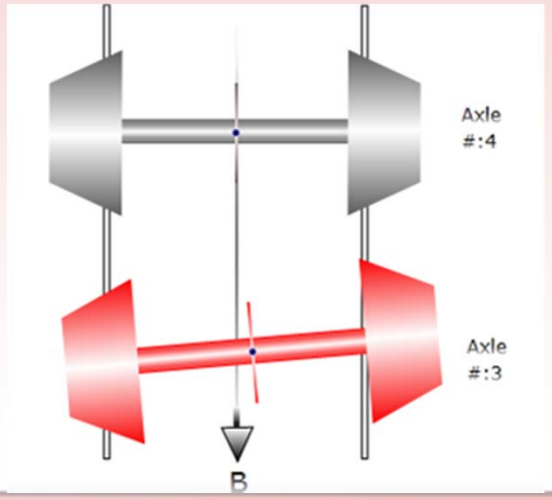
How Wayside Detector Data Can Drive Forensic Analysis of Derailments

G Walter Rosenberger
Norfolk Southern –
Research & Tests



Outline

Case Study 1: Sheffield Switch Derailment

Case Study 2: Grove GA Derailment of Train 118

Further Examples

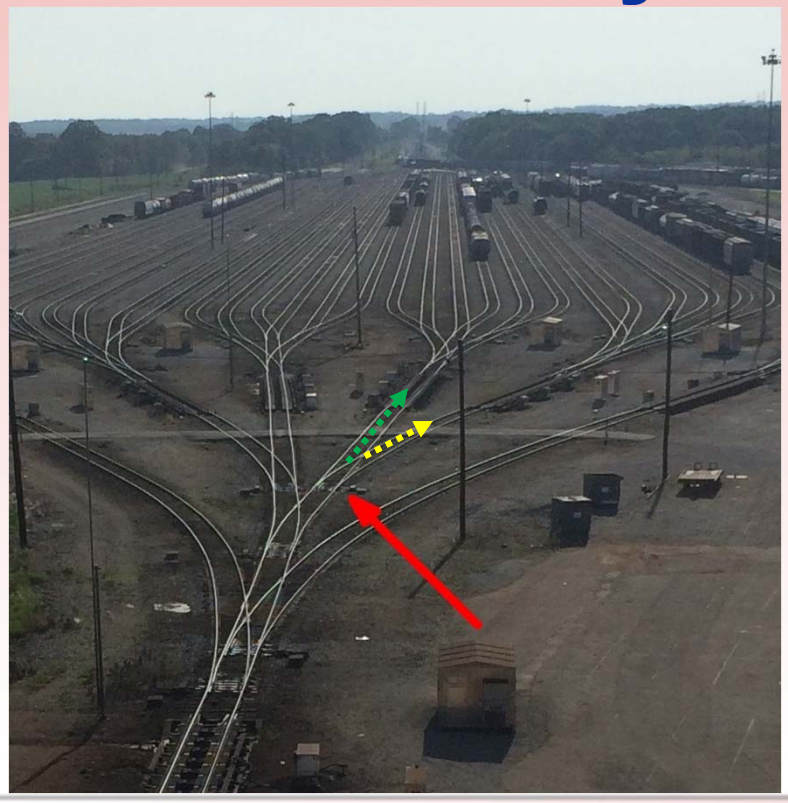
Conclusions and Thought Questions

Case Study 1: Sheffield Switch

Description:

NS 612742, a loaded coil steel gondola, was humped singly with A-end leading toward track CT21 when the trail right wheel of the lead truck picked the point of Switch 26.

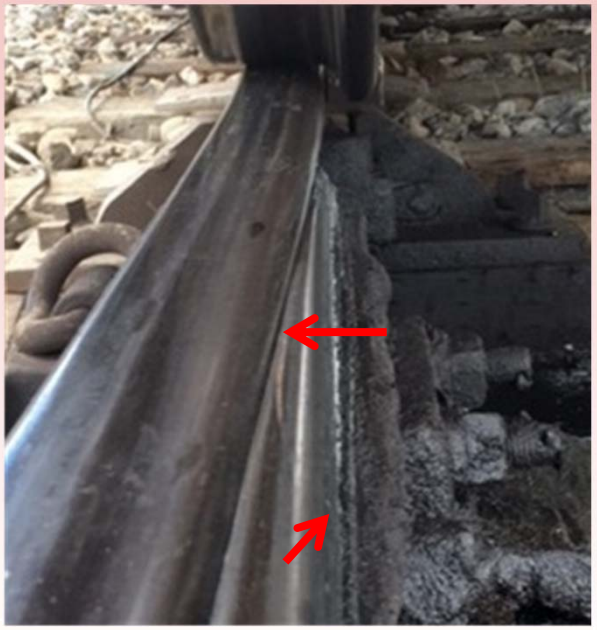
Case Study 1: Sheffield Switch



- Switch 26 (red arrow) was lined for Track 21 (green arrow).
- Lead truck R4/R3 blunted/picked switch, but took intended route.
- Wheel behind the point rail forced switch to reverse position.
- Trail truck took diverging route (yellow arrow) and derailed.

