Quebec, North Shore & Labrador...

...signaling includes a power switch at south end and spring switch at north end of each siding, and the block is from siding to siding. Communications on one wire pair include dispatcher's phone and 11 channels of carrier for telephone and Teletype as well as CTC code and carrier. Radio on trains and in yards.

Numerous special features are included in the signaling and communications facilities on the recently completed Quebec, North Shore & Labrador Railway, which was built to haul iron ore from Schefferville, southward 363 miles to docks at Seven Islands, on the north shore of the Gulf of St. Lawrence, 484 miles down the St. Lawrence river from Montreal.

The first ship was loaded with ore on July 31. Approximately 1.5 million tons is the goal for the 1954 season; about 6 million for 1955 and perhaps 10 million for 1956. Three ore trains are being operated daily. For a season of 165 days, 10 million tons will require seven 100-car trains of ore southward and an equal number of empty cars northward every 24 hours.

In addition to ore trains, numerous work trains and supply trains are being operated. In future normal operations the railroad expects to operate one "heavy supply" and two "express supply" trains each week. The "express supply" trains will distribute food and other lightweight supplies. The "heavy supply" train will haul heavy supplies to railroad camps, and do whatever switching is necessary.

Most of this railroad was built through very rough terrain. The first 10 miles is on an open plain with light ascending grades. Near MP 12 a 2,206 ft. tunnel leads through to the Moisie river. For the next 138 miles the railroad follows up the valleys of the Moisie, Nipissis and Wacouno rivers and headwater lakes, and thence to the Quebec-Labrador boundary at MP 150 which is the height of land at 2,056 ft. Then the line goes across the plateau, but in general follows the Ashuapi and Menihke lakes to MP 330 where it turns across the grain of land to Silver Lake yard at Knob Lake, now known as Schefferville which is on the south edge of an iron ore area 80 miles long and 6 miles wide.

Grades are Controlling Factor

For the most part, the heavy ascending grades are northward, with one section of 1.32 per cent about 16 miles long between MP 59 and MP 75. Southward there are a few sections of ascending grade that range up to 0.4 per cent between the mines and the height of land at MP 150. The tonnage of loaded cars which locomotives can haul up these 0.4 per cent grades is the controlling factor, rather than the tonnage of empty cars up the 1.32 per cent ascending grade northward. Maximum curvature is 8 degrees, and all the sharp curves are in the rugged country between MP 12 and MP 97.

Trains stop at Oreway, MP 186,
for inspection and to change crews. Normally the southbound trains of loaded cars run from Silver Lake yard to Oreway 180.4 miles without stop, and from Oreway to Seven Islands yard 186 miles without stop. At present the speed of loaded trains is limited to 30 m.p.h. maximum, and to 20 m.p.h. on descending grades. When the roadbeds are settled and rock ballast is required, the capacities of 125 ore cars including a four-unit diesel locomotive and a caboose. The turnouts to the sidings are No. 12 with 22 ft. 6 in. points.

Special Type of CTC

The centralized traffic control was designed to meet the special requirements of train operation on this road. The loaded ore trains, which move south, stay on the main track when making meets with northward trains of empty cars, which take siding. To route northward trains into sidings, a power switch machine was installed at the south end of each of 22 sidings. A spring switch at the north end permits northward trains to pull out without stopping. Power switches were installed at both ends of Oreway siding where the crews change. The southward signal 185, located immediately in approach to the spring switch is an automatic signal that serves two purposes: (1) as facing-point protection for the switch; and (2) as an approach signal to control signal 25L at the south end of the siding. Northward signal 163 is the approach signal for the northward dispatcher-controlled signal 25R at the power switch.

Normally the trains of the same direction are spaced uniformly throughout the 24 hours. If four ore trains are operated southward they are about 6 hours apart and run maybe 100 miles apart. Accordingly there was no reason for installing intermediate automatic block signals to permit following trains to occupy the same siding-to-siding block, the longest of which is about 22 miles. Referring to Fig. 2, a typical block (for use by one train at a time) extends from one power switch to the next power switch; for example, from northward signal 21R at Kemat to northward signal 25R at Tellier.

