Root Cause Investigation Findings

M-Line Service Disruptions

June 11, 2026 | BART Board of Directors Meeting

Traction Power System Overview

Investigation & Testing

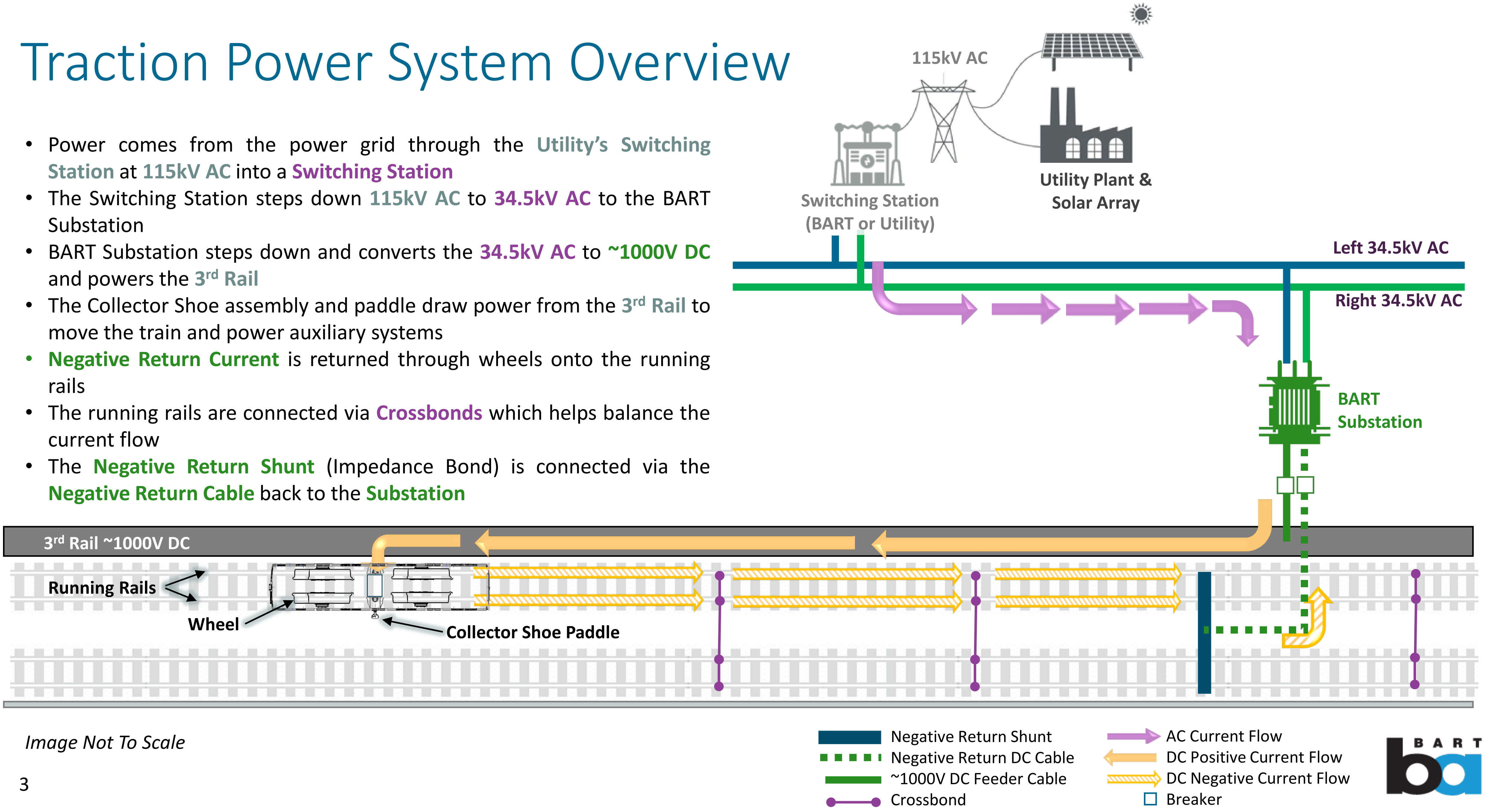
Key Actions Completed

Post Key Activities

Conclusion

Traction Power System Overview

- Power comes from the power grid through the **Utility's Switching Station** at **115kV AC** into a **Switching Station**
- The Switching Station steps down **115kV AC** to **34.5kV AC** to the BART Substation
- BART Substation steps down and converts the **34.5kV AC** to **~1000V DC** and powers the **3rd Rail**
