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Gary Wolf

President

Wolf Railway Consulting

Current Status and Trends in Track Caused Derailments

Presented by:
Gary Wolf
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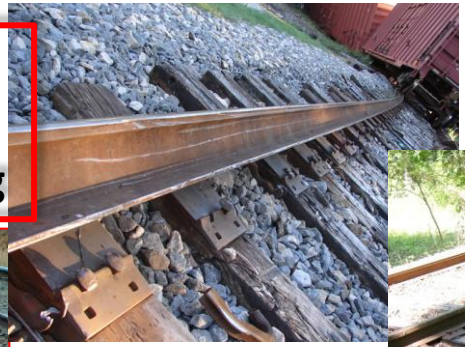
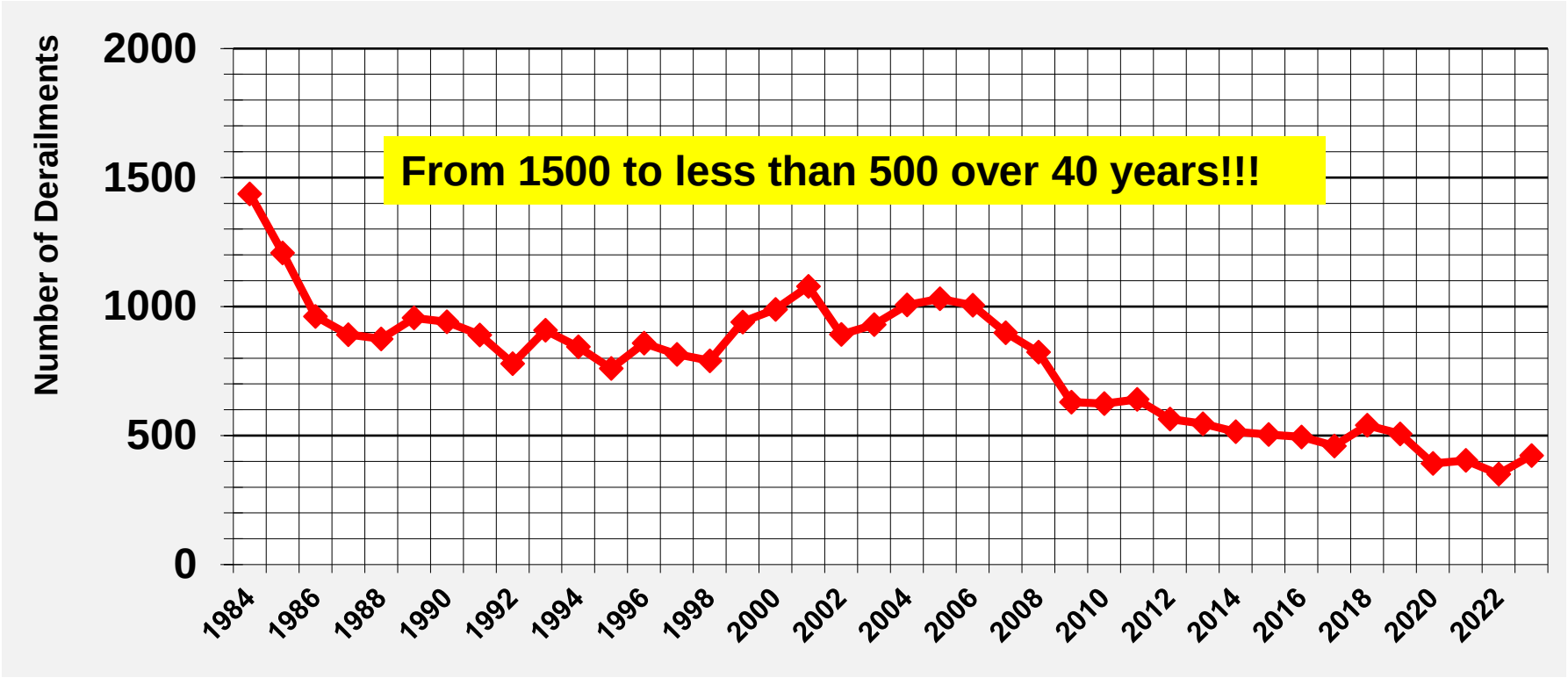
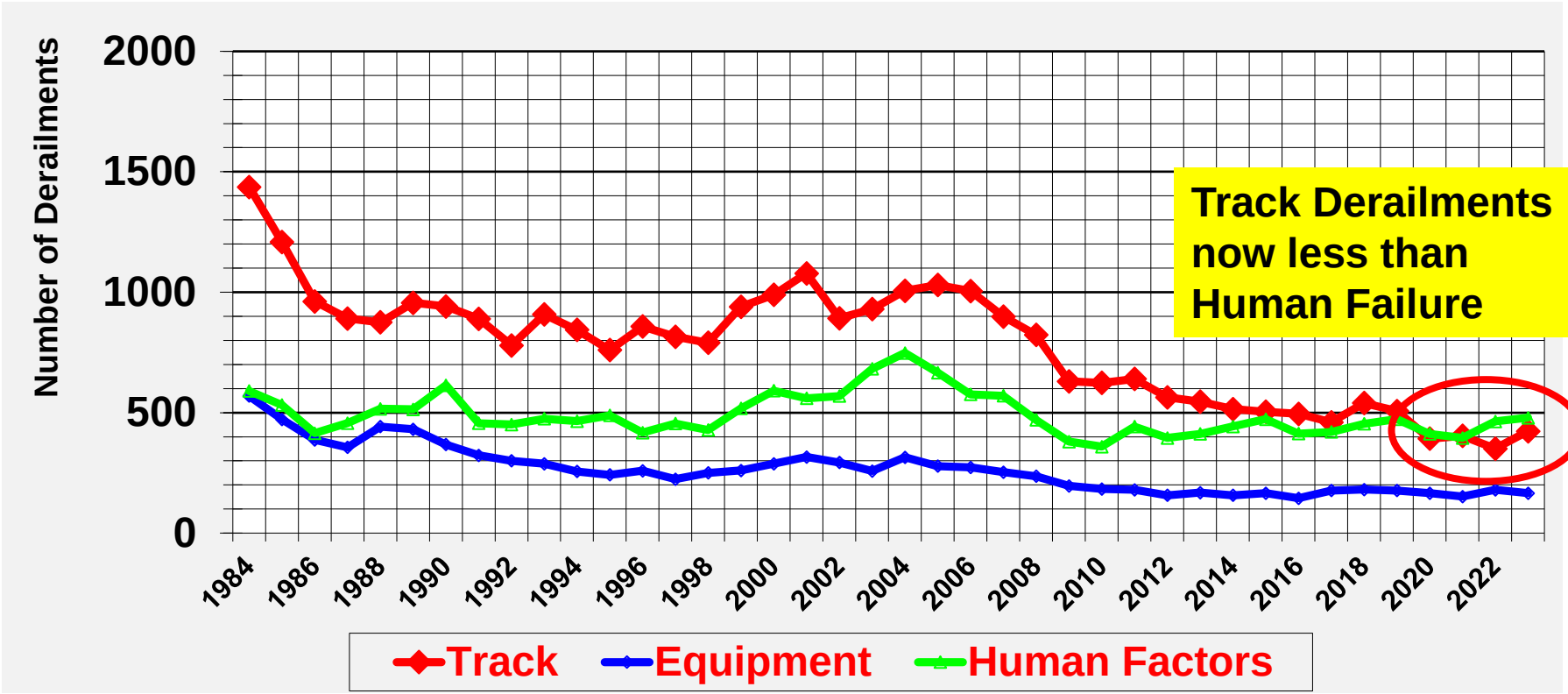


Let’s start with some good news!

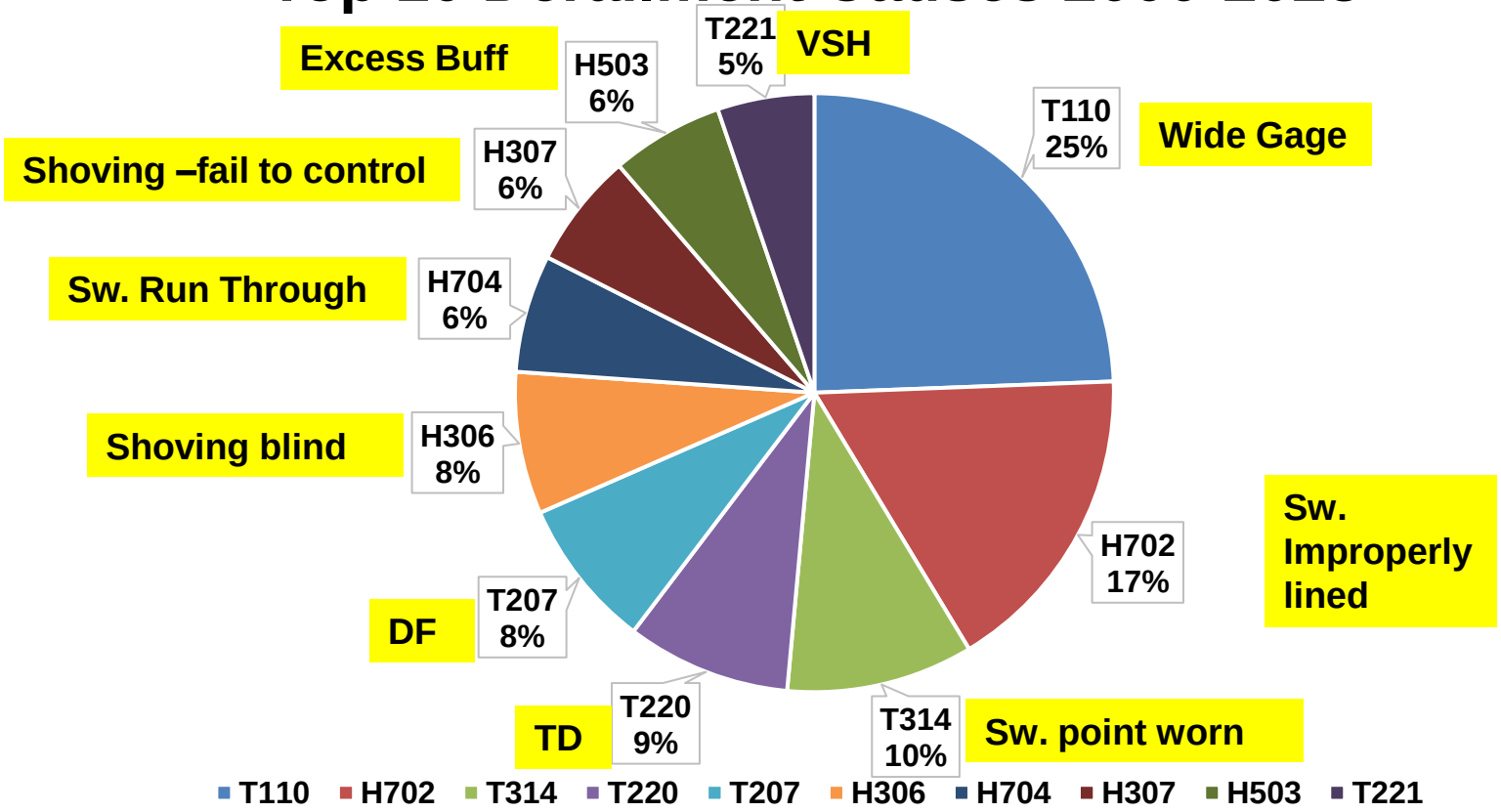
1984-2023 FRA Reportable Track Derailments



