TECHOLOGY DIGEST
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Comparison of ECP Brakes to Conventional Brakes on an Iron Ore Train

by Fred Carlson and *Yvon Rioux

Summary

Analyses by Transportation Technology Center, Inc. (TTCI) on the Quebec Cartier Mining (QCM) Railroad indicate electronically controlled pneumatic (ECP) brake systems offer many benefits over conventional braking systems. In these tests TTCI analyzed the operational and maintenance data of an iron-ore train equipped with stand-alone electronically controlled pneumatic (ECP) brakes made by the New York Air Brake Co (NYAB). Performance was compared with conventionally braked trains in the same service. Some equipment reliabilty problems were noticed early in the test and corrective actions have been taken. QCM has been operating a stand-alone ECP train since April of 1998. Results from 21 months of service show that:

- The low air consumption of ECP brakes allowed QCM to increase train lengths from 158 cars to 180 cars without the use of compressor cars or increasing the number of locomotives. In addition, the ECP train was able to operate through the severe winter months without the use of mid-train compressor cars, which are required on the conventional trains. In fact, on January 2, 2000, QCM reported that an ECP train with 170 cars in -22°F weather showed 0.5 cubic feet per minute airflow and no measureable gradient.
- Fuel consumption of the ECP train was reduced overall by 4.7 percent. Since November 1998, when the ECP train length was increased to about 180 cars, the ECP train fuel consumption per million gross tons reduced by 5.7 percent.
- Car miles per brake shoe of the ECP train have improved by 59.8 percent over the conventionally braked trains.
- Car miles per coupler or knuckle failure have improved by 21.6 percent over the conventionally braked trains. This result indicates that ECP brakes can reduce longitiudinal train action forces, and thus reduce loss and damage claims on general merchandise, intermodal, and automobile trains.
- Undesired emergency brake applications (UDEs) have been eliminated on the ECP-equipped train. The four conventional trains have experienced 131 UDEs during the same test period.
- The occurrence of sticking brakes has been sharply reduced on the ECP train. The conventional trains have had 57 cases of sticking brakes, while the ECP train had only three. The sticking brakes on the ECP train were due to faulty slack adjusters and were in no way attributable to the ECP brake system.

*QCM Railroad

Suggested Distribution:
- ❑ Chief Mechanical Officer
- ❑ Planning & Analysis
- ❑ Airbrake Officer
- ❑ Safety

Work performed by TTCI Transportation Technology Center, Inc.
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INTRODUCTION

Since April of 1998, Quebec Cartier Mining (QCM) Railroad has been operating a stand-alone electronically controlled pneumatic brake (ECP) equipped iron ore train, which is being compared with conventionally braked trains in the same service. Analyses by TTCI indicate the ECP brake systems offer many benefits over conventional braking systems.

The stand-alone ECP train is not equipped with conventional service and emergency portions. Previous revenue service tests of ECP equipped trains used overlay systems, which allowed operation as a conventionally braked train. Some conventional operation always occurred with these trains due to shortage of ECP equipped locomotives and trained crews. Such operation tended to make the test data questionable since defects could not be attributed to one type of operation or the other. However, with the stand-alone ECP system on the QCM, conventional operation is not possible. Therefore, defects and delays can be confidently allocated to either the ECP or conventional brake systems.

QCM operates from Port Cartier, Quebec, on the north shore of the St. Lawrence River to the iron ore mines at Mount Wright 260 miles north. The railroad profile is slightly undulating except for the southern 66 miles, which descends into the St. Lawrence valley with a maximum grade of 1.35 percent.

QCM has been carefully recording operational and maintenance data such as fuel consumption, wheel replacements, brake shoe life, undesired emergencies (UDEs), sticking brakes, broken knuckles, causes for train delays, and other ECP and conventional air brake component failures. This is the most comprehensive revenue service testing of ECP brake systems to date.

TRAIN SIZE

ECP brake systems use less air per brake application than conventional brake systems, because no air pressure is released to atmosphere to control brake applications or to increase signal propagation times. This fact allowed QCM to eliminate a compressor repeater car from the ECP train in cold weather. It also allowed an increase in the length of the ECP train in November of 1998 from about 158 cars to 180 cars without changing the locomotive consist, as shown in Exhibit 1. This is due to the reduced air demand of ECP brakes.