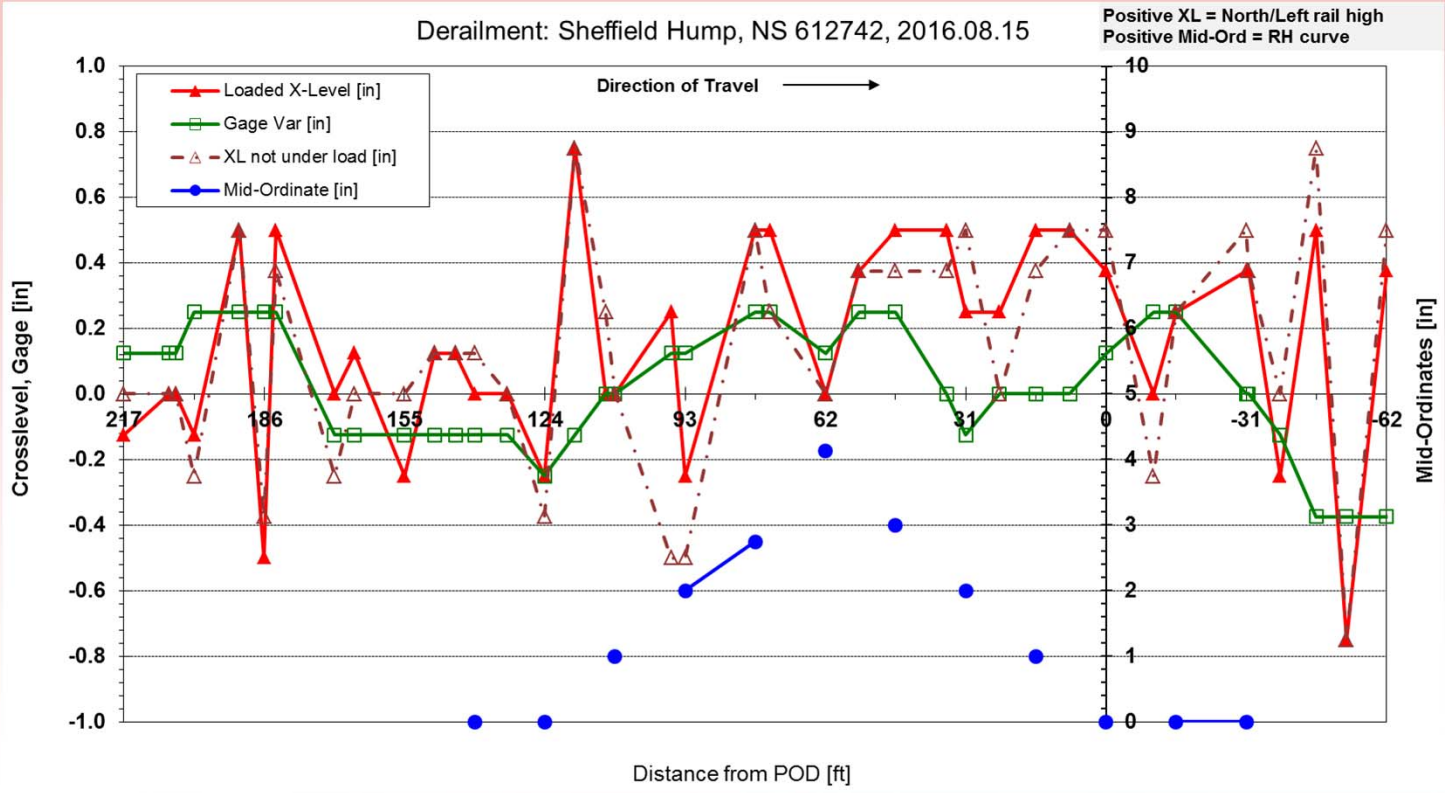
Sheffield – POD Evidence

Switch 26, RH straight point, blunted



Flange mark on top of RH straight point

Sheffield – Track Conditions



Sheffield – Wheel Conditions

- NS 612742 was a 100-ton loaded coil steel car, equipped with Barber S-2 trucks, built in 1968 and rebuilt in 1992.
- R3 & L4 – 2mm tread hollow (not defective)
  - Rolling Radius Differential: Dia. R3 < L3, Dia. L4 < R4
- R3 & L4 – flange wear (not defective)
- This asymmetric wheel wear usually indicates abnormal lateral wheel forces.

Sheffield – Wheel Conditions

L3: fuller flange and normal tapered tread

R3: thinner flange and 2mm hollow tread – **picked switch point**

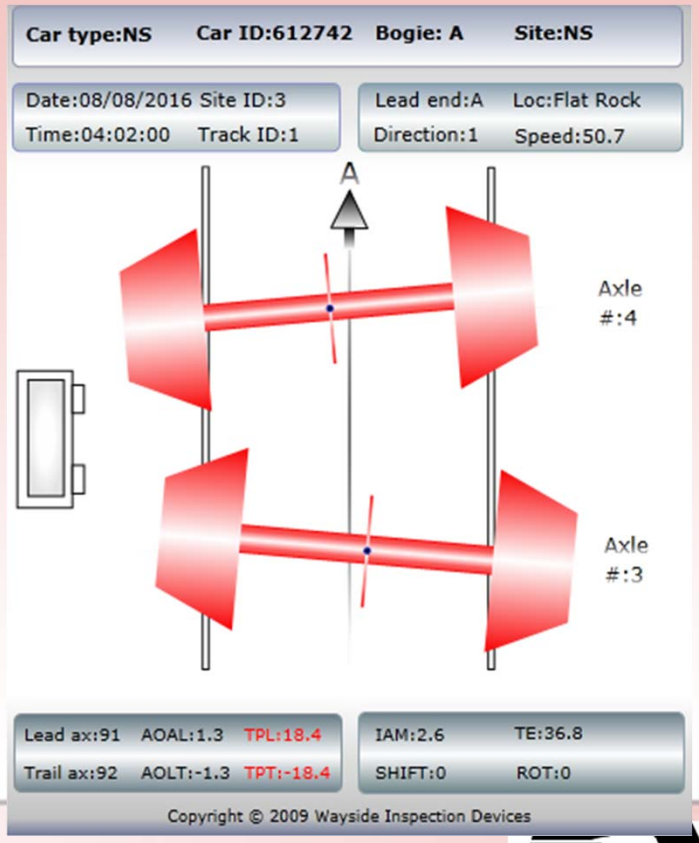
L4: thinner flange and 2mm hollow tread

R4: fuller flange and normal tapered tread – **may have blunted point**

Sheffield – Wheel Conditions

L4: thinner flange and 2mm hollow tread

L3: fuller flange and normal tapered tread



R4: fuller flange and normal tapered tread – **may have blunted point**

R3: thinner flange and 2mm hollow tread – **picked switch point**

Sheffield – Tbogi History

Car type	ID	Bog	Lead end	Lead Ax	Dir	Dir geo	Date	Hunt P	Hunt A	Hunt F	IAM	ROT	TE	SHIFT	AOA L	AOA T	TPL	TPT	Speed	Cnf	R Owner	Site ID
NS	612742	A	B	69	1	South	2015-08-15 14:11				0.2	0.0	32.5	0.0	0.5	0.3	16.4	-16.1	63.9	0	NS	3
NS	612742	B	B	67	1	South	2015-08-15 14:11				0.4	0.0	14.0	0.0	-0.1	-0.5	8.9	-5.1	64.4	0	NS	3
NS	612742	A	B	237	0	North	2015-07-16 20:23				-1.8	0.0	-28.0	0.0	0.2	2.0	-14.1	13.9	57.5	0	NS	3
NS	612742	B	B	235	0	North	2015-07-16 20:23				-0.7	0.0	-14.1	0.0	0.1	0.8	-7.4	6.7	57.5	0	NS	3
NS	612742	A	A	47	1	South	2015-05-31 17:41				1.1	0.0	30.7	0.0	1.2	0.1	14.9	-15.8	71.9	0	NS	3
NS	612742	B	A	49	1	South	2015-05-31 17:41				-0.3	0.0	-10.2	0.0	0.1	0.4	-5.0	5.2	72.1	0	NS	3
NS	612742	A	B	247	1	West	2015-04-25 12:09	1.7	0.0	0.0	1.6	0.0	31.6	0.0	1.2	-0.4	16.2	-15.5	64.2	0	NS	6
NS	612742	B	B	245	1	West	2015-04-25 12:09	1.9	0.0	0.0	0.2	0.0	13.0	0.0	0.1	-0.1	6.4	-6.6	64.2	0	NS	6
NS	612742	A	A	245	0	East	2015-04-13 02:48	2.0	0.0	0.0	-0.7	0.0	-31.7	0.0	-0.1	0.7	-15.7	15.9	66.8	0	NS	6
NS	612742	B	A	247	0	East	2015-04-13 02:48	3.5	0.0	0.0	0.3	0.0	-1.9	0.9	0.2	-0.1	0.4	2.3	66.7	0	NS	6
NS	612742	A	B	151	0	North	2015-03-27 16:34				-1.7	0.0	-30.1	0.0	-0.6	1.1	-16.0	14.1	65.1	0	NS	3
NS	612742	B	B	149	0	North	2015-03-27 16:34				-1.4	0.0	-16.4	0.0	-0.4	1.0	-8.5	7.9	65	0	NS	3
NS	612742	A	A	173	1	West	2015-02-03 22:51				1.6	0.0	29.3	0.0	1.4	-0.2	22.4	-6.9	56.7	0	NS	1
NS	612742	B	A	175	1	West	2015-02-03 22:51				0.3	0.0	2.2	-2.4	0.3	0.0	-1.3	-3.5	56.4	0	NS	1
NS	612742	A	B	79	1	South	2015-02-02 06:28				-0.1	0.0	27.6	0.0	0.0	0.1	13.6	-14.0	52	0	NS	3