Signal Aspects

The signals are the searchlight type. A high signal, such as southward signal 25L, at Tellier, normally displays the Stop aspect, red-over-red. This signal can be controlled by the dispatcher to display green-over-red which authorizes a train to proceed to signal 21L at Kemat. These are the only two aspects displayed by signal 25L. A signal such as 21R at Kemat can be controlled to display green-over-red, to authorize a train to proceed to signal 25R at Tellier. With the power switch reversed, signal 21R displays red-over-yellow to authorize a train to enter the siding. Dwarf signal 23R displays green to authorize a train to pull out of the siding and proceed to signal 25R at Tellier. Approach signal 163 displays the green aspect when signal 25R displays green-over-red, and approach signal 163 displays yellow when 25R displays red-over-red, or red-over-yellow.

In each siding-to-siding block the track circuits are the either-direction coded type. Normally these track circuits are deenergized. When a signal such as 25L is to be cleared, a preliminary part of the controls is to feed the track circuits northward from Kemat to Tellier, in cascade. The power switches are operated by GRS 24-volt switch machines.
View showing rear of southbound train on main track and dwarf signal on the siding to direct northbound empty-car train to pull out through spring switch

which include dual-control, so they can be operated by hand when making switching moves. The buffer-spring units for the spring switches are the Mechanical Switchman type made by Pettibone-Muliken, and each such layout includes a mechanical facing-point lock made by the General Railway Signal Company. Vertical-pin type front rods and switch rods, made by Ramapo Ajax, are used in the power switches, as well as in the spring switches. Each layout includes four insulated gage plates with Racor adjustable rail braces, made by the Dominion Brake Shoe Co. Two of the gage plates extend and are attached to the switch machine to maintain the exact distance between the machine and the stock rail.

The power switches and signals for authorizing train movements, on the entire 363 miles of road, are controlled by levers in the dispatcher's machine at Seven Islands. The track diagram on this machine has lamps which are lighted to show the locations of trains when on a corresponding track section of main track or on sidings. The desk section of the machine includes an automatic graphic recorder that records the movements of trains. The major items of equipment for the signaling system were furnished by the General Railway Signal Company.

Fast Movement From Yard to Dock

The receiving yard at the Iron Ore Company's Seven Islands terminal has five tracks, each of which has a capacity of 125 cars. Ordinarily the fifth track is left open as a running track. Area is available for five more tracks. From the receiving yard, cars are pushed up to the hump leading to the classification yard.

Sometimes the fogs are so heavy that the retarder operator cannot see the cars when passing down the hump and through the retarders and switches. Therefore a row of six General Electric sodium vapor lamps were installed just below the hump along the track and master retarder, on the side opposite the office and the retarder control tower. Even in a dense fog, these lamps cast shadows of cars so the operator can see their progress. On each car, the car number and light weight are in “Scotchlight” reflecting print to assist the scale clerk in identifying car numbers, and as an aid to the retarder operators in watching the progress of cars.

Because all of the cars to be classified are loaded, a very low "hump" is sufficient. From the receiving yard
a grade of 1 per cent ascends to the
hump which is at elevation 50 ft.
From the hump the grade descends
at 1 per cent for 145 ft. including the
scale which is 60 ft. long. Then
the grade descends at 0.97 per cent
for 95 ft. including the 86-ft. master
retarder. Then the grade descends
at 0.485 per cent for 515 ft. through
the 88-ft. group retarder on the lead
connecting to the eight yard tracks.
Then a grade of 0.18 per cent ex-
necting to the eight yard tracks.

The seven switches leading to the
classification tracks are operated by
high-speed 110-volt electric switch
machines. At each switch there is a
color-light type indicator “target”,
which indicates the position of the
switch; green for normal and yellow
for reverse.

