Portable Ride Quality Meters for Detecting Vehicle and Track Safety and Maintenance Issues

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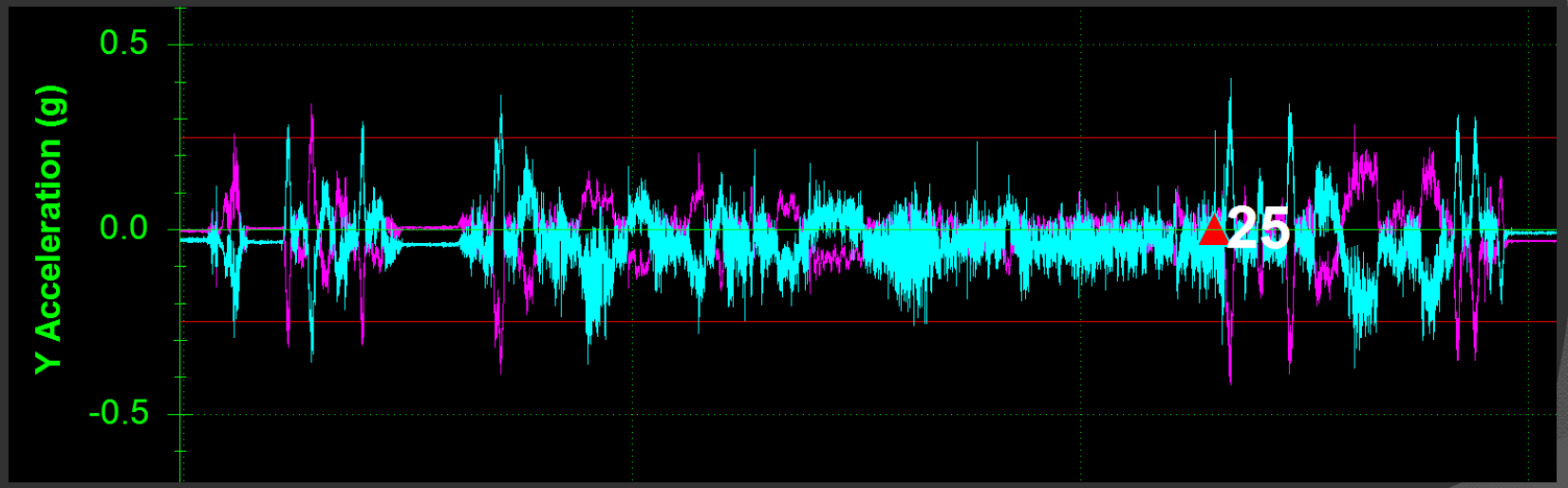
r-Wetrix®

Agenda

- Ride Quality
- Ride Quality Meters (RQMs)
- Detect Track Issues with RQMs
- Detect Vehicle Issues with RQMs
- rMetrix: Portable RQM
- Leveraging Portable RQM Technology
- Future of Portable RQMs