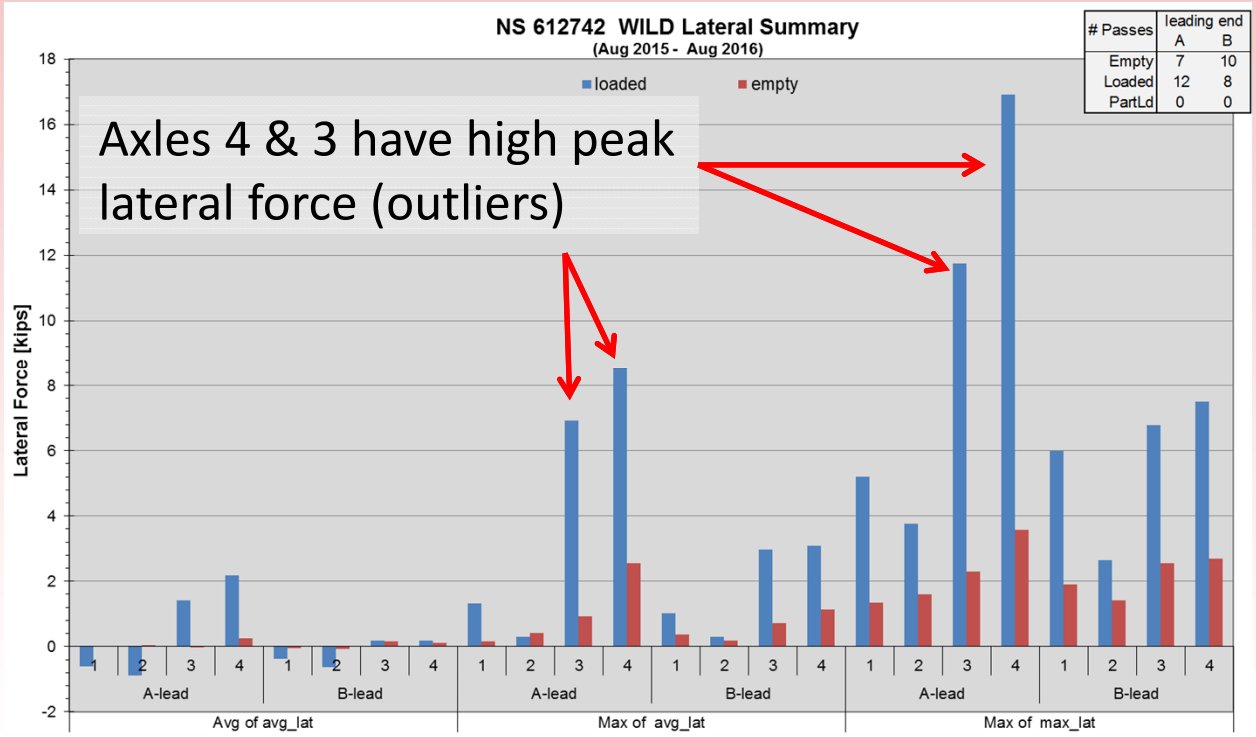
Sheffield – Truck Conditions

- BL, BR wedge rise was $1^{5}/_{16}$" and $1^{1}/_{8}$"
  - well over the condemning limit of ¾" for a Barber S-2 truck. (defective, AAR Rule 46)
- AL, AR wedge rise was $^{11}/_{16}$" (both)
  - not yet defective, but close to the limit
- New wedges were applied to the A-end on 11 Aug 2014.
- Car last shopped on 4 Nov 2015. B-end wedge rise would have been evident at that time.

Sheffield – Equipment Conditions

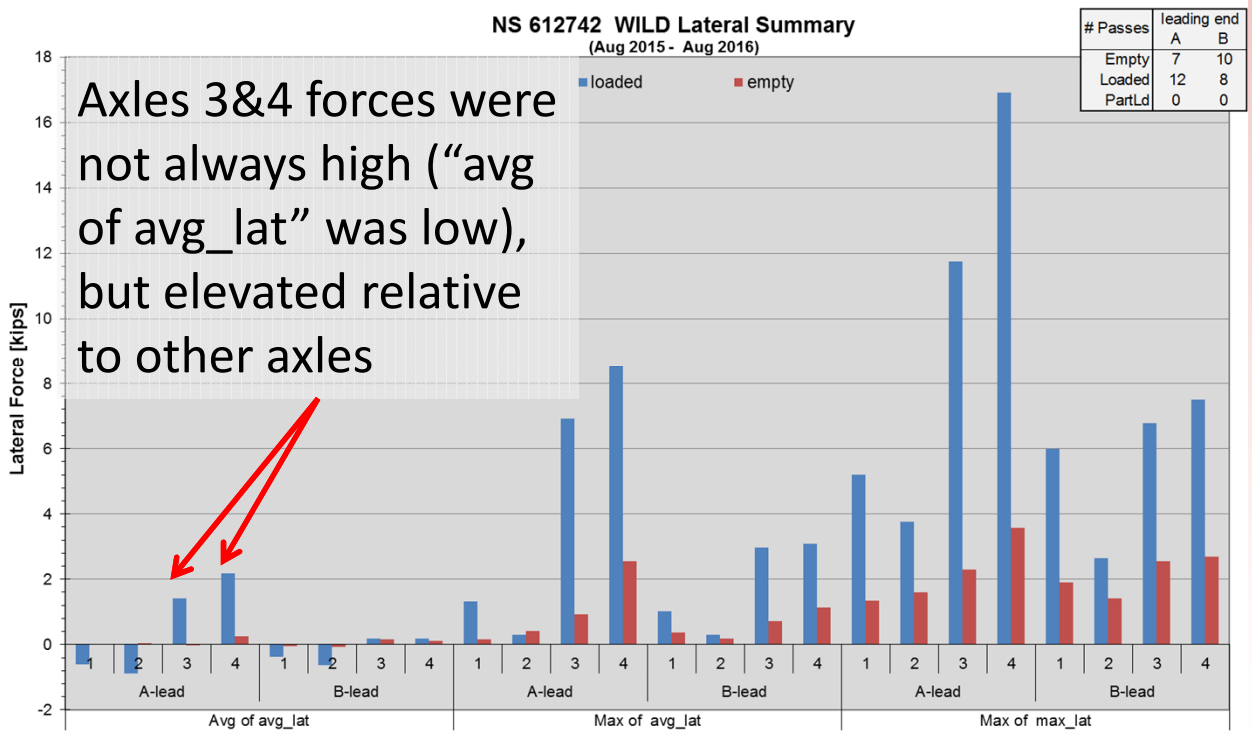
- Excessive wedge rise + asymmetric wheel wear
- Was there any correlation to wayside forces?
- Next slide shows lateral force data from 37 WILD passes over the previous 12 months.