The reason why the cars must be
classified is that they must be
grouped for dumping so that the
ore mixture, when delivered into the
hold of a ship, will meet the
selling specification. Before leaving
Silver Lake yard near the mines,
samples are taken of the ore in each
car. Analyses are made by the chem-
ical department of the Iron Ore
Company, and while the trains are
on the way south, the information is
sent by Teletype to the dock office
at Seven Islands, and is used in con-
junction with the train consist re-
port to prepare the switching list.

An IBM card-to-tape machine
makes a train consist tape from the
punched mine waybills which is
being added, and space is available
for a total of 45 tracks. Power
switches and retarders are in serv-
ice, using conventional lever con-
trols. Automatic switching controls
and automatic retarder controls may
be added later when the yard is
enlarged.

From Cars to Ships

At the lower end of the classifi-
cation tracks, side-arm pusher loco-
motives, running on narrow-gauge
tracks alongside the classification
tracks, move the cars, two at a time,
to the Barney pit; from which the
barney hoist pushes the cars, two at
a time, into the rotary car dumper
which empties the cars. The whole
two-car cycle can be completed
every 65 seconds. When dumped,
the ore goes through a crusher and
onto a belt conveyor which loads the
ore into the hold of a ship at the
dock, or if no ship is waiting, the ore
is taken to a stock pile nearby. The
maximum capacity of the conveyors
is 8,000 tons an hour with an aver-
age of about 6,500 tons. At this rate
a 25,000 ton ship can be loaded in
about 4½ hours, requiring 300 cars
of ore.

When ore is to be taken from
the stock pile, a 7-ycd. shovel loads
it into cars. Samples are taken of
the ore in each car, and then the
cars are routed through the classi-
fication cycle as previously dis-
cussed. Thus this introduces addi-
tional operation of the classification
yard, over and above the incoming
cars from the mine.

After the cars pass through the
dumper, they roll by gravity around
a 190-degree curve, leading to an-
other retarder 49 ft. long and to power switches where the cars are routed to any one of the four tracks in the “empty-car” yard. In this yard, trains are made up by the terminal personnel, and are handed over to the Q.N.S.&L. Railway which operates only between yard limits at Seven Islands and Schefferville. Once within yard limits, the further handling of trains is assumed by the Iron Ore Co. itself, although railway crews bring their train into the yard on arrival and out on departure. The power switches, retarders and control machines in these yards were made by the General Railway Signal Company.

Power Supply for Retarders

The car retarder motors operate on 220 volts d.c., and the switch machine motors on 110 volts d.c. A diverter-pole motor-generator, rated at 285 volts, 10 kw output, is normally in operation to provide a floating charge across a set of 180 cells of 142 a.h. Nicad storage batteries. The 265-volt feed for the retarders is across the battery. Feeds for the switch motors, at 132 volts, are in groups, each of which is across half of the battery.

The track circuits in the yard are straight a.c. If the incoming a.c. fails, the a.c. required for track circuits, lamps, etc. is supplied by a motor-generator set which starts automatically and is fed from battery. The output of this machine is rated at 21.7 amp., 110 volts a.c. A second and similar power supply is in service in the “empty-car” yard.

Only Four

The railway pole line is unusual, not only because of its construction but also because it has only four wires. One pair, at the top, is for the 23,000-volt single-phase power for the signal system, and future wayside-to-train radio, and the bottom pair is for the CTC line code and similar power type communications.

