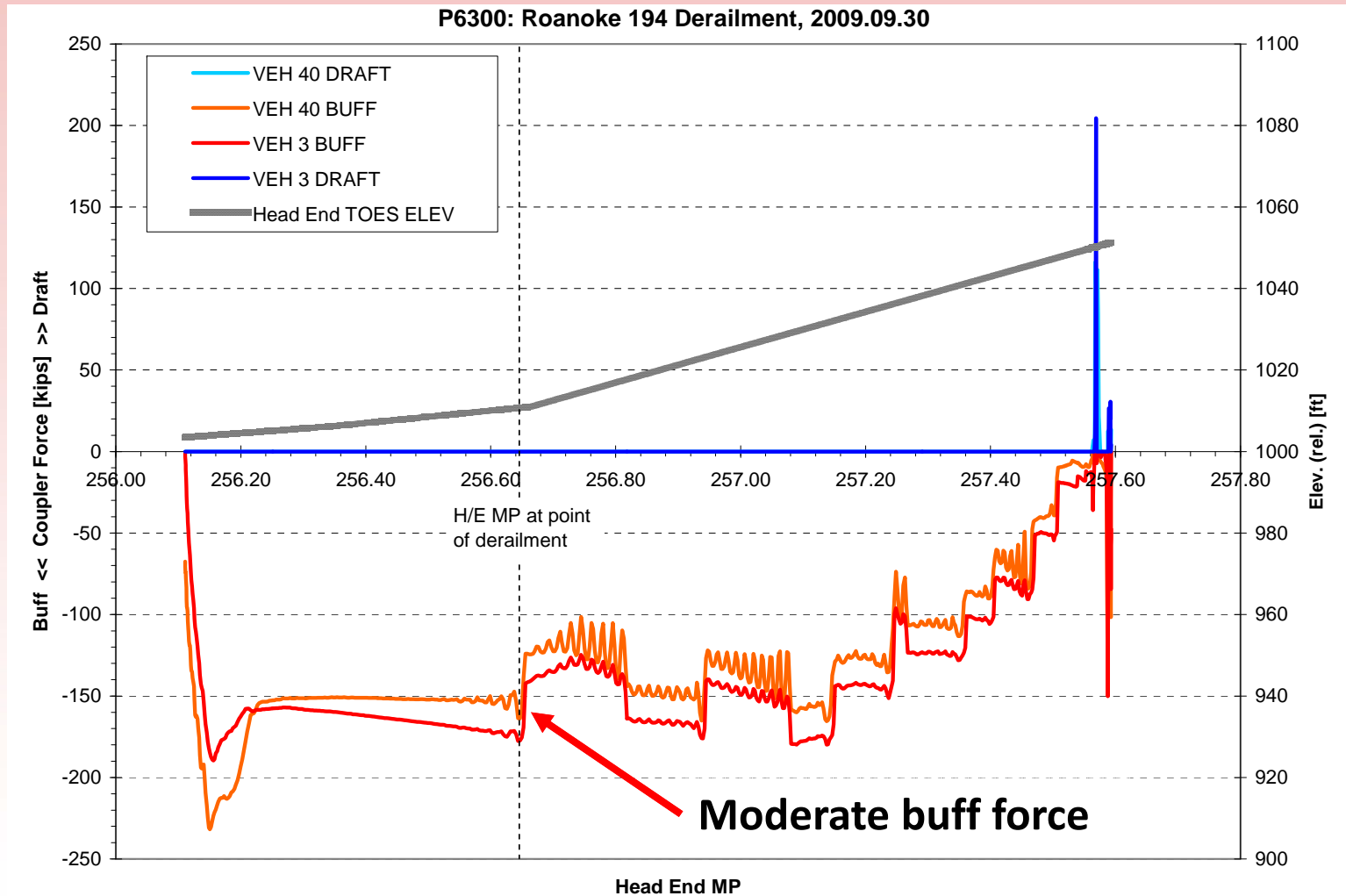
Roanoke 192: track evidence

6.5 Long Car/Long Car In Crossover

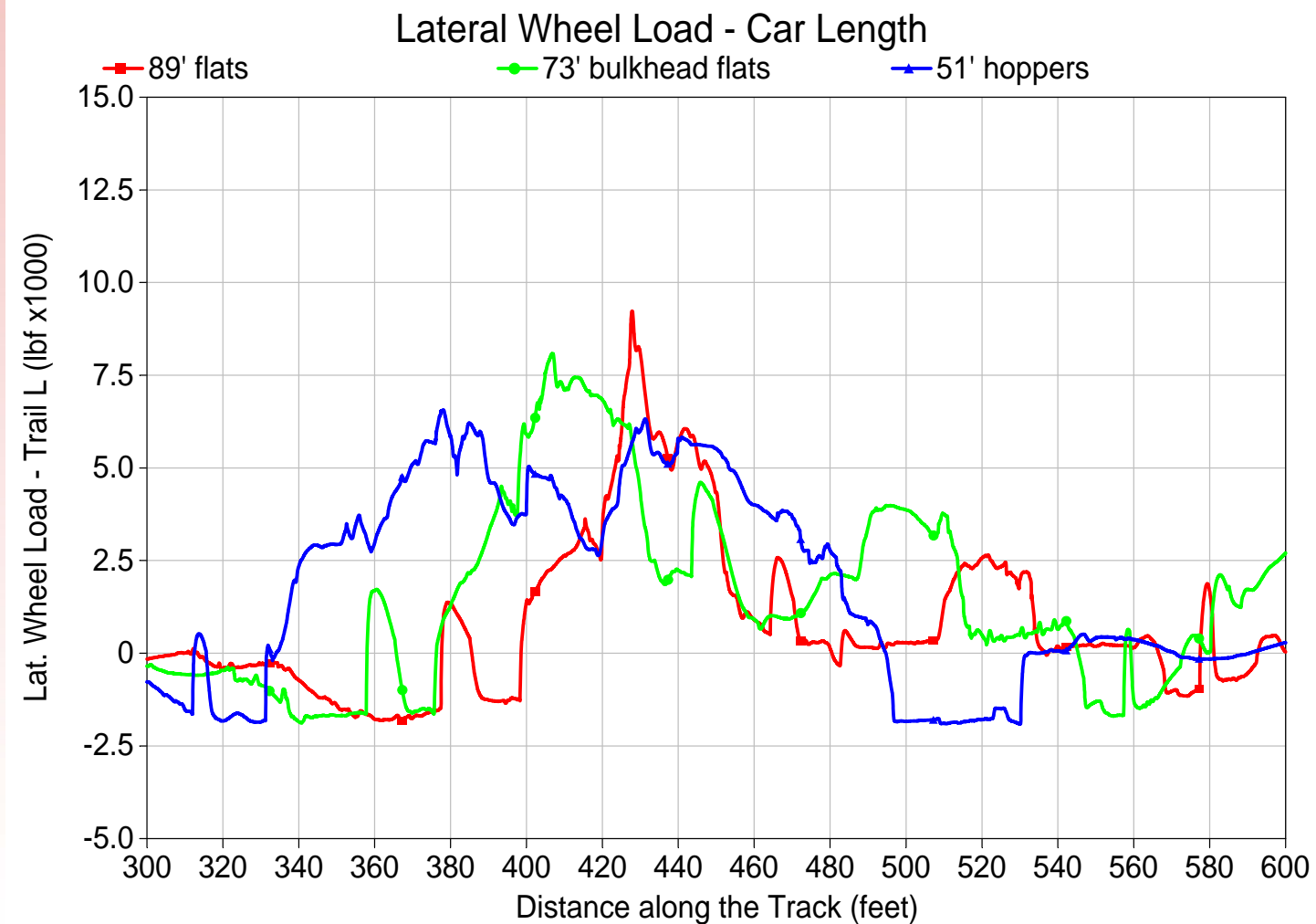
This situation can become critical where there is less than one car length of track in between the lead curves of the switches in a crossover. It becomes more severe for the sharper turnouts (#10 and less). The problem is caused by the long overhang on these long cars. Consideration should be given in yards for this train make-up by limiting the routes traversed to areas where the above mentioned problem is minimized.



