IRON ORE COMPANY OF CANADA

HISTORICAL DATA

1866-70

Reverend Louis Babel, O.M.I., a surveyor-missionary, made a long journey through what is known today as Québec-Labrador.

1892-95

A. P. Low, as a geologist for the Canadian Geological Survey, discovered large areas of iron formation and at a later date, published reports on the subject.

1938

Labrador Mining and Exploration Company acquired a concession in Newfoundland-Labrador from Weaver Minerals Limited.

1942-43

Hollinger Consolidated Gold Mines acquired control of Labrador Mining and Exploration Company. Also, Hollinger North Shore Exploration Company was formed and acquired, under license from the Québec Government, an area in New Québec adjacent to the Labrador Mining and Exploration concession. The M.A. Hanna Company joined forces with the Hollinger interests in both exploration companies.

1945-49

Exploration and development work proved in excess of 400 million tons of "direct shipping" open pit iron ore reserves.

1949

The Hollinger and M.A. Hanna interests joined with Armco, Labrador Mining, National, Republic, Wheeling and Youngstown to form the Iron Ore Company of Canda. Besides the financing provided by the partners, 19 American and Canadian insurance companies agreed to lend $145,000,000.

1950

A small steamer in the coastal trade slipped into the Bay of Sept-Iles with the first construction equipment. The tasks to be completed before the 1954 ore shipping season included:

a) Construction of a 357 mile mainline railway linking the Schefferville mining area with the receiving-shipping terminal at Sept-Iles.
b) Construction of two hydro-electric power plants capable of supplying the power requirements at Sept-Iles and Schefferville.
c) Construction of a receiving-shipping terminal at Sept-Iles, capable of handling 10 million tons of annual ore production.
d) Readying of the mine area for production, which included construction of roads and mine spurs, installation of ore processing plants and loading facilities, and construction of maintenance facilities for the mining equipment.

Completion of these tasks required the operation of the largest civilian airlift in history, building of maintenance and accommodation camps to house and feed 6,900 workers, and commencing the construction of two townsites to house permanent employees.

1954

On February 13th, Mr. J. R. Timmins drove the Golden Spike symbolizing completion of the Quebec North Shore and Labrador Railway. On July 15th, the first rail shipment of iron ore left the Schefferville marshalling yard — Silver Yard — for Sept-Iles.

On July 31st, the "Hawaiian" left Sept-Iles with the first shipment of Ungava iron ore.

1955

Iron Ore Company of Canada became the largest Canadian iron ore producer.

The "Vercharmian" reached the Contrecoeur Transfer Dock where iron ore was transhipped to Great Lakes canallers.

1958

Bethlehem Steel Corporation acquired an interest in the Iron Ore Company.

1959

Intensive mapping and drilling of the Wabush area, which was discovered by Labrador Mining and Exploration forces, and on which work was done early in 1949, was undertaken, with 1962 as a production target for the Carol Project.

The "Triconica" was the first vessel loaded with iron ore to go through the St. Lawrence Seaway.

1960

On May 22nd, the Golden Spike signifying completion of the railway owned by Northern Land Company Limited was driven. This 38 mile railway links the Carol Project to the main line of the Quebec North Shore and Labrador Railway and is jointly owned by the Iron Ore Company of Canada and Wabush Iron Company.

On August 10th, the Ore Drying Plant at Sept-Iles started its operations.

1962

The Carol Lake concentrator and the Smallwood Mine were officially opened in July.

1963

In April the Pelletizing Plant in Carol started its operations. In Sept-Iles, the second dumper and surge pile to handle pellets went into operation in May.

1964

On August 1st, 1964, exactly ten years to the day since the first iron ore was shipped by the Iron Ore Company, the one hundred millionth ton was loaded into the holds of the M.S. "Monksgarth" at the Terminal in Sept-Iles.

1966

The magnetic separation plant added to the Carol Lake Concentrator to increase the amount of high grade concentrate recovered from ore, started operating in March.

1967

Carol's Pelletizing Plant expansion completed, all lines in full operation by the end of the year. This expansion increased pellet capacity from 6 to 10 million tons per year.

1968

In the early summer construction was started on the Iron Ore Company's new dock which was designed to handle carriers of 250,000 tons. The design maximum loading rate of the two new shiploaders will be 15,000 tons per hour.

1969

In November 1969, the largest single cargo ever loaded in Canada was poured into the holds of the 100,000 ton "Skaufast" at the existing Company facilities in Sept-Iles.

At the end of the year work on the new dock was being completed with operation scheduled for early 1970.

1970

In February, the first giant carrier was loaded at the new dock.

A 290 million dollar expansion was announced. This would increase Carol concentrate production to 21.8 million tons and install a beneficiation complex at Sept-Iles to process Schefferville lean ore and produce 6 million tons of pellets annually.