Each line “wire” consists of seven strands of bare aluminum which are spiral wound around a steel core. The overall conductivity is equal to No. 6 copper. Where the terrain permits, the poles are spaced 20 to the mile, 284 ft.; however, where necessary some of the spans range up to 1,500 ft. High-voltage insulators, made by Ohio Brass Company are used not only on the 23,000-volt a.c. pair, but also on the communications line. These power type insulators, made by Ohio Brass Company, are used on the 23,000-volt a.c. line in an effort to reduce the usual attenuation fluctuation between dry and wet weather by taking advantage of the high leakage path (128 in.). Physical construction requirements using No. 4 ACSR and armour rods requires a physically large insulator in order to properly support and tie the conductor. The OB insulator is of the noise free type to further reduce the possibility of noise in the communication system. The insulators are on metal side brackets; the 23,000-volt pair, at the top of the pole, are 36 in. apart, and the second pair, 13 ft. 6 in. lower, are spaced 24 in. The power wires are not transposed being a balanced system supplied from a supply transformer with the center tap grounded, but the bottom pair are in a continuous roll that is completed every fifth pole, thus minimizing interference.

The 23,000-volt a.c. signal power is fed north from Seven Island to Oreway, 186 miles. From a hydroelectric plant at MP 330, the 220-volt signal power line is fed south to Oreway and north to Silver Lake yard. The 23,000 was chosen since it is low enough not to be troublesome from corona and insulation problems, and yet provides good voltage characteristics on the system. It is to be noted that the supply is 23,000 line to line but only 11,500 line to ground due to the center tap feed arrangement. Special precaution was taken in engineering the power system to minimize the possible of induction and noise problems even to the point of specifying a TIF (telephone interference factor) of 15 or less for the generators installed in the hydro plants.

Line Wires

Line-break knife switches are located at the south end of each siding so that the line can be sectioned in case of trouble. No small capacity 23,000-volt transformers are commercially available. Therefore, at each siding two 11,500-volt transformers with the primaries in series, are connected to the 23,000-volt line. The 220-volt secondaries of the two transformers are connected in parallel. Each transformer is rated at 3 kva, totaling 6 kva. The 220 volts feed the low-voltage transformer to supply the signal lamps and to operate the rectifiers.
to charge the storage batteries. The 220-volt power is extended on a separate pair of line wires to the signal at the spring switch end of the siding and to the approach signal in the opposite direction.

At each power switch, a set of 18 cells of 180-a.h. storage battery feeds the switch machine motor and the coding equipment. A set of 9 cells of 120-a.h. storage battery feeds the local 12-volt controls and is standby for the signal lamps if the a.c. fails. At each spring switch, 18 cells of 90-a.h. battery operates the coding equipment, and 9 cells of 185-a.h. battery supplies the local 12-volt circuits and serves as standby for the signal lamp. At each outlying approach switch, such as signal 16 in Fig. 2, there is a set of 9 cells of 120-a.h. which feeds the signal operating coil and the lamp.

At siding switches and at approach signals, where a.c. power is available to operate rectifiers, storage batteries are used to feed track circuits. Each OS track circuit is normally energized by two cells of 120-a.h. storage battery connected in series. Also there is a similar normally-energized track circuit on each siding, which is used to control the track-occupancy lamp on the dispatcher's control panel. These track circuits do not enter into the control of signals. Track circuits other than those mentioned above are normally deenergized, coded, and where a.c. is available, each such track circuit is fed by one cell of 120-a.h. storage battery. All the storage batteries listed above were made by the Nickel Cadmium Battery Corp.

At the track cut locations between sidings, no a.c. is available, and at each such location there are two sets of four cells each of 1,000-a.h. Edison primary battery type M-1302. One set of these batteries is used when the feed is north, and the other when the feed is south.

Many Circuits on Bottom Pair

The bottom pair of line wires handles as many as 21 circuits, including: (1) the CTC codes as d.c. pulses and as carrier; (2) the dispatcher's telephone as a physical pair; (3) eleven carrier voice channels and six frequency-shift Teletype circuits derived from carrier. The CTC uses conventional d.c. code, at 150 volts, for the 181-mile section from the control station at Seven Islands to Oreway. Coded outgoing CTC carrier is superimposed on the line wires between Seven Islands and Oreway. At Oreway, this carrier code is converted to d.c. codes for controls to CTC field locations on the 181 miles between Oreway and Silver Lake yard. From these field stations, d.c.
indication codes go south to Oreway where they are converted to coded carrier, to go on back to the control machine at Seven Islands.