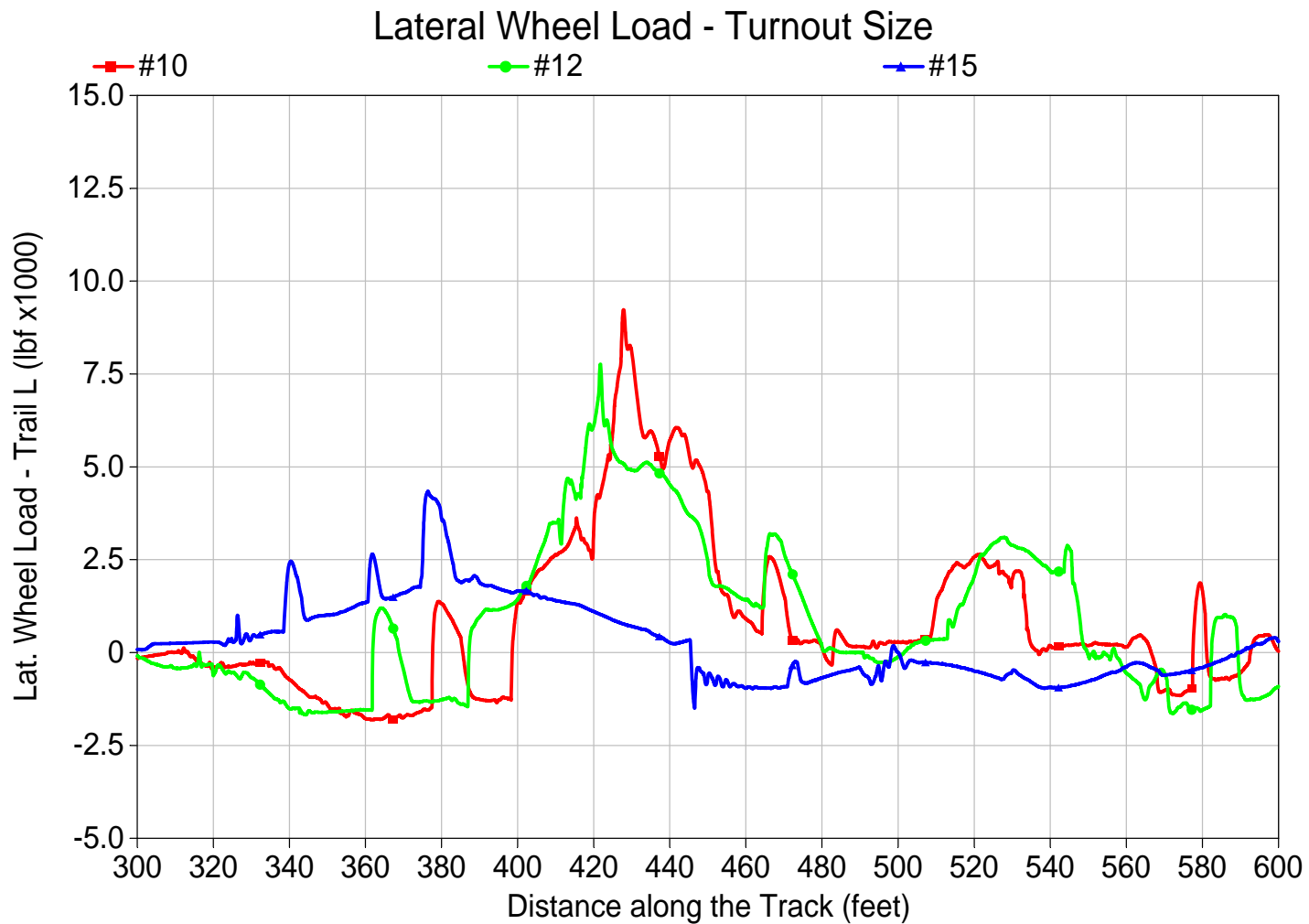
Roanoke 192: TOES buff forces



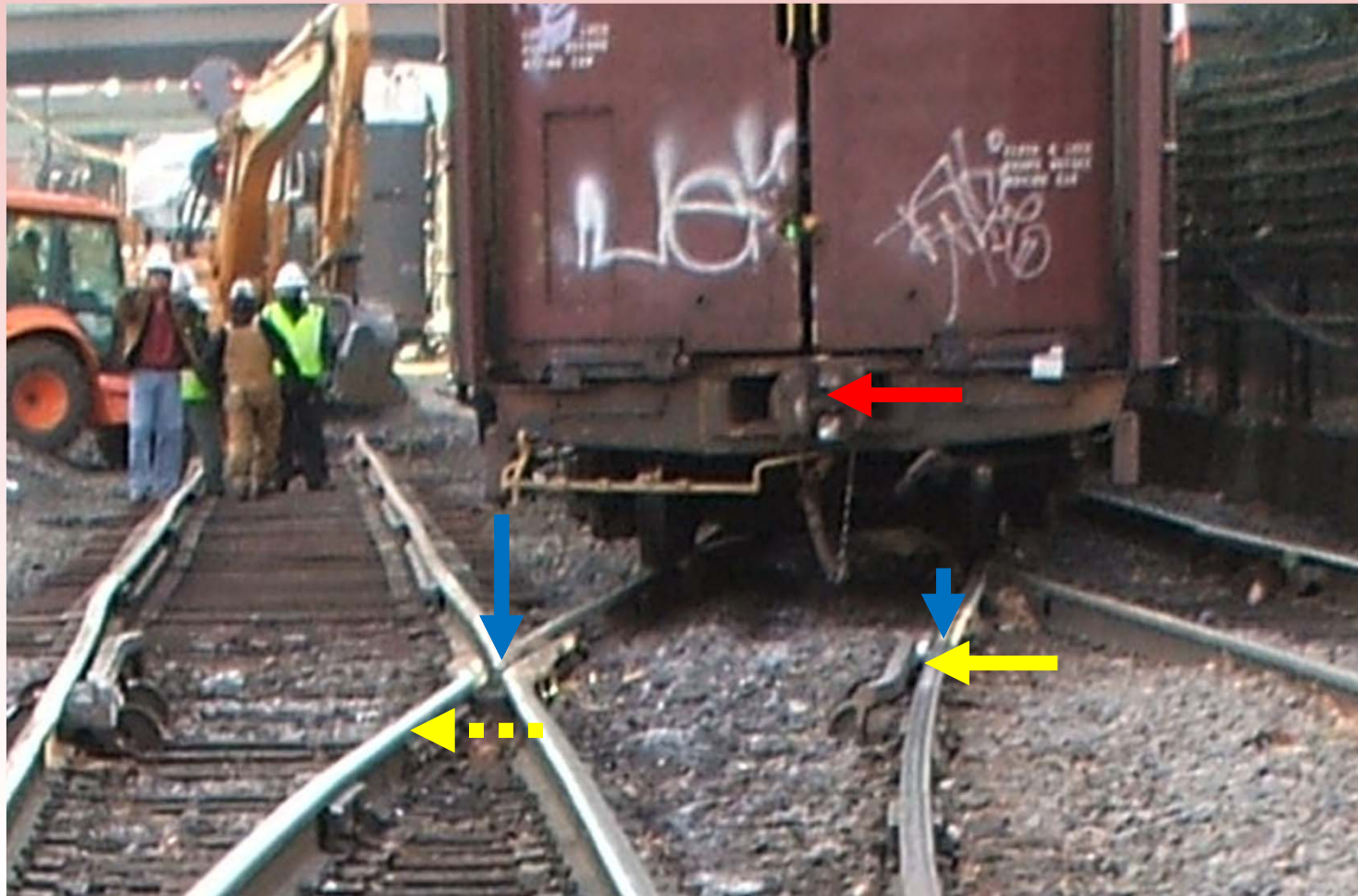
Lateral force in turnouts – car length



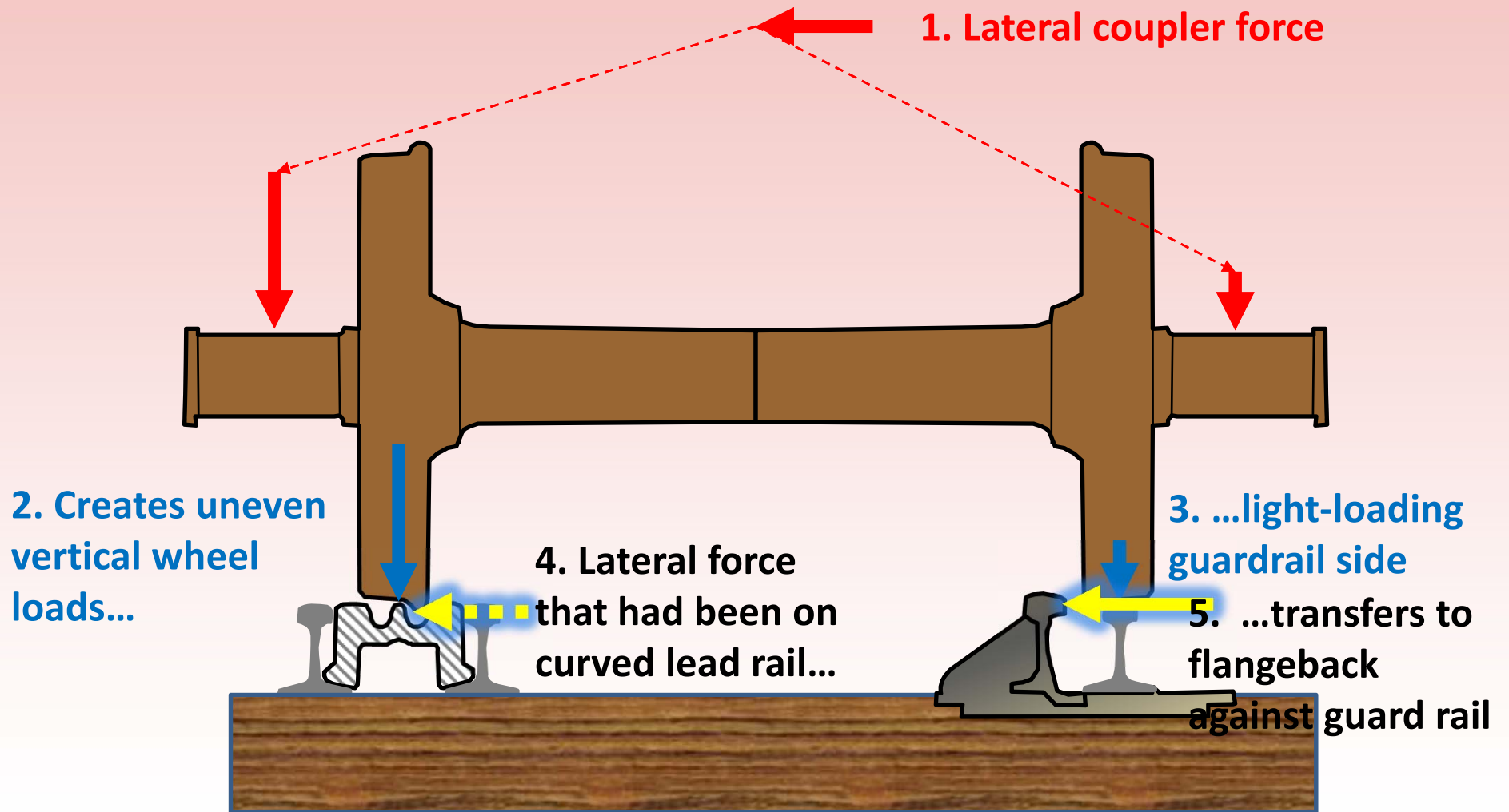
Lateral force in turnouts – frog



