Essential Strategies for Derailment Elimination in Today’s PSR Environment

Presented by: Gary Wolf
Disclaimer

The views and opinions presented here are mine alone and do not reflect the views of the University of Illinois, Major League Baseball, or hardly anyone else for that matter. In fact, some may find these views iconoclastic, too critical, or offensive, but sometimes tough love is required to effect long lasting change and improvement. These views are presented in hope of moving the needle downward on derailments in the coming years. If your feathers are easily ruffled, you may want to tune out or watch The Masters.
Presentation Outline

• Where are we on derailment numbers/rates?
• Impact of changes in the PSR operating environment and potential effects on derailment rates
• The role of the Railroads, FRA, and Investigative Agencies (NTSB, TSB)
• Suggested strategic changes required to move the needle
• 12 specific tactical strategies to reduce derailments
Where Are We?
U.S.A. Total Number of FRA Reportable Derailments 1984-2020

Reportable Threshold Currently $11,200
Track, Signal and Equipment Costs

Investment, Staggers Act, Technology, TTD/VTS

286K and 315K, More traffic
Detectors, Regulations, Less traffic

???

CV 19

Source FRA Accident Database
Train Accident Rate per Million Train Miles

GOAL 1.0

Source FRA Accident Database
1984-2019 FRA Reportable Derailments by Cause

Source: FRA Accident Database
Annual Total Derailments (2000-2020)

Source FRA Accident Database

3-4 per day

CV 19
Annual Total Derailments and Expenses (2000-2020)

Source FRA Accident Database
Annual Human Factor Derailments and Expenses

Source FRA Accident Database
Total Derailments and Expenses by Cause (2000-2020)

Number of Derailments

- Equipment
- Human Factor
- Misc.
- Signal
- Track

Expenses (millions)

- $0.0
- $500.0
- $1,000.0
- $1,500.0
- $2,000.0
- $2,500.0

Cause

- Number of Derailments
- Expense (millions)
Recent Years Have Been Among the Safest Ever

Thanks to robust investments to modernize their networks, the widespread adoption of advanced safety-enhancing technologies, and more rigorous employee training, the past ten years have been the safest in history for U.S. railroads. Railroads are proud of their safety record, but they also know the safety challenge never ends. They will continue working hard to reach the ultimate goal of zero accidents.

% = change in rate from 2000-2019. Source: FRA
Track and Equipment Costs Do Not Typically Include:

• Rerailing/clean up
• Lading damage and claims (trailer/containers are lading)
• Environmental clean up/damage
• Opportunity cost of track out of service; loss of network reliability
  ✓ Car hire
  ✓ Crew costs
  ✓ Locomotive costs
  ✓ Train delay penalties ($$)
• Litigation costs
• Injuries/fatalities
• Evacuations
• Public relations costs
• Access costs to get to derailment site
• Damage to adjacent land owners
Since 2000, The U.S. Railroads Have Spent ~$5.0 Billion on Derailments (T&E).

Factoring in all other Ancillary Costs, the Actual Total may be Closer to ~$10.0 Billion!
Inconvenient Truths

Derailment costs can vary widely based on speed, commodity, and location.

Lac Megantic derailment estimated to cost ~$3 Billion.

We probably would have never heard of Lac Megantic if the train was carrying frac sand.
The PSR Environment and Potential Effects on Derailments

(BTW – We are not here to discuss the merits of PSR)
PSR, PTC, CV19 and WTF (Where’s the Freight???)
Carload Freight

United States*** | Total Carloads
Originated Rail Traffic

* Canadian traffic includes the U.S. operations of Canadian railroads.
** Mexican traffic includes the U.S. operations of Mexican railroads.
*** United States traffic excludes the U.S. operations of Canadian and Mexican railroads.
Coal Traffic

United States*** | Coal Originated Rail Traffic

* Canadian traffic includes the U.S. operations of Canadian railroads.
** Mexican traffic includes the U.S. operations of Mexican railroads.
*** United States traffic excludes the U.S. operations of Canadian and Mexican railroads.
If car loadings drop, and revenue slides, will we have the funds available for maintenance and investment?
Tenets of PSR