1971

On March 5th, the 200 millionth ton of iron ore was shipped on the freighter "Chelsea Bridge". The vessel was the 9,616th vessel to put into Iron Ore Company docks for iron ore.

1972

Year of construction. New concentrator and pellet plant take shape in Sept-Iles.

1973

New Concentrator and Pelletizing Plant started operations in Sept-Iles. Expansion to the Concentrator in Labrador City completed.

1974

The 225,000 ton "Berge Adria", largest vessel to enter the Gulf of St. Lawrence, loaded ore at the Company docks.

1975

In May, the "Adria Maru" took on record tonnage of 165,400 tons. At year end, 25 years from start of construction, combined shipments totalled 292 million long tons.

STATISTICAL SUMMARY — AS OF JANUARY 1, 1976

DISTANCES

Sept-Iles to Schefferville:	320 air/360 rail miles
Sept-Iles to Montreal:	484 air miles
Sept-Iles to Baltimore:	1,550 nautical miles
Sept-Iles to Rotterdam:	2,636 nautical miles
Sept-Iles to Labrador City:	192 air/266 rail miles
Labrador City to St. John's (Nfld):	728 air miles
Sept-Iles to St. John's (Nfld):	656 air miles
Sept-Iles to Japan (Via Capetown):	14,700 nautical miles
Sept-Iles to Japan (Via Panama):	10,700 nautical miles

RAILWAY OPERATIONS

Locomotives	65-3000 HP
	18-1750 HP
Ore Cars	3600
Other Rolling Stock	1000
Ore Cars per train	165 minimum, 260 maximum
Tons of iron ore per car	between 85 and 100 long tons
Curvature: 611 Curves max. 8°	43 complete circles
Ruling grade southbound	0.5%
Ruling grade northbound	1.35%
Top speeds	30 MPH loaded, 40MPH empty
Running time:	
Sept-Iles/Labrador City	12 hours northbound
	14 hours southbound
Sept-Iles/Schefferville	15 hours northbound
	19 hours southbound

MINES AND EXPLORATION

Ore Reserves: Knob Lake Region:	380 million long tons
Carol Lake Region:	2 billion long tons
KNOB LAKE	
Electric Shovels:	6-10 cubic yards
	5- 6 cubic yards
Blast Hole Drills:	8 — for $9^{7}/_{8}$" diameter blast holes
Haulage Trucks:	34-120 ton diesel electric
Screening/crushing plants:	5 — located at Ferriman, Redmond, Retty, Rowe and Timmins Mines.

OPERATING MINES — 1976

Burnt Creek no. 5 (Que.)	
Fleming no. 3 (Que.)	Rowe (Que./Nfld)
Redmond no. 1 (Nfld)	Timmins no. 1 (Nfld)
Redmond no. 2 (Nfld)	Timmins no. 2 (Nfld)

CAROL

Electric Shovels:	13-10 cubic yards bucket capacity
Blast Hole Drills:	13 — from 9⅞″ to 15″ diameter blast holes
Haulage Trucks:	25-120 ton diesel electric
	15-130 ton diesel electric
	12-170 ton diesel electric
Concentrator:	23 million ton capacity (10 mills)
Pelletizing plant:	10.3 million ton capacity (6 lines)

OPERATING MINES — 1976

Smallwood
Humphrey
Lorraine

SEPT-ILES TERMINAL

SCHEFFERVILLE ORE AND PLANT FEED

Dumper No. 1 (tandem) — capacity	100 cars per hour
Shiploading — 2-60″ conveyor systems	4,000 LTPH each
Shiploading — 2-72″ conveyor systems	7,500 LTPH each
Stockpiling — 2-38″ conveyor systems	4,500 LTPH each
Stockpile — capacity	6,000,000 LT

CAROL PELLETS

Dumper No. 2 (single) — capacity	60 cars per hour
Surge pile — capacity	60,000 LT
Shiploading — 2-60″ conveyor systems	4,000 LTPH each
Shiploading — 2-72″ conveyor systems	7,500 LTPH each
Stockpiling — 1-48″ conveyor systems	2,000 LTPH
Stockpile — capacity	2,000,000 LT

CAROL CONCENTRATE AND PELLETS, KNOB LAKE PELLETS

Dumper No. 3 (tandem) — capacity	96 cars per hour
Stockpiling and shiploading 2-72″ conveyor systems	7,500 LTPH each
Stockpiling capacity	5,500,000 tons

GENERAL

Drying Plant (KL Direct Ore)	300 LTPH
Loading Dock No. 1-length	800 feet
Loading Dock No. 2-length	875 feet
Mooring Dock-length	800 feet
Dredged depth at dock no. 1 at mean low tide	37 feet
Dredged depth at dock no. 2 at mean low tide	60 feet
Maximum tide variation	12 feet