Sheffield – Equipment Conditions



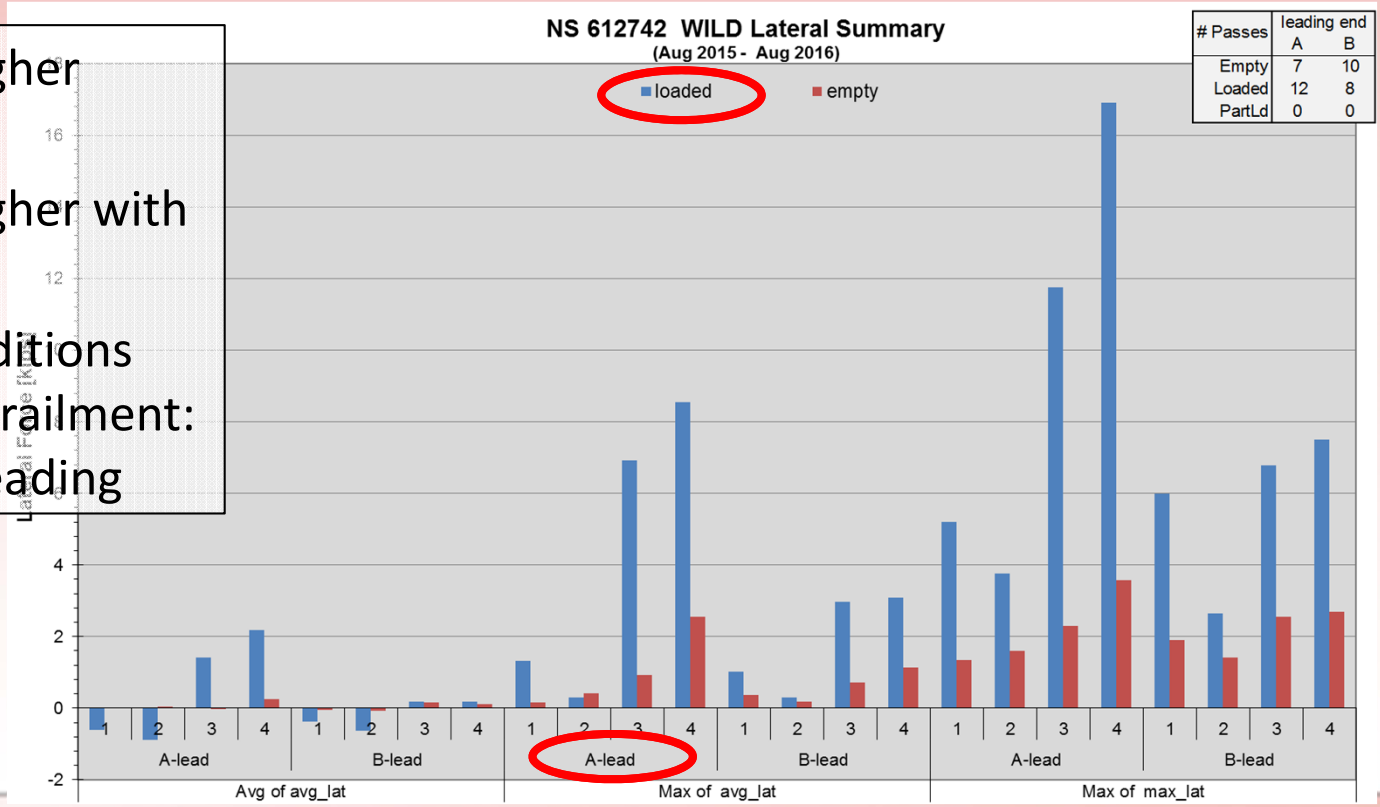
# Passes	leading end A	B
Empty	7	10
Loaded	12	8
PartLd	0	0

Sheffield – Equipment Conditions



Sheffield – Equipment Conditions

- Lateral forces higher when loaded
- Lateral forces higher with A-end leading
- These same conditions existed at the derailment: Loaded, A-end leading



Sheffield – Cause Statement

- "Lead truck wheels of loaded coil steel gondola NS 612742 blunted and picked the straight point rail of hump lead switch, account asymmetrical wheel wear and wedge rise, which generated lateral forces sufficient to deflect the stock rail and blunt the point."
- FRA Primary Cause Code: **E64C worn flange**
- FRA Secondary Cause Code: **E47C defective snubbing**

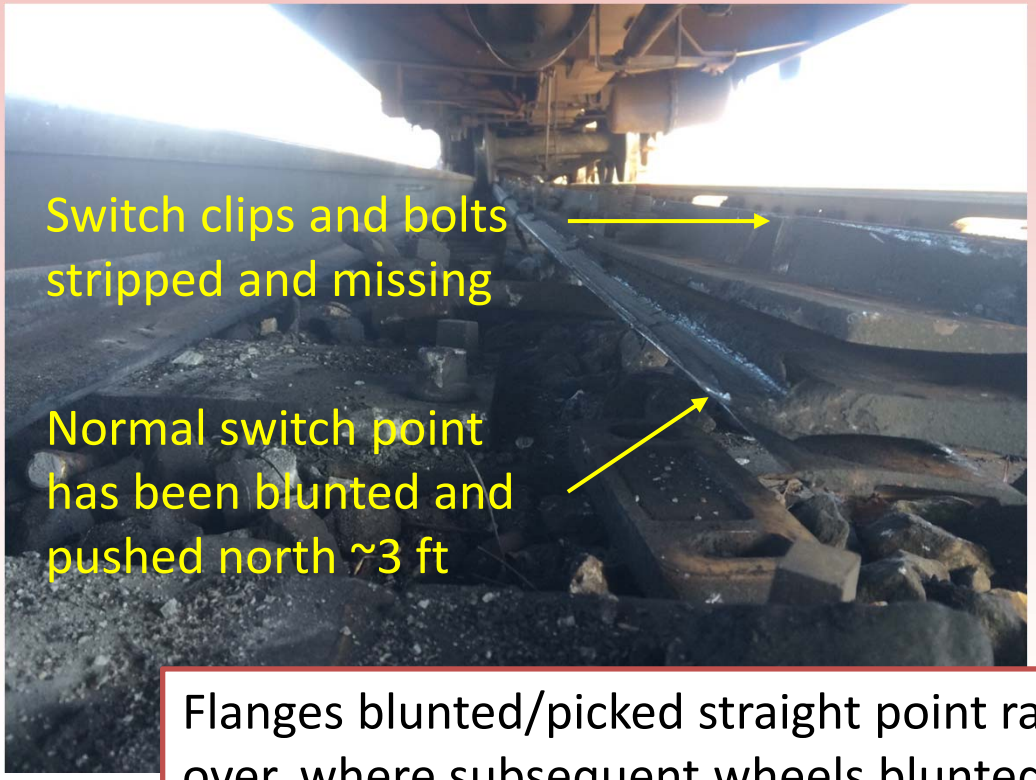
Case Study 2: Grove GA - 118

Case Study 2: Grove GA - 118

Description:

Train 118G205 (3 units, 68 loads, 68 empties, 10,561 tons and 8813 ft) traveling northbound at 38 mph with 464 Amps dynamic brake, derailed 18 cars (lines 72-91) at the switch at CP Grove, MP 183.5.