• Less touches per car – less switching, more destination blocking
• Focus on car performance; less on train performance
• Car/train velocity important; less terminal dwell
• Less Unit trains
• Optimizing network, not just single divisions/terminals
• Longer full tonnage trains; filling out tonnage enroute
• Running on Schedules; more predictability
• Less fire fighting; knowing what to expect
• More flat switching; less humping
• Drive decision making to local level; less bureaucracy
PSR Summary

• Will see a change in train lengths(+/−) and speeds (+/−)
• Will see a change in traffic (Coal↓; Intermodal↑)
• Do more with Less…
  ✓ Fewer locomotives
  ✓ Fewer crews
  ✓ Less staff
  ✓ Fewer cars
  ✓ Less yards
  ✓ Less track (where not needed)

Higher utilization of assets means accelerated degradation of those assets, both physical and human.
Potential impacts of PSR on Derailments

• Curve elevation issues
  ✓ Higher car velocity may increase speeds on certain curves; insufficient elevation
  ✓ Longer trains may operate slower on certain portions of the track; excessive elevation
  ✓ Effect on rail grinding and RCF
• Higher speeds
  ✓ More truck hunting; effect on equipment and track
  ✓ Change from slow coal/oil/ore trains to fast intermodal trains
• Possible changes in train blocking
  ✓ More slack action; effect on equipment and track
  ✓ Higher steady state coupler forces with longer trains
• Longer trains = more heat into the rail
  ✓ Implications for track buckling
  ✓ Effect on gage face and TOR lubrication retention rates
Potential impacts of PSR on Derailments Con’t

• Longer trains = more locomotive horsepower
  ✓ Effect on rail anchoring; ballast sections
  ✓ Larger drawbar forces = larger lateral forces in curves

• Longer trains; more air brake problems (especially cold weather)
  ✓ Sticking brakes; flat wheels; wheel impacts on rail

• Longer/Faster trains = potentially bigger derailments

• Less track time available for maintenance; penalties for impacting schedules; might need more slow orders

• More turns per car/loco; faster degradation of equipment (inspection intervals?)

• Increased switching volumes in flat yards; More degradation of flat yard tracks

• Changing traffic patterns/crew districts; lack of route familiarization

• Fewer crews; human fatigue?

• Less management to handle exceptions; less bench strength

• Greater emphasis on derailment track clearing; less time for investigation
PSR and derailments…the bottom line (or, WTBD)

Operating precision and reliability cannot coexist with derailments, disruptions, slow orders, signal malfunctions, and human failure.

To operate a precision network we must eliminate disruptions/outages
A New PSR goal

An OR of 60% is great, but…
how about a new goal of:

1.0 Derailments/Million Train Miles

Can we get there??
What is needed?

And who are the stakeholders?
The Derailment Reduction/Prevention Trinity

Railroads

Investigative Agencies (NTSB/TSB)

Regulators (FRA/TC; AAR)

1.0/MTM
To the Railroads:

- Assign corporate ownership to derailment prevention
  - Somebody must own it; it can't be everyone's job or it falls through the cracks
- Better training in derailment cause finding
  - Many changes in the workforce; many new faces
- Better use of “Big Data” from the operating network to spot trends and conditions
- Continue application of automated detector systems
  - Drones, on-track, wayside, on-board, autonomous, IOT
- Provide adequate time and resources for derailment investigation
- Insure corrective actions are working; no unintended consequences
- Greater emphasis on understanding/eliminating human factor derailments
- Revise rules and instructions for greater clarity; less ambiguity
To the Regulators:

• Ensure regulations are keeping pace with technology and infrastructure improvements
• Re-write, update, reconsider, simplify some of the sections in 49CFR
• Consider revamping all the derailment cause codes; need less ambiguity and more specificity. Reduce the number of miscellaneous codes. Minimize use of “cause not found”.
• Special emphasis on revising Human Factor Cause codes; move from accident description to the “Why”
  • “Switch run through” is not a cause, it is a description of what happened.
• Follow-up on railroad causes to ensure there is supporting data for the stated cause and ensure accurate causes enter the accident database
Ensure regulations are keeping pace with technology and infrastructure improvements
Regulations often Lag Usage/Implementation

- Concrete Crossties 1980’s → Regs ~ 2005
- Constant Contact Side Bearings 1970’s → No fed regs yet; AAR regs ~ 2006 (rule 62)
- CWR 1950’s/1960’s → Regs ~ 1999
- Event recorders 1970’s → Regs ~ 1992
- Plastic Centerbowl Liners → AAR regs ~ 2012
Re-write, update, reconsider, simplify some of the sections in 49CFR
213 Track Safety Standards Compliance Manual

213 Track Safety Standards

CFR 49 1981 ~ 500 pages

CFR 49 2018 ~ 1200 pages
Consider revamping all the derailment cause codes; need less ambiguity and more specificity. Cause Codes need to lead to corrective actions and focused research.

