Derailment Prevention – From Causes to Cures

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Derailment Prevention – From Causes to Cures

1. Switch point wheel climb
2. Rail roll-over
   - Adverse rail profiles
   - Adverse wheel profiles

Switch Point Wheel Climb

Track supervisor to mechanical supervisor: “The last 100 cars made it over this switch point, then that car derailed. And you’re blaming the point???”

What three conditions are present in most switch point wheel-climb derailments?

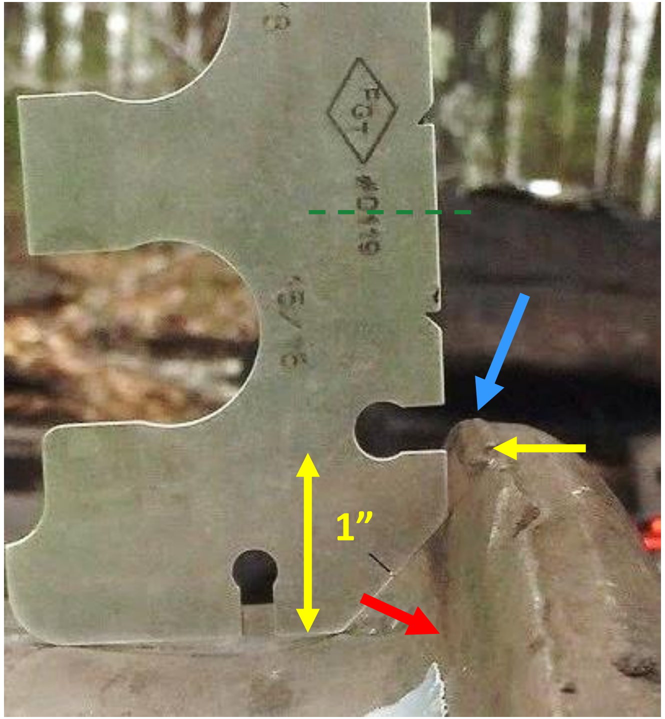
1. A gapped, worn or broken switch point

What three conditions are present in most switch point wheel-climb derailments?

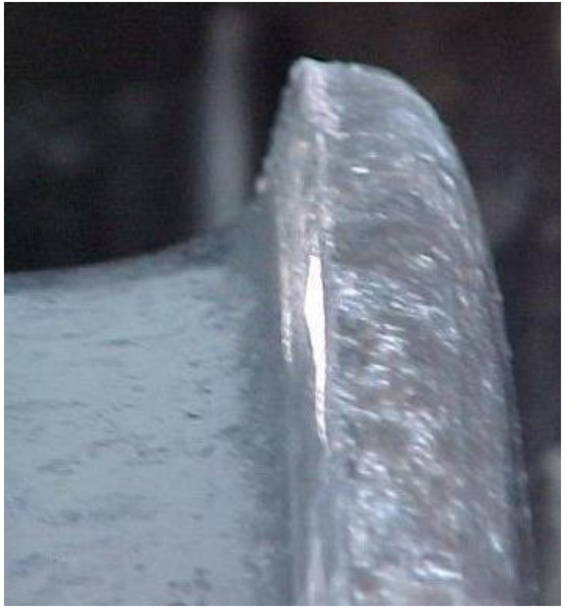
1. A gapped, worn or broken switch point
2. A worn wheel profile – one with a small flange root radius and (often) a sharp edge on the tip of the flange

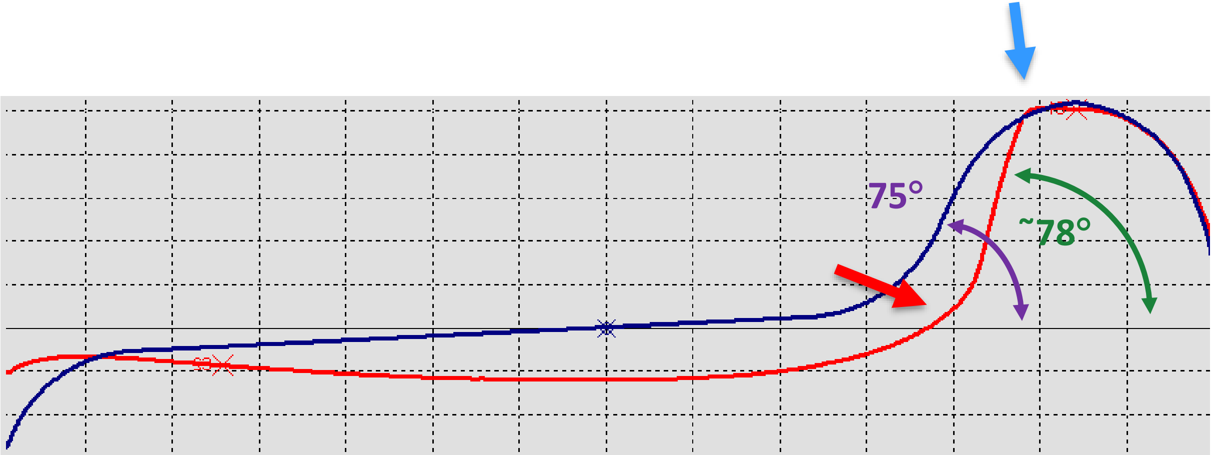
Can a wheel be condemned for a vertical flange?

Yes – but only if the wheel gauge contacts the flange 1” above the tread. Very few wheel flanges achieve 90°.



Why does a worn wheel increase risk of wheel climb?