Grove – Track Conditions

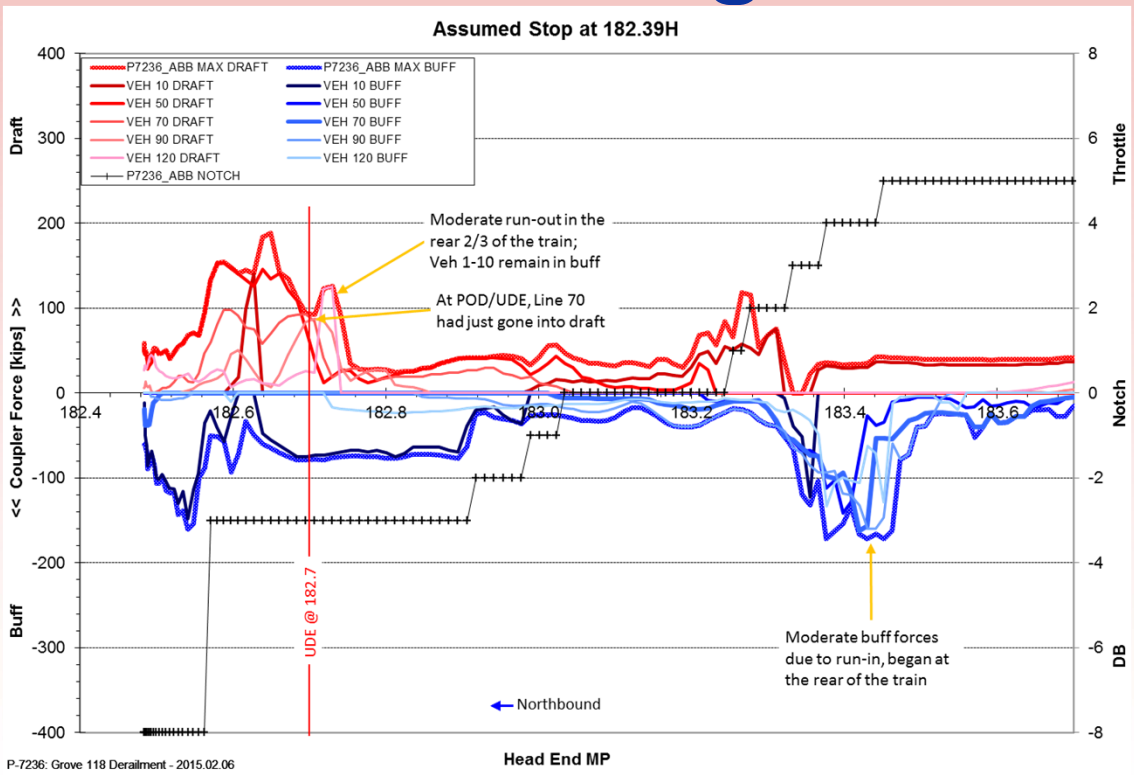


Flanges blunted/picked straight point rail, forcing points over, where subsequent wheels blunted reverse point rail

Grove – Train Handling

TOES simulation output:

- Moderate run-in at rear of the train
- Moderate run-out in the rear 2/3 of the train
- Maybe enough slack action to aggravate a crabbing truck?
- Last exited a LH curve

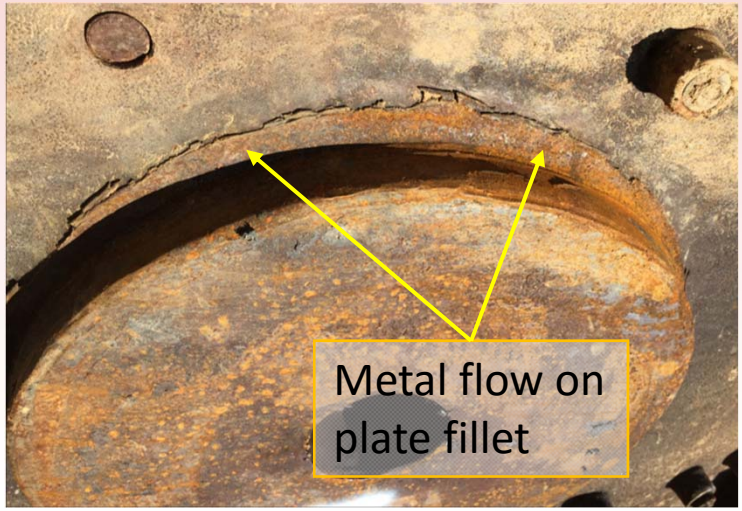


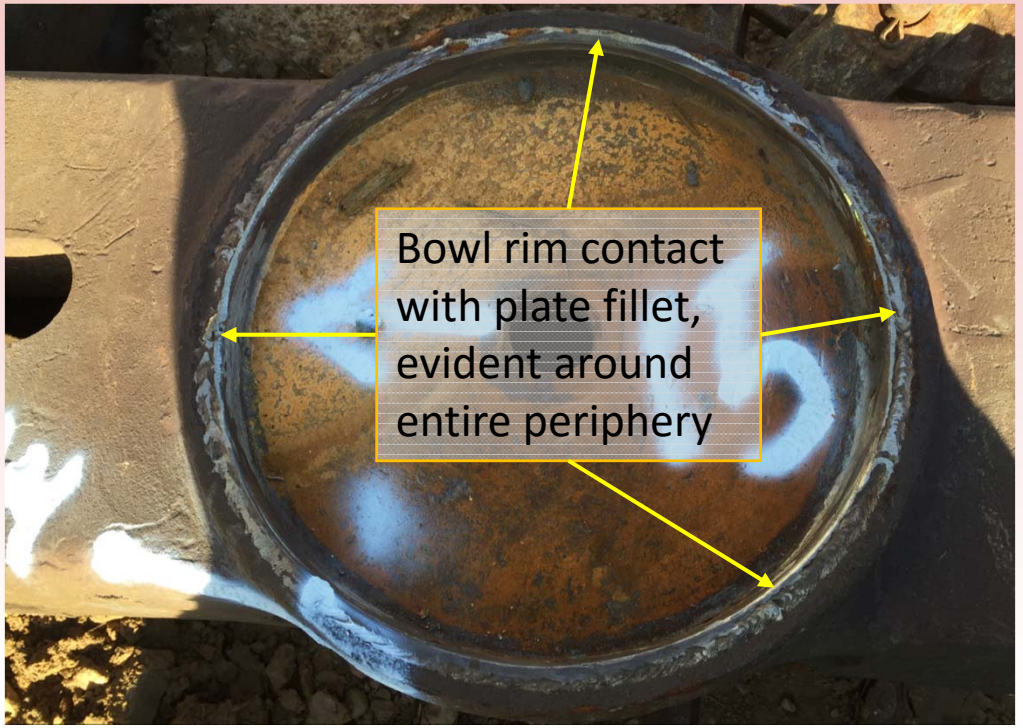
Grove – Equipment Conditions

- Line 72, SOU 565282, B-end leading
- B-end centerplate measured approx. 1” in height
- Divots worn into B-end side bearing wear plates