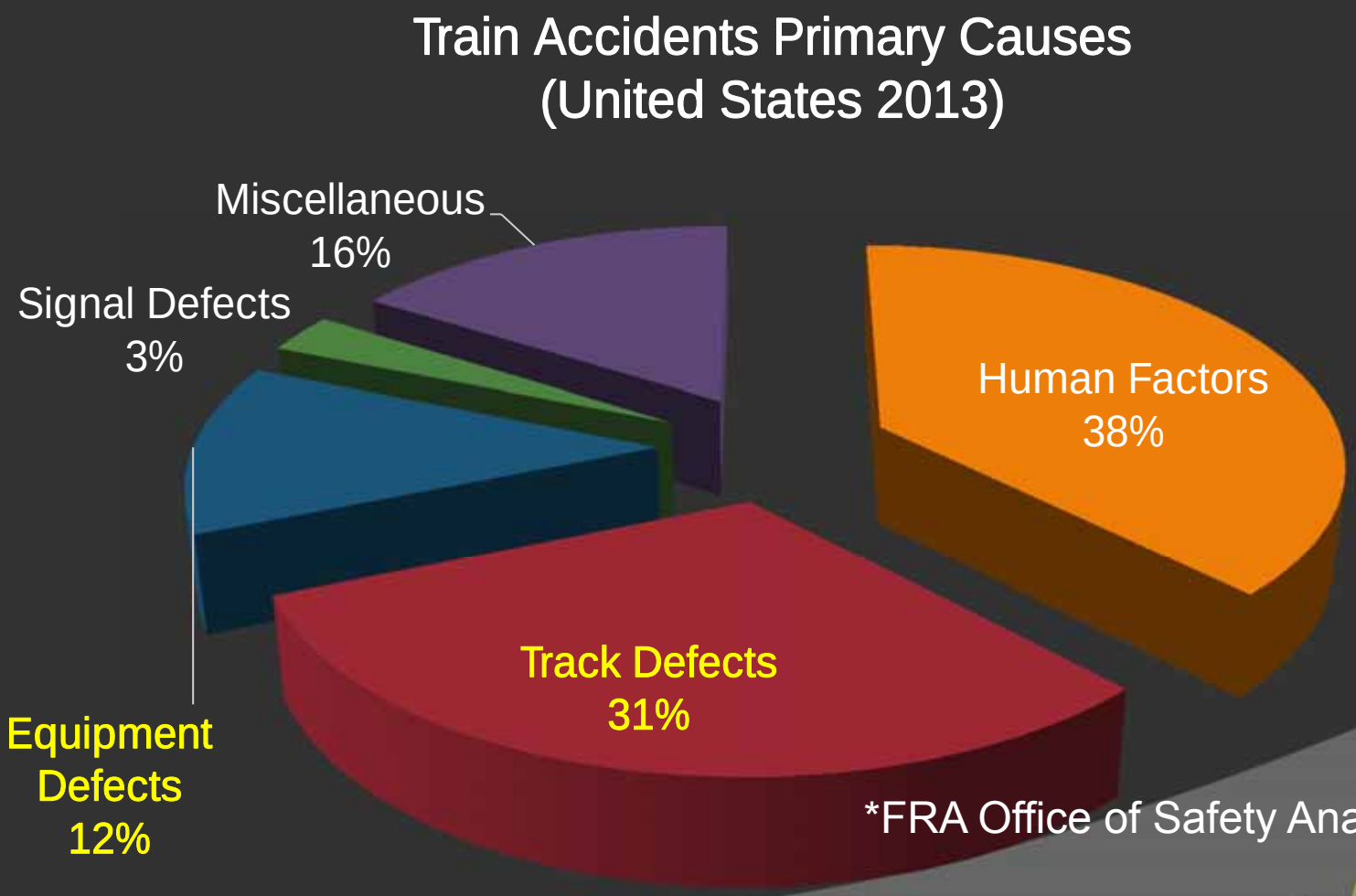
Ride Quality and Ride Comfort

- Ride Quality: How a Vehicle's Vibration Correlates to the Vehicle/Track Interaction Forces to Detect Issues on the Track or of the Vehicle



- Ride Comfort: How a Vehicle's Vibration Affects the Ride for its Passengers or Crew

Ride Quality Importance



*FRA Office of Safety Analysis Website

Ride Quality Standards

- 49CFR213.333 (United States)
- UIC 518 (International Union of Railways)
- EN 14363 (Europe)
- Individual Rail Companies
  - Amtrak
  - Indian Railway
  - Queensland Rail
  - SNCF
  - Union Pacific
  - CSX

FRA 49CFR213.333 V/TI Safety Limits

	Threshold	Passenger Cars	Power Cars
	Carbody Vertical Transient	1.0g Peak-Peak	1.25g Peak-Peak
	Carbody Vertical Sustained Oscillatory	0.25g RMS LTR	0.25g RMS LTR
	Carbody Lateral Transient	0.65g Peak-Peak	0.75g Peak-Peak
	Carbody Lateral Sustained Oscillatory	0.10g RMS LTR	0.12g RMS LTR
	Truck Lateral Sustained Oscillatory	0.30g RMS LTR	0.30g RMS LTR