Reduce the number of miscellaneous codes. Minimize use of “cause not found”.
2014-2016 Derailment Cause Breakdown
U.S FRA Statistics

% Breakdown

- Equipment 12%
- Misc. 13%
- Signal 2%

- Track 39%
- Human 34%

3889 Total Reportable Derailments – 3 years

Source FRA Accident Database
What is the difference in swivel vs. slew?

Multiple failures to cause stiff truck; stiff truck is result of poor maintenance such as:

- tight side bearings
- insufficient bowl rim clearance
- excessive bowl wear
- broken CB liner
- improper centerplate repair

Truck hunting is a condition, not a failure. Multiple reasons for hunting

- hollow worn wheels
- insufficient CCSB restraint
- defective/broken CCSB elements
- poor friction damping restraint; wedge rise
- speed restriction violation of restricted cars
A small sample of Track Cause codes

Track buckle is a condition, not a cause. There are multiple causes of track buckle/sunkink:
- poor anchoring pattern
- worn out anchors
- poor ballast section
- poor ballast quality
- poor control of neutral temperature
- improper rail laying temperature
- geometry irregularities
- fouled ballast
- failure to observe/set slow orders
Special emphasis on revising Human Factor Cause codes; move from accident description to the “Why”
<table>
<thead>
<tr>
<th>Causes</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car(s) shoved out and left out of clear</td>
<td>H301</td>
</tr>
<tr>
<td>Cars left foul</td>
<td>H302</td>
</tr>
<tr>
<td>Derail, failure to apply or remove</td>
<td>H303</td>
</tr>
<tr>
<td>Failure to couple</td>
<td>H310</td>
</tr>
<tr>
<td>Failure to stretch cars before shoving</td>
<td>H309</td>
</tr>
<tr>
<td>Hazardous materials regulations, failure to comply</td>
<td>H304</td>
</tr>
<tr>
<td>Humping or cutting off in motion equipment susceptible to damage, or to cause damage to</td>
<td>H317</td>
</tr>
<tr>
<td>Humping or cutting off in motion equipment susceptible to damage, or to cause damage to other equipment</td>
<td>H317</td>
</tr>
<tr>
<td>Instruction to train/yard crew improper</td>
<td>H305</td>
</tr>
<tr>
<td>Kicking or dropping cars, inadequate precautions</td>
<td>H318</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Causes</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual intervention of classification yard automatic control system modes by operator</td>
<td>H316</td>
</tr>
<tr>
<td>Moving cars while loading ramp/hose/chute/cables/bridge plate, etc., not in proper position</td>
<td>H311</td>
</tr>
<tr>
<td>Other general switching rules (Provide detailed description in narrative)</td>
<td>H399</td>
</tr>
<tr>
<td>Passed couplers (other than automated classification yard)</td>
<td>H312</td>
</tr>
<tr>
<td>Portable derail, improperly applied</td>
<td>H315</td>
</tr>
<tr>
<td>Retarder yard skate improperly applied</td>
<td>H314</td>
</tr>
</tbody>
</table>

These describe what happened but don’t provide any information as to why the human failure occurred.
Follow-up on railroad causes to ensure there is supporting data for the stated cause and ensure accurate causes enter the accident database
.................Track Information.................

Yard  Damage $13,784  Milepost 18  FRA Class 1  Total Casualties: 0 Deaths and 0 Injured

....Signalisation....  ....Cause(s)....
Non signalled
Investigation complete, cause could not be determined

....Supplemental Codes....