- The Collector Shoe assembly and paddle draw power from the **3rd Rail** to move the train and power auxiliary systems
- **Negative Return Current** is returned through wheels onto the running rails
- The running rails are connected via **Crossbonds** which helps balance the current flow
- The **Negative Return Shunt** (Impedance Bond) is connected via the **Negative Return Cable** back to the **Substation**



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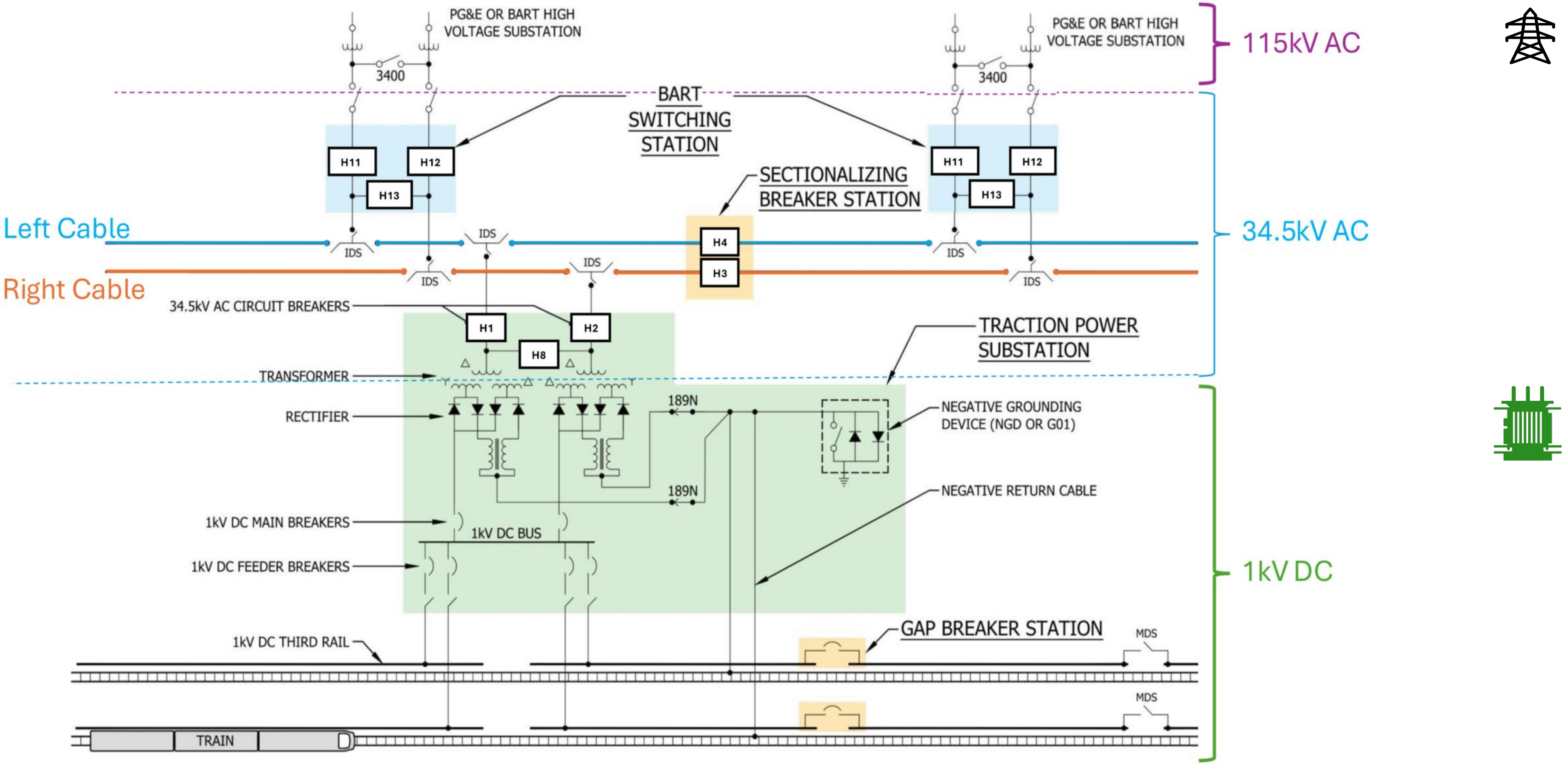
Traction Power System Overview