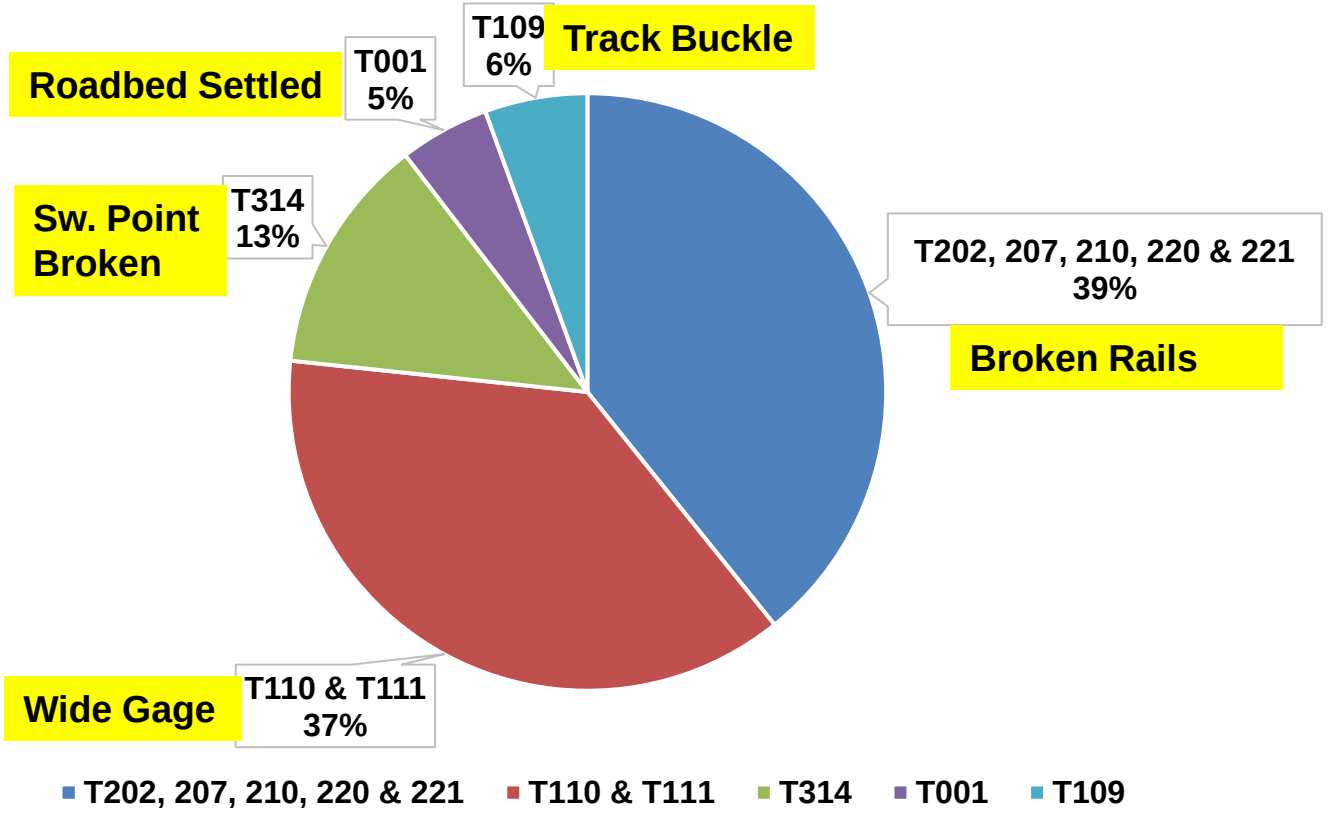
1984-2023 FRA Reportable Derailments by Cause



Top 10 Derailment Causes 2000-2023



Top 10 Track Derailment Causes 2000-2023



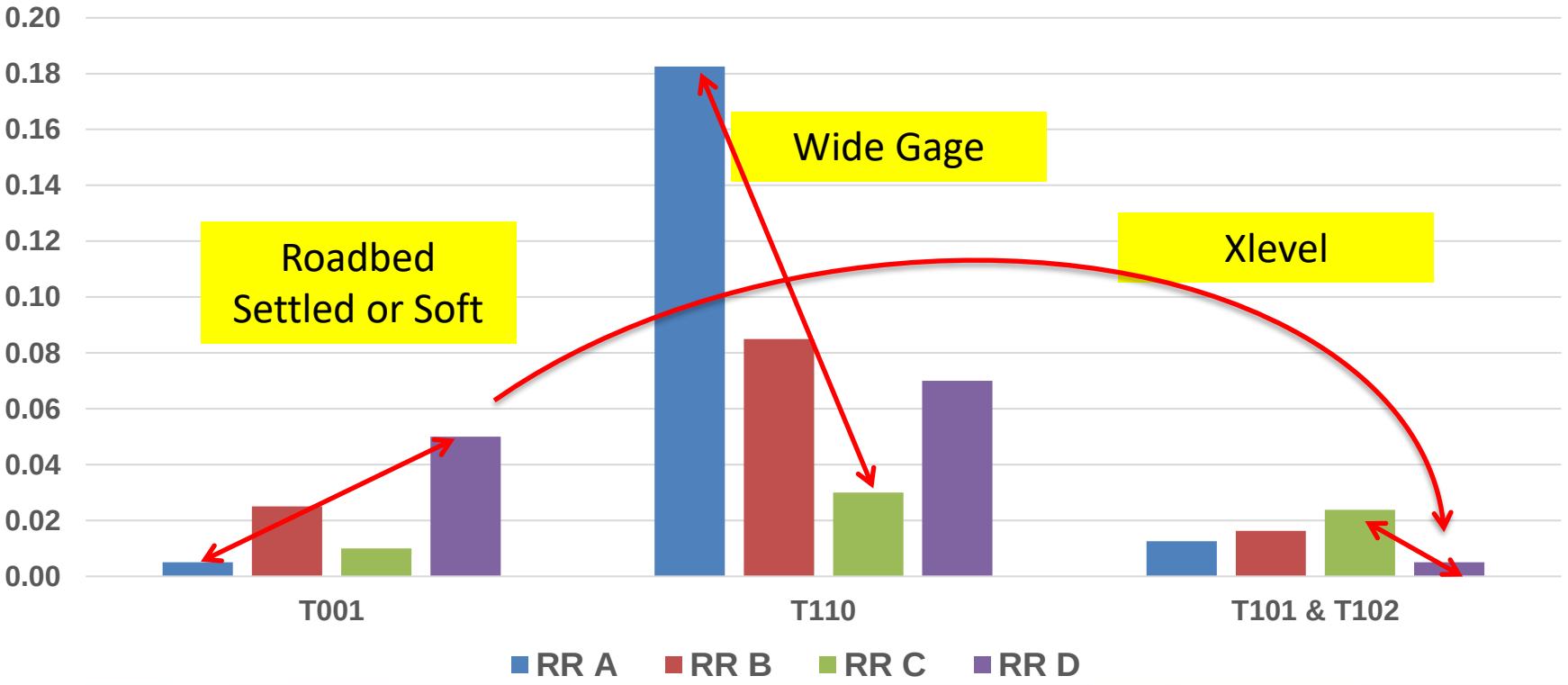
Major Track Causes
1/2000 through 12/2023
Comprising 16,247 Total Track Derailments

- Broken Rails (Top 5) – 3,970
- Wide Gage (T110 & T111) – 3,791
- Switch Point Worn/Broken (T314) – 1,305
- Sun Kink (T109) – 562
- Roadbed Settled or Soft (T001) – 494

10,122 Total ~ 62%

Top 5 Categories Comprise 62% of All Track Causes

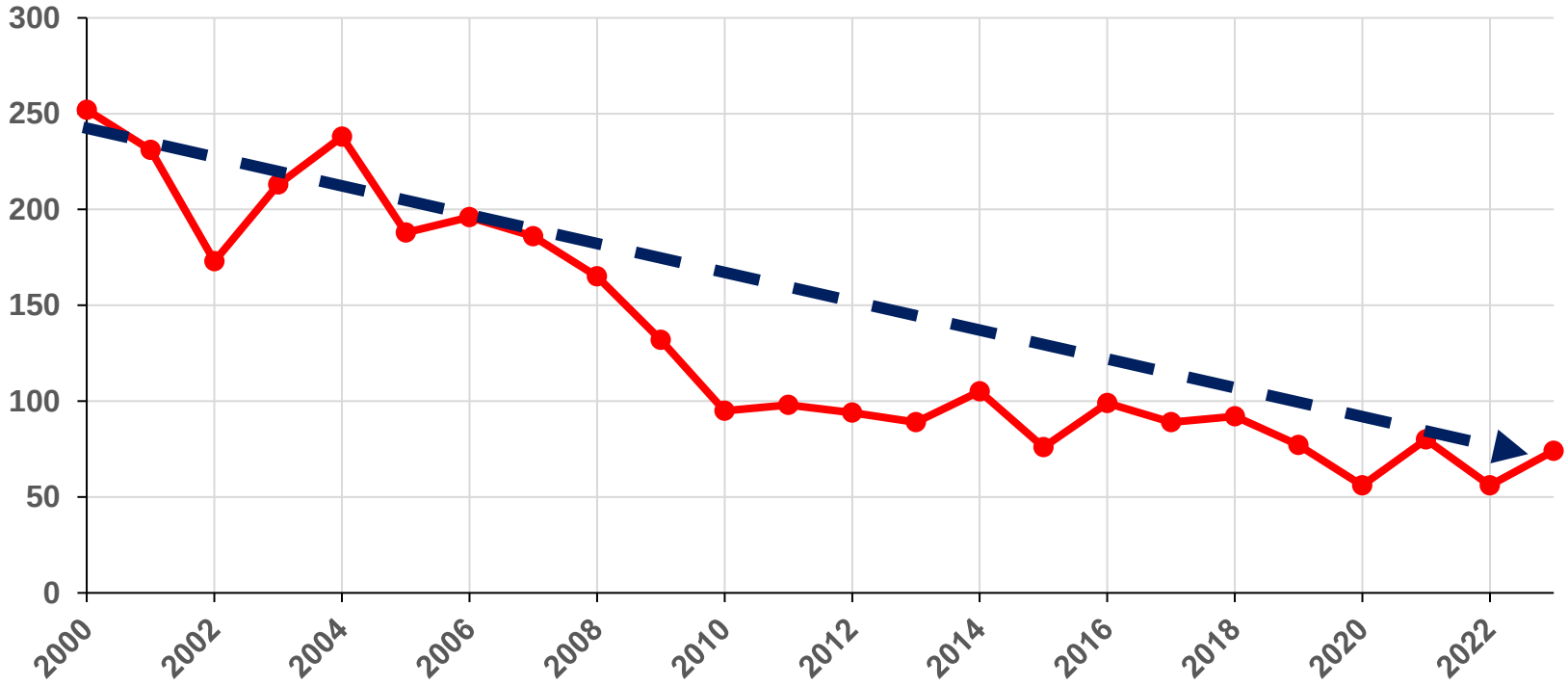
Derailment Cause Rates for Different Railroads 2020-2023