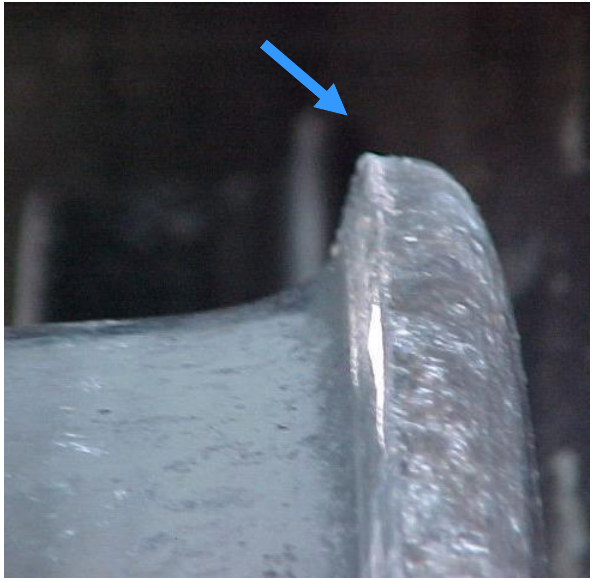


A worn flange root allows the flange tip to get much closer to the point

What three conditions are present in most switch point wheel-climb derailments?

1. A gapped, worn or broken switch point
2. A worn wheel profile
3. Tracking position – the worn wheel is shifted toward the switch point

A wheel climbs a switch point

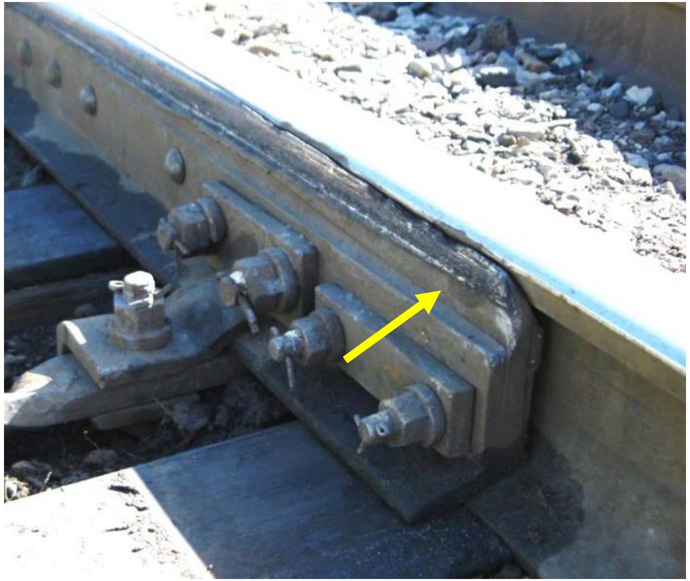


Worn profile and a sharp edge on the flange tip

The worn flange is tracking close to the stock rail, approaching a gapped point

The flange climbs the switch point

What is a good indicator that a switch point problem is developing?



Wheel flange contact at the front of the point

One more switch point wheel climb

Main track, no. 10 spring switch to a siding, LH diverging point

No indication of wheel climb on the point

However, there was a cross-over wheel mark on the RH point back at the heel block

One more switch point wheel climb

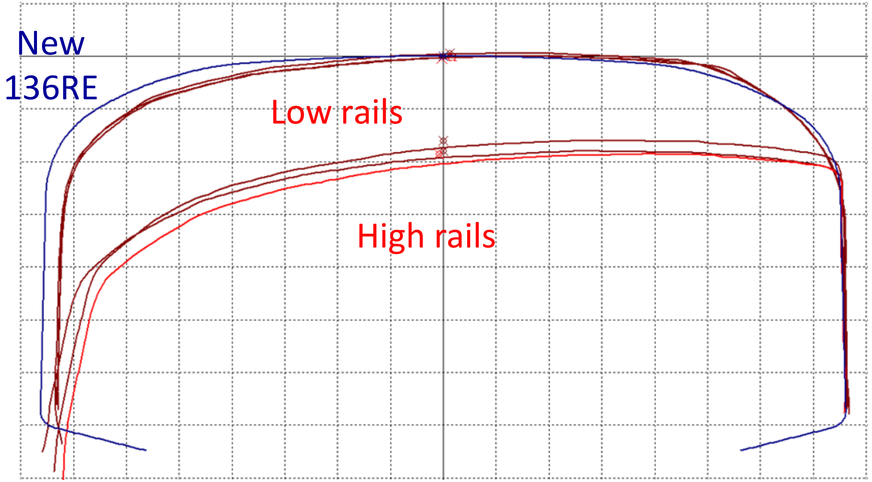
- ✓ Slightly worn point
- ✓ Evidence of flange contact at the tip (tracking position)
- ✓ Worn (but not condemnable) wheel flange