TYPICAL BART TRACTION POWER PLANT

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Traction Power System Overview

WAYSIDE

Potential Factors

Switching Stations (14)	Coverboards (21000)
Substations (12)	Third Rail / Jumpers (6900)
Multi-Purpose Protection Relays (100+)	Insulators (21000)
Negative Return	Insulated joints (16)
Breakers (100+)	Crossbonds (14)
Gap breaker stations (7)	Contact Rail (6900)

PG&E

Breaker

Exist. Substation

New Substation

Portable Substation

Station

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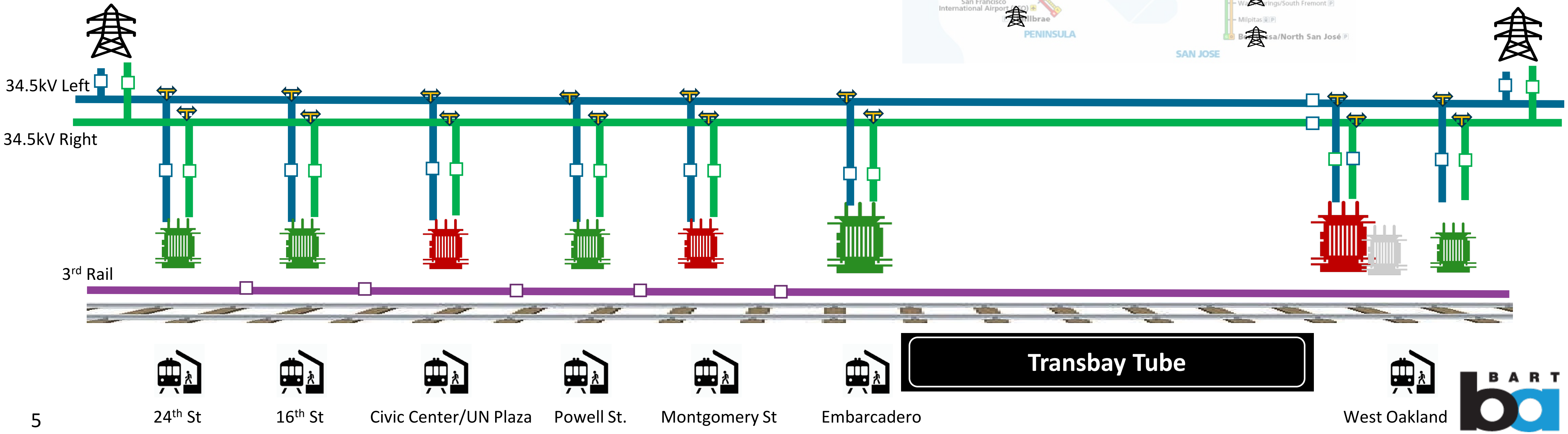
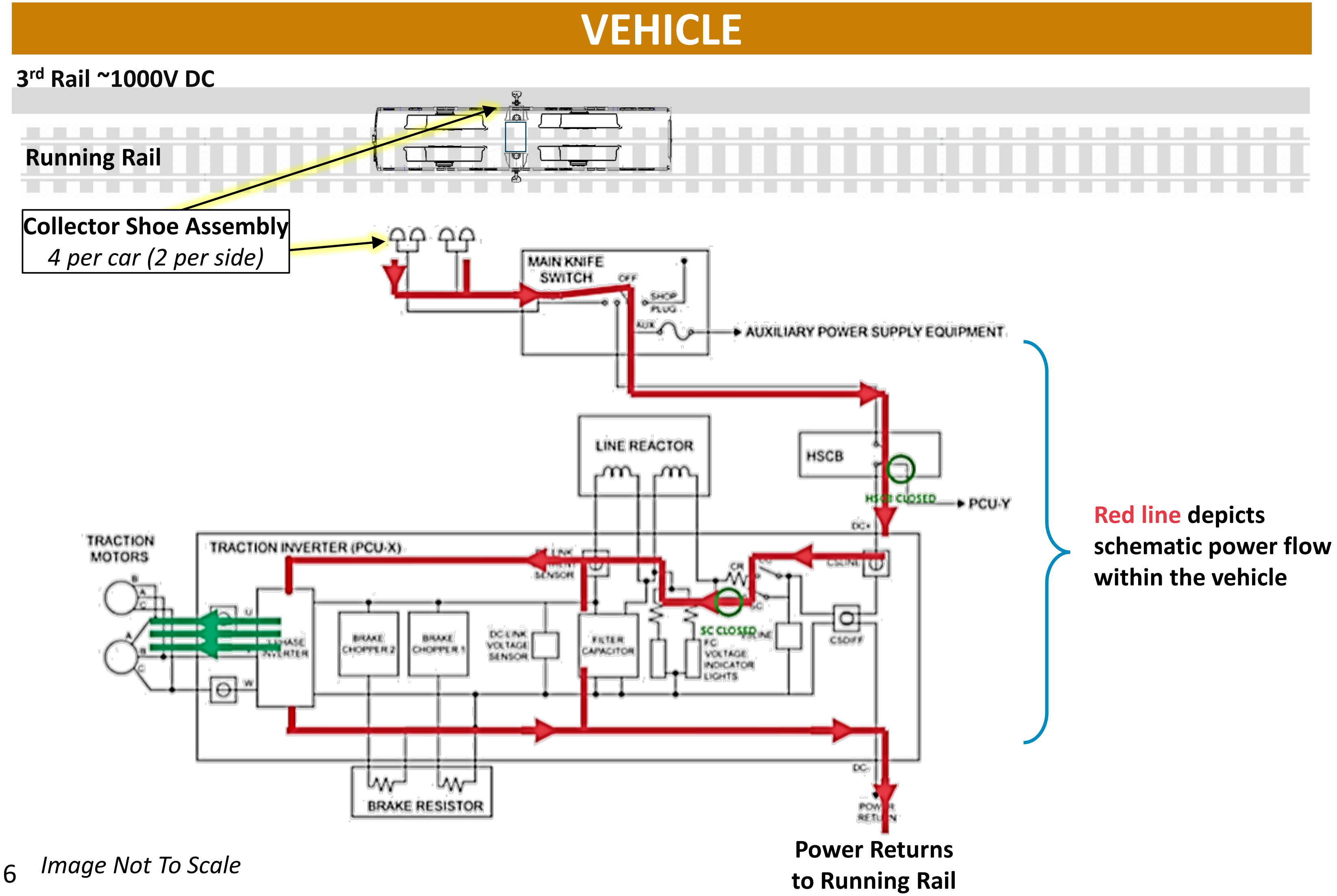