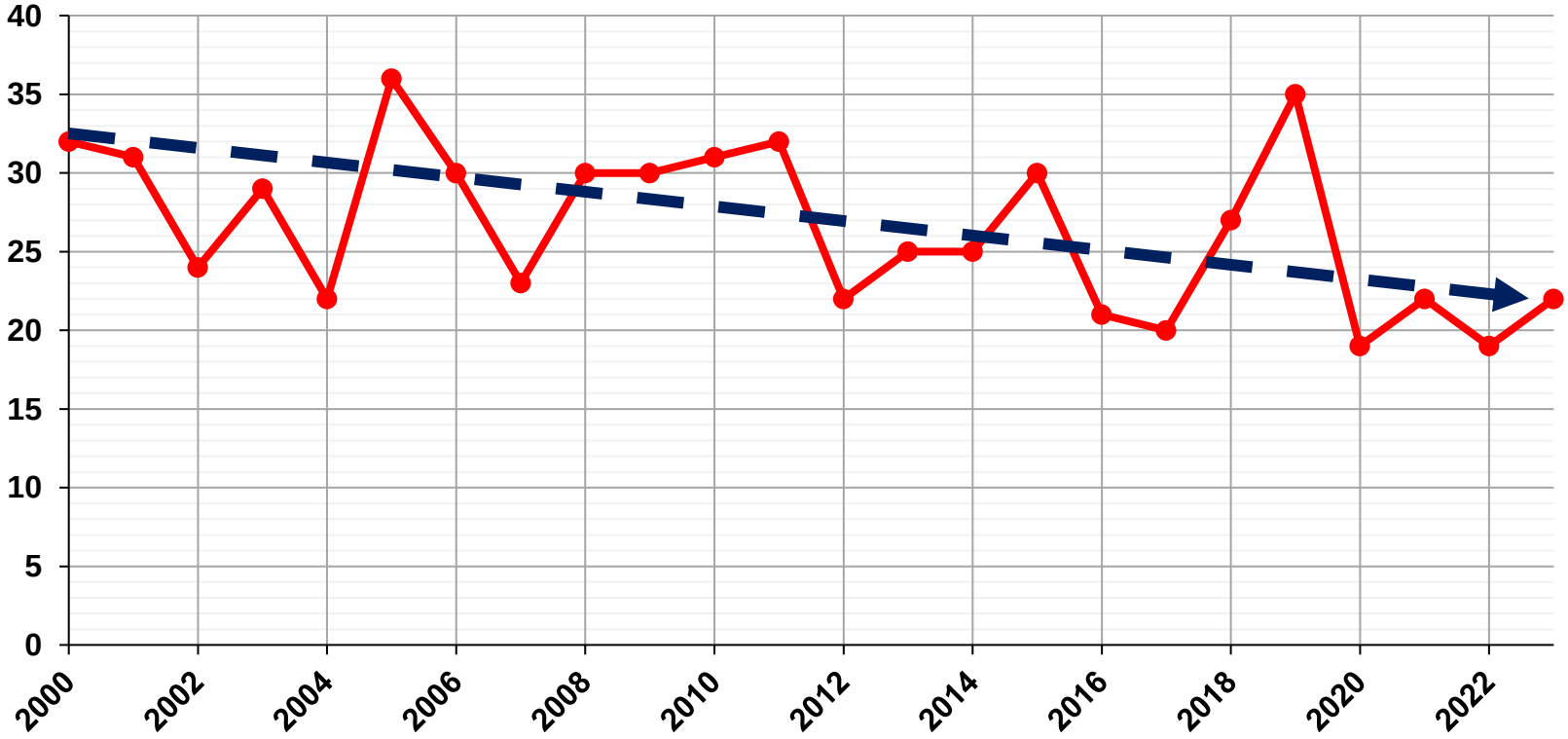
Accuracy of Derailment Reporting

- There appears to be great disparity over how different railroads assign cause codes
- FRA cause codes were developed ~50 years ago with minor changes over the years
- There could be confusion in understanding how to apply codes
- FRA needs to review/update/improve cause codes for greater clarity and specificity; maybe a compliance manual??
- Railroads need to develop uniform reporting practices

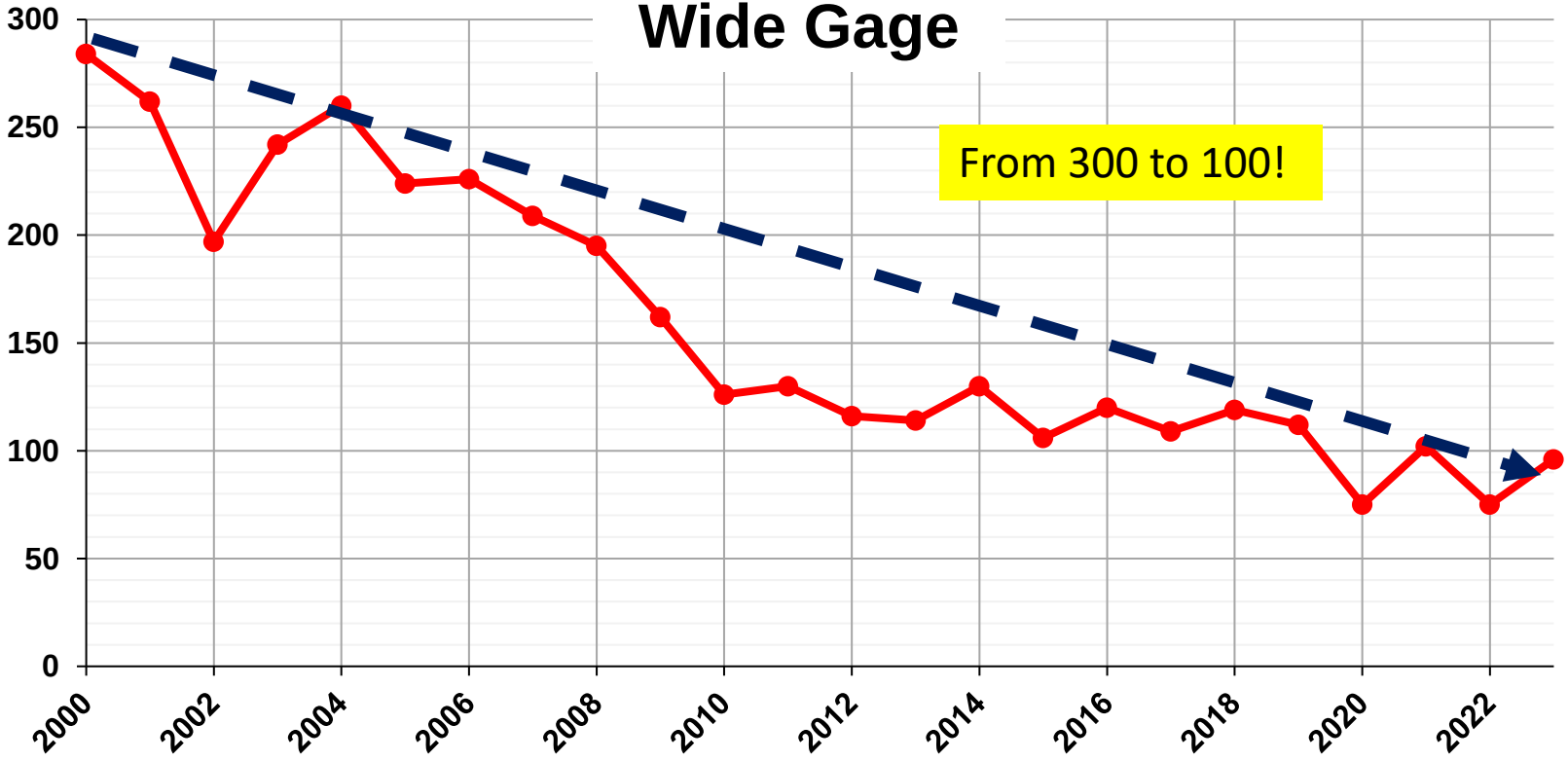
T110 - Wide gage (defective/missing crossties) Derailments 2000-2023