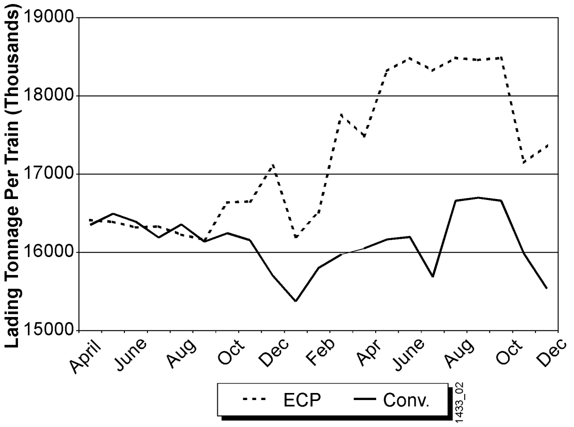

Exhibit 1. Lading Tonnage per Train

FUEL CONSUMPTION

QCM fuels its locomotives only at the south end of the railroad at Port Cartier, and a three-unit set of MLW 3600-hp six-axle locomotives will stay with the same train for the entire 520-mile trip to the ore mines and back. Thus, the fuel consumption of each ore train operated can be reliably obtained. Exhibit 2 shows the fuel consumption in gallons per 1,000 gross ton-miles. Since the ECP train length was increased in November 1998, the fuel consumption of the ECP train has been 5.7 percent lower than the conventional trains. The reduced fuel comsumption can be attribued to reduced power braking from graduated release.

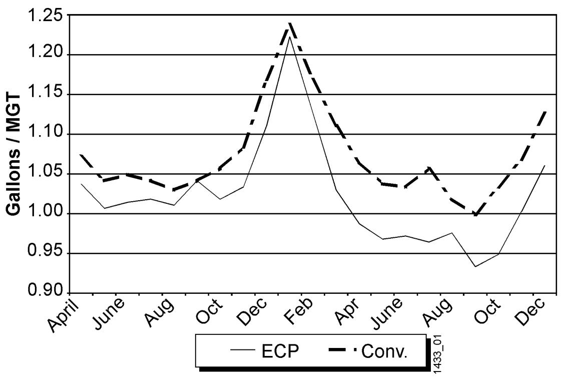

Exhibit 2. Fuel Consumption

BRAKE SHOE USAGE

Brake shoe life on the ECP train has increased by 37.4 percent over the conventional trains. This agrees with data previously published on the BNSF revenue service tests of overlay equipped ECP trains. The increased brake shoe life can be attributed to the reduced need for power braking due to the ability to graduate the ECP brake applications. Another factor is the more uniform brake cylinder pressures throughout the ECP train. This type of savings has not been experienced on intermodal trains, where the ECP brake is used often for slight speed corrections at speeds where dynamic brakes are not fully effective.

UDEs AND STICKING BRAKES

The ECP brake system has eliminated the occurrence of UDEs, while the conventional trains have experienced one UDE every 10 round trips. The ECP train has experienced three train stops due to sticking brakes, but these were found to be caused by defective slack adjusters. These were not caused by defects in the ECP brake system. The conventional trains have experienced a train delay due to sticking brakes every 24 round trips. It is not known how many of these were caused by defective slack adjusters.

COUPLER KNUCKLE BREAKAGE

The ECP train has experienced a 21.6 percent improvement in car miles between coupler knuckle failures. While some of these knuckle failures are due to slack run-out, certainly the trend indicates that the brake induced slack action in the ECP train is sharply reduced. This reduction is due to the simultaneous application and release of the brakes on each car in the train. Reduced slack action should result in a substantial reduction in loss and damage claims in conventional and intermodal freight service.