Switch point wheel climb - the cure

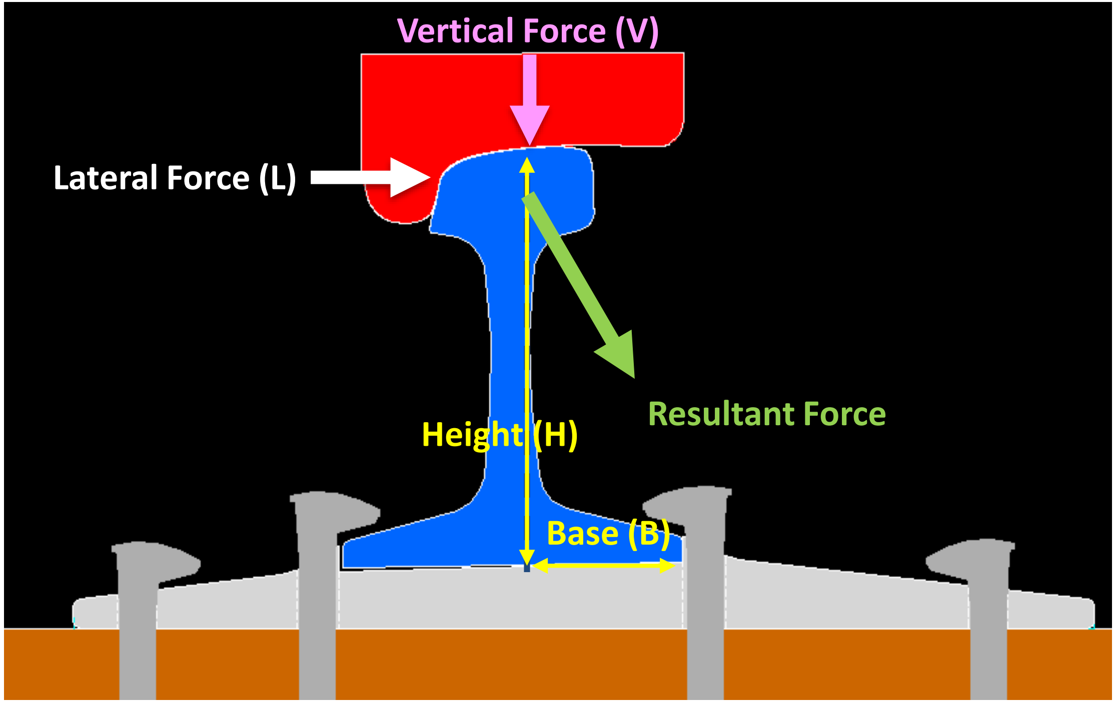
<u>Maintain your switch points with worn wheel flanges in mind!</u>

- Worn flanges are more likely to pick a poor-fitting point
- Worn flanges are common
- Most wheels that climb points are not condemnable
- Good-fitting points should be able to accommodate worn flanges

Rail Roll-over: Adverse (High) Rail Profiles



What affects rail stability?



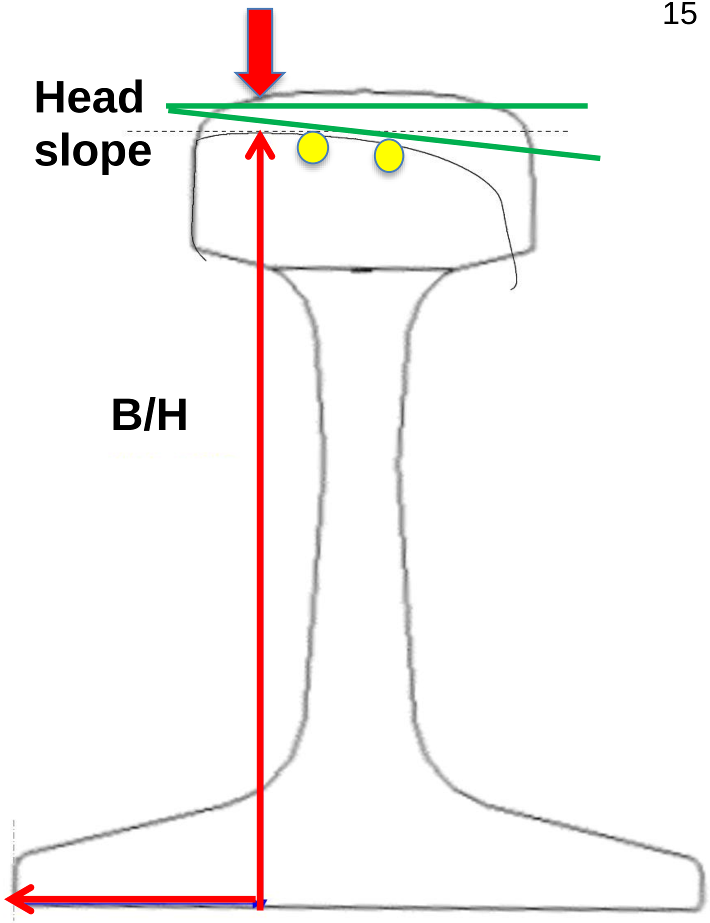
Rail stability (roll potential) affected by:

- magnitude & location of V
- magnitude & location of L

Location of V affected by:

- rail profile
- wheel profile

How do we describe a high rail profile?



Two profile measurements:

- B/H (base / height)
- Head slope (2 points ½" either side of rail center)

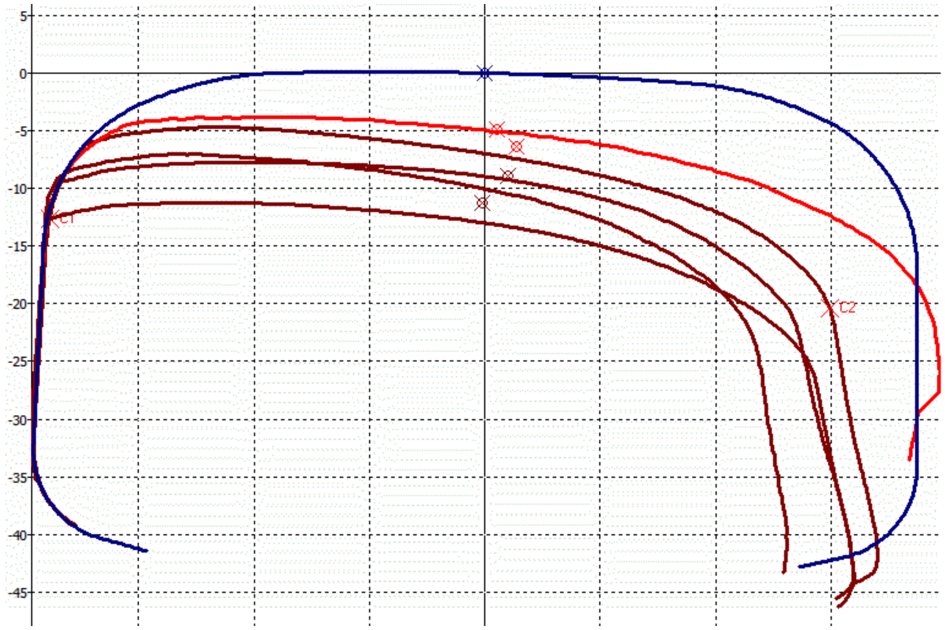
What makes an adverse profile?