The dispatcher's telephone is on the two-wire physical circuit. This line is connected to phones in boxes at ends of sidings, at spurs leading to gravel pits, stone quarries and in headquarters of track crews and signal maintainers. From Seven Islands north to and including Oreway there are 26 such phones. From Oreway north to Silver Lake yard there are 25 such phones.

Special Protectors

At each of these telephone locations, a special protector was installed to prevent personal injury to a man using the phone if the 23,000-volt a.c. power line should break and fall onto the lower pair of line wires or if high voltages from induction should appear on the code line due to faults on the power pair. However, both conditions would be for a fraction of a second only until the fault protection functioned to remove voltage from the power line. One item in each of these protectors is a 1-to-1 transformer to isolate the telephone circuits. Rare-gas arresters operate to ground if more than 450 volts comes in. If more than 4 amp. of a.c. flows, the lines are shorted to ground by a relay. A particular interesting feature of the protector is the unique electrical characteristics of the unit as a whole. Sufficient inductance and the necessary capacitance was added to the relay inductance to make the whole unit function as a carrier bridging filter usable from 10 to 200 kc. If a surge of more than 440 volts comes in, a relay is operated to ground the line. Capacitors are connected across a choke to form a filter. As originally installed, these chokes caused leakage which prevented proper operation of the CTC carrier. This trouble was corrected by replacing the iron cores in the chokes. These special protectors, which cost about $300 each, were made by Osborne Electric Company Limited, Toronto.

Carriers for Communications

The through telephone circuits are derived from 11 sets of Westinghouse single-channel carrier, which operates at 8 watts on the line, and therefore goes through with one repeater station for 363 miles. Six channels, between 40 kc and 180 kc are used as voice for through telephone service between offices at Seven Islands and Schefferville. Four channels are used as voice between Seven Islands and Oreway. When construction is finished, perhaps two of these channels will be changed to operate all the way between Seven Islands and Schefferville.

The frequency-shift Teletype channels are separate and operate independently of each other in the range 100-130 kc. One party line circuit connects No. 19 Teletype machines at the Iron Ore mine offce at Schefferville to a similar machine equipped with a perforator at the hump office in Seven Islands. No. 15 page printers are also con-
Automatic Telephone Exchanges and Radio

Automatic telephone exchanges, with phones in offices and yards are located at Schefferville and Oreway, these exchanges being manufactured by the Automatic Electric Company. Another automatic exchange made by the Telephone Manufacturing Company, London, connects the offices, yards and docks of the Iron Ore Company at Seven Islands in a private system. Subscribers on the telephone system at Seven Islands in a private system. Subscribers on the telephone system at Seven Islands, Oreway and Schefferville may dial each other direct or over the carrier system or may dial the Seven Islands operator for connection to the local Seven Islands telephone system or to the area toll center for long distance. The manual switchboard at Seven Islands is the point of connection with the local telephone company, and the operators actually act as attendants for the Knob Lake and Oreway exchanges, eliminating operating staff at these points.

About 50 road locomotives and 15 cabooses are now or soon will be equipped with two-channel radio. One channel is for communication, head to rear, between trains, and with wayside radio stations at Seven Islands, Oreway and Schefferville. When a locomotive is in the yard, the second channel is used for communication with the yardmaster. In addition to the conventional radio on each caboose, a walkie-talkie set circuit is operated for the Iron Ore Company operational traffic between Seven Islands and Schefferville. Teletype connects the Knob Lake and Seven Islands airport for company airline operations.