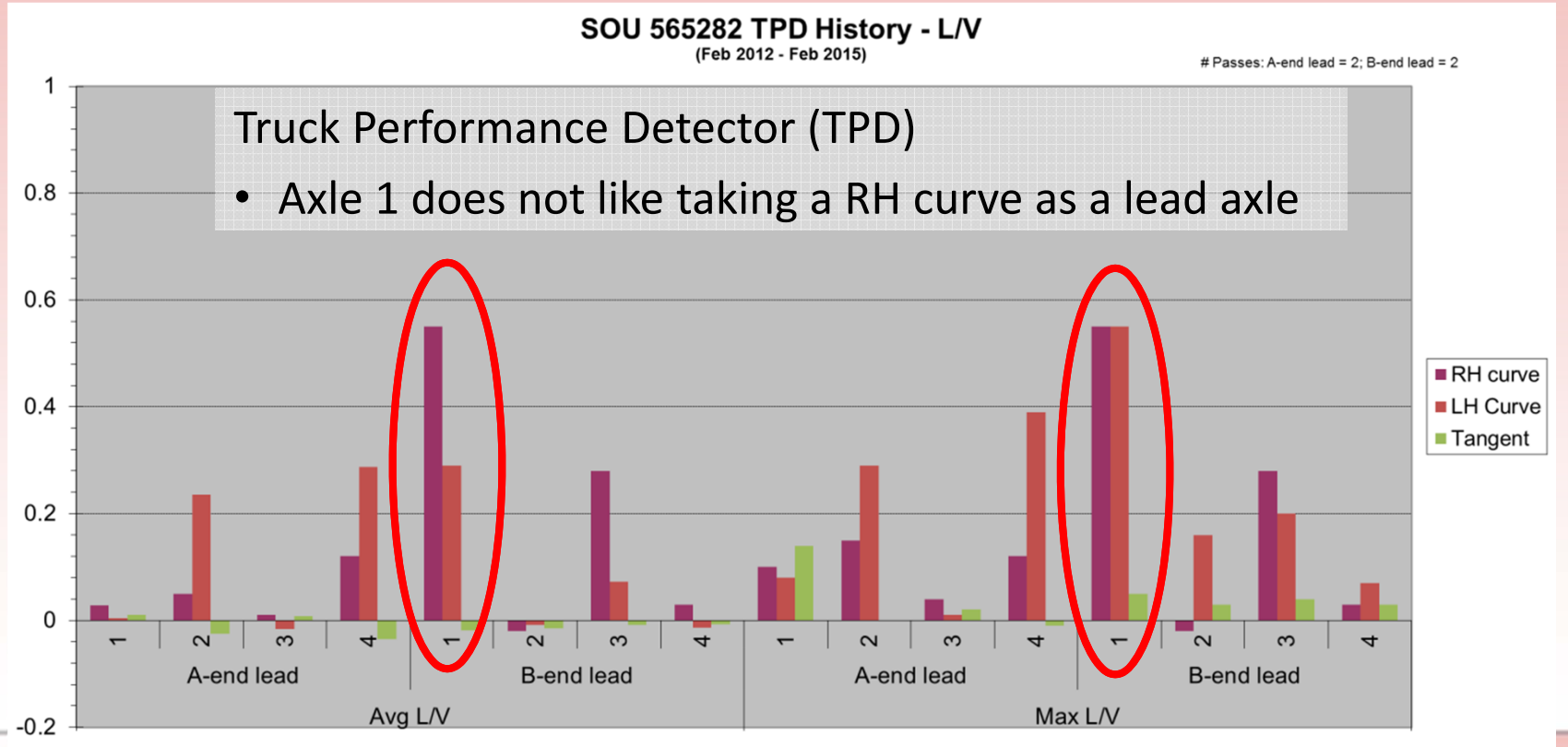
Grove – Equipment Conditions

B-end centerbowl rim contact + tight side bearings = stiff-turning truck

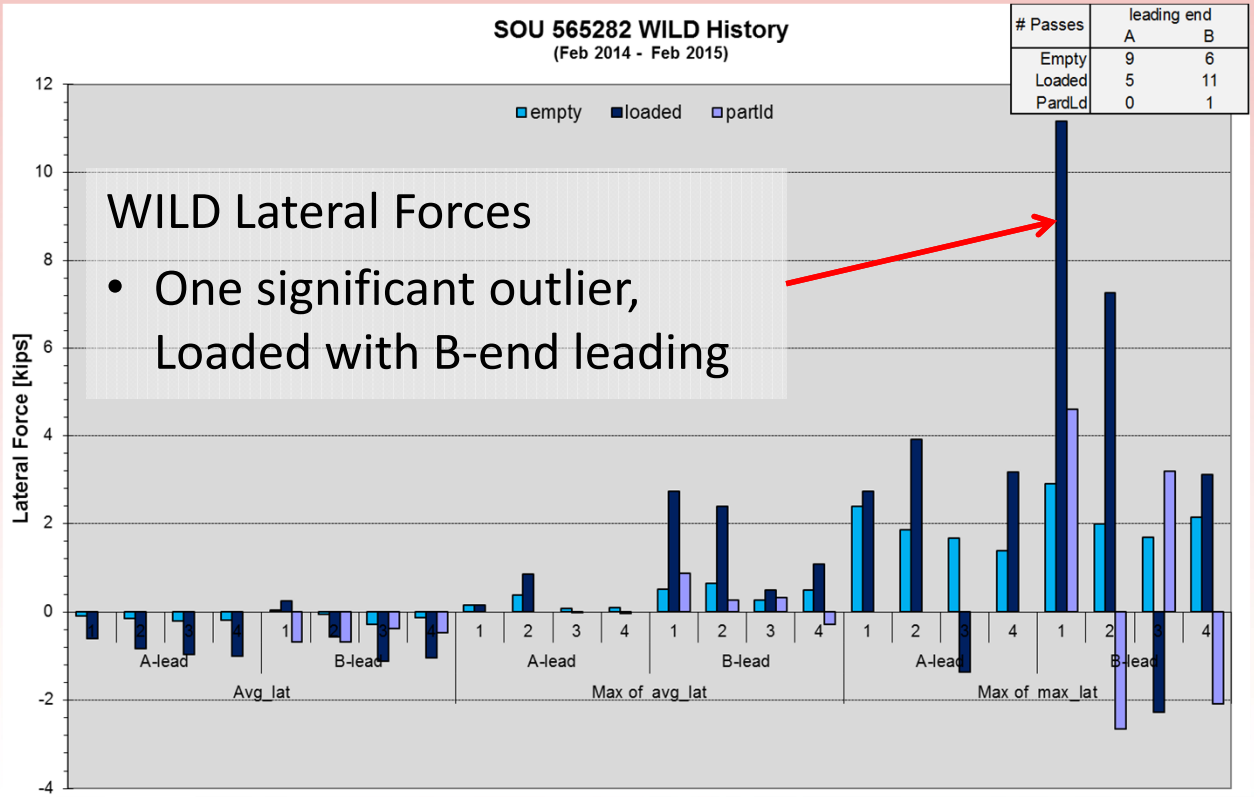




Grove – Truck Performance Detector



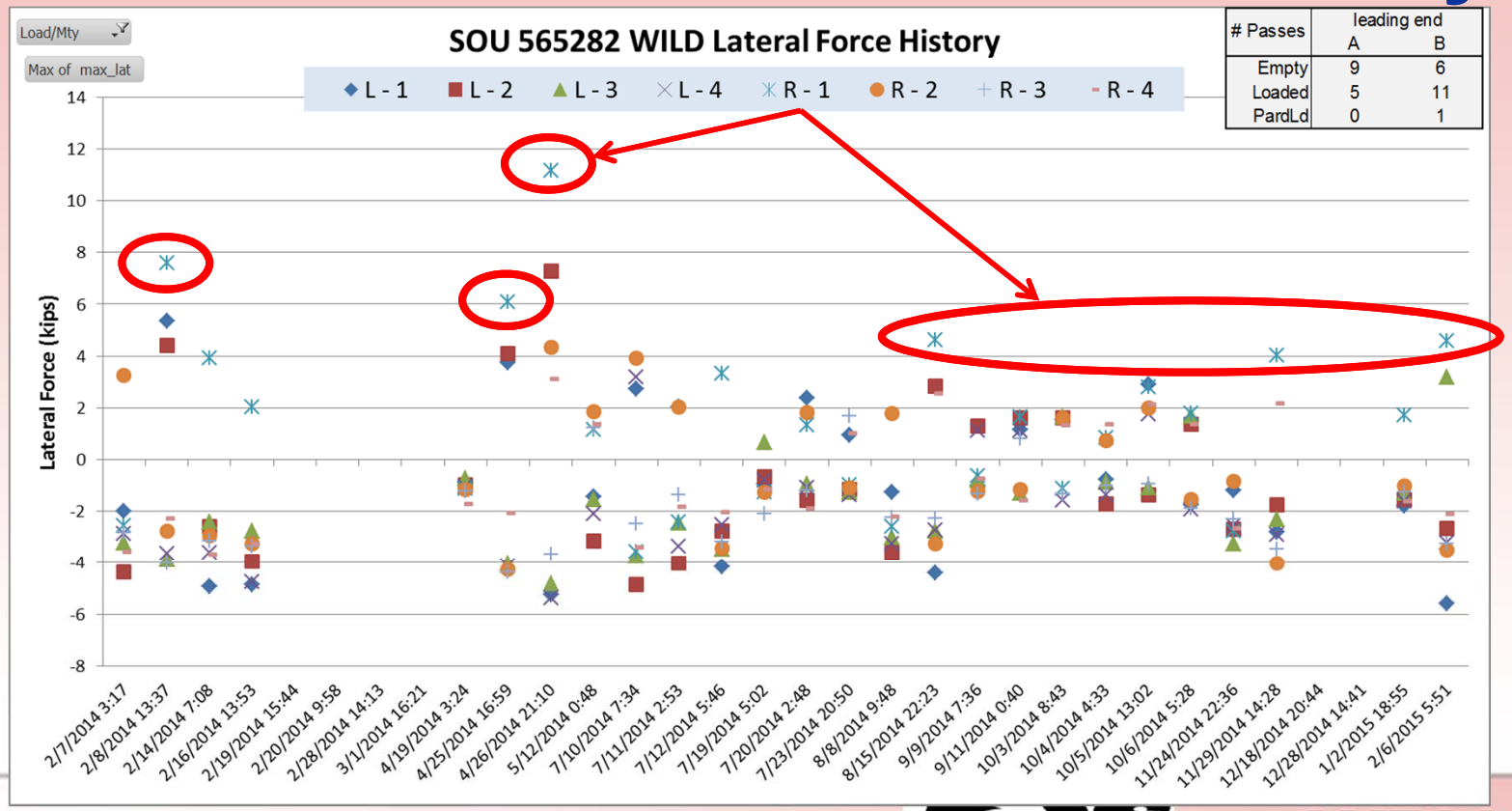
Grove – WILD Lateral Forces



WILD Lateral Forces

- One significant outlier, Loaded with B-end leading

Grove – WILD Max Lateral History



# Passes	leading end A	B
Empty	9	6