OPERATING SEASON

MINING

Knob Lake	(Ore)	260 days
	(Waste)	365 days
Carol	(Ore and Waste)	365 days

SHIPPING: ex Sept-Iles

Direct Shipping Ore	230 days
Concentrate and Pellets	365 days

WORK FORCE (complete project)

	1975 Average
Schefferville	1216
Labrador City	3013
Sept-Iles	3418
TOTAL:	7647

PRODUCTION AND SHIPMENTS (in thousands of long tons)	**1974**	**1975**
PRODUCTION		
A) Schefferville (total)	11,702	11,020
B) Labrador City (Pellets)	7,969	9,518
C) Labrador City (Concentrates)	13,175	16,227
D) Sept-Iles (Pellets)	1,999	3,154
SHIPMENT EX: SEPT-ILES		
A) Schefferville (direct)	6,568	4,069
B) Labrador City (Concentrates)	4,443	6,360
C) Labrador City (Pellets)	7,572	9,017
D) Sept-Iles (Pellets)	1,885	2,958
TOTAL:	20,468	22,404

RECORD MONTHS (in thousands of long tons)		
PRODUCTION		
A) Schefferville	Sept. 1,746	Sept. 1,672
B) Labrador City (Concentrates)	Dec. 1,463	Dec. 1,770
C) Labrador City (Pellets)	Dec. 900	Dec. 1,059
D) Sept-Iles (Pellets)	Nov. 253	April 341
SHIPMENT EX: SEPT-ILES		
A) Schefferville (direct)	June 1,038	July 848
B) Labrador City (Concentrates)	June 796	May 1,278
C) Labrador City (Pellets)	June 1,039	Dec. 1,123
D) Sept-Iles (Pellets)	Dec. 317	June 443

LARGEST SINGLE CARGO	1974	1975
	Arafura Maru	Adria Maru
	152,920	165,400

VESSELS LOADED	1974	1975
	560	564

KNOB LAKE MINING DIVISION

The center of current mining operations is adjacent to the town of Schefferville 320 miles due north of the port of Sept-Iles. The height of land dividing the Atlantic and Ungava watersheds in this area defines the provincial boundary between Quebec and Newfoundland-Labrador, and it is along this irregular boundary that the ore deposits are situated. Schefferville is located on the Quebec side of the boundary at 54° 49′ north latitude.

To date, forty-six separate deposits of iron ore, ranging in size from one to fifty million tons each, have been located and explored. Production since mining began is 184 million tons and the combined tonnage remaining in these deposits exceeds 380 million tons of direct shipping and beneficiating ore that can be extracted by open pit mining methods.

Approximately 60% of the reserve tonnage is located in Quebec with the remainder in Newfoundland-Labrador. The average natural iron content of the current shipments is better than 54% for direct shipping and 50% for plant feed. The chief mineral constituents of the ores, which vary in colour from yellow through brown, red and blue-black are limonite, goethite and hematite. Ores are subdivided into three main categories: non-bessemer, manganiferous and plant feed. Chief deleterious constituents are silica, alumina and moisture.

All mining is done by open pit methods utilizing earth moving equipment including 6, 8 and 10 cubic yard electric shovels, L-700 front end loader and 120-ton diesel electric haulage trucks, tractors, graders and rotary drills. As the ore is removed, it is transported by trucks to crushing plants where the size of ore chunks is reduced to less than two inches. From the crushing plants the ore is moved by conveyor belts to loading pockets where it is charged directly into rail cars.

The ore production season normally extends from mid-March to early December approximately 260 days. Average daily production depends on the annual commitment, but on occasion more than 100,000 tons have been produced in 24 hours. During the remainder of the year, when ore is not being produced, the waste rock and overburden overlying and adjacent to the ore bodies is stripped. For each ton of ore mined, two tons of waste must be stripped and hauled to the dumps.

The use of large equipment requires skilled tradesmen and operators while relatively few unskilled labourers are employed.

The mining division is subdivided into five main departments:

Operations
Maintenance
Engineering
Administration
Cost Services

OPERATIONS

The Operations Department is responsible for extracting the ore, loading it into rail cars and moving it to a marshalling yard from where it is transported by rail to Sept-Iles. Directly associated with the mining operation is the stripping of waste, construction of haulage roads and waste dumps, railway spurs, and control of drainage, etc.

The ore is mined from faces which average 38 feet in height. Before all of the ore on one level is removed, a sinking cut is made to expose ore on the next lower level. This assures continuous production. During the stripping season from December to March waste rock is removed to expose the ore required for the following ore season.