- One that produces field-side wheel contact

On NS, our thresholds for concern are

- B/H < 0.35 (new 136RE, B/H = 0.42)
- Head slope > 5˚

Adverse high rail profiles



Profiles from 5 rail roll-over derailments

What do you notice?

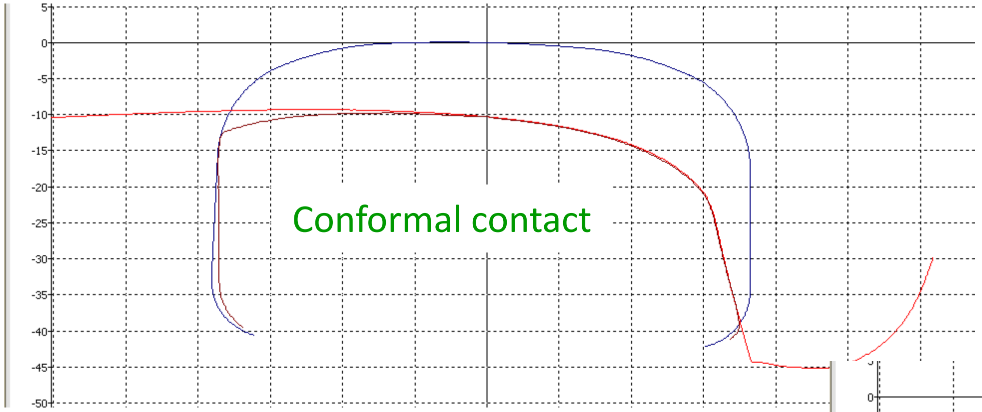
- Significant side wear
- Significant head slope
- Likely some field-side wheel contact

How does an adverse profile develop?

Worst case: Prolonged train operation and many grinding cycles over outward-canted rail

New ties or gaging (with adzing) will change orientation of a previously canted rail; rail will be "set up" to 0^{o} cant

How does an adverse profile cause trouble?