T111 - Wide gage (spikes/other rail fasteners) Derailments 2000-2023



T110 & T111 Derailments 2000-2023
Wide Gage



Elimination of Rail Cant

Concrete Ties

Larger Tie Plates

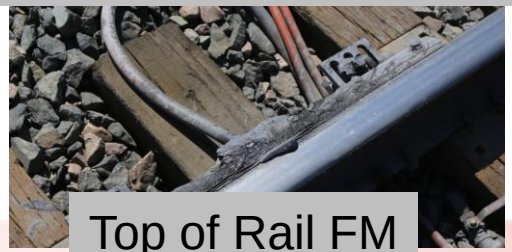
Elastic Fasteners

PTLF

Technologies and Maintenance Practices to Reduce Wide Gage

GRMS

Automated Tie Inspection



Top of Rail FM

Rail Profile Grinding

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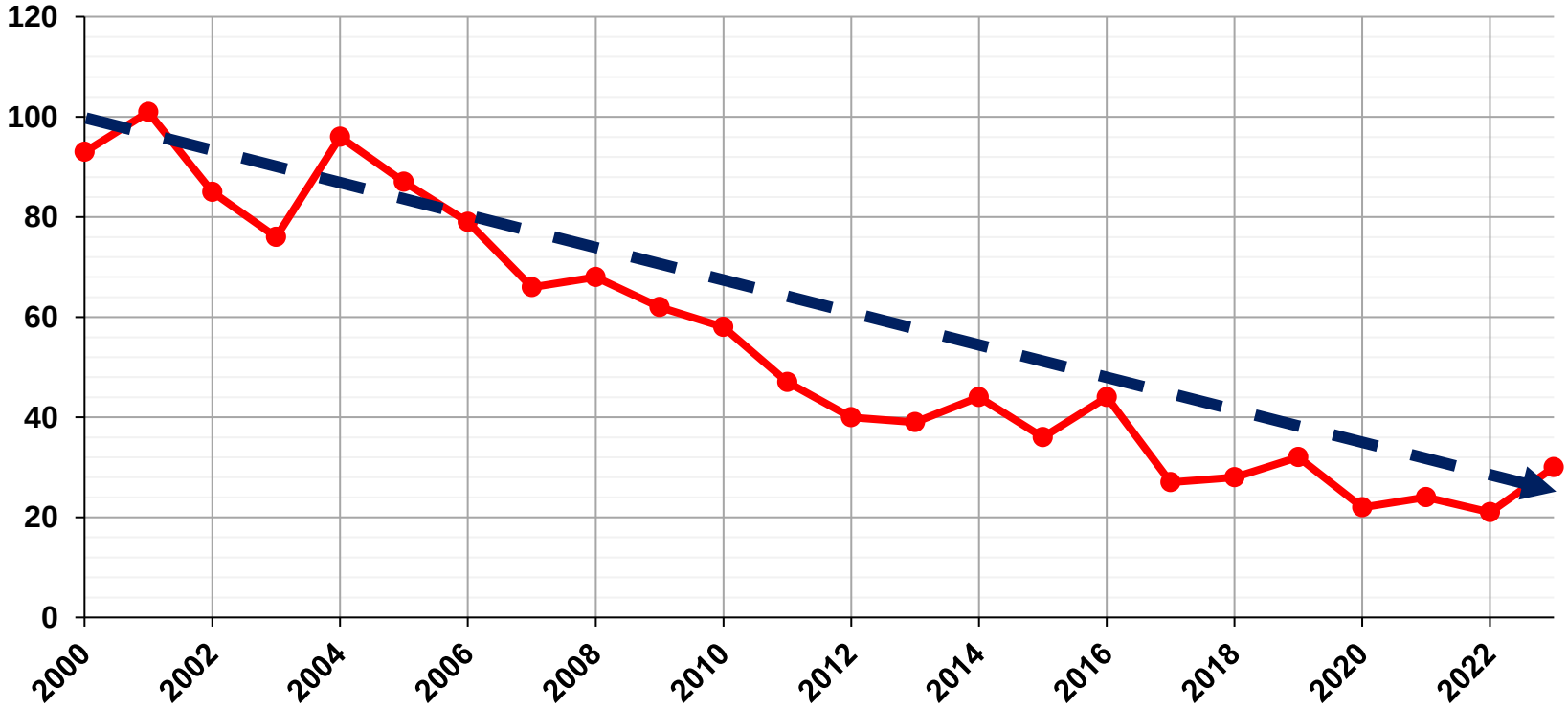
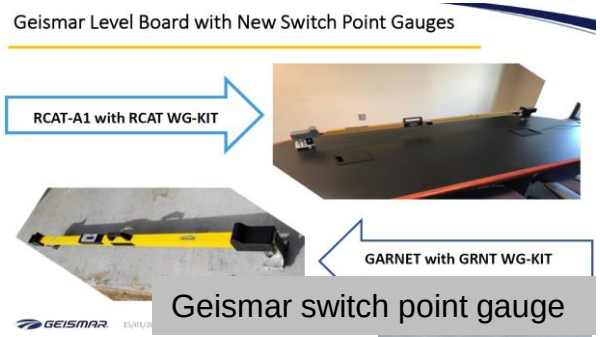
T314 - Switch point worn or broken
Derailments 2000-2023



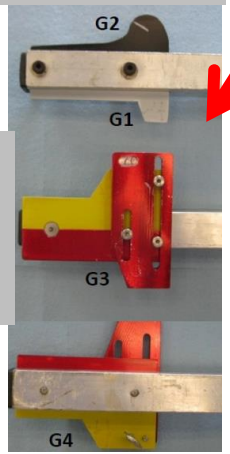


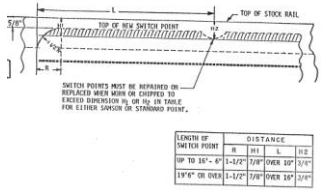
Geismar switch point gauge

NS/Kerchoff Switch Point Gauge

Automated Switch Inspection Vehicle

NS/Kerchoff Switch Point Gauge

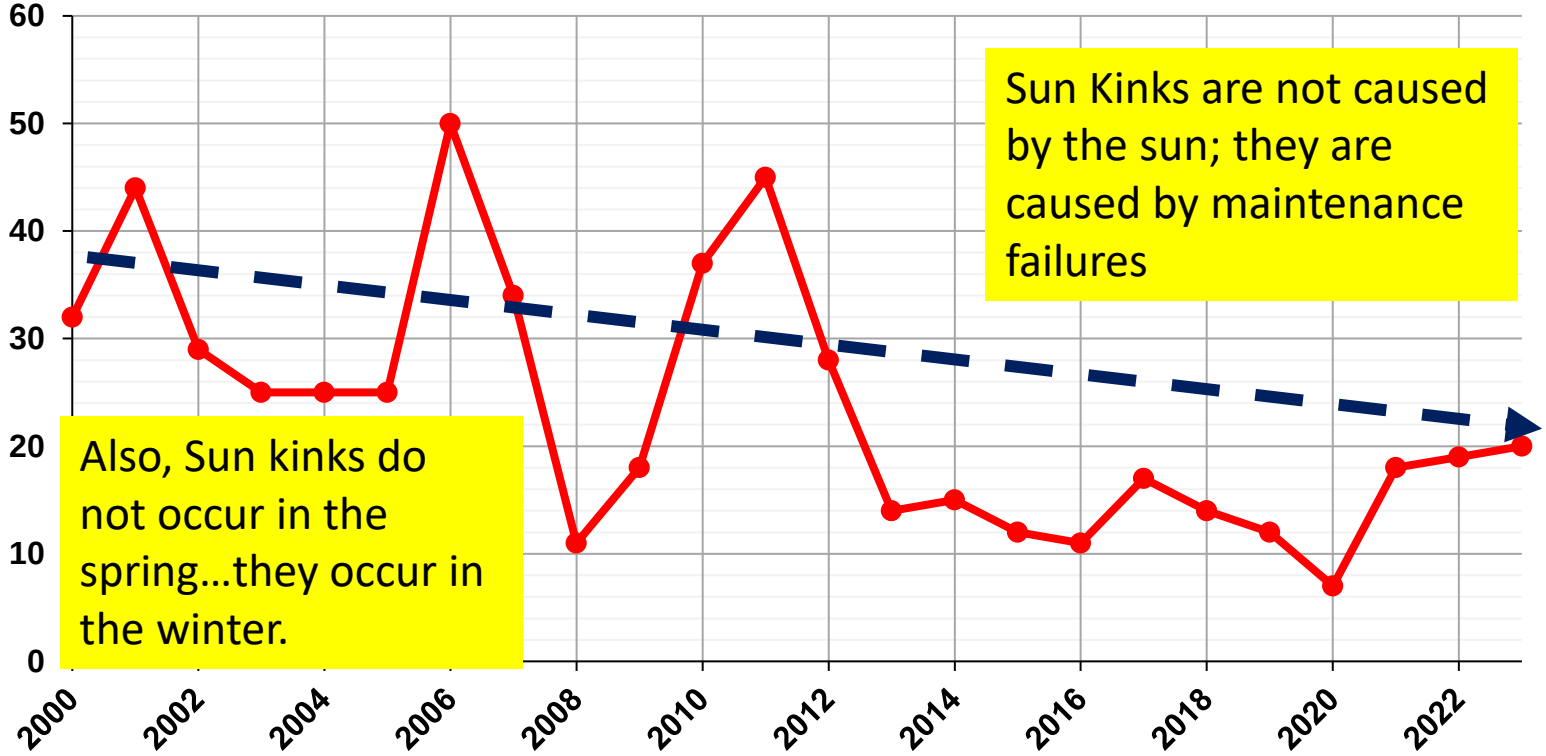


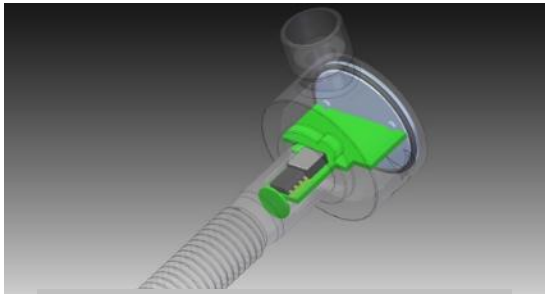


Alternate Voluntary Switch Point Wear Standard adopted by several RR's

? (h) Unusually chipped or worn switch points shall be repaired or replaced. Metal flow shall be removed to insure proper closure. ?

T109 - Track alignment irreg. (Buckled/Sunkink) Derailments 2000-2023





Vortok Multi Sensor for Rail Stress Measurement

Staking Curves

Technologies and Maintenance Practices to Reduce Sun Kinks

Rail Stress Monitoring

Procedures for the Installation, Adjustment, Maintenance and Inspection of CWR

Railroad CWR Plans

Subpart D

§ 213.118 Continuous welde… plan review and a…

(a) Each track owner with track c… have in effect and comply with a plan that contains written procedures which address: the installation, adjustment, maintenance, and inspection of CWR; inspection of CWR joints; and a training program for the application of those procedures.

213 Regulations

VERSE Testing

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U.S. Department of Transportation
Federal Railroad Administration

FRA

Guidance on Continuous Welded Rail (CWR) Plan Requirement

Background and Example Generic Plan

Updated: July 2021

FRA says laying 20° under DRNT is acceptable. Do you agree?

Rail laying procedures are established based upon geographic considerations and annual temperature variations to achieve and maintain a specific Desired Rail Neutral Temperature (DRNT) that reduces the risk of both track buckles and broken rails. Research has shown that the RNT can drop shortly after installation. To compensate for this, the Preferred Rail Laying Temperature (PRLT) may be set slightly higher than the DRNT, but it must still be within the Desired Rail Neutral Temperature Safe Range (DRNT +/- 20°F).

(e) Determine the amount of adjustment required to achieve the [DRNT or PRLT].