Traction Power System Overview



Potential Factors

- Speed of Trains
- Passenger Load
- Percentage of working propulsion systems per consist
- Receptivity of Third Rail
- Interaction with 3rd Rail
- High speed circuit breakers
- Anomaly of signals monitored
- Regenerative Braking

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Investigation & Testing

Investigation & Testing

Total Hours: 21,000+

- BART Staff
- Independent 3rd Party Investigative Teams
- External Subject Matter Experts

Total Site Visits: 52+

- Forensic Field Visual Inspections & Measurements
- Investigate Potential Cause / Hypothesis
- TBT, Market Street Tunnel, BART Stations, Substations, Gap breaker stations, Switching stations, Wayside, Yards, Shops & Facilities

Subject Matter Expert Disciplines: 16+

- Vehicle Systems
- Traction Power & Electrical
- SCADA
- Track & 3rd Rail
- Structures
- Fire Life Safety
- Mechanical, Safety & Hazard Engineering
- Reliability & Maintenance
- Electromagnetic Interference/Compatibility (EMI/EMC)
- Protective Relay Schemes
- Grounding & Fault Current
- Materials, Component & Forensic Sciences
- Data Analysts
- Modeling & Simulations
- Systems Integration & Interface
- Root Cause Investigation

Vehicle Inspections: 200+

- Visual and Forensic Inspection
- Check the undercarriage equipment
- Inspect fuse & current collector cable
- Inspect 2-3 trains ahead of inspection train
- Performed a suite of electrical tests on collector assembly and fuses
- Tested 7-car train on the BART Hayward Test Track with sections of coverboard removed
- Checked tolerances and clearances between collector assembly & 3rd rail interface

Total Tests: 75+

- Negative Return System Mapping
- Power Quality Monitoring on AC and DC side
- Rail to Earth Resistance Tests
- Negative Grounding Device (NGD) Tests
- Non-Destructive and Destructive Tests on Collector Shoe Assemblies, Fuses & Insulators
- Incoming voltages from utility

Files Reviewed: 1,600+

- Design Documents (e.g. Vehicles, Traction Power, Track)
- Maintenance Records (e.g. Maximo)
- Supervisory Control & Data Acquisition (SCADA) / Integrated Computer System (ICS) Logs
- Operations Control Center (OCC) Daily Reports, Operating Bulletins, Unusual Occurrence Reports (UOR)
- Interim Operating Procedures (IOP) & Site-Specific Work Plans (SSWP)
- Timetables & Passenger Ridership
- System/Vehicle Logs & Video Streams
- RIV

Key Actions Completed

Key Actions Completed

3 Substations Added to the System (one 5 MW Unit & two 10 MW Units)

- Two in Downtown SF and one in TBT East Portal areas

Completed Surveys, Inspections & Replacement Of Negative Returns & Crossbond Systems

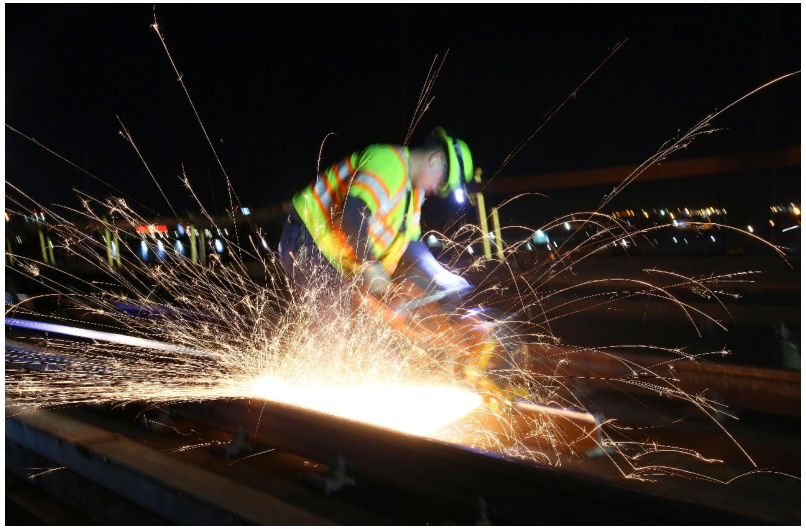
- Balanced loading and return path to substations
- Isolated faulty Negative Grounding Devices

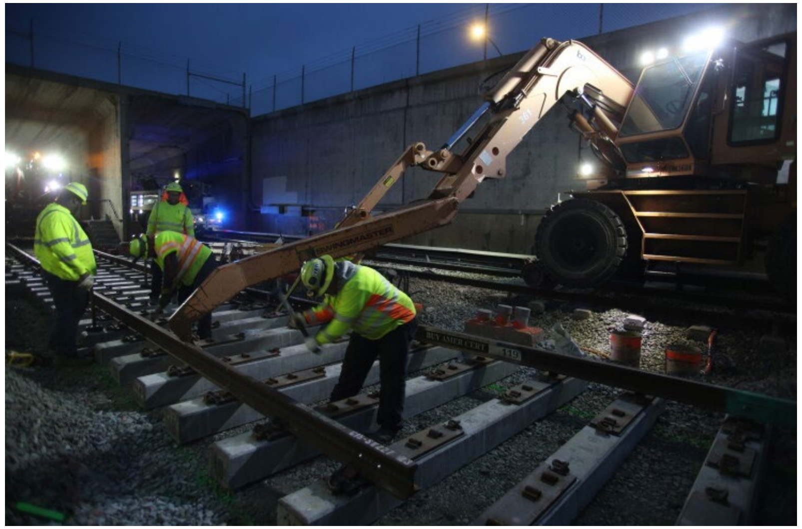
Improved Load Sensing, Sequencing & Breaker Response Performance

