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Remote Control Unit Operation On Pacific Great Eastern Railway

by M. C. Norris*

I WOULD LIKE TO EXPRESS my gratitude for having this opportunity to address this Forum and to give you an insight into how Pacific Great Eastern is taking advantage of technological advances.

The subject of my talk is remote control unit operation and, during the course of my remarks, I will describe the equipment used in general terms, outline PGE experience to date, and indicate how we intend to use the equipment in future.

You are all familiar with the changeover within the railroad industry from steam locomotives to diesel electric locomotives, which permitted the use of additional diesel units in a locomotive consist without adding crews. The normal means of controlling one or more diesel units from the lead unit has been by direct electrical cable and air trainline between units. However, all power was concentrated on the head end of the train unless a manned pusher locomotive was cut in toward the rear of the train.

The knowledge gained in the communications field, permitting a modern communication link with pneumatics, has provided a break through for the railroad industry in the handling of long freight trains. Effective distribution of motive power throughout a train is accomplished with a radio control system which, by replacing the direct link of electrical cable and air trainline, permits automatic means of synchronous control of train handling by widely separated units of motive power.

In effect, remote control unit operation provides precise automatic remote control from the lead consist, by radio link, to a second locomotive consist back in the train.

Pacific Great Eastern benefited greatly from the testing commenced during November, 1967 by CP Rail. We observed the results of CP Rail testing with a great deal of interest and, during February, 1968 began serious research of our own. We corresponded with the Norfolk & Western, Great Northern, Southern, Kansas City Southern, Louisville & Nashville and Penn Central Railways and the comments we received from these user roads strengthened our belief that remote control unit operation would be a forward step, considering our 2.2% grades and manned pusher engines.

By October, 1968, we decided to enter remote controlled operation with the purchase of two lead control sets, mounted in new MLW-Worthington 3000 HP units. One remote car was built from the frame of an Alco "B" unit. The installation in both units and the remote car was done in our Squamish shops.

**Regional Manager Operations, Pacific Great Eastern Railway, Vancouver, B.C.*

The equipment chosen was Locotrol, manufactured by Radiation Incorporated of Melbourne, Florida. I will now describe this equipment in some detail.

The lead locomotive (master) components comprise the existing throttle stand, brake valve stand, locomotive relays and switches and the 27-conductor trainline jumper cables. Added is a push button brake control console, brake control manifold, control console, radio receiver and transmitter, logic and sensing circuits and interface relays.

The remote control car has a brake equipment rack to provide the functions of the 26-C brake valve on the lead unit. This compact rack is designed in three sections to include the equipment rack, brake control manifold and reservoir rack. In addition, of course, there is a radio receiver and transmitter, logic and sensing circuits and interface relays. The remote control car is connected for control to the trailing units with the normal 27-conductor trainline jumper cable.

The control console in the lead (master) locomotive is placed at the engineman's position so that the remote consist status and alarms are clearly displayed. In addition, the console contains the control switches which make it possible to isolate or independently operate the slave (remote) unit.

Logic units contain the trainline sensing circuits and the control logic. Printed circuit boards are used throughout.

Interface relays provide the electrically isolated connection between the Locotrol logic and the consist trainline.

Radio equipment is standard FM half-Duplex carrier with locotrol utilizing 2 KC bandwidth.

The air brake manifold provides electric to pneumatic control on both the lead and slave units.

The push button air brakes control electrifies the control of the braking system. This is necessary in order to provide an electrical control signal to the lead consist locotrol unit and for operation of the slave consist air brake.

OPERATIONS OF THE SLAVE EQUIPMENT

The system can be employed in either of two modes: Synchronous automatic operation or independent operation. When the synchronous mode is employed, the lead locomotive operational functions, which are controlled from the engineer's position, are sensed and signals are transmitted to the slave consist where they are translated instantly into command signals to the slave consist control equipment.

Failure of communications between the master and slave units is termed loss of continuity and may occur in mountainous territory or in deep cuts or in lengthy tunnels. The equipment is designed so that if there is a loss of continuity for a period in excess of forty six seconds, the slave units go into idle control until continuity is again established. There is an override feature in the synchronous automatic mode which, if desired, prevents the slave units from being throttled down to idle when loss of continuity exceeds the accepted time limit. This is useful at known locations of loss of continuity—thus when the override feature is activated, the slave units continue working in the throttle position or braking position, as the case may be, in effect at the time of override.