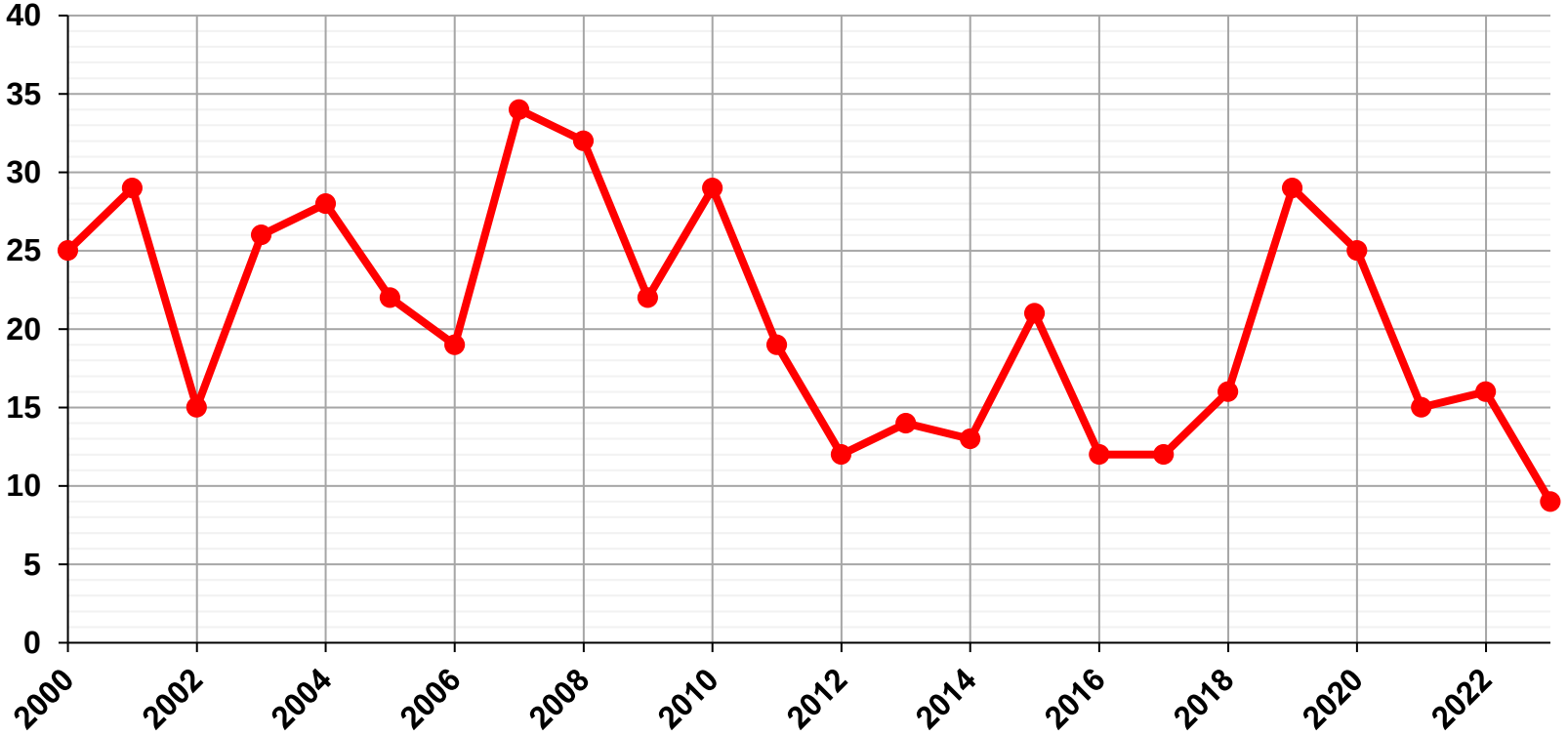
(1) If the RT is within the safe range (DRNT +/- 20°F), further adjustment may not be required. Measure the RT at the location where the anchors or clips are being applied to restrain the rail. If at any time the RT is no longer within the safe range (DRNT +/- 20°F), stop fastening the rail and use the following procedures to ensure the appropriate expansion is achieved.

Question:
Who in the room would want to start a football game down 20 points?

Recommendation

- Write a modification to the FRA generic plan that supersedes the FRA language:
  - *“When laying CWR and the rail temperature is below the PRLT/DRNT, use rail pullers or heaters to adjust the rail to the PRLT/DRNT or higher. If the rail temperature is within the low end of the safe range, rail will not be considered properly destressed”*

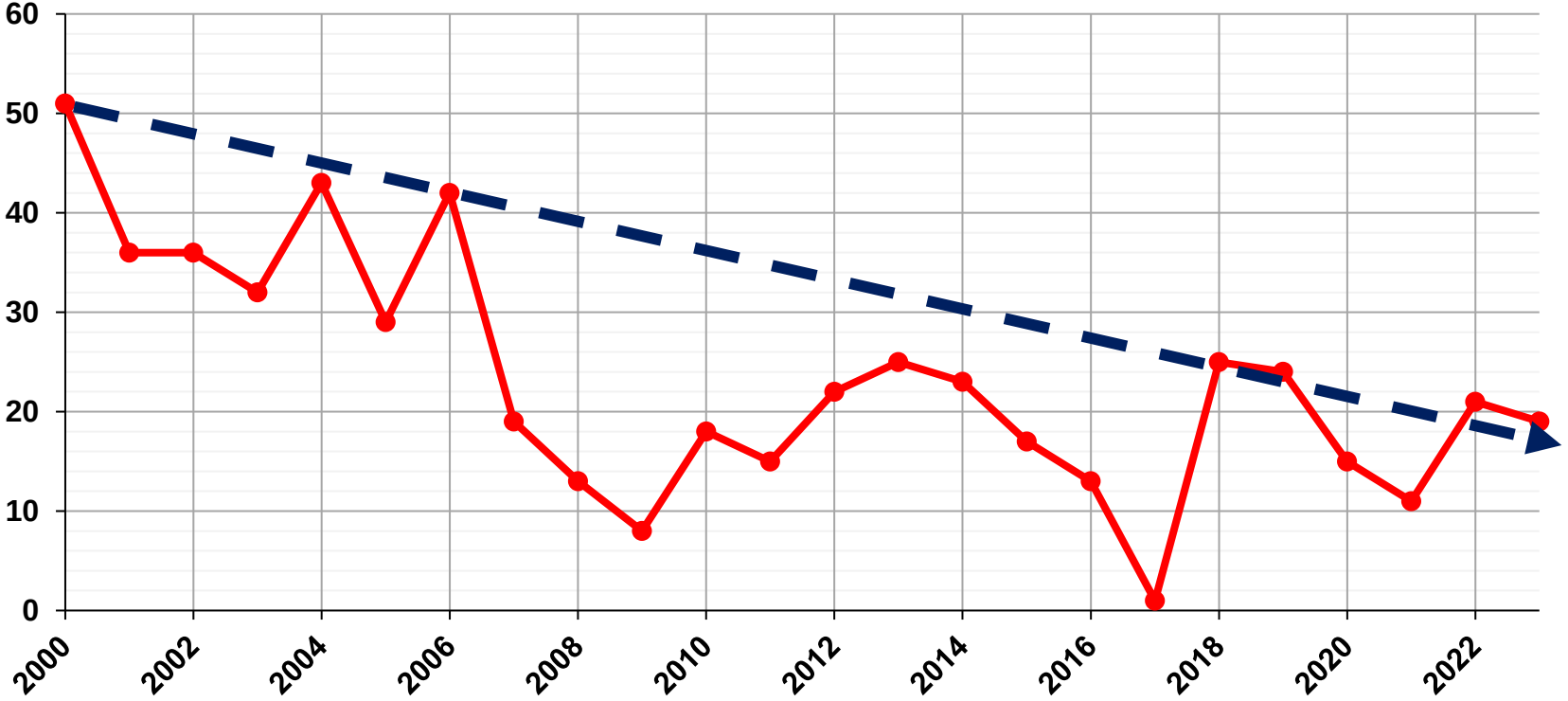
T001 - Roadbed settled or soft
Derailments 2000-2023



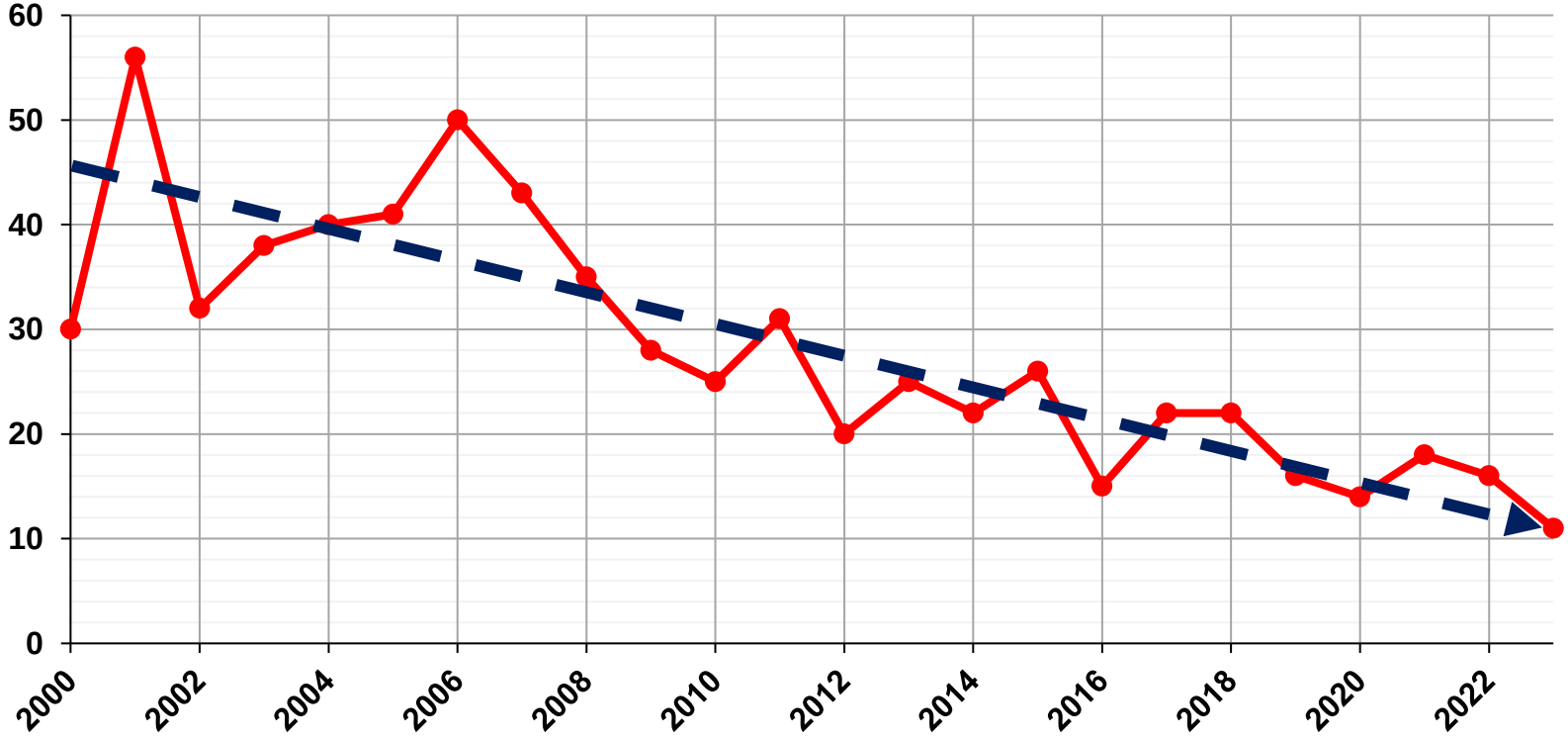
Roadbed Settled or Soft

- It is possible a number of railroads may use this cause code instead of citing a specific track geometry defect.
- Roadbed settlement must cause a geometry defect in order for a derailment to occur.
- FRA needs to eliminate/revise this code and require railroads to cite a specific geometry defect(s) or combination of defects.
- Soft roadbed without a specific geometry defect should not cause a derailment (maybe use this when you have a combination of several minor soft spots in a row).
- Other FRA cause codes need more specificity, e.g. T109, T222