- Installed and configured new MPR units
- Enhanced guidance for breaker open / close cycles to reduce nuisance trips

Insulated Joints, New Rail Installation & DF Pad Work

- Insulated Joint Renewal: **4**
- Insulated Joint, Removed in the TBT: **8**
- New Rail Installed: **4000 Linear Feet**
- DF Pad Renewal: **699**





Key Actions Completed - Multi-Purpose Protection Relays (MPRs)

Replaced MPR's at three Gap Breaker Stations

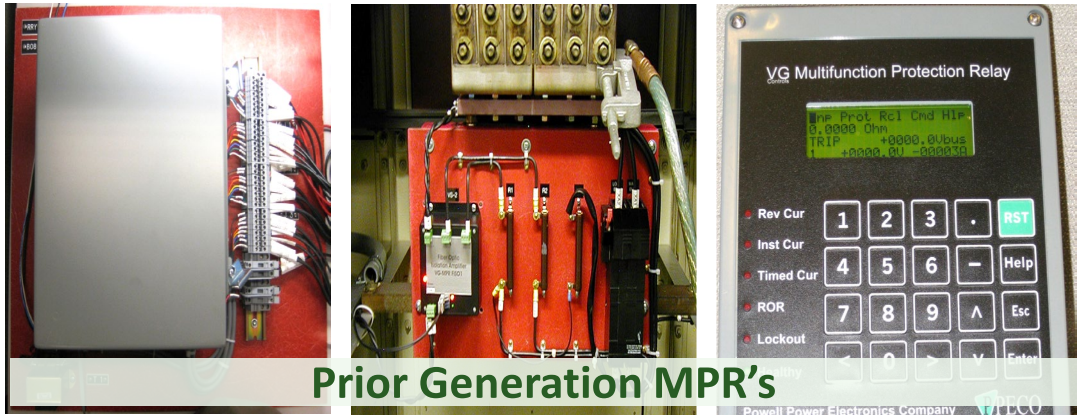
- MCG / MEG / MWG – located inside the Transbay Tube
- New MPR's are latest generation providing **more modern, higher sensitivity and improved performance**

Role of MPR Relays

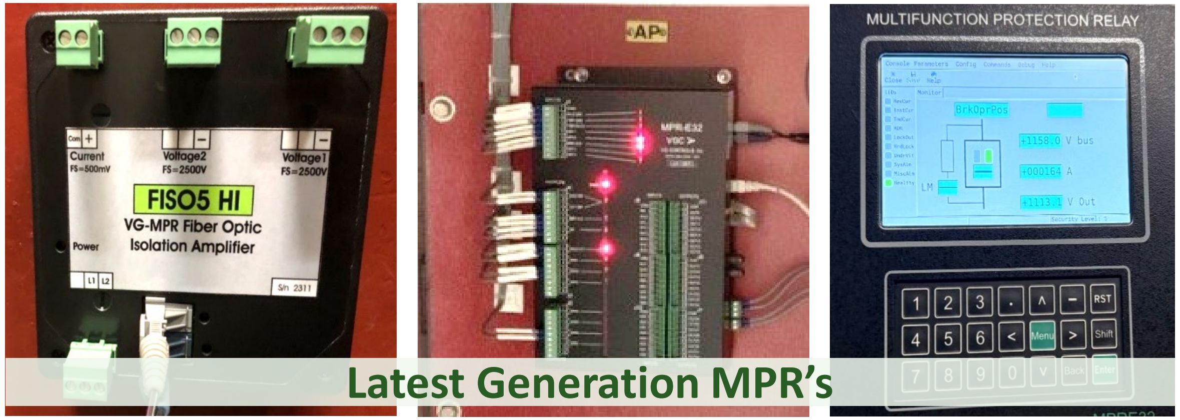
- Monitor proper current levels in traction power system within its zone of protection
- Detect and quickly isolate overcurrent and fault conditions
- Coordination with other protective relays
- More "fine / adjustable" setting options beyond basic breaker protective settings