Loaded	5	11
PardLd	0	1

Grove – Cause Statement

- "Lead truck of 69th head car, loaded box SOU 565828, picked normal switch point account B-end centerbowl rim contact created lateral forces sufficient to deflect stock rails and gap switch point."
- **FRA Cause Code: E4BC** Truck bolster stiff (failure to slew)

Further Examples – thin flange

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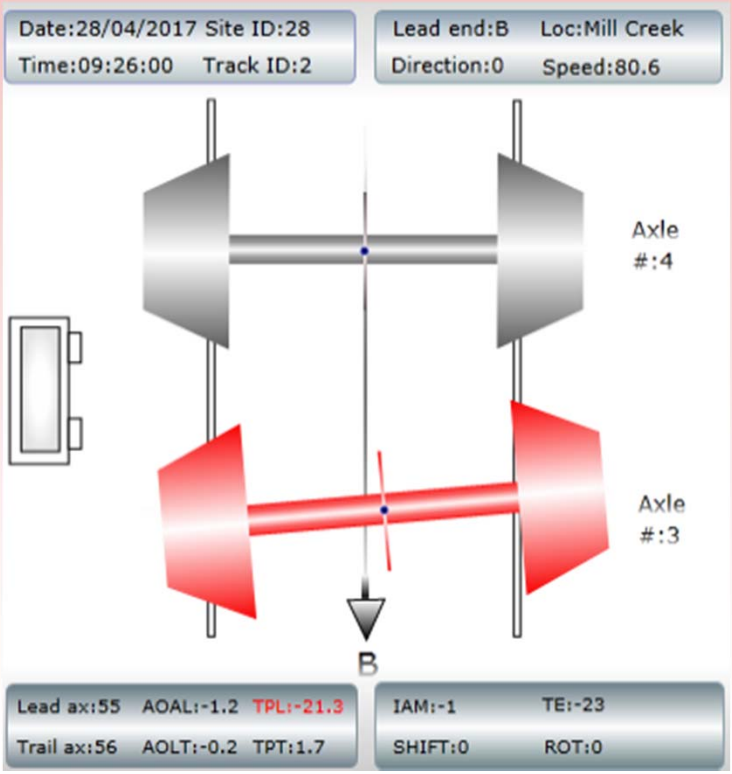