LP 10 Hz, 100 Hz Sample Rate (Minimum)

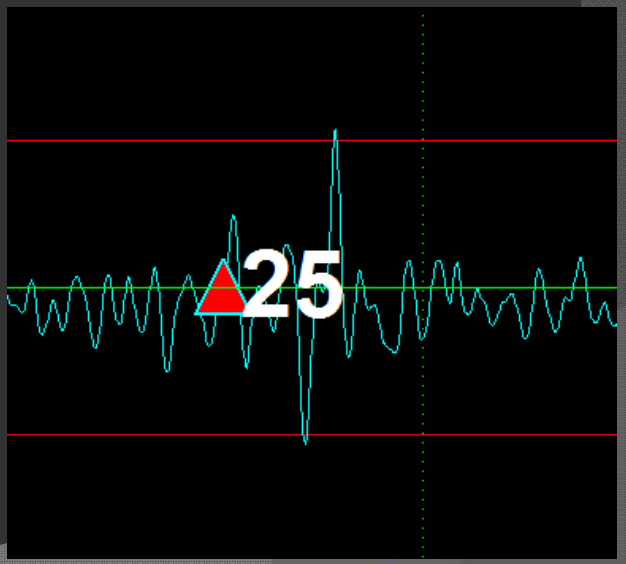
Maintenance Limits (Option)

	Threshold	Passenger Cars	Power Cars
	Carbody Vertical Transient	0.40g Peak-Peak	0.80g Peak-Peak
	Carbody Vertical Sustained Oscillatory	0.22g RMS LTR	0.22g RMS LTR
	Carbody Lateral Transient	0.25g Peak-Peak	0.50g Peak-Peak
	Carbody Lateral Sustained Oscillatory	0.08g RMS LTR	0.08g RMS LTR
	Truck Lateral Sustained Oscillatory	0.27g RMS LTR	0.27g RMS LTR

LP 10 Hz, 100 Hz Sample Rate (Minimum)

Ride Quality Meter

- Records Acceleration At:
  - Carbody
  - Truck
  - Axle
- Compares Computed Acceleration Measurements Against:
  - Safety Thresholds
  - Maintenance Thresholds
- Reports
  - Excessive Acceleration Events
  - Correlated Location



Ride Quality Meter History

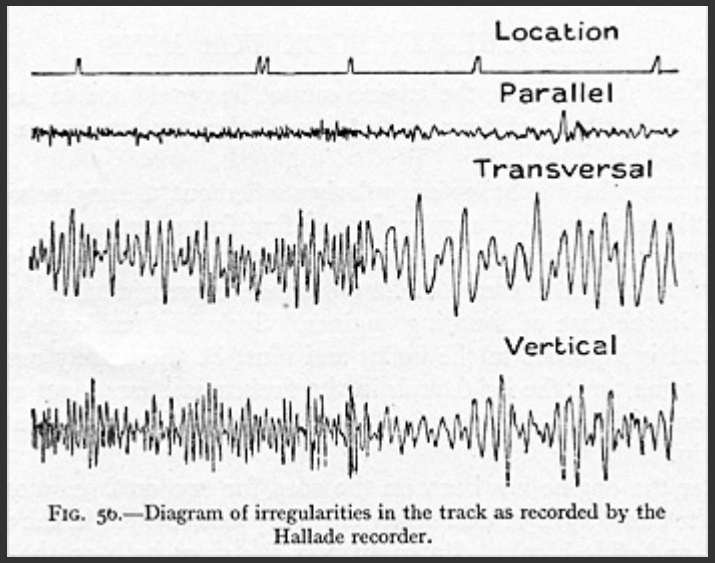


Fig. 56.—Diagram of irregularities in the track as recorded by the Hallade recorder.