Restricted Speed or Equivalent

Special Instructions

ROUSTABOUT CREW REPORTED DERRAILING WHILE MAKING A DRILL MOVE FROM THE SWITCHING LEAD TO NO. 6 TRACK IN YARD. THE B END (3L, 3R, 4L, 4R) OF THE WEST CAR 7419 DERAILED. WHILE NO DEFINITIVE CAUSE WAS POSITIVELY IDENTIFIED FOR THIS DERAILMENT, IT FALLS WITHIN THE CATEGORY OF "LOW SPEED WHEEL CLIMB". THERE ARE A NUMBER OF FACTORS THAT CAN CONTRIBUTE TO THIS, INCLUDING TRACK GEOMETRY, TRACK CONDITION, TRACK CONDITION, WHEEL CONDITION, RAIL AND FLANGE COEFFICIENT OF FRICTION, TRAIN HANDLING, ETC. ALTHOUGH WITHIN FRA TRACK STANDARDS, THE CLASS OF TRACK FOR THE AREA IS MAINTAINED TO CLASS 31 CRITERIA. CONSEQUENTLY, WITH THE LOWER STANDARD OF TRACK, GREATER TOLERANCES TO ISSUES THAT MAY CONTRIBUTE TO SLOW-SPEED DERAILMENTS ARE DEEMED ACCEPTABLE. NO ONE FACTOR IS IN GENERAL ENOUGH TO CAUSE THE WHEEL CLIMB. IN MANY ININSTANCE, ALL THE PERTINENT MEASUREMENTS ARE WELL WITHIN APPLICABLE FRA SAFETY STANDARDS AND OFTEN WITHIN MAINTENANCE REQUIREMENTS AS WELL.
EMPLOYEE FAILED TO PROPERLY LATCH DOWN THE SWITCH HANDLE. AS THE TRAIN WAS PASSING, THE POINTS BEGAN TO FLOAT DERAILED IT. 1 CARS DERAILED. NO HAZARDOUS MATERIALS WERE RELEASED.

How does a human failure description morph into a track cause of insufficient rail anchoring????
Speed??? How did speed cause the derailment? What was speed? What was speed limit? Why did overspeed occur?
Wheel popped off track while sitting still? Hmmm?
No mention of car condition, track condition, how the train make-up was improper.

> $250,000 in cost
Other Truck component defects??? What failed and why?
Cost exceeded $100,000

<table>
<thead>
<tr>
<th>Yard</th>
<th>Damage</th>
<th>Milepost</th>
<th>FRA Class</th>
<th>Total Casualties:</th>
<th>0 Deaths and 0 Injured</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>B278.0</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

...Signalization....   ...Cause(s)...
Nonsignaled
Object or equipment on or fouling track, other
...Supplemental Codes...
Restricted Speed or Equivalent

RUN IN OF COUPLER MOVEMENT CAUSED OLD YOKE MOUNTED TRAINLINE TROLLEY TO BREAK, RESULTING IN THE NEW COUPLER MOUNTED TRAILINE TROLLEY TO BREAK (100% NEW). NEW COUPLER MOUNTED TRAINLINE TROLLEY WAS DRAGGING WHILE L681320 MOVED WEST. AS L681320 MADE SHOVEL MOVEMENT EAST, TRAINLINE TROLLEY BECAME WEDGE INTO HEEL BLOCK OF CROSSOVER SWITCH RESULTING IN ADMX 283 27 A-END TRUCK, WHEEL #3 TO DERAILED DURING SHOVEL MOVEMENT, DERAILED THE SUBSEQUENT CARS ALL WHEELS ON ADMX 26724, ADMX 25462, ADMX 25799, AND LOCOMOTIVE THE R1,2,3 AND L1,2,3

This was not an object fouling track cause (Misc. Cause Code), this was a mechanical failure of equipment. Or possibly improper train handling.

No Information provided on why the run-in occurred, magnitude of the run-in, or why the trolley broke.
To the Investigators (NTSB/TSB):

• Provide final reports in a timely manner; less than one year. If corrective actions required they must be given in a timely manner while attention is still focused on the accident.

• Cooperate with railroads at accident site; work as a team; eliminate us vs. them attitude. Share information and access to artifacts.

• Quit listing human failure as a cause, and explain why and how human failure occurred. Loss of situational awareness is not a cause. Utilize current research on human performance and attention awareness (Atticus Consulting, DEKRA, others) used in other safety sensitive industries.

• Minimize political inferences in the investigations; stick to nuts and bolts.