The railroad communications controls for the Seven Island area are located in a new 25-ft. by 47-ft. concrete building that has one story and a full basement. In the main room, the radio apparatus is along the north wall and the switchboard and carrier panels are on the south wall. The radio transmitter and receiver equipment for the road train radio station is the FMTRU type made by Motorola. Equipment of the same type is used for radio communication between Seven Islands and the hydro-electric plant at Clark City, about 25 miles west. Two sets of RCA radio transmitters are for communication with prospecting crews working in the bush, and with pilots of company aircraft.

The 11 panels of Westinghouse single-channel carrier are in two rows, and the wire chief's switchboard and test panel are at the left of this group. The manual switchboard, for connecting between the commercial telephone system and the railroad telephones, is in a sepa-
rate room at the east end of the building.

The telephone system is fed at 48 volts d.c. from a set of 23 cells of 50-a.h. Exide lead type storage batteries, that are on floating charge by a Lorain battery charger, known as a Flotrol. If the commercial a.c. power fails, a 10-kva gasoline engine-driven generator starts automatically to provide 220 volts a.c. The antennas for the radio are on an aluminum tower 100-ft. high, on the top of the building. A 90-deg. directional beam is used for the communications.

The pole line with the four wires is extended to a pole located about 100 ft. from the communications center building. As explained previously, the top pair are the 23,000-volt a.c. signal power line, and the lower pair is for the CTC line code and the communications, including the dispatcher's telephone as a physical pair, and 11 channels of carrier. On the pole 100 ft. from the building there is an arrangement of capacitors and protectors. In the 100 ft. between this pole and the building, the circuits are in buried coaxial cable.

**Tough Work Building Pole Line**

This railroad was built through rugged uninhabited country where previously there was no means of transportation other than on foot or in a canoe on the rivers and lakes. In order to maintain reliable communications, the pole line had to be built at the same time the railroad was laid, or ahead of the rail laying. Numerous work trains movements were required to bring up the ties, railroad, joint bars, etc., so that there was very limited opportunity to bring rafts of poles. Trucks, tractors and outboard motors were used to transport men and materials, as well as to move rafts of poles.

A maximum of 115 men were employed in pole line construction. These men were housed in temporary camps, constructed in advance of the rail laying. The pole line was completed to Knob Lake on December 23, 1953, and the golden spike was driven to complete the track laying on February 13, 1954. Thus the pole line was available throughout the major portion of the project to provide telephone communication needed to coordinate the overall construction project.

**Signal Construction**

After the main track and sidings were in place and the pole line completed, the signal construction work was pushed along as fast as possible with the forces available. The holes for the bonds were drilled with an Ohio Brass Company twin bond drilling machine. All the bonds are the rail-head pin type, about half were made by the Ohio Brass Company, and the remainder by the United States Steel Company.

The sheet-metal instrument houses at siding switches and the cases at approach switches are on concrete foundations, precast at Seven Islands. Between the housings and bootleg outlets, the track circuits are on No. 8 stranded single-conductor buried cable. The bootlegs are the 445-27 type made by Raco. Control circuits between housings and signals are on No. 14 stranded buried cable. A small crew specialized on the placing of switch machines and spring switches, and the installation of electric locks on hand-throw switches at spurs.

Power derricks or cranes were used to set the sheet-metal instrument houses, and to unload the switch machines, cases, signal masts etc. A maximum of 60 men and 3 foremen were employed on the construction of the CTC. During part of this period, a crew of 12 men and a foreman were installing the power switches, retarders signals and yard control machines.

On the entire project, mine, railway and terminal, the communications facilities as well as the centralized traffic control, power switches and the Seven Islands retarder yards, were installed by railroad forces. Where required for maintenance of communication and signal equipment in the mine and terminal area, men have been assigned from forces of the Q.N.S. & L. Railway, a wholly owned subsidiary of the Iron Ore Company. A. K. Hansen is superintendent of communications and signals with headquarters at Montreal and W. S. Switzer is signal engineer with headquarters at Seven Islands.