Guardrail climb: Force Diagram

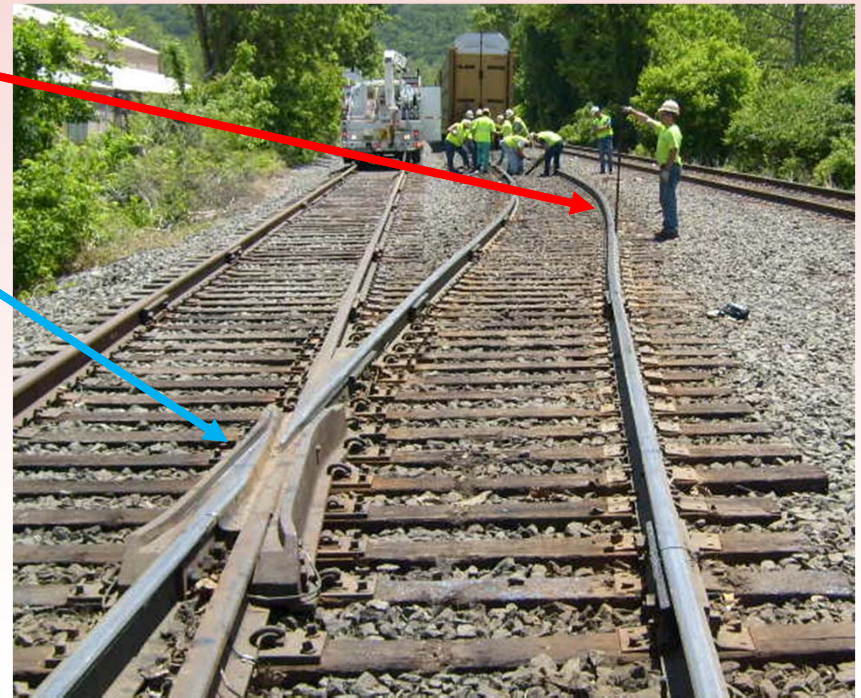


Guardrail climb: Force Diagram



Allentown – May 2014

- Shoving 4626 tons with 18 powered axles at 7 mph, 271 kips buff
- Derailed empty 89' Multilevel, 7th from locomotive
- Rolled high rail of 11.5°
Return Curve, not at frog,
account *Self-Guarded Frog*



Remediation

- **Reduce buff forces**
- **Optimize placement of long EOCC cars with respect to tonnage**
- **Reduce curvature**
- **Limit population of EOCC-equipped cars**