Key Challenges in Selection and Settings for MPR Relays

- Balancing service reliability vs asset protection
- Differentiating between momentary system overload and low-level fault currents
- Setting too sensitive could result in nuisance trips and service disruptions
- Setting too high could result in thermal and short circuit damage to equipment



Prior Generation MPR's

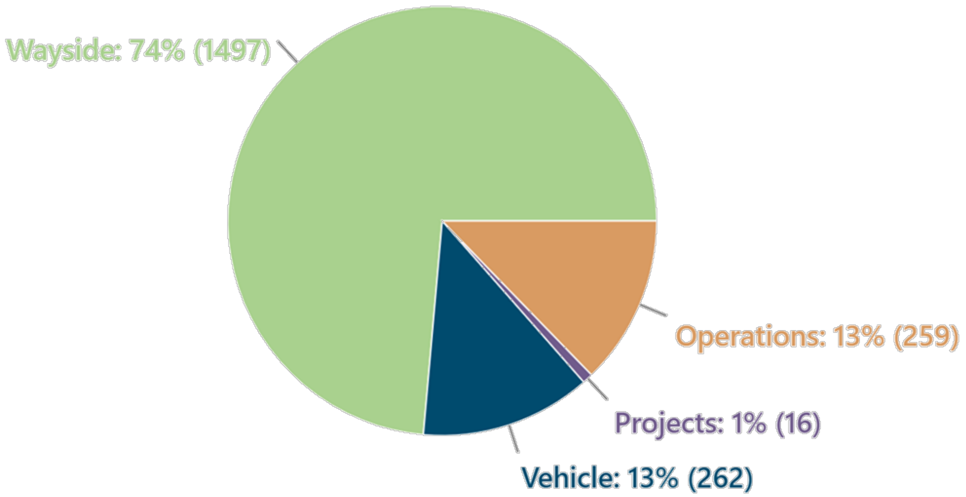


Latest Generation MPR's

Post Key Activities

Post Key Activities – Service Improvements

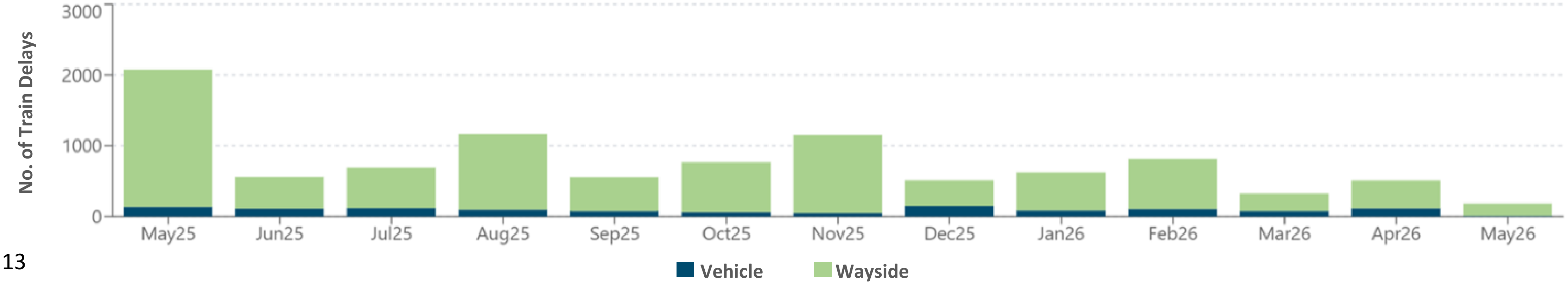
FY26 Q3 Quarterly Service Performance Review
Train Delays due to State of Good Repair



"BART achieves highest Quarterly Passenger On-Time Performances since early 2014"