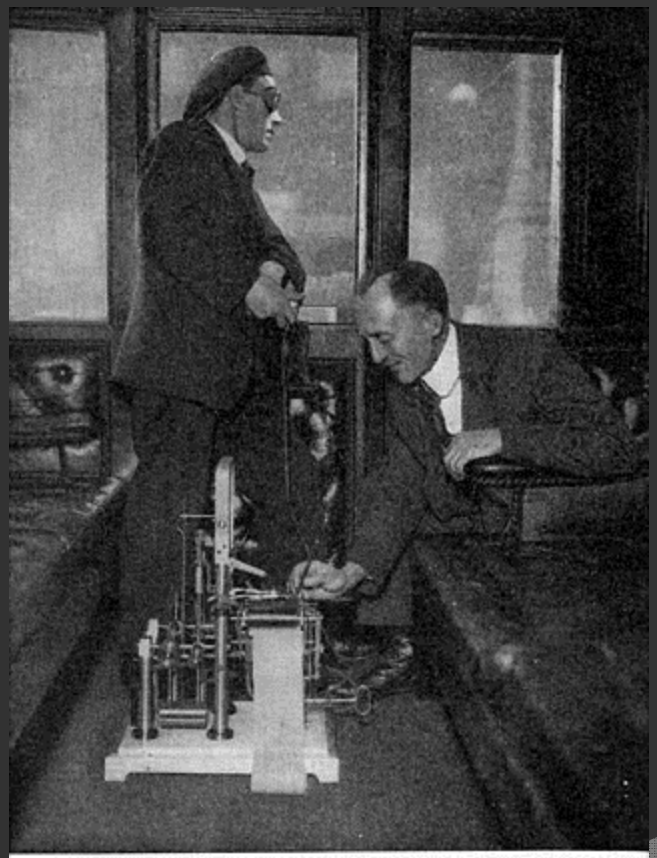


Fig. 55.—Using the Hallade track recorder.

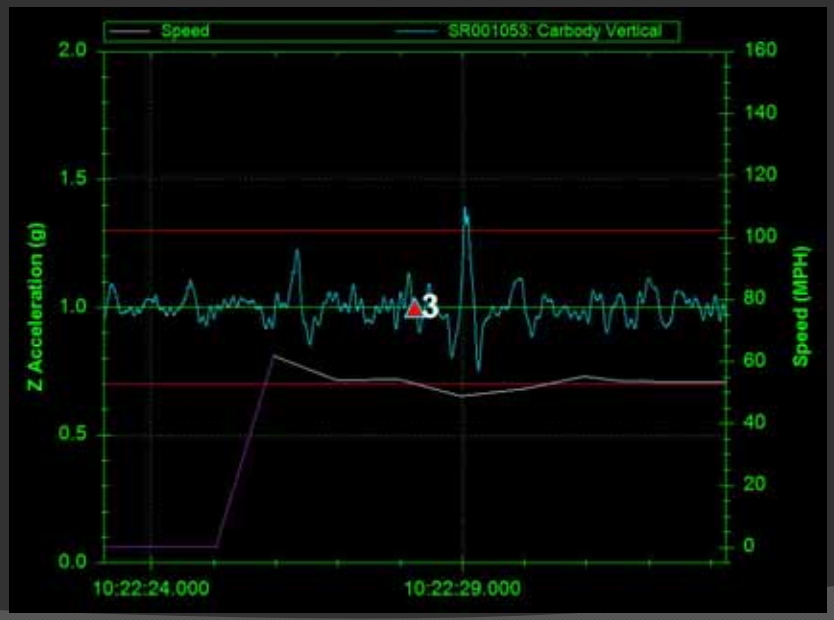
http://www.youtube.com/watch?v=vybOobUK1FE
Illustrations from "The Railway Book for Boys", 1930

Detect Track Issues with RQMs

- Lateral Track Geometry Issues
  - Alignment Deviations
  - Gage Deviations
- Vertical Track Geometry Issues
  - Profile Deviations
  - Cross Level Deviations

Real-World Example 1

- Excessive Carbody Vertical Acceleration
- Profile Condition:
  - Mud Spot
  - Pumping Tie