Each mine is under the supervision of a Mine Supervisor who controls one or more mining units. A unit is centered around an electric shovel and normally includes two to six haulage trucks, one or two tractors, a rotary drill, and a screening plant. Each unit averages fifteen workmen per shift under the supervision of a pit foreman. The Superintendent of Operations directs and coordinates the programs at the various mines.

A rail spur connects all operating mines with the marshalling yard and the movement of loaded and empty cars from the mines is under the direction of the Operations Department and is supervised by a trainmaster.

Other sections of the department look after the transportation of personnel and road maintenance. A rock crushing plant is operated to produce material for road surfacing, ballast, and aggregate. Another section drills wells, installs and maintains pumps and lays pipelines in order to keep the mines dewatered. Total pumping capacity is 27,042 U.S.G.P.M. from 37 operating wells. Other sections deal with blasting, blasting and drilling control, equipment studies and research.

MAINTENANCE

This department is responsible for the maintenance and construction work on all equipment and facilities. It is fully equipped, both in the main repair shop and in the mine service garages, to do servicing and repairs of all kinds. The department is divided into four sections: Mobile Equipment, Mechanical, Electrical and Construction, each under the direction of a Supervisor.

The Mobile Equipment section maintains trucks, tractors, graders, light trucks, and other wheeled equipment. Each mine has a service garage where the equipment of that mine receives regular service, minor repairs and tire changes. All other equipment is maintained at the main shops. A sub-section, the Motor shop, repairs mobile equipment components such as engines, transmissions and differentials.

The Mechanical section maintains the shovels, drills, and crushing plants and directs the work in the Machine shop, Heavy Component Repair Shop and Welding and Blacksmith Shops. Mobile crews of mechanics do field service and repairs on the larger equipment whereas small units and components are brought to the shops. In the Machine Shop, metal working machines such as drill presses, lathes, planers, and boring machines are used to repair equipment. Operation of the cranes and floats is directed by this section. Tradesmen such as mechanics, machinists, welders and sheet metal workers are employed here.

The Electrical section maintains, repairs and installs all electrical equipment, transmission lines, sub-stations and other parts of the electrical distribution system. The town and the Company are supplied with electricity by the Menihek hydro-electric station located 30 miles south of Schefferville, which is under the direction of the Maintenance Department. The shovels, drills, pumps, screening plants and others are dependent on this supply.

The Construction section deals with buildings and structures, their erection and maintenance. Carpenters, pipefitters and other tradesmen are employed here. Maintenance of the heating and ventilating systems also come under this section as well as erection of mine plants and buildings.

ENGINEERING DEPARTMENT

The Engineering Department consists of five sections which are known as Development, Mine Engineering, Design Engineering, Chemical Laboratory and Safety.

The Development Section is responsible for the development and exploration of deposits and adjacent areas within the main ore zone. The Development Section is divided into three subsections. These are Mine Geology, Tonnage and Test Drilling and Surface Development. Mine

Geology is responsible for the geological control required in the operating mines. Tonnage and Test Drilling is responsible for all of the development drilling required within the main ore zone. Surface Development is responsible for the mapping and trenching programs required. All sub-sections overlap on the interpretation of any one deposit and co-ordinate their efforts in the search for future reserves.

The design of all open pits, roads, railroads, as well as ore and stripping estimates, short and long range planning, permafrost blasting, bank stability and other geotechnical studies, are the responsibilities of the Mine Planning section. The Pit Engineering section is responsible for the Engineering Work at the mines, primarily to apply the Planning section designs in the mine areas. This involves sampling, and ground water control. The prime responsibility of the Grade Control & Engineering Studies section is to co-ordinate the mining of ore with the ore requirements of the Sept-Iles Terminal to enable cargoes to be loaded with a minimum of delay and stockpile recovery. Other responsibilities are the production of grade estimates, ore reserves, and non-routine studies of truck requirements, and equipment studies.

The Design Engineering section is responsible for all mechanical, electrical, architectural and civil engineering design work. The main areas of design are crushing and screening plants, mine buildings and garages, as well as domestic and industrial buildings and installations. Construction cost estimates, specifications, and bills of materials for buildings and plants, as well as the originating of purchase orders for materials and equipment, are part of the section's duties.

The Chemical Laboratory is responsible for the sampling and assaying of all ore shipped and the assaying of all samples sent to them from Engineering, Technical Services and Operations. The former is under the supervision of umpire chemists, Lerch Brothers Inc., but is performed by Company personnel. Sampling is done at the mine. As cuts of loaded cars arrive from individual mines, samples are taken from the top of each car, using a small scoop. Thirty-three scoopfuls taken from each of 6 cars represent one sample. Each sample thus represents about 500 long tons of ore. Samples are sent to the Chemical Laboratory where the percentage weights of iron, phosphorous, manganese, silica, alumina and moisture are determined on an X-ray spectrometer. Results are sent to the departments concerned and shipping sample details transmitted by computer to Ore Grading in Sept-Iles before the arrival of each ore train.