• Develop corrective actions/recommendations for primary and contributory causes.
Provide final reports in a timely manner; less than one year. If corrective actions required they must be given in a timely manner while attention is still focused on the accident.
# NTSB Accident Reporting in the 1970’s

<table>
<thead>
<tr>
<th>Report Number</th>
<th>NTSB Title</th>
<th>Accident Date</th>
<th>Report Date</th>
<th>City</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>RHR-71-01</td>
<td>Illinois Central Railroad Company, Train No. 1, Collision with Gasoline Tank Truck at South Second Street Grade Crossing</td>
<td>1/24/1970</td>
<td>7/8/1971</td>
<td>Loda</td>
<td>IL</td>
</tr>
<tr>
<td>RAR-71-02</td>
<td>Chicago, Burlington, and Quincy R.R. Co., Train 64 and Train 824, Derailment and Collision with Tank Explosion</td>
<td>2/18/1969</td>
<td>2/24/1971</td>
<td>Crete</td>
<td>NE</td>
</tr>
<tr>
<td>RAR-68-03</td>
<td>Pennsylvania Railroad, Train PR-11A, Extra 2210 West and Train SW-6, Extra 2217 East, Derailment and Collision</td>
<td>1/1/1968</td>
<td>12/18/1968</td>
<td>Dunreith</td>
<td>IN</td>
</tr>
</tbody>
</table>
# More Recent NTSB Accident Reporting

<table>
<thead>
<tr>
<th>Report Number</th>
<th>NTSB Title</th>
<th>Accident Date</th>
<th>Report Date</th>
<th>City</th>
<th>State</th>
<th>Country</th>
<th>NTIS Number</th>
<th>Time to Reporting</th>
</tr>
</thead>
</table>

**25 mo. Average**
The Grand Daddy…took over 5 years

62 months !!
Nearly 4 years and NO Cause found

CSX Freight Train Derailment and Subsequent Fire in the Howard Street Tunnel

Probable Cause

The National Transportation Safety Board, after an exhaustive investigative effort, could not identify convincing evidence to explain the derailment of CSX freight train L-412-15 in the Baltimore, Maryland, Howard Street Tunnel on July 18, 2001.

No preaccident equipment defects or rail defects were found. Computer simulations were used to evaluate locomotive event recorder data, train profile data, track profile data, and preaccident track geometry data. These simulations indicated that neither train operations nor changes in track conditions alone likely resulted in a derailment. Available physical evidence and computer simulations also showed that the most likely derailment scenario involved an obstruction between a wheel and the rail, in combination with changes in track geometry. However, postaccident fire, flooding, and necessary emergency response activities, including removing burning freight cars from the tunnel, significantly disturbed the accident site; and, no obstruction was identified that could be convincingly connected to wheel climb and evidence was insufficient to determine changes in track geometry.

41 months
# Canada TSB Investigation Length

<table>
<thead>
<tr>
<th>Completed</th>
<th>Instrument</th>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R20W0031</td>
<td>2020-02-18</td>
<td>Main-track train derailment</td>
</tr>
<tr>
<td></td>
<td>R20W0005</td>
<td>2020-01-07</td>
<td>Main-track train derailment</td>
</tr>
<tr>
<td></td>
<td>R20W0329</td>
<td>2019-12-31</td>
<td>Main-track train derailment</td>
</tr>
<tr>
<td></td>
<td>R1U0911</td>
<td>2019-11-16</td>
<td>Main-track train derailment</td>
</tr>
<tr>
<td></td>
<td>R1U09111</td>
<td>2019-10-11</td>
<td>Main-track train derailment</td>
</tr>
<tr>
<td></td>
<td>R1B09150</td>
<td>2019-09-26</td>
<td>Main-track train derailment</td>
</tr>
</tbody>
</table>

- 5 months
- 10 months
- 8 months
- 7 months
- 6 months
- 6 months

**7 Month Average**

Kudos to the TSB!
Quit listing human failure as a cause and explain why and how human failure occurred. Loss of situational awareness is not a cause. Utilize current research on human performance and attention awareness (Atticus Consulting, DEKRA, Others) used in other safety sensitive industries.
Why did he ride the car on the side between the building? Why not on outside?
- distractions
- job pressure; lack of job briefing
- were job steps interrupted
- lack of rule knowledge
- rule test history; rule violation
- were close clearance signs present
- why wasn’t ice/snow cleared

How to prevent recurrence?
Probable Cause

The National Transportation Safety Board determines that the probable cause of the accident was that the conductor slipped, tripped, or fell during his attempt to board locomotive [redacted] as it passed at 12.5 mph, which is three times the maximum authorized speed to board moving equipment.

