Rail Freight Operations:
A Brighter Future with ECP Brakes

The Sandhouse Gang
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Federal Railroad Administration

Agenda
- The Technology
- ECP Study Background
- Role of the Expert Panel
- Study Findings
- ECP Internationally
- The Path Forward

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ECP brakes are a powerful technology advance for railroads with safety and capacity benefits.

ECP brakes differ from conventional brakes because they transmit the brake signal at the speed of light rather than the speed of air.

**Conventional Brakes**
- Brake signal transmitted by air pressure in brake pipe, as first developed by George Westinghouse in the 19th century
- Brakes apply sequentially front to back with in-train forces
- Reservoirs cannot be charged while brakes are applied; engineers must calculate remaining braking power to avoid runaways
- Cars are not wired, requiring hand inspections for problems

**ECP Brakes**
- Brake signal transmitted electronically
- Brakes apply simultaneously eliminating in-train forces
- Reservoirs are continuously charged eliminating danger of losing braking power
- Cars are wired allowing communication back to the locomotive from a potential multitude of car sensors
Without ECP brakes, the brake signal reaches the end of a long train after several minutes, causing extreme push and pull forces.

**Problems with Sequential Braking**

- With sequential braking the front cars on the train are braked first, but end cars continue to run free.
- The end cars push against the front cars, extending brake distance.
- During braking, couplers experience tremendous force thereby shortening their useful lifespan.
- Cargo can also be damaged by the extreme forces caused by sequential braking.
- Especially in long heavy freight trains, braking can cause trains to buckle and derail.

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ECP brakes require locomotives to be equipped with special hardware

Cars also require additional equipment
The ECP equipment allows the ECP operation screen to be straightforward...

... And makes it possible to constantly monitor the status of cars.
Despite these benefits, years of ECP experimentation in North America had by 2004 gone nowhere in terms of adoption.

The Cycle of Inaction

- Solid business case needed to support upfront investment
- Government support may be required
- Labor issues
- Competing capex needs
- Locomotive vs. freight car mismatches
- Regulatory unknowns
- "Who pays" vs. "Who benefits" imbalance
- But significant uncertainties

ECP Tests and Conversions

- **1995**: BNSF testing of ECP on selected unit coal, taconite and doublestack trains
- **1995**: CR testing of ECP on one unit coal train
- **1995**: CP testing of ECP on one intermodal train
- **1998**: Quebec Cartier Mining begins converting its iron ore trains to ECP

In late 2004, FRA commissioned a benefit-cost analysis of ECP in an effort to break the decade-plus conversion stalemate.

**FRA Objectives**

- Assess the business benefits and costs of ECP brakes
- Review the rail safety benefits of ECP
- Develop three alternative implementation plans for ECP
- Describe the steps to implementation and the barriers to achievement

**Report Response**

- Quantified implementation costs and operating benefits
- Reviewed safety performance information
- Set forth and prioritized the three plans
- Identified seven principles for successful implementation and the risks of inaction
ECP implementation requires five key stakeholders to work together to design the ECP conversions and monitoring.

Managing an Implementation Initiative

- **Suppliers**: Continue to support technology development for ECP brakes and scale up cost-efficient manufacturing capacity to meet demand.
- **Railroads**: Determine key services and corridors that make sense to initially convert.
  - Manage converted operations so that ECP-equipped locomotives are available for ECP-converted freight trains.
- **Private Car Owners**: Determine their role in the conversion and how they will benefit.
  - Work with the railroads to convert cars to ECP at least cost in terms of both conversion and out-of-service time.
- **AAR**: Enact the rule requirements for ECP conversion of locomotives and freight cars under an overall timetable for conversion.
- **FRA**: Grant the regulatory relief for ECP operation, determine the level of financial assistance, and design the benefit-cost monitoring program.

Booz Allen formed an Expert Panel of these key investors in ECP to guide the analysis during 2005-06.

Booz Allen | Allen | Hamilton
The FRA-sanctioned Expert Panel identified seven principles for successful ECP implementation

<table>
<thead>
<tr>
<th>Focus</th>
<th>Principle</th>
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<tbody>
<tr>
<td>Initial Conversions</td>
<td>Maximize the benefit-cost ratio for the first conversions</td>
</tr>
<tr>
<td>New Equipment</td>
<td>Require conversion “kits” for all new cars and locomotives</td>
</tr>
<tr>
<td>Federal Support</td>
<td>Provide incentives through regulatory relief, other programs</td>
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<tr>
<td>Gainsharing</td>
<td>Resolve equitably the stakeholder financial imbalance</td>
</tr>
<tr>
<td>Data Capture</td>
<td>Collect and publish results of the initial conversions</td>
</tr>
<tr>
<td>Intermediate Conversions</td>
<td>Capitalize on the experience of the initial conversions</td>
</tr>
<tr>
<td>End State</td>
<td>Set a detailed timetable to make full conversion transparent</td>
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Careful implementation of ECP could move the current stagnant situation to a successful technology and ROI end state

Current Situation
- No clear path for making the investment in ECP cars and locomotives
- Variety of incomplete experiments and proprietary conversions
- Limited Experience
- Lack of funding
- Outdated Technology
- ECP Now
- Employee Burdens
- Continued reliance on brake technology invented in the 19th century
- Operation of heavy tonnage long-haul trains presents crew training and fatigue obstacles

Phased Implementation
- Public private partnerships to generate initial funding
- Pre-planned information gathering and analysis with data transparency
- Grants and Gainsharing
- End Vision
- Monitoring Operation
- Train Diagnostics
- Employee Lifestyle Gains
- Improved train handling and condition monitoring
- Eased crew training, supervision, and daily-to-day operating demands
The study found that over 90% of the total non-capacity related savings from ECP lie in three areas: fuel, wheels and brake tests.