When operating conditions require independent operation of the lead and slave units, an "inhibit" capability, which disables the sensing circuits in the lead consist, is available to the engineman. When the "inhibit" capability is activated, the slave consist can be independently controlled by command signals from the lead locomotive—a rotating type deck switch on the control console in the lead locomotive provides this control.

DESCRIPTION OF PGE TERRITORY

We have been testing remote control units since February 10, 1970 between North Vancouver and Kelly Lake, a distance of about 193 miles, which includes the Squamish Subdivision, North Vancouver to Lillooet and part of the Lillooet Subdivision to Kelly Lake from Lillooet.

The terrain throughout this territory is rugged and mountainous with 2.2% grades, 12 degree curves and 13 tunnels. There are 74 trestles and 24 steel bridges on the Squamish Subdivision, a distance of 158 miles. The track in this area consists of 100 lb. rail laid on creosote ties and crushed rock ballast, except for a 10 mile section of 115 lb. rail in the Cheakamus Canyon. The initial tests were confined to the Squamish Subdivision.

Tonnage on this Subdivision is predominantly southward—the northward tonnage is about 69% of southward tonnage. Therefore, southward trains require pusher assistance from Lillooet to Mons, a distance of 80 miles. Within this 80 miles southward are two separate sections of 2.2% adverse grade. One section extends nine miles from Darcy to Birken, and the other extends 15 miles from Pemberton to Parkhurst. These trains handle up to 7,100 tons with a 4-3000 HP units on the nose and 3-1800 HP units cut back. Generally, however, 6000 tons is not exceeded with 3-3000 HP units leading and 2-3000 HP units assisting. We expect, under remote control unit operation, that most of our freight traffic will be handled through the mountains with 3-3000 HP units leading and 3-3000 HP units on remote with equated tonnage of 7000 tons.

Descending southward, grades extend 15 miles at 2% between Birken and Mount Currie and 22 miles at 2.2% between Alta Lake and Mile 51.

After the initial tests were made on the Squamish Subdivision, the equipment was tested on our Kelly Lake hill which climbs from Lillooet (elevation 1100 feet) along the side of mountains above the Fraser River to Kelly Lake (elevation 3510 feet). This climb of 35 miles includes 22 miles of continuous 2.2% grade.

OPERATIONAL TESTING OF REMOTE CONTROL UNITS

Trip No. 1 from North Vancouver was made with the remote equipment coupled to the lead equipment to permit checking of both lead and remote lamp monitors in full load service.

Trip No. 2 was made with the remote consist separated from the lead power in order to locate and test areas of marginal radio reception which could result in loss of continuity. These early trips, were, of course, accompanied by representatives of Radiation and the New York Air Brake.

From February 10, 1970, until the end of the year, the total working mileage of our remote control car, designated as RCC-1, was 27,909 miles.

During this time, the following trains were handled:

Squamish Subdivision:
101 northward
94 southward

Lillooet Subdivision:
5 northward
5 southward

The heaviest train handled was 7200 tons and the lightest train handled was 1640 tons. In all cases, the remote units were placed in the train two-thirds of the distance back from the lead locomotive.

General acceptance of the system has been good by all personnel connected with the tests, especially by our enginemen who feel that the train handling advantages are extraordinary—not to mention their increased wage rate due to handling up to 18,000 horsepower.

The equipment appears ruggedly built and reliable.

CONCLUSIONS REACHED

We have come to a number of conclusions as a result of operating tests:

1) We have not had difficulties with slack action or with draft gear damage and attribute this to the following:
   i) The trains have been relatively light, i.e., less than 8000 tons.
   ii) The slave units have been properly positioned within the length of the train.
   iii) We have not experimented with conventional pushers combined with the slave unit operation.

2) Air recovery is speeded up to the point that our methods of train handling down heavy grades have been changed in some cases. We have situations where there is a grade reversal or dip in the middle of a long 2.2% downgrade. We can now release the air brakes coming into the dip, hold the slack bunched with dynamic breaking and allow the tonnage to push the train through the dip, reapplying the air in ample time to keep control of the train. Formerly, we handled this situation by making a reduction of eight lbs. and working throttle over the dip.

3) Communication failure or loss of continuity between the master and the slave units is less of a problem than expected.