WHEEL USAGE

The brake related wheel defects on the ECP train are slightly higher per car mile than with the conventional train. This is contrary to all previous revenue service testing experience with ECP brakes. The reason for this anomaly has been identified as a train yard car handling problem related to training. Conventional cars are equipped with manual or automatic empty-load valves, but the ECP cars are not so equipped. When an ECP train is initialized, it is set electronically to either empty or load, and the ECP system modulates the brake cylinder pressure accordingly. When the ECP train is moved through the dumper, or when ECP cars are moved with conventional cars for maintenance, they are often in a pneumatic backup brake application. Without empty/load valves, the braking on the empty cars is excessive, so the cars were experiencing either stopped wheels or slipping wheels. These are prime causes of the brake related defects shown in Exhibit 3. QCM now requires its personnel to bleed the air from all ECP cars prior to movement

Exhibit 3. Wheel Defects and Car Mileage

Defects	Conventional		ECP		Percent Improved
	Car Miles	Number of Occurrences	Car Miles	Number of Occurrences	
MR03 - hollow wheel	594834	189	521055	59	-12%
Why made 60 – thin flange	594834	189	487972	63	-18%
Why made 64 – high flange	69742	1612	68316	450	-2%
Why made 71 – shattered rim	3122878	36	2794747	11	-11%
Why made 73 – thin rim	281059	400	247921	124	-12%
***Why made 74 – thermal crack**	112423600	1	15371110	2	-86%
***Why made 75 – shelled (or spalled)**	3212103	35	1808366	17	-44%
***Why made 76 – built-up tread**	7494907	15	404503	76	-95%
***Why made 78 – slid flat**	1307251	86	698687	44	-47%

**Brake related defects*

Exhibit 4. Train Delay Minutes per Train

Delay	ECP	Conventional
UDE	0	2.88
Sticking brake	0.45	0.99
Coupler	3.49	3.20
Knuckle	1.42	0.84
Draw bar	0	0.18
HEU	2.59	0
Power supply	2.77	0
CCD	0.08	0
Connector	0.82	0
Cable	5.59	0
Car I.D.	6.15	0
Totals	**23.37**	**8.09**

with non-ECP equipped locomotives and/or with non-ECP equipped cars.

TTCI and QCM will continue to track the performance of the ECP train, and it is expected that the new car handling methods will result in reduced brake related wheel defects.

TRAIN DELAYS

The ECP train experienced 23.32 minutes of delay per train versus 8.09 minutes per train for the conventional brake. This is due to developmental problems with new technology. The ECP system used by QCM is an engineering prototype developed by NYAB to Association of American Railroads (AAR) standards. It is not a hardened production version. Exhibit 4 shows the results.

Note that the ECP train was superior to the conventional trains in all non-ECP categories except for coupler failures, where the difference is not very significant due to the low number of failures of that type. The remaining failures on the ECP train can be explained as follows:

- HEU failures were due to software errors, which have been corrected.
- Head-end power-supply failures were corrected five months into the test period. No failures have occurred since that time.
- Connector and cable failures were of old, non-AAR connectors and associated wiring. Since July 1999, the ECP train has been equipped with the AAR connectors, manufactured by Amphenol, with no electrical failures. Amphenol is addressing some eyebolt failures.
- Car I.D. failures from a design defect began to occur after the 1998-99 winter. The design defect was identified and corrected.
- Early CCD failures occurred due to software errors, which have since been corrected. Other CCD failures were actually caused by the car I.D. failures. A failed CCD will not cause a train stop.

Since the above corrections have been made, ECP train delays have been reduced from 0.250 minutes per 1,000 car-miles in the first 16 months of the test to 0.024 minutes per 1,000 car-miles in the last 3 monts of 1999. The conventional train has experienced 0.047 minutes of train delay per 1,000 car-miles over the entire 19-month peirod.

FUTURE WORK

QCM, NYAB, and TTCI plan to continue this revenue service test into 2000. The ECP train is expected to experience improved wheel life as a result of better car handling through the dumper and in the train yard. Train delays are expected to reduce sharply as developmental bugs are eliminated. An economic analysis is planned early next year.

Note: Please contact Fred Carlson at (719) 584-0718 with questions or comments about this document.

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A MORE DETAILED REPORT, WHICH MAY CONTAIN REVISED INFORMATION, MAY BE AVAILABLE AT A LATER DATE THROUGH AAR/TTCI, PUBLICATIONS, P.O. Box 79780, BALTIMORE, MD, 21279-0780.