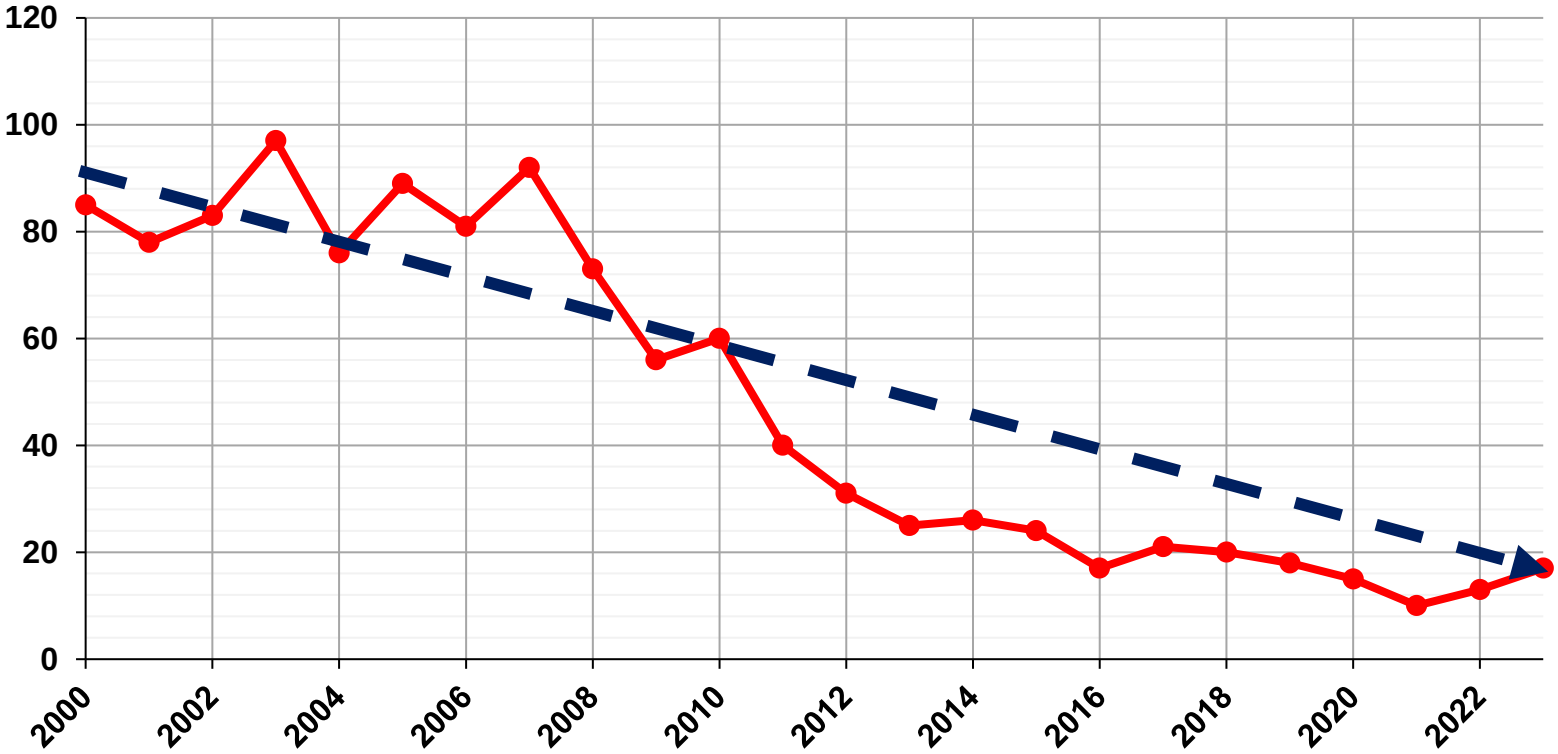
T202 - Broken base of rail
Derailments 2000-2023



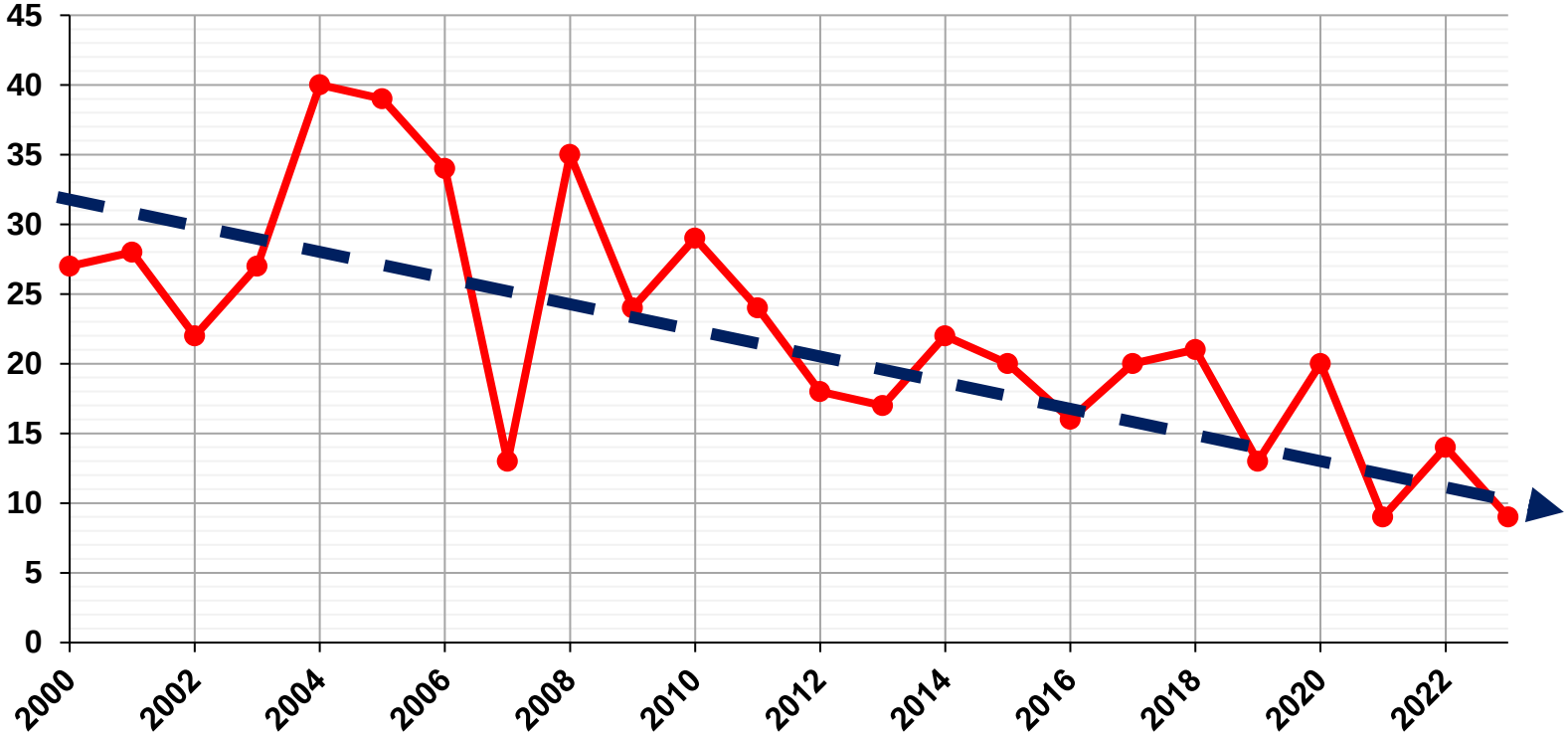
T221 - Vertical split head
Derailments 2000-2023



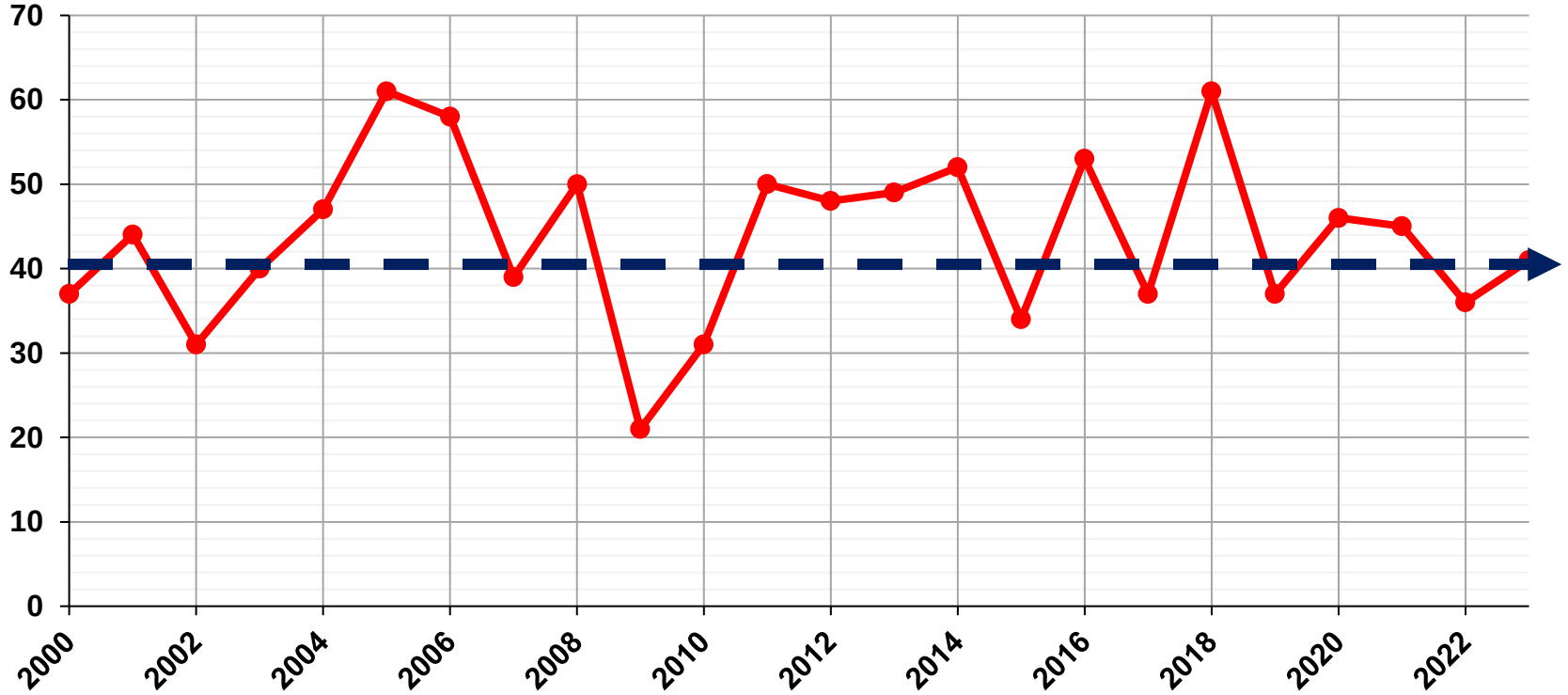
T220 - Transverse/compound fissure Derailments 2000-2023