The Safety section assists supervision to provide and maintain safe and healthy working conditions and in safeguarding operating practices. Management delegates authority for safe operation down through various levels. The foreman is the key man in the accident prevention program as he is in constant touch with employees. The Safety section acts in a staff capacity to help administer policy, to provide technical information, to help train, and to supply program material.

ADMINISTRATION

The responsibilities of the Schefferville Administration Department include Accommodation of employees and their families, Catering, Personnel, Training, Warehousing and related functions.

COST SERVICES

The responsibilities of the Schefferville Cost Services Department include Accounting, Data Processing, Statistics, Budgets and related functions. Company policy in many of these areas is formulated at the Head Office in Sept-Iles. Head Office and Schefferville Cost Services Department collaborate closely in all respects.

Redmond Mine — Schefferville

TOWN OF SCHEFFERVILLE

The town of Schefferville, named in honour of Bishop Scheffer, is located in the heart of the Labrador Peninsula, 320 miles due north of the port of Sept-Iles. The town lies between Knob and Pearce Lakes in Quebec at latitude 54 degrees 49′ N and longitude 66 degrees 50′ W, and is the center of current iron ore mining operations in this area.

Actual construction on the townsite began in late 1953, but it was not until the spring of 1954, when the Quebec North Shore and Labrador Railway was completed that construction was carried out on a large scale.

The town was incorporated in 1955 under the Act to organize mining towns and since that time its affairs have been administered by a mayor and four aldermen, directly responsible to the Quebec Government under the Towns Act.

Planning and layout of the town was done by the engineering department of Iron Ore Company of Canada with assistance and guidance from the Department of Mines, Quebec. A large area in the central portion of the town was reserved for construction of schools and churches. A similar block was reserved for development of commercial enterprises.

The residential area of the town has approximately 670 permanent family dwellings of 18 different styles, ranging from single bungalows to four-family apartments. In addition, a trailer park has been established and now includes approximately 110 units. In 1972, a new 106-unit settlement was built in Schefferville, to replace the reserve a few miles out of Schefferville, which was home to some 700 Montagnais and Naskapi Indians. In 1975, a three year program was launched for the addition of 225 bachelor units to be rented to employees now living in bunkhouses. 48 of these prefabricated units were installed in 1975. The paved streets are laid out on gentle curves with concrete sidewalks. Lots are landscaped and planted with grass and shrubs.

In the center of the town there are three churches and three modern school buildings. The Roman Catholic, Anglican and United Churches are represented while one Protestant and two Catholic schools provide the necessary facilities for educating the numerous children.

The commercial area of the town includes two banks, a theatre, two hotels, restaurants, hardware store, service stations and general department and grocery stores. Many smaller enterprises such as a news stand, hairdressing shop, ladies' and men's wear, jeweller, laundry, etc., are located in two commercial buildings. The Town Hall with the adjacent police station and fire station, as well as the federal post office are also situated in this area.

Medical services are provided by a completely equipped thirty-nine bed hospital with two doctors in attendance.

Daily commercial flights connect Schefferville to other centres. Quebec North Shore & Labrador Railway Aviation Division operates for Company personnel to and from Sept-Iles.

The Quebec North Shore and Labrador Railway operates two passenger trains per week to and from Sept-Iles. The rail journey of 360 miles requires approximately 12 hours.

Sports and cultural activities fall under the jurisdiction of the town. In 1975, all facilities were centralized under one roof comprising the Arena, Recreational Center, Cultural Center and gymnasium. The arena, complete with artificial ice, provides entertainment for 8 months of the year: hockey, skating, broomball. It can also be used for indoor sports during the summer months. In the Recreation Center, there are four bowling alleys, an olympic-size swimming pool, a three-sheet curling rink, library and conference room. The cultural society of Schefferville is formed by people whose aim is to promote the arts in general and the Cultural Center provides ample facilities for them, such as teachers, workshops for painting, sculpture, acting, photography, and handicrafts.

Outdoor activities include a baseball field, a soccer field, and two tennis courts. There is also, for the youngsters, a well equipped playground, open during the summer.

Three miles from the center of town, a ski hill with a 2,000 foot long poma-lift is the rendez-vous for skiers. The club also provides a 10 kilometer trail for cross-country skiing.

In 1976, Schefferville hosted the Arctic Winter Games, a sporting competition which grouped more than 1,000 athletes from Yukon, Alaska, North-West Territories and Northern Quebec.

Radio and Television coverage is provided live in both French and English by the Canadian Broadcasting Corporation.