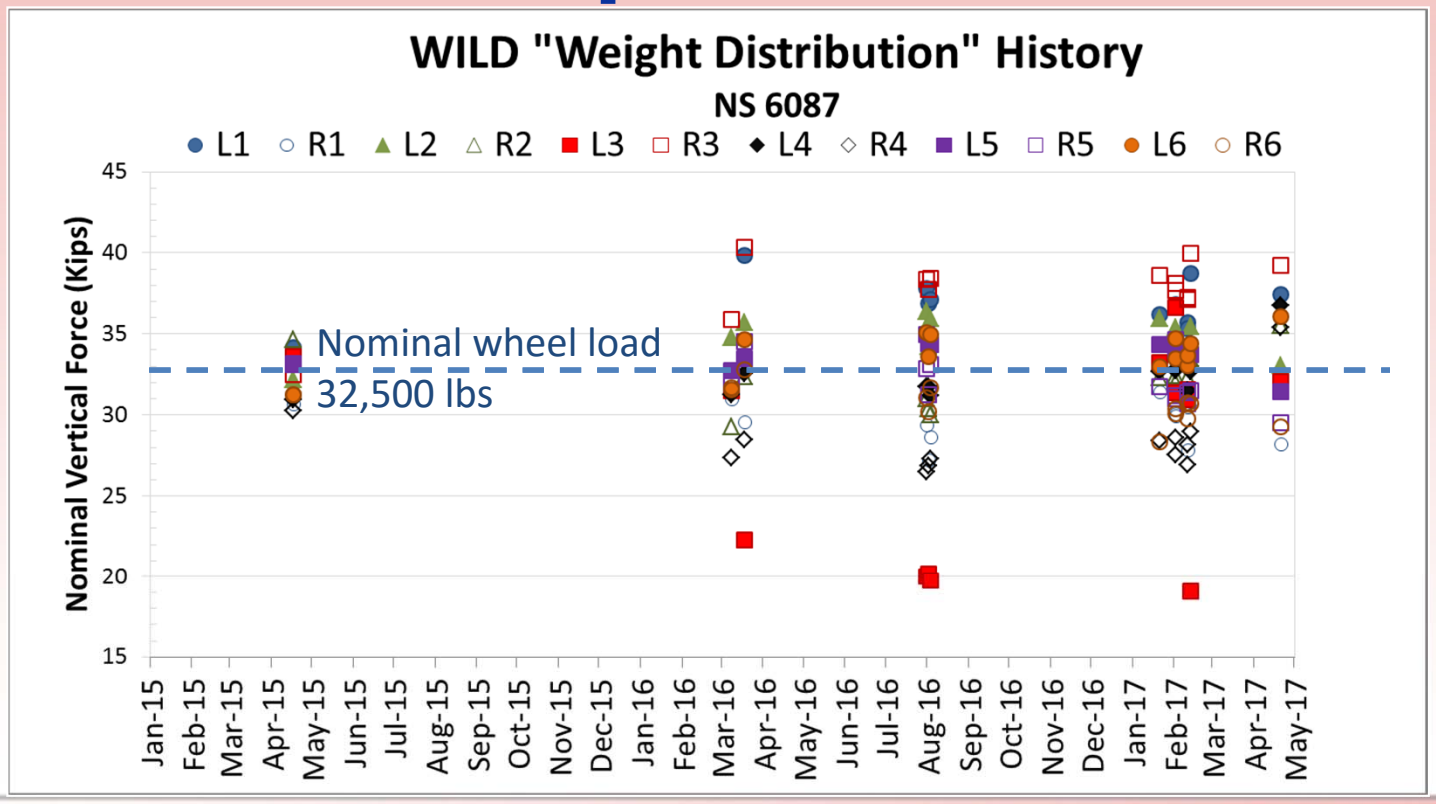
Further Examples – thin flange

- Tbogi identified a thin flange on 5th of 5 cars to derail (per train list)
- POD: We knew one low rail wheel dropped in, then high rail wheel climbed out, and the thin flange wheelset appeared to be the first derailed.
- Tbogi and observations made sense when we realized train was pulled in reverse down branchline.
- Cause analysis underway: contributions from thin flange, wide gage, and buff (pusher) forces

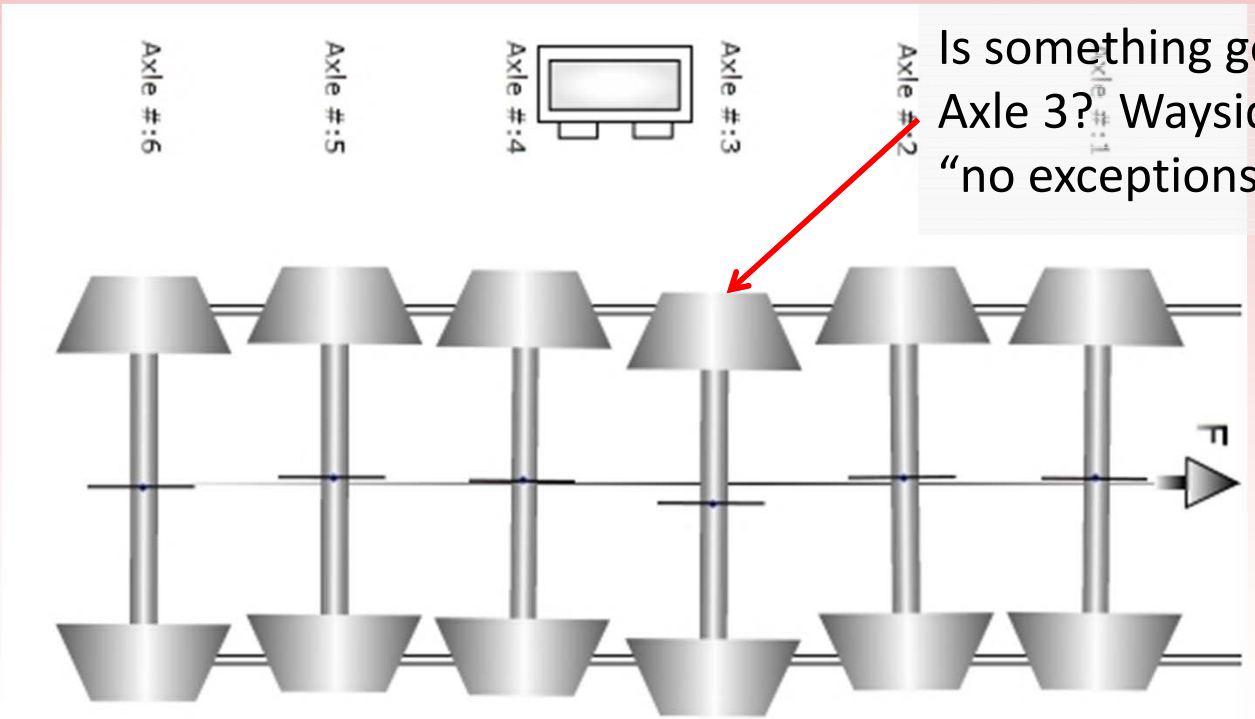
Further Examples – wheel climb

- SD40-2 Lead wheel, trail truck (L3, long hood leading) climbed high rail in 20-21 degree curves, industry track, low speed
- Two derailments in one day, same conditions
- #3 wheelset/combo recently renewed
- Truck inspected in Chattanooga after derailment – “no exceptions”
- Unit is on the way to Juniata for truck teardown
- Root cause remains under investigation

Further Examples – wheel climb



Further Examples – wheel climb



Is something going on with Axle 3? Wayside teams says "no exceptions."

Conclusions & Thought Questions

1. Different detectors yield different aspects of equipment performance: multiple “views” needed.
2. More passes/more data yields better conclusions. Duh.
3. A key to gaining *knowledge* is how you look at the data.
4. Reviewing Wayside Detector data should be a normal component in derailment investigation and analysis.
5. How can field operations better use detector information?
    1. Query Wayside data for any car shopped? (data pull)
    2. AHSI (EHMS) – identifying poor performers (data push)

References

1. Tournay and Lang, Performance History and Teardown Results of Five Loaded Coal Cars Identified as Poor Performers while Passing across a Truck Performance Detector, AAR Research Report R-985 and R-986, August 2007
2. Tournay and Lang, Measurement of the Rotational Resistance of the Center Plate of the A-Truck of a Loaded Coal Car Identified as a Poor Performer across a Truck Performance Detector, AAR Research Report R-979, September 2006