T210 - Head and Web sep. (outside jt bar limit) Derailments 2000-2023



T207 - Detail Fracture - shelling/head check
Derailments 2000-2023

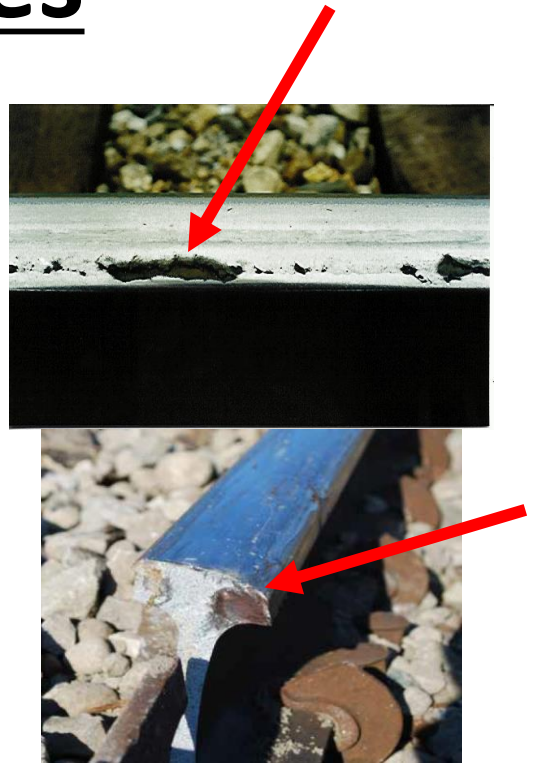


Detail Fractures

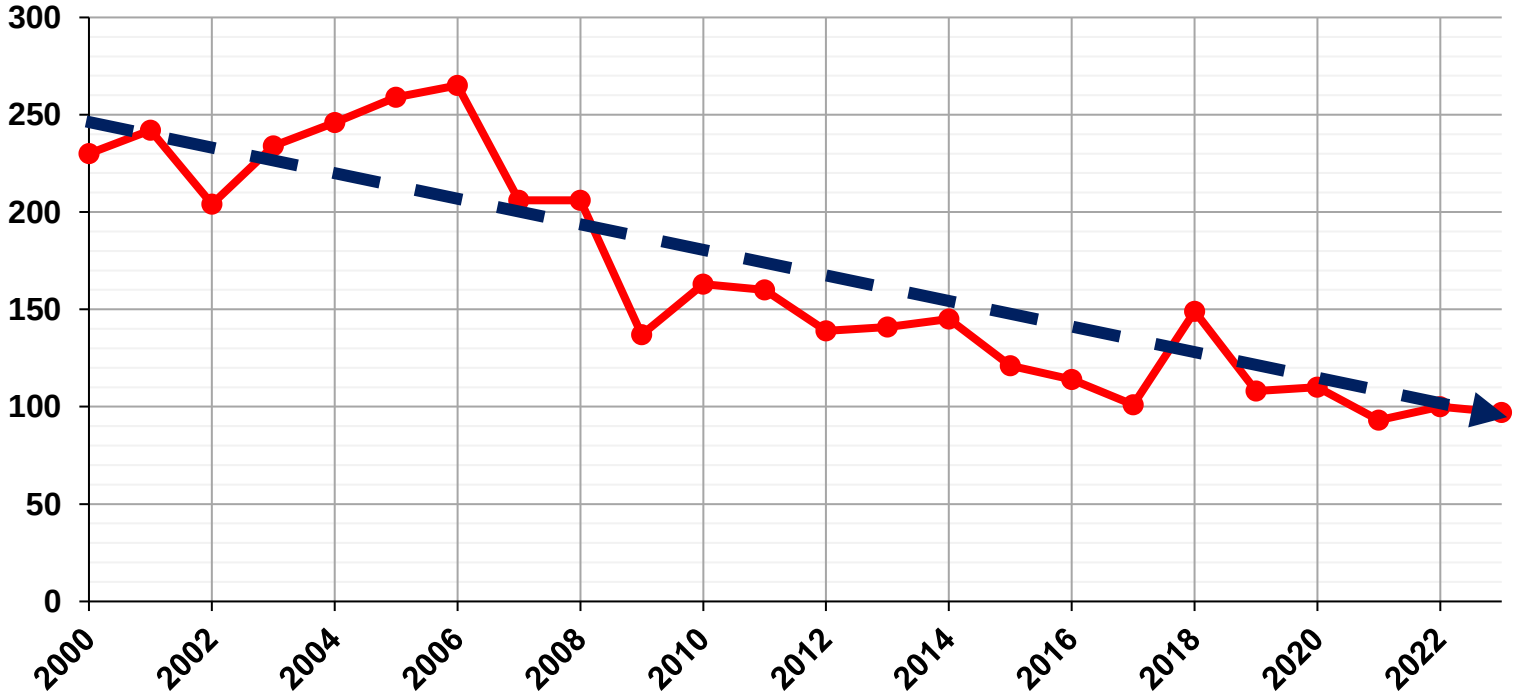
- Largely Self Induced due to:
  - Failure to control RCF
  - Failure to grind
  - Failure to properly grind
  - Failure to ensure crack propagation is stopped
  - Failure to properly elevate curves
  - Failure to properly lubricate

"Grind or Die!"

Norm Hooper (WRI 1990's)



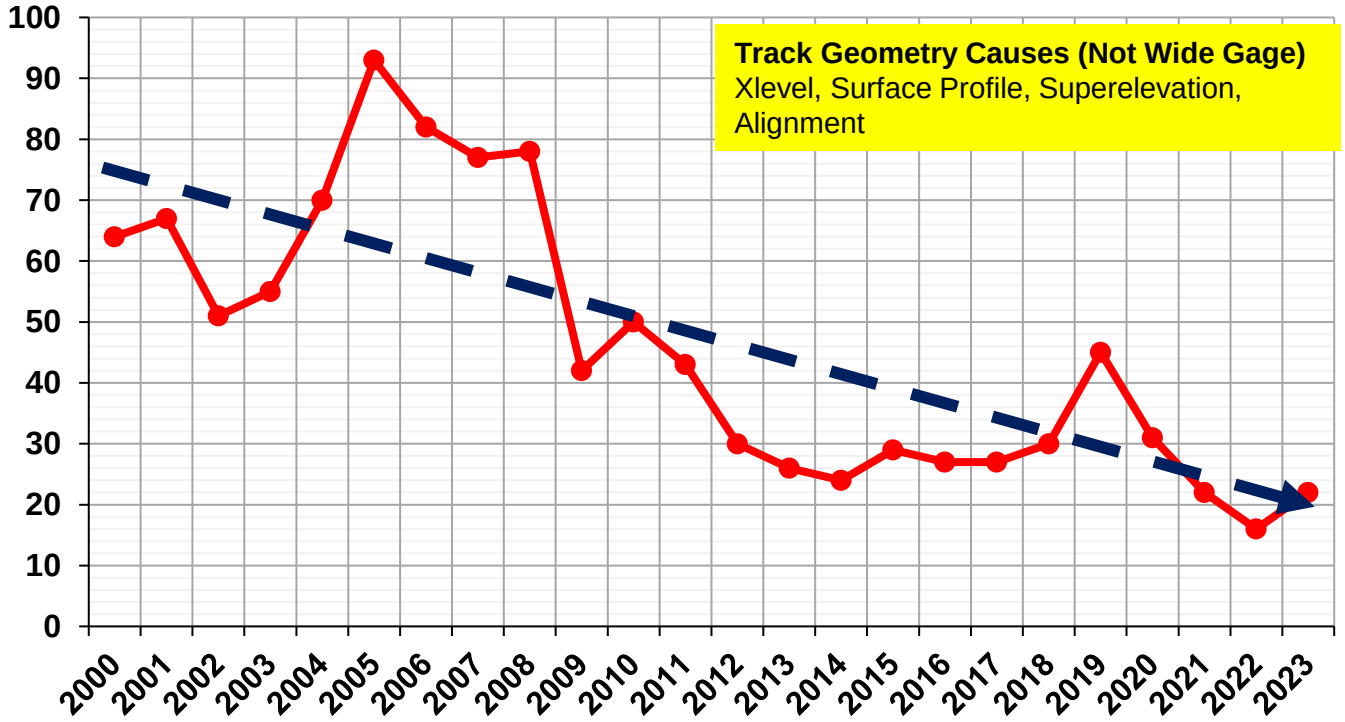
T202, T207, T210, T220 & T221
Derailments 2000-2023



Reduction in Broken Rails

- Better testing frequency algorithms/regulatory testing requirements
- Better software and data analysis/visualization; use of AI
- Better transducer technology
- Continuous testing vs. stop and verify
- Better training and certification of operators
- Better Rail grinding to remove RCF (?)
- Better use of WILD detectors to reduce rail impacts
- Better compliance with rail wear limits
- Better welding practices (Plant and Field)
- Better/Cleaner Rail steels

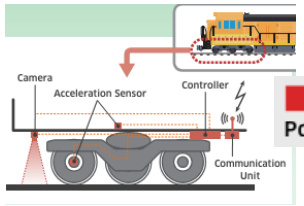
T101, T102, T103, T106 & T107
Derailments 2000-2023



Andian Hy-Rail Geometry System

RailPod Modular Geometry System

Innovative/Autonomous Technologies to Find and Reduce Geometry Defects



Kawasaki
Powering your potential

Vehicle/Track Interaction (VTI) Monitoring (ENSCO)

ENSCO Autonomous Track Geometry Measurement System (ATGMS)

mermec

Holland Argus & UGMS Geometry System

TETRA TECH

HEAVY HAUL SEMI

WOLF
Railway Consulting

WRI2024

Track Geometry Defects

- **Many derailments are closely correlated with track geometry defects**
  - Broken rails/ Broken joint bars
    - Due to increase in internal rail stress due to increase in dynamic wheel loadings
  - Track Buckles
    - Due to increase in lateral and vertical rail stress on heat stressed rail
    - Due to breaking of ballast skin friction with ties
  - Wide Gage
    - As gage widens, greater wheelset angles of attack possible; steering degrades
    - Over-elevation in curves placing greater stress on low rails
  - Switch Derailments
    - Due to X-level twist approaching and leaving point rails
    - Alignment defects approaching points and on closure rails

Recommendation - Geometry

- Continue to deploy autonomous track inspection technologies (ATIP)
  - FRA needs to re-institute waiver process to incentivize ATIP investment
- Continue to utilize conventional track geometry cars
- Continue to utilize hi-rail mounted geometry systems
- Continue to utilize onboard systems (VTI)
- Develop and utilize AI algorithms to categorize and prioritize defects; lots of data

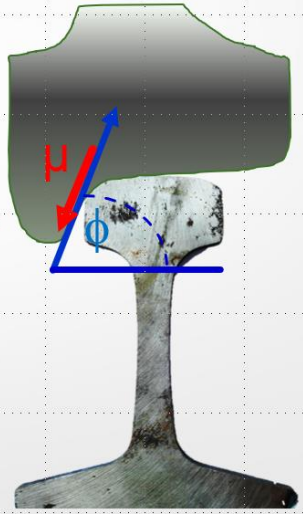
Rail Geometry/Shape can Affect Wheel Climb and Rail Rollover L/V thresholds

Nadal's Formula

Angle between wheel and rail

Friction between wheel and rail

$$\frac{L}{V} = \frac{\tan(\phi) - \mu}{1 + \mu \tan(\phi)}$$



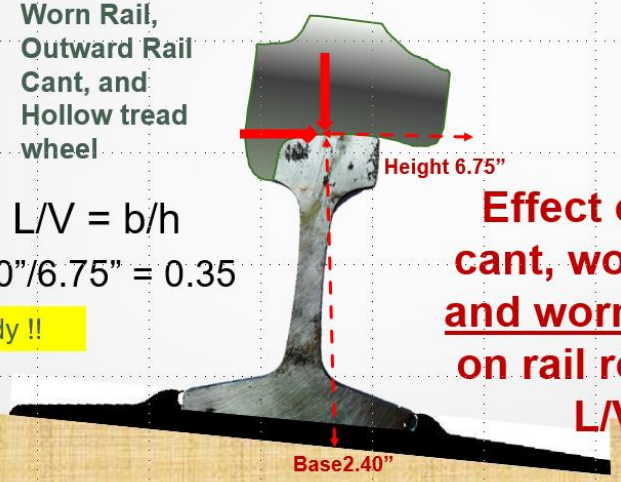
High Rail Side of Curve

Effect of Worn Rail, Outward Rail Cant, and Hollow tread wheel

L/V = b/h

2.40"/6.75" = 0.35

Triple Jeopardy !!