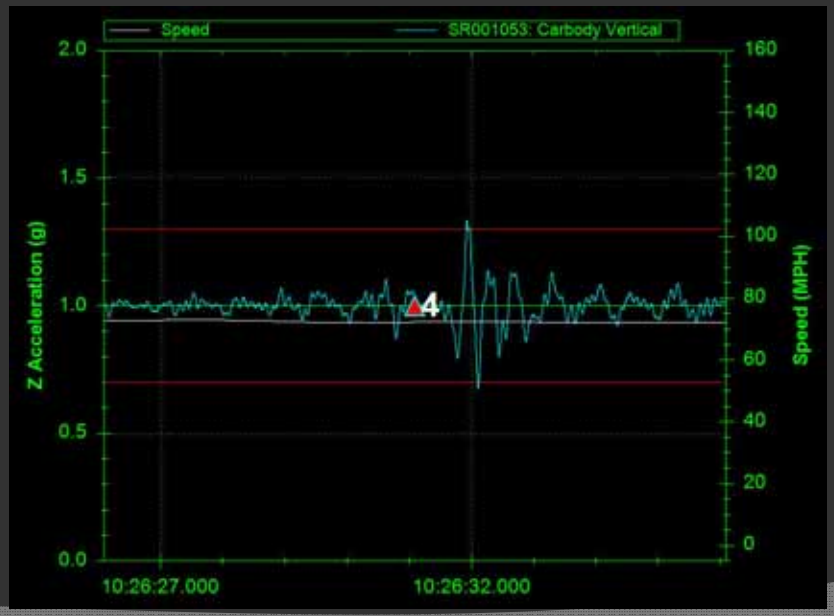


Detect Track Issues with RQMs

- Track Structure
  - Mud Spots
  - Fouled Ballast
  - Pumping Joints
  - Loose Ties
  - Crushed Heads
  - Low/Joints/Joint Batter
  - Broken Heel Blocks
  - Broken Switch Points
  - Engine Burn
  - Corrugation

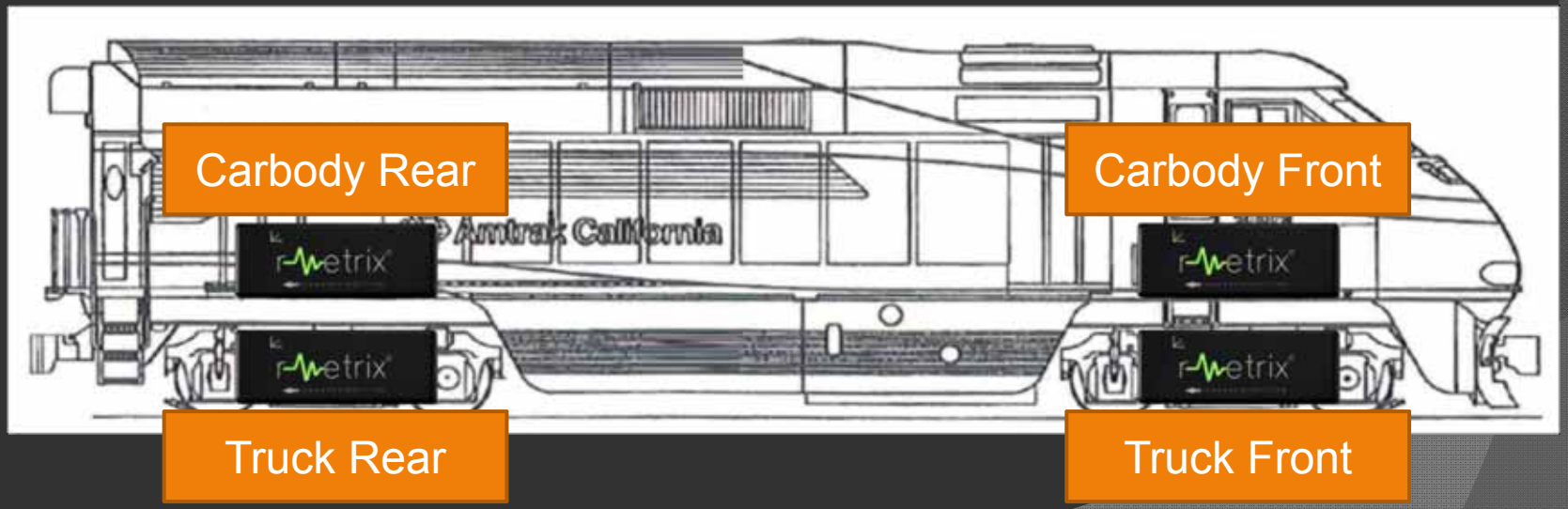
Real-World Example 2

- Excessive Carbody Vertical Acceleration
- Findings:
  - Engine Burn
  - Pumping Tie