Why did he attempt to board the train?
- distractions
- job pressure
- were job steps interrupted
- lack of rule knowledge; rule violation
- rule test history

Falling is a result of actions, not a cause.
Did he trip/fall due to objects on track?
How to prevent recurrence?
Why did he lose “situational awareness”?
- distractions
- job pressure
- were job steps interrupted
- content of job briefing
- lack of rule knowledge; rule violation
- rule test history

How much separation between the cars?
How to prevent recurrence?
What has our derailment experience taught us?

• We have learned that current methods of condition assessment, i.e., individual measurements of track geometry, rail, and vehicles at discrete increments, may not be sufficient to prevent all derailments.

• Current practice of periodic human track and vehicle inspections is not finding conditions that can lead to derailment. Compliance with standards is not always enough.

• Why?
  • Humans may not be capable of correlating all the conditions they observe and making connections as to possible outcomes
  • Human inspection is variable - based on skill, experience, and physical/mental condition.
  • The interval between geometry/vehicle measurements may be too long to catch rapidly developing conditions (PSR).
  • Track inspections may not be taking into account variability of vehicle conditions, wheel profiles, operating speeds and drawbar forces.

• Current management methods, training, rules, rules testing, and job briefings are not providing continuous reductions of human factor derailments
Strategic changes needed for rail industry

- Move away from maintenance based on pass/fail regulations. Change from reactive to proactive.
- Performance based derailment risk assessment based on actual geometry measurements, taking into account the types of vehicles that may operate over that track (including defects), magnitude of drawbar forces, and the speeds they may operate.
- Autonomous and automated track geometry and rail profile measurements performed frequently at time intervals commensurate with traffic conditions on line.
- An automated method to measure rail neutral temperature
- Updated track regulations based on actual performance vs. measured conditions. This should include combination conditions in the track instead of just discrete measurements.
- Regulatory incentives to move in this direction by relaxation of mandated labor intensive and safety sensitive weekly/monthly/mileage inspections.
- Develop $$ incentives for deployment of more premium trucks
- Further deployment of continuous ultrasonic rail testing
- Automated inspection of turnout geometry, wear, and condition
- Increased emphasis and understanding of why human failure occurs
Can we do this?

• YES!!
• Most of the technology exists today to make this happen.
• What is needed:
  • A cultural shift at the railroad and regulatory level.
  • A realization that new and different data may be needed in our measurements
  • Better data mining to connect the dots in the mounds of data we are collecting
  • Collaboration within the vehicle, track and operating departments; *It is a system!*
• We need to change finders into fixers.
• Need a business model to show cost effectiveness
  • Economic modeling taking into account the cost of failure and loss of precision/reliability on the network
How to start?

▪ Start small, one division or territory
▪ Get buy in from stakeholders
  ✓ Labor
  ✓ Regulatory
  ✓ All affected departments
▪ Determine criteria for evaluation; Define Success.
▪ Make Business case $$$$
12 Tactical Strategies
to bring derailments under 1.0/MTM
12 Tactical Strategies

1. Develop a corporate Focus
2. Develop a network of integrated and automated inspection/detection systems
3. Leverage Big Data
4. Insure Correct Curve Elevations
5. Manage Wheel/Rail Interface
6. Develop an effective rail lubrication program
12 Tactical Strategies con’t

7. Eliminate Rail Cant
8. Eliminate tight side bearings and excessive friction wedge rise from your cars/wagons
9. Manage CWR and Rail Neutral Temperature
10. Develop train make up rules and strategies
11. Perform Root Cause Analysis on Human failures; Change descriptions into causes.
12. Increased focus on drainage/water management
Part 2. of this presentation will include a complete and more thorough discussion of the 12 tactical strategies. TBC.

(If U. of I. invites me back for a second time)
And now the commercial….

435 page handbook, ~ 1000 photos/diagrams, full color on coated paper, with steel spiral binding for laying flat. Pocket sized (a Carhartt pocket) for use on site.

Covers freight, passenger, transit, locomotive equipment. Large chapter on human failure investigation. Complete discussion of track and vehicle inspection. Every type of derailment, symptoms and causes is thoroughly explained.

Also includes the 12-step Derailment Dozen™ investigation process.

Available at www.wolfrailway.com. $75.00 plus S&H.
Thank You for your attention.

gary@wolfrailway.com