Effect of rail cant, worn rail, and worn wheel on rail rollover L/V

Opinions/Conclusions

- Broken/sheared spikes continue to be a problem
  - Wood ties w/elastic fasteners, sharper curves, high tonnage routes, high tractive effort
  - Walking inspections; GRMS technology (Holland TrackStar)
- Ensure curve elevations consistent with train speeds
  - PSR and long trains may change train speeds; some RR's moving away from long trains (Make up your mind!)
  - Watch for low rail spalling, gage widening, canted rail
- Optimize rail lubrication policies
  - Proper gage face and top-of-rail lubrication can dramatically reduce lateral curving forces (30-40%)
  - Provides a reduction in rail wear, RCF development, plate cutting/rail cant, tie life, derailments
  - Work with operations to reduce use of sand when using friction modifiers; accelerates rail wear

Opinions/Conclusions

- Many “Wide Gage” derailments are not caused by the track structure
  - Mechanical and Operations causes being missed
  - Inspect rail cars for truck warp; stiff truck; wheel defects causing excessive gage widening forces
  - Review train handling event recorders for excessive in-train forces; bypass couplers during switching
- Switch Derailments
  - Develop internal standards for switch point wear; forget the FRA and what is “unusual”
  - Utilize switch point gages to eliminate subjectivity (Hint: FRA, can you help here?)
  - Ensure proper crosslevel and alignment geometry
  - Always check for human failure; inspect cars for worn wheels and non-steering (It is a TURNout)
- Track Buckles/Sun Kinks
  - Education/training and full court press every spring to raise awareness of critical locations
  - VERSE testing for accurate RNT
  - Continue to explore technologies to monitor rail stress
  - Ballast maintenance/cleaning to ensure adequate ballast quality and quantity
  - Supersede/Tighten FRA guidance on PRLT

Just about every track caused derailment is linked to human failure…

- Failure to inspect
- Failure to find or observe
- Failure to understand what you are seeing
- Failure to comply
- Failure to repair or fix, or fix properly
- Failure to protect w/slow order
- Failure to provide adequate capital/expense budgets

Most track defects develop over weeks and months, not minutes and hours!

Final thought….

Subpart A—General

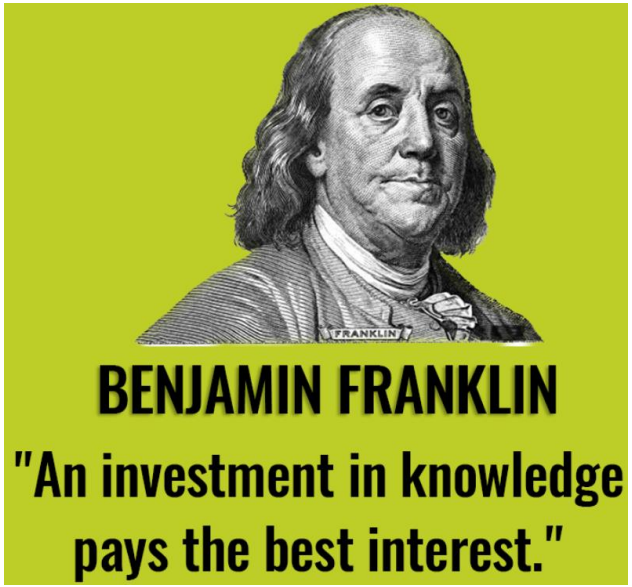
§ 213.1 Scope of part.

(a) This part prescribes minimum safety requirements for railroad track that is part of the general railroad system of transportation. In general, the requirements prescribed in this part apply to

Question:

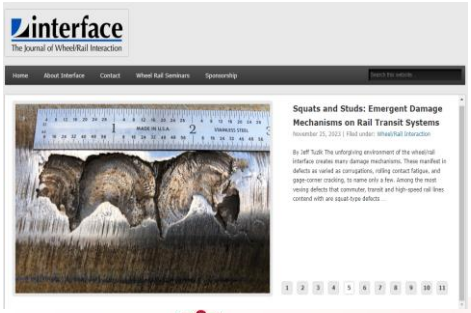
1. Do you want your football team to meet the minimum requirements?
2. Do you want your spouse to meet the minimum requirements?
3. Do you want your paycheck to meet the minimum requirements?

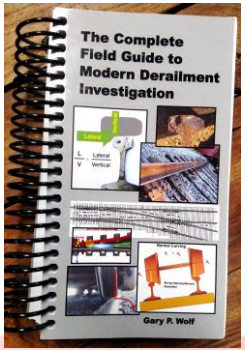
Then why do you want to maintain your track to the minimum requirements???

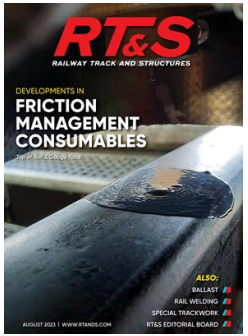


To prevent derailments, get educated:

- ✓ WRI 2025 KC and Seattle
- ✓ AREMA
- ✓ MxV and ENSCO Research Review Seminars
- ✓ TRB
- ✓ ICRI
- ✓ FRA Track Safety Symposium (?)
- ✓ Railway Track & Structures Magazine (RT&S)
- ✓ Interface Journal
- ✓ WRC Derailment Investigation & Prevention Training
- ✓ WRC Textbook





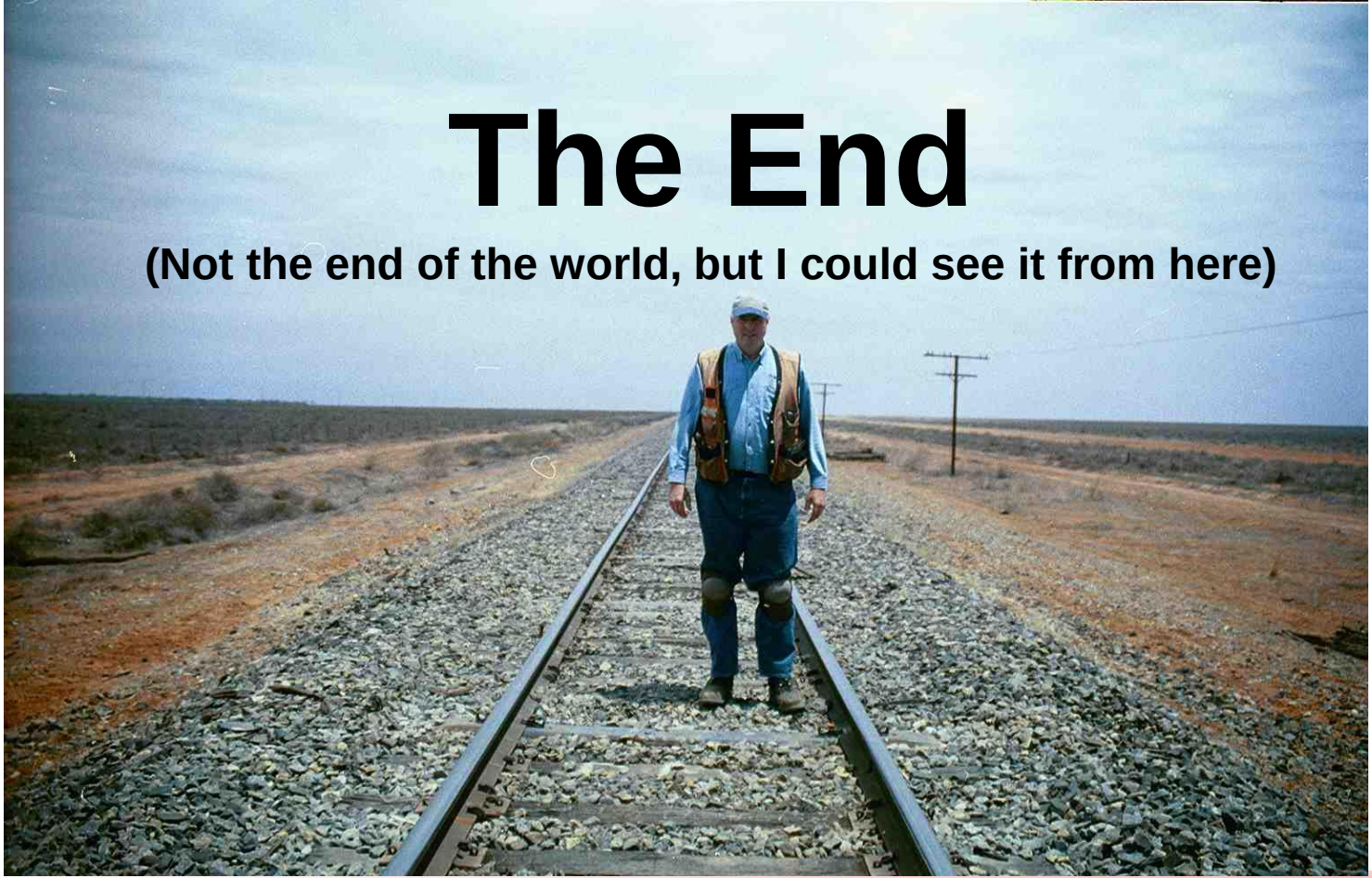


Where do we go from here?

- Great progress over past 40 years, but more work to be done.
- Still not achieving all the benefits that rail lubrication offers. Need to get corporate buy-in. Eliminate silos.
- DF data would indicate more work needs to be done to properly grind rail, control RCF, improve contact stresses
- Maintain constant battle against track buckle, with education, proper control of RNT, ballast maintenance, and understandable CWR maintenance policies
- Many derailments are being blamed on track that have other root causes. Need more comprehensive cause finding efforts.
- Need more quantitative gauges, detector cars, and standards for switch point/frog wear

Where do we go from here?

- Constant vigilance on curve elevations due to changing operations
- Better utilization of ATIP systems using AI algorithms to prioritize maintenance activities. Too much data for humans to sort through.
- Continue improvements in rail flaw testing with greater emphasis on frequency and productivity
- Better utilization of wayside detectors to find and repair bad actor cars doing most of the damage to the track structure
- FRA:
  - Incentivize investment in ATIP and other track inspection technologies
  - Revise derailment cause codes for more specificity
  - Ensure uniform application of derailment codes; e.g., a compliance manual
  - Ensure railroad derailment causes are consistent with data, and all departments involved
  - Develop better standards/gauges for switch point wear


The End
(Not the end of the world, but I could see it from here)