Major ECP Cost Savings

- Fuel: 41%
- Wheels: 29%
- Intermediate Testing: 21%
- SCABT: 8%
- Brake Shoes: 1%

Total = $600 million per year

Source: Booz Allen analysis
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The real leverage of ECP comes from installing it on unit train equipment that generates a disproportionate share of rail RTMs.

The Leverage of PRB Coal

RTMs Per Locomotive
- PRB Locomotive: 197
- Average Locomotive: 76

RTMs Per Freight Car
- PRB Freight Car: 16
- Average Freight Car: 4

Source: AAR, Booz Allen analysis
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Coal is expected to increase its share of the Nation’s energy generation to 60% – much of it from Wyoming’s PRB

- Over the next two decades, coal production is expected to nearly double – from 1.1 to 1.8 billion tons per year
- At its current burn rate, the US has 200 years of coal reserves
- There are 440 coal-fired plants in the US – over the next decade there are plans to add 153 more in 42 states
- Wyoming’s PRB – with hauls averaging 1.100 miles – already accounts for more than a fourth of all Class I revenue ton-miles

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Preliminary financials for the conversion of PRB coal to ECP indicate a 3-year payback, an IRR of 47%, and a $700 million NPV

<table>
<thead>
<tr>
<th>One-Time Costs</th>
<th>Amount ($ million)</th>
<th>Annual Benefits</th>
<th>Amount ($ million)</th>
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</thead>
<tbody>
<tr>
<td>Locomotive Conversion @ $40,000 per unit</td>
<td>112</td>
<td>Fuel Savings</td>
<td>112</td>
</tr>
<tr>
<td>Freight Car Conversion @ $4,000 per car</td>
<td>320</td>
<td>Reduced Wheel Defects</td>
<td>320</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Brake Inspection Savings</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Brake Shoe Savings</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>432</strong></td>
<td><strong>Total</strong></td>
<td><strong>170</strong></td>
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Source: Booz Allen analysis, using a discount rate of 12%

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Other countries are adopting ECP to improve capacity: for example, QCM in Canada and QR in Australia run ECP trains

South Africa’s Spoornet has operationally and financially justified ECP conversion for its export coal fleet of 6,600 cars

The Port of Richards Bay will increase its export coal capacity from 72 to 92 million metric tons by 2009
Spoornet made the business case to convert to ECP based on major savings in train costs and gains in capacity

- South Africa’s Spoornet has embraced ECP for its huge export coal operations, reporting savings in train energy consumption of 23%.
- Spoornet’s ECP-equipped cars and locomotives have increased capacity, reducing turn times from mine to port by 9%.

Ironically, US ECP manufacturers primary markets are now abroad.

Spoornet’s preliminary analysis indicates a wide variety of benefits from adoption of ECP

- Stopping Distance Reduction: 60 to 70%
- Max. Tractive In-Train Forces Reduction: 37%
- Max. Braking In-Train Forces Reduction: 23%
- Cycle Time Reduction: 9%
- Energy Savings: 23%
- Dynamic Brake Absorption: 26% Increase
- Wheel Temperature at Bottom of Long Grade:

<table>
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<tr>
<th>Statistical Measure</th>
<th>ECP:DP °C</th>
<th>Pneum. °C</th>
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<tbody>
<tr>
<td>99 Percentile</td>
<td>139</td>
<td>280</td>
</tr>
<tr>
<td>Average</td>
<td>89</td>
<td>110</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>21</td>
<td>41</td>
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</table>

Source: Wabtec
Spoornet could have also cost-justified its entire conversion to ECP by avoiding one runaway train handling wreck in May 2005.

‘Wiring the train’ for the first time in North American rail history offers a platform for other safety and efficiency based electronics.
**Beyond PRB, other unit trains generally lend themselves to ECP conversion, but the costs and benefits will vary by commodity type**

![Diagram showing grain, non-metallic minerals, ores, intermodal, and non-PRB coal categories with high mileage dedicated trains and high traffic percentage.]

**Thoughtful design of the initial ECP conversion is critical to the success of later stages and eventual widespread adoption of ECP**

- **Questions of:**
  - Who participates?
  - How much does it cost?
  - Who pays?
  - How will the benefits be monitored?

- **Testing to Date:**
  - Demonstrated readiness of the technology
  - Gained US and international experience
  - Tested ECP in a variety of train operations and climates

![Diagram showing PRB conversion, expansion for unit train services, ECP implemented for most major train operations, conversion completed for carload traffic and Class IIs and IIIIs.]

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A sustainable implementation for ECP over, for example, 15 years will require careful phasing of unit train and carload conversions...

Potential Approach and Timeline

**Year 1**
- **Phase 0 Ramp-Up**
  - Organize participants
  - Plan data capture
  - Determine Federal support and gainsharing

**Year 2-4**
- **Phase 1 – Focus on PRB Coal/Other Unit Trains**
  - Set the overall conversion schedule

**Years 5-10**
- **Phase 2 – Complete Unit Train Conversion**
  - Expand to new markets and services
  - Detail ECP benefits across service types
  - Finalize participant obligations

**Years 11-15**
- **Phase 3 - Finalize Implementation**
  - Deliver on the commitment to full industry conversion to ECP while minimizing financial hardships

Gaining Experience

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Two of the first ECP revenue movements are now taking place on NS for utility coal shuttles; BNSF will follow with PRB conversion

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