Detect Vehicle Issues with RQMs

- Primary and Secondary Suspension Components
  - Springs
  - Dampers
- Worn Wheels



Differentiating Track and Vehicle Issues

- Use Multiple Systems (Fleet Deployment)
- Track Root Cause
  - Multiple Vehicles Exhibit Same Exception at Same Location
- Vehicle Root Cause
  - One Vehicle Exhibits Acceleration Responses Inconsistent with Other Vehicles

Portable RQM History

- 2006: FRA Solicited Proposals for ULTRA-PORTABLE Ride Quality Meters
  - Existing Commercial Systems:
    - Not “Portable”
    - Lacked GPS Integration
    - High Maintenance
    - Too Expensive
  - Subjective Measurements
    - Rough Ride Locations Manually Noted
    - Rough Ride Conditions Varied Between Inspectors
- Ideal Time to Revisit Ride Quality Meters
  - Components are Increasingly Cost-Effective
  - Components are Increasingly Smaller and Portable

Portable RQM Objectives

- Quantify Ride Quality Exceptions
- Real-Time Display of Data Channels
  - GPS
  - Acceleration
- Powered by Inspector's Laptop
- Ultra-Portable
- Low-Cost

Quantify Ride Quality Exceptions

Parameter	Options
Filter	Low Pass (Different Frequency Ranges) Band Pass (Different Frequency Ranges)
Window	Milliseconds
Measurement Type	Peak to Peak Zero to Peak RMS RMS Mean Removed RMS Linear Trend Removed
Exclude Duration	Milliseconds
Level 1 Threshold	g (Alarm Condition)
Level 2 Threshold	g (Alert Condition)

Real-Time Display of Data

Powered by Laptop

- GPS Receiver (USB/Bluetooth)
- Tri-Axial Accelerometers (USB)
- Ride Quality Software Installed on Inspector’s Laptop

Portable

Field Use

rMetrix History

2007-2008
- System Prototype (SBIR Phase I)
- Commercial System (SBIR Phase II)

2010-2011
- Version 1.3: Time and Frequency Analysis
- Version 1.4: Email Exceptions Data with Google Map Information

2012-2013
- Version 1.5: ISO 2631 Ride Comfort/Health
- Version 1.6: Upload Exceptions to Online Portal

2014
- Version 1.7: Overlay Geometry Defect Data
- Autonomous System

Autonomous Portable RQM

- Hardware
- Ride Quality Software Engine
- Real-Time Online Visualization
- Reporting

Impact of Low-Cost Portable RQMs

- Variety of Track Inspection Technologies
- Augments These Technologies More Comprehensively and Cost-Effectively
- Increased Situational Awareness of Track and/or Vehicles
  - Safety Standards
  - Proactive Maintenance Activities

Leveraging Portable RQM Technology

- Vehicle Qualification
- Suspension Systems
- Jerk Analysis
- Window Limits
- Speed Profile
- Time and Frequency Based Analyses
- Steady State Acceleration Measurements
- Frequency-weighted acceleration levels can be correlated to:
  - Crew and Passenger Comfort
  - Crew and Passenger Health

Future of Portable RQMs

- Economies of Scale
  - More Coverage
  - Smaller, Cost-Effective Sensors
  - Data Storage Capacity
- Track Defect Identification
  - Rail Fractures
  - Chipped Rails
  - Broken Concrete Foundations
- Carbody Acceleration to Detect Long-Wavelength Track Geometry Defects

Contact Us

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