The population of Schefferville is about 4,500. The town, which grew from the wilderness in the short space of eight years, is modern in all respects and a far cry from the usual impression that all mining camp towns are dull, drab and lacking in modern conveniences.

Aerial view of Schefferville

CAROL PROJECT

Carol Project is situated wholly within Newfoundland-Labrador, near the west shore of Wabush Lake at Labrador City, some 38 rail miles west of Mile 224 on the Quebec North Shore and Labrador Railway main line to Schefferville.

The Company commenced work in the area in 1949 but it was not until late 1958 that the decision was made to proceed with mining operations. During 1959 and 1960 a Pilot Plant was operated on the property and results obtained from it were used as a basis of design for the main concentration plant. The mining facilities, crushing plant, concentrator, office building and maintenance facilities were designed, erected and placed in operation during the period 1960, 1961 and the early part of 1962. In late summer of 1961 a decision was taken to build a pelletizing plant adjacent to the concentrator. This plant was designed, erected, and placed in operation during 1962 and the first half of 1963. Since the completion of the pelletizing plant, additional expansions to both the concentrator and pellet plant have taken place, with the most recent having been completed in 1973. Today, Carol Project has the capacity to produce 21.8 million tons of concentrate from which 10.3 million tons of pellets can be produced, leaving 10.4 million dry long tons of concentrate for sale as concentrate.

The operation at Carol is broken down into three main divisions:

Mining
Beneficiation
Administration

MINING

a) ORE DEPOSITS

The ore deposits in the Carol Lake area are located in hills rising 500 to 1,000 feet above the adjacent lakes, and the majority of them are covered by very little overburden. The iron ore in these deposits occurs as Magnetite (Fe_3O_4) and Specular Hematite (Fe_2O_3), usually called Specularite. The average grade of the ore bodies is 38.4 percent iron. The initial mining operation was started on the Smallwood ore body which had a potential in excess of 500 million long tons. Mining is now carried out on the Humphrey and Lorraine deposits as well. An extensive programme of diamond drilling, ore analyses, and surveying is continuously being carried out to further define ore body limits and reserves.

b) HAULAGE

The ore bodies are mined in a series of 45 foot high benches. The broken rock is loaded onto haulage trucks by 13-10 yard shovels. The trucks haul the crude ore to three loading pockets having surge capacities of 2,500, 18,000 and 60,000 long tons respectively. An apron feeder under each surge pocket draws out and loads the ore into the ore cars which are moved underneath. Each ore train has twenty 100 long ton capacity ore cars.

Seven ore trains are continuously in motion carrying crude ore from loading pockets to the two crushers, and returning empty to the mine. This railway is fully automatic in that there are no personnel operating the locomotives or the switches. The starting, stopping, inching, reversing and travel of the trains as well as switch operation is accomplished by servo-mechanisms receiving electrical signals and then performing the various control functions.

Each locomotive is driven by electric motors and power is transmitted to the units by an overhead continuous catenary or trolley wire.

Waste removal is carried on continuously and the 1976 program includes 5,000,000 cubic yards.

c) MAINTENANCE

The Main Repair Shops, located in the Service Building adjoining the Warehouse and Concentrator, include approximately 70,000 square feet of maintenance floor area. Shops are provided for welding, plate work, machining and repair of mine equipment (shovels, drills, pan-feeders), mobile equipment (haulage trucks, loaders, dozers, graders, cranes and service trucks), mill and pellet plant equipment (screens, chutes, cyclones, pumps, etc.), electrical and control equipment (motors, generators, relays, etc.) as well as tires and equipment components.

Two Mine Service Garages, located in the mine areas, have approximately 41,000 square feet of maintenance floor area. They provide for the day-to-day servicing of all mobile equipment in the mine area and the overhaul and repair of the large haulage trucks.

d) ENGINEERING

The Mine Engineering section provides services to the Mine Operations Department, in the field of geological engineering, surveying, mining, blasting and dewatering.

BENEFICIATION

Concentration

a) CRUSHING

Ore, having a maximum size of 5 feet and varying from fines to this limiting size, is received from the three mine loading pockets located at distances of 5, $5^{3}/_{4}$, and $7^{1}/_{2}$ miles from the crusher house. The average daily rate of crude ore extraction is 120,000 long tons. Two 60 x 89 inch gyratory crushers are used to crush run of mine ore to a maximum size of 6 inches in one pass.

The crusher is fed by side dumping cars each containing 100 tons of ore. At the crusher dumping point the cars are lifted on one side by a mechanical car dumper and the contents are discharged into the respective crusher surge pits. Two cars are dumped simultaneously.