A typical trip northward from North Vancouver to Lillooet in November, with 128 cars and the remote equipment operating 22 cars from the caboose, showed loss of continuity at eight locations as follows:

Mile	10.5	8 seconds
	17.9	28 "
	19.0	10 "
	27.3	16 "
	28.7	45 "
	29.3	23 "
	65.0	3 "
	132.0	4 "

Although the override feature is used at known continuity loss locations, very few of the losses are of sufficient duration to result in remote equipment shutdown. Our longest tunnel over this Subdivision is 1635 feet long at Mile 24.9.

4) Safer emergency stops can be made with remote control unit operation. The very fast reaction of an emergency application due to the fact that pneumatic brake system is divided into two units which operate simultaneously to reduce the "run-in" of slack.

We had the misfortune to have a derailment close behind the lead units when descending a 2.2% grade. The derailment was observed by the engineman, who immediately applied the brakes in emergency.

In all similar derailments in conventional trains, the rear of the train pushed forward causing a buckling action at the derailment with subsequent heavy track damage and severe damage to rolling stock.

In this particular case, the brakes in the rear of the train applied immediately and the severe pushing action was avoided to the extent that the derailed cars did not leave the grade. The damage to both track and equipment was very light.

5) Fire hazard, due to braking, can be greatly reduced. A portion of the PGE is in the dry belt of the interior of British Columbia and summer extreme temperatures often reach over 100°F. The fire hazard is great and brakeshoe sparks can quickly start uncontrollable fires. We have found that the dynamic braking supplied by the remote units along with the lead units enables us to handle heavy trains down our steepest grades with a minimum brake application of five to seven lbs. During the fire season, PGE is compelled to run fire patrols after each train in the dry belt territory. Costs incurred in this service in 1970 were $40,588.00. We feel that when all of our trains are equipped with remote control units, we can eliminate fire patrols completely.

6) While it is obvious that longer and heavier trains can be handled, we feel that major advantages accrue in the following areas of the air brake system.

   i) Brake pipe gradient is reduced and, as a result, the train braking power is increased, thereby shortening stopping distances.

   ii) Brake release times are reduced

   iii) Charging times are shortened. This is particularly important in extremely cold weather when brake pipe leakage forces us to reduce tonnage and run shorter trains.

PROBLEMS

One small problem which has been encountered is that when a brake application is made during a momentary loss of communication between the master and remote units, a continuous blow on the lead unit results and the brakes do not apply.

The situation is rectified by immediately pressing the release button and then reapplying the automatic brake. I believe that some roads manually cut out the feed valve on one or more units of a multiple unit remote consist on short trains so that it is impossible for the remote units to keep brakes pumped off under these conditions. We have not found it necessary to do this as the continuity loss is so short that the normal application is made within seconds.

A second problem is not with the equipment but with our air brake laws and regulations. We operate in sub zero temperatures (40-50 below) in northern British Columbia and it is our intention to run remote units over the entire line. One advantage with the remotes is the ability to maintain full train line pressure under the coldest conditions. Air recovery is fast, high (90 lb.) brake pipe pressure can be maintained and train handling is excellent even with heavy leakage. However, we still must use the leakage test with a maximum of 7 psi leakage. We feel that leakage does not control trains; the standards in which we are interested is the pressure we have in the equipment reservoirs and the speed with which it can be restored. Certainly we agree that there are limits to leakage, but we feel that if gradient is held within 15 lbs., recovery is reasonable and leakage can be compensated for by a pressure maintaining brake system and trains can be handled with complete safety. There is no doubt in our minds that a freight train operating with 90 lbs. trainline pressure, 8 psi leakage and 10 lbs. gradient, although illegal under existing regulations, has greater safety than the same train reduced to a 70 lb. trainline in order to bring the leakage within limits.

FUTURE PLANS

During 1971, we will put three more remote cars into service along with four sets of lead equipment to be installed in new power. It is our intention to increase this equipment on a pre-planned basis until all of our through traffic is handled in this manner.

We will be able to keep our density of traffic to a point where it is manageable, hold our crew complement to a minimum, which will enable us to handle bulk coal, grain, concentrates and lumber to export markets at a rate which keeps our resources competitive on the world markets.

There are tremendous deposits of both steam and coking coal adjacent to our road, which will be exploited in the near future, and these resources could not be moved economically without the use of remote units.

To sum up our feelings on remote control unit operation—it is not without problems but we believe because of our heavy adverse grades and the fact that we are a resource railroad, it is our only practical method of operation.