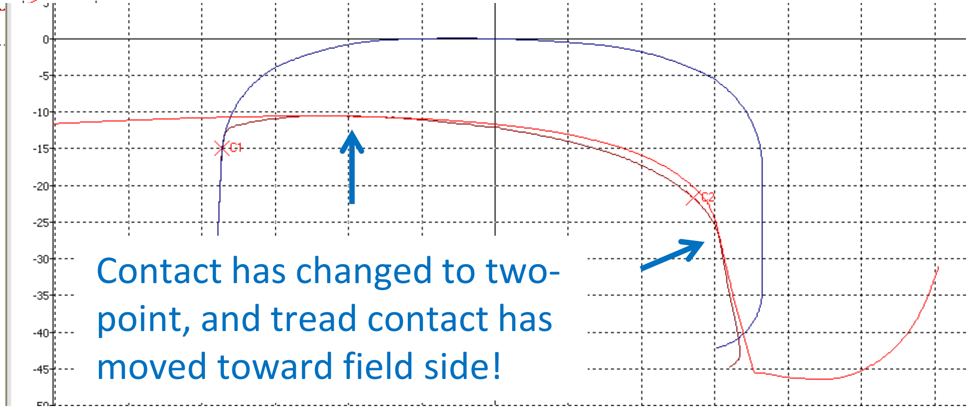


Brown trace - 3°canted rail

Red trace – worn wheel

Brown trace - 0° canted rail

Red trace - worn wheel



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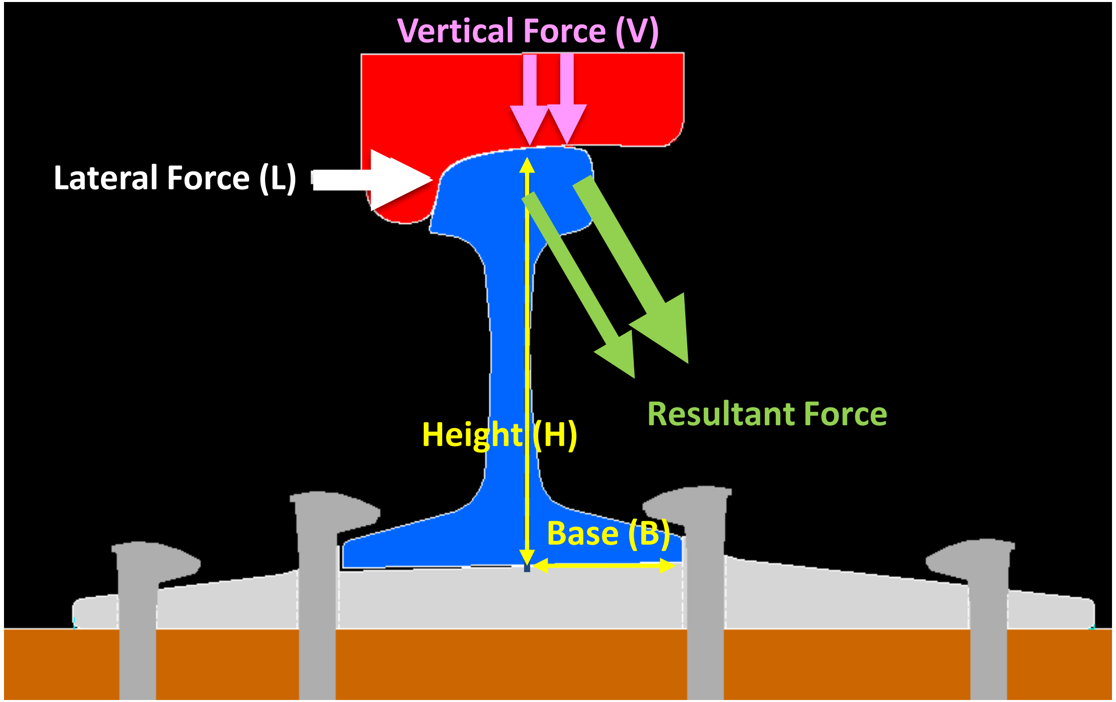
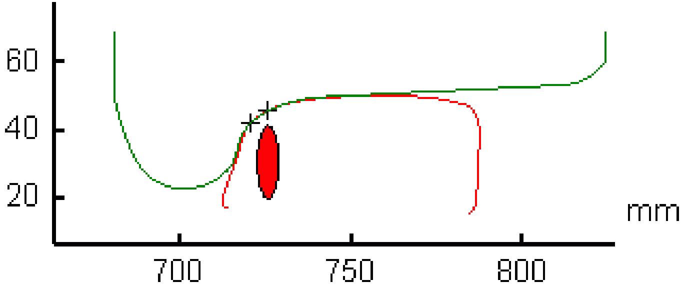
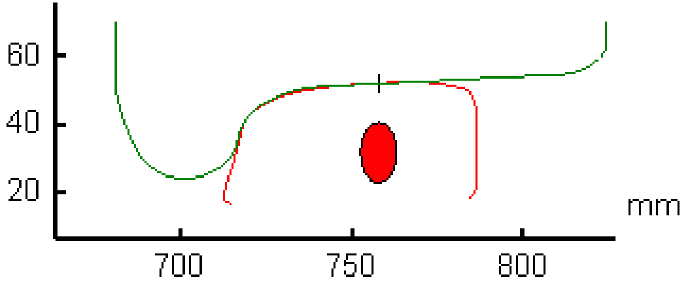


VAMPIRE wheel/rail contact plots

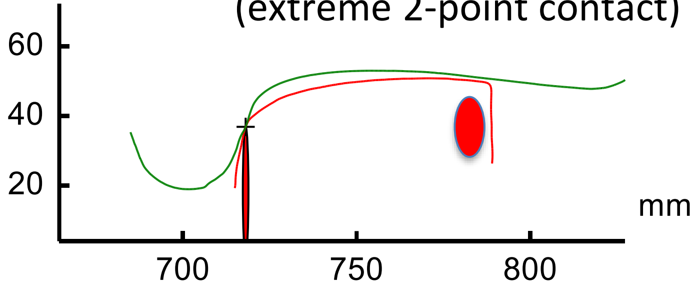


Slightly worn wheel on
3° canted rail

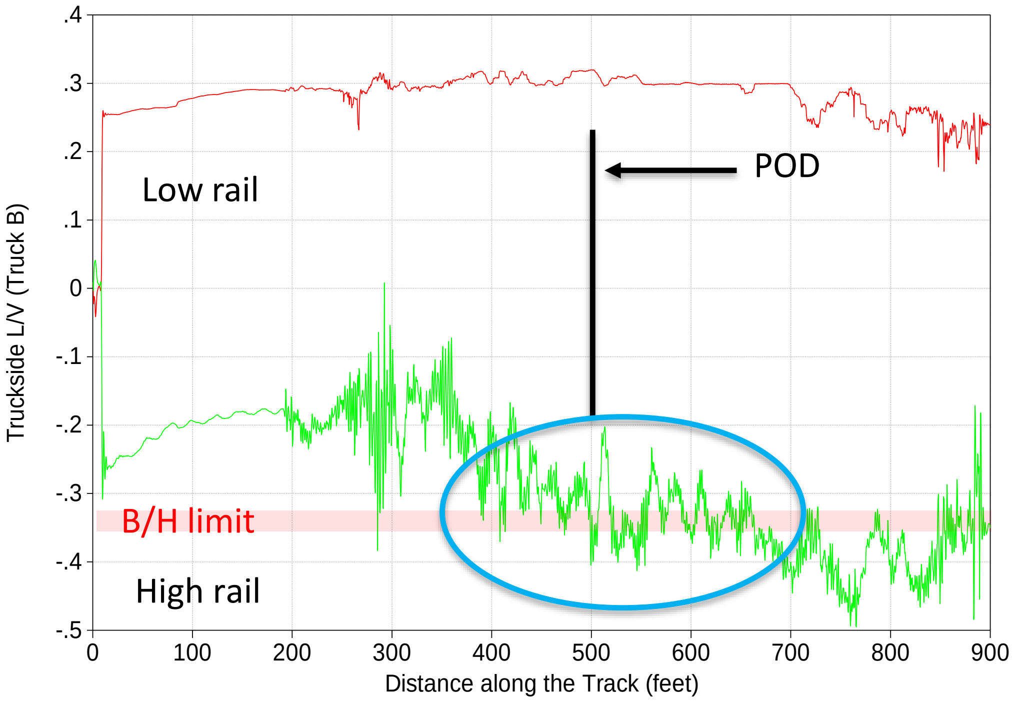


Slightly worn wheel on
0° canted trail - tread
moves toward field side
(2-point contact)

3.5 mm tread-hollow
wheel on 0° canted rail
(extreme 2-point contact)