On passing through the crusher the ore falls into a surge pocket and is drawn from there by means of an apron feeder. The level of ore in the surge pocket is indicated to the crusher operator by means of three radio active probes which enable him to dump ore on ore and not on an empty apron feeder which could thereby be damaged.

From the apron feeders the ore is discharged from each crushing installation respectively to two 60-inch conveyors. These conveyors feed to two shuttle conveyors which distribute the ore throughout the covered ore storage building.

The levels of ore throughout the ore storage building are indicated by electronic probes which register on the crusher operator's control panel.

The ore in the ore storage building is fed by conveyor belt to ten Aerofall Mills.

b) GRINDING

As the iron ore values are dispersed throughout the mined rock, intermixed with silica impurities, it is necessary to grind the ore to such a size where it is liberated from the associated undesirable minerals.

The grinding is done in ten dry autogenous Aerofall Mills. Eight mills in the original plant are 22 feet in diameter and two mills in the new plant section are $34^{1}/_{2}$-feet in diameter.

The crushed ore is extracted from the covered storage area by means of feeders located beneath the storage. From the feeders the ore is fed to the individual mills by conveyor belts. The rate of feed to the mills is controlled by a sonic listening device placed beneath the mills so that the ore condition in the mills is known and maintained at an optimum level.

At the ore feed point to the mills, heated air is supplied to remove all moisture in the ore. The autogenous grinding action of the mills reduces the ore to a sand which is drawn from the mills by an air stream. This air stream passes through three stages of classification from the 22-feet mills and two stages from the 34 1/2 feet mills during which the heavier particles are removed. All particles larger than 14 mesh (0.046 inches) are screened out and returned to the mills for further size reduction.

The dust laden air which leaves the last classification stage is cleaned in two stages of wet scrubbers in the 22-feet mill system and one stage of wet scrubbing followed by electrostatic precipitators in the 34 1/2-feet mill system before being emitted to atmosphere.

The ground product from the mills is subject to positive classification on screens.

The screened ore is fed by means of 4 tripper conveyors to the coarse ore surge bins which feed 30 individual spiral lines.

All ore concentration is accomplished in 5-turn Humphrey gravity spirals. These spirals are curved sloping launders which utilize the forces of gravity, centrifugal action, and friction to separate the high specific gravity iron grains (Sp. gr. — 5.0) from the lighter waste rock particles (Sp. gr. — 2.6). The iron ore grains (concentrate) are collected along the inner edge of the spiral while the waste particles are washed out and down the spiral along its outer edge. In order to produce an acceptable grade of concentrate (65.7% iron), three successive stages of spiralling are necessary. The first stage, called the "roughers", is used to produce a finished tailings and a rougher concentrate. This concentrate is cleaned by being put through cleaner spirals, then recleaner spirals. The tailings, produced on the cleaner and recleaner spirals contain some iron and are fed back to the rougher spirals. The recleaner spirals concentrate is of acceptable grade and is fed to filters, where free moisture is removed, then conveyed to the stock pile, to train loadout silos, or as feed to the pelletizing plant. All rougher tailings are pumped to the Magnetic Separation Plant.

The concentration plant has 30 spiral lines for a total of 7,056 spirals. Water is used to transport the ore (as a pulp) to the spirals. The plant water is supplied by 6-10,000 GPM pumps and 2-15,000 GPM pumps located at Wabush Lake. Normally, approximately 200,000 GPM of pulp are circulated in the plant, 35,000 as fresh water while the remainder is continuously reclaimed from the process tailing by dewatering cyclones.

d) MAGNETIC PLANT

A magnetic plant addition to the concentrator was designed and constructed in 1965/66. This plant became operative in March 1966. A further expansion of this complex was completed in 1973. The function of the magnetic plant is to remove all magnetite from the tailings waste of the spiral process where, because of the fine grain size, the material could not be effectively concentrated.

The feed to the plant is in slurry form. This is dewatered, the reclaimed water is returned for re-use and the thickened pulp is fed to cobber magnetic separator drums where the magnetic material is removed from the non magnetic waste.

The concentrate from cobber separators is dewatered and fed to four ball mills, three mills of 1,200 HP and one mill of 4,000 HP. The magnetic material has to be reduced in size to liberate mineral values from associated magnetic impurities. This ground product is fed to the second magnetic separation stage where a concentrate and tailings separation is made.

This rougher stage concentrate is treated in three stages of mine wedge screening where oversize, requiring further grinding, is screened out and recirculated. The screened undersize,

the final product, is pumped to the pellet plant thickeners where it is stored pending further processing prior to pellet manufacture.

The tailings from the magnetic process are dumped by means of two-stage pumps to the tailings disposal area.