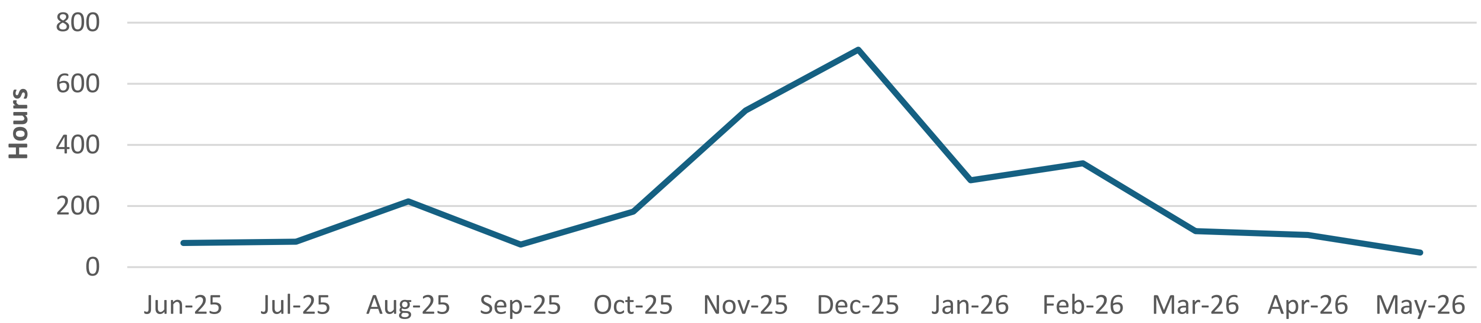
"May had lowest number of delayed trains due to Vehicles (10) ever!"

Train Delays Per Month



Post Key Activities – Service Improvements

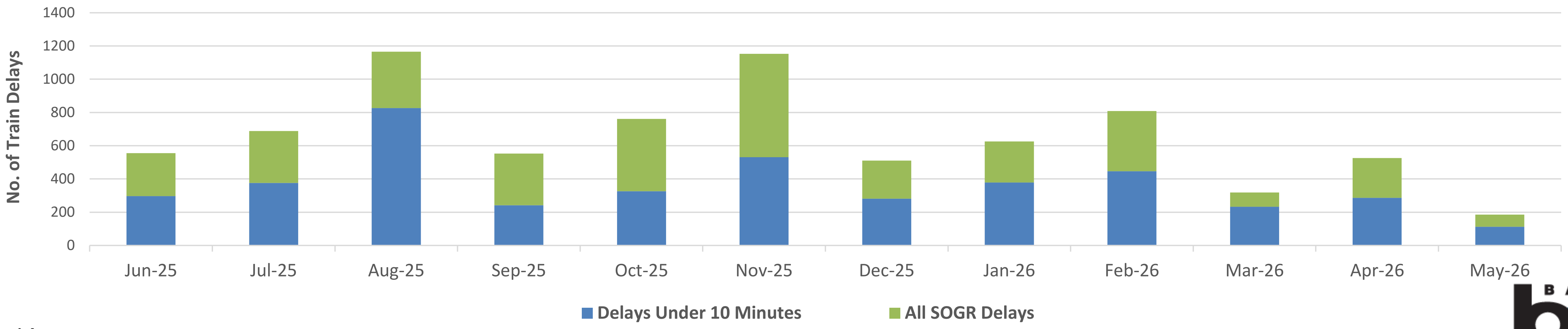
Corrective Maintenance Labor Hours



"22 Days in May had a Train on Time greater than 90%"

"30 Days in May had a Passenger on time greater than 94%"

Train Delays 10 Min or Less due to State of Good Repair (SOGR)



Conclusion

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- There is no single mutual cause, or asset failure, for all incidents
- Multiple factors most likely contributed to these incidents:
  - Missing Crossbonds
  - Disparity between adjacent substations
  - Performance between 3rd rail Gaps
  - Over Voltage Conditions
- Investigate procurment of predictive software mapping tools to improve resiliency
- Real-time monitoring and time synchronization will help identify anomalies before they become an incident
- Implementing formal Change Management and Governance Procedures with executive review and concurrence will significantly reduce the potential for these types of incidents in the future

Thank You