VAMPIRE - predicted L/V



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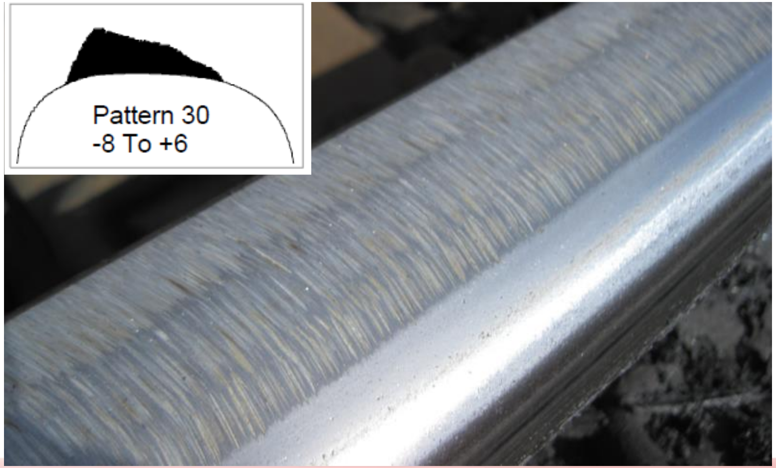
Inputs: rail & wheel profiles, track geometry, equipment features & conditions

Output: truckside L/V

When L/V exceeds B/H (could be either rail), there is a risk of rail roll.

Adverse rail profile - the cures



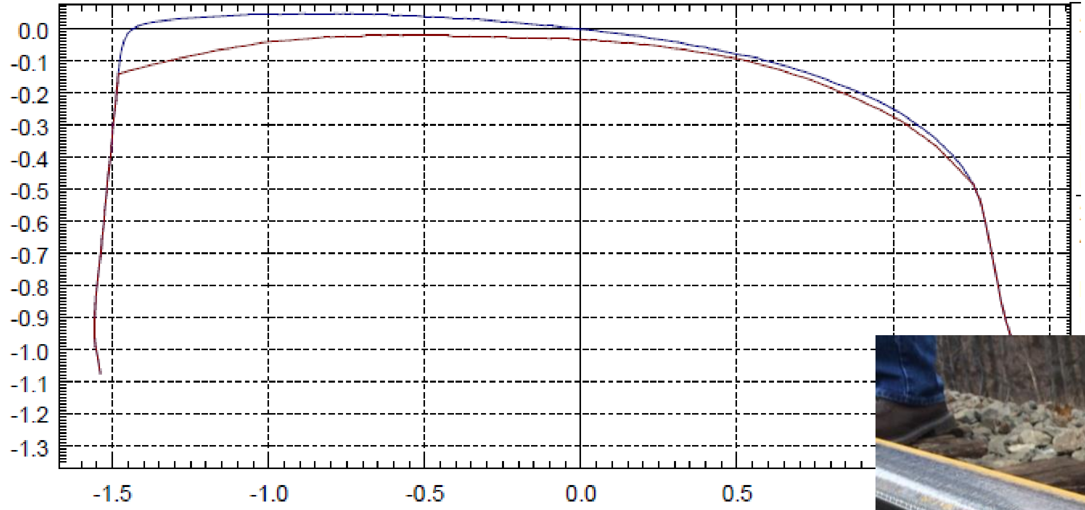
<u>Strength track</u>

- ➢ Elastic fasteners instead of spikes

<u>Reduce forces</u>

- ➢ Manage rail profiles by grinding

Grinding as the cure



Graph: High rail before and after grinding; 1/8” was removed from the field corner.

Photo: Same rail after grinding (3° cant). Wheel contact has been moved to a much more desirable location.

Adverse rail profile - the cures

Strengthen track

- Elastic fasteners instead of spikes

Reduce forces

- Manage rail profiles by grinding
- TOR friction control

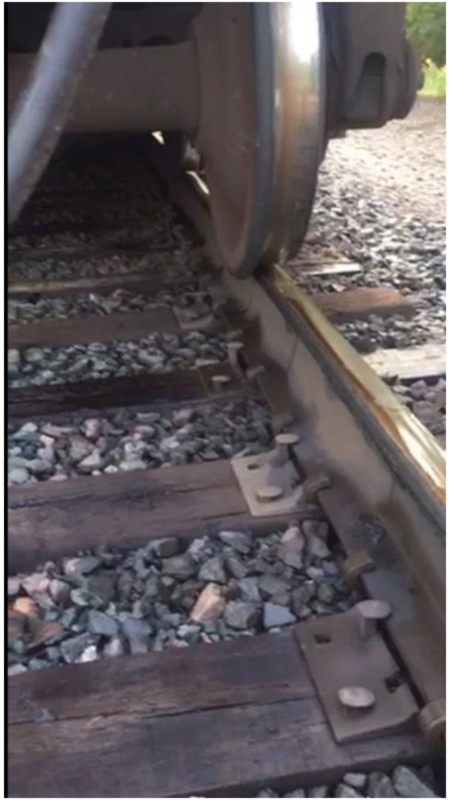
Inspection

- Look for evidence of spike lift

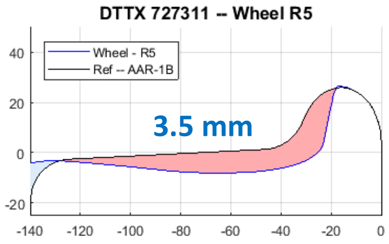
Rail Roll-over: Adverse Wheel Profiles

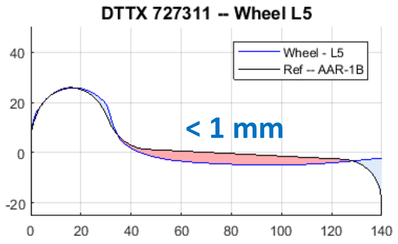
When do wheel profiles become the problem?

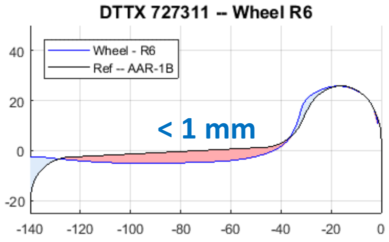
1. Does the wheel exceed the 4 mm tread-hollow standard? (not common)
2. Evidence of unusual wheel contact leading to the POD?
3. What do wayside detectors tell us?
4. What does VAMPIRE modeling reveal?

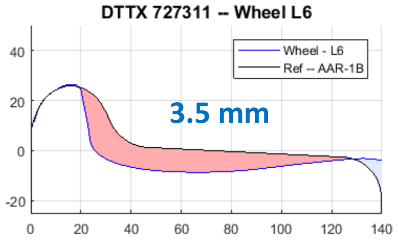


Hollow-tread wheels









<u>AAR standard</u>

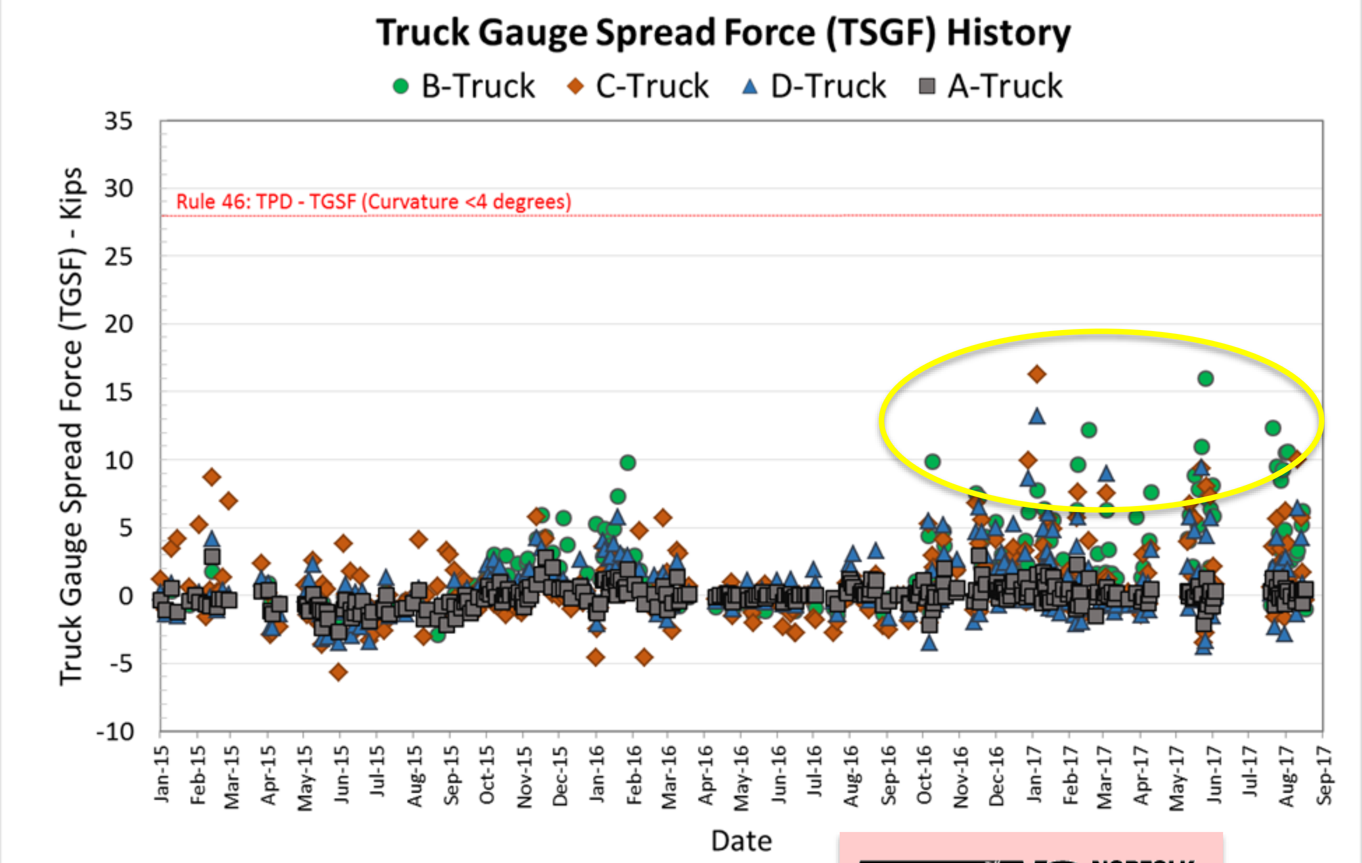
- 5 mm off a rip track
- 4 mm on a rip track

Unusual wheel / rail contact near the POD

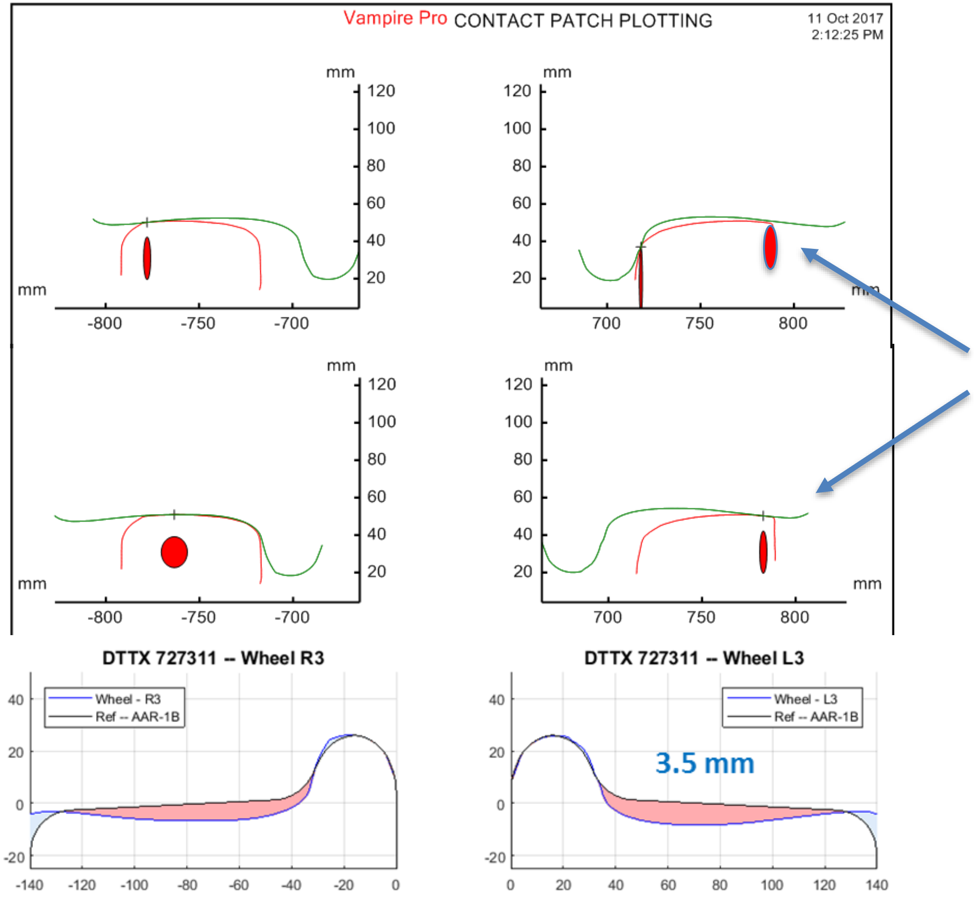
These 3 unusual conditions were noted on the low rail leading up to the POD:

1. Scuff marks on field side of the head
2. Wheel flange contact on the gage face
3. Evidence that rail has been canting out under load

Wayside detector data



VAMPIRE wheel contact plots



In all tracking positions – from high rail flanging to low rail flanging, the L3 wheel always contacts the field edge of the high rail.

Consequences of this type of contact:

- high gage-spreading forces
- poor rail stability

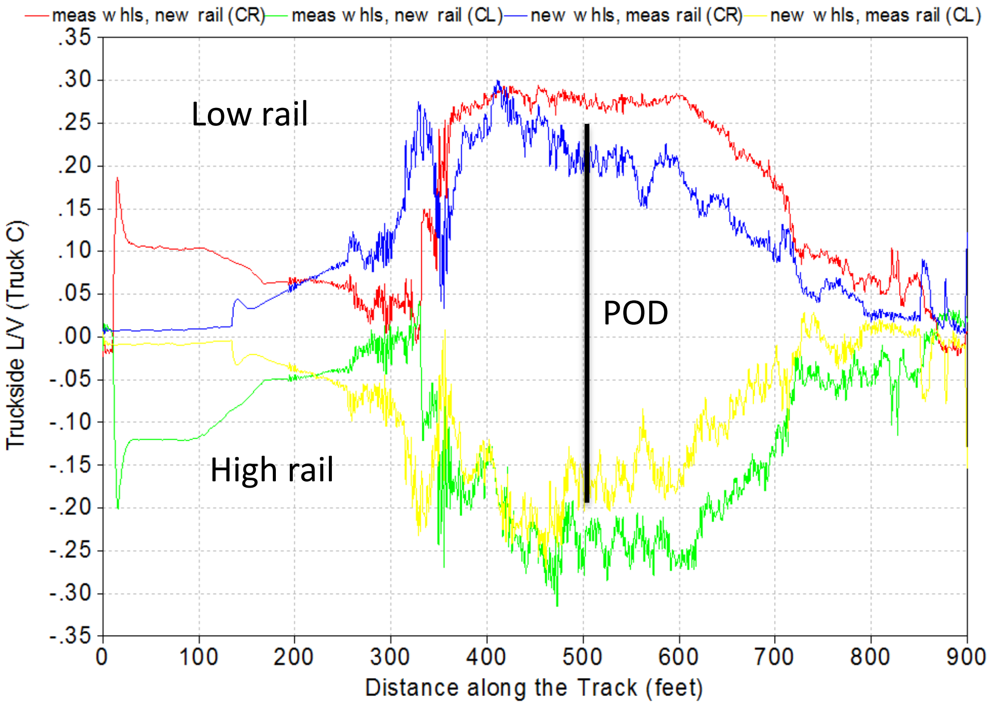
VAMPIRE L/V modeling – wheel or rail?

Which has a greater impact on L/V?

- ☒ worn wheels on new rail (red/green) or
- ☐ new wheels on worn rail (blue/yellow)?

In this case, worn wheels produced higher L/V.

This, plus the other evidence, allowed us to identify hollow-tread wheels as the primary cause.



Adverse wheel profile: the cure

<u>Long term</u>

- The industry is evaluating whether there is justification for reducing the current hollow-tread limits (5 mm off rip track, 4 mm on rip track)

  (My hope - 3 mm)

<u>Short term</u>

- Pay close attention to rail profiles
- Corrective grinding
- Look for evidence of spike lift

Thank you!