Pelletizing

Pelletizing is a means of physically converting the concentrates available from the concentrator to approximately 1/2 inch round balls (pellets) which are more suitable for blast furnace feed.

a) REGRINDING

The finished concentrate which is fed to the pellet plant is predominantly plus 150 mesh in size. This is reground in thirteen wet ball mills having a total capacity of 38,000 horsepower. The ball mills output is pumped to cyclones where a separation is made. The cyclone overflow, containing 65 to 70 percent minus 325 mesh is fed by gravity to two 150-feet diameter outside thickeners, while the underflow is fed back to the ball mills for regrinding.

The thickners overflow clear water is re-used in the process.

b) FILTERING AND BALLING

Twenty-six identical sets of disc filters, feeders for ground concentrate and bentonite, balling drums and seed screens form the basis of the balling circuits. Four balling circuits supply green balls to indurating furnaces 1 through 4, and five balling circuits supply furnaces 5 and 6.

The thickener underflow is pumped to disc filters where it is filtered to approximately 9% moisture then dropped into a small storage bin. A rotary table feeder discharges a controlled amount of concentrate onto a feed belt. Bentonite (used as a binder to provide strength to the green feed balls) is added in ratio of approximately 20 pounds per ton of concentrate, and then mixed intimately on the belt.

The blended feed is discharged into a rotating, inclined, open end balling drum along with seed balls returned from the drum discharge screen. As the drum rotates the seeds roll on the loose concentrate and pick up layers of it thereby increasing in size (much the same as rolling a snowball). At the balling drum discharge a screen separates green pellets at 11/32 of an inch. The pellets smaller than this are returned to the balling drum for further passes while the larger pellets form the feed to the indurating furnaces.

c) INDURATION

The indurating furnace converts the wet green balls into hard finished pellets by heating them to approximately 2,500 degrees Fahrenheit. During this temperature rise the thousands of tiny particles of concentrate that make up each green ball are, in effect, cemented together by intercrystal growth and some slag formation at points of contact between particles. Prior to heating, the balls must be dried (without excessive ball crumbling) and, after heating, they must be cooled sufficiently for handling on conveyor belts. To accomplish these functions, a travelling horizontal grate carries the balls through the various zones in the furnace as follows:

a) Updraft Drying Zone — (15% of the furnace) Hot gases from the firing zones are drawn up through the green balls, removing moisture from them.

b) Downdraft Drying Zone — (6% of the furnace) Hot gases from the cooling zone are used to complete the green ball drying. Here air is pulled down through the bed of balls on the travelling grates.

c) Firing Zone — (44% of the furnace) Oil fired burners are used to rapidly heat the green balls to the required temperatures. Heat is pulled through the bed by movement of air down through it. The grate speed is such that all green balls have been heated to 2,500 degrees Fahrenheit at the point where the bed passes the last burner.

d) Cooling Zone — (35% of the furnace) Cold air brought in from outside the building is forced upwards through the bed of fired pellets to cool them down to approximately 250 degrees before discharging from the machine.

The air flow through each machine is approximately 250,00 CFM and maximum use is made of recuperation systems in order to minimize heat losses to the exhaust stacks.

The cooled pellets are conveyed to a central screening house which separates a fines (chip) fraction which is conveyed back to the ball mills for regrinding, a size fraction which is returned back to the machine to act as a hearth and side protective layer on the grates, and screen pellets which are fed to the Pellet Loadout System.

Finished pellets are deposited by a boom stacker to a reclaim stockpile or emergency stockpile.

Pellets are loaded onto ore cars for shipment to Sept-Iles port facilities. Ore cars are loaded, while in motion, by a series of gates under a small surge bin. The surge bin is fed by a reclaim system, drawing pellets from under the stockpile through a series of gravity feeders.

Control Systems

The Concentration Plant has a rated daily tonnage of 133,000 long tons. This means that a continuous flow of approximately 5,500 LT per hour, 92 LT per minute or 1.5 LT per second must be maintained. A malfunction on operating equipment must be caught immediately or excessive damage and spills result. The large, complicated machines necessary to crush, grind, concentrate, and pelletize iron ore require constant vigil and continuous correction for the many variables in order to achieve maximum efficiency.

This is accomplished by extensive use of automatic monitoring and controlling devices capable of instantly detecting any change in circuit conditions or potentially hazardous conditions.

For ease of starting, stopping and operating equipment, this array of automatic controls is placed in 4 control rooms as follows:

1) Crusher Control Room — contains controls necessary for complete operation of the automatic Railway, Car Dumping, Crushing, and Conveying of crude ore and its dispersal into Ore Storage.

2) Grinding Control Room — contains controls necessary for complete operation of the Aerofall Mill grinding and classification systems as well as product handling to the coarse ore surge bins.

3) Process Control Room — contains controls necessary for operation of the spiral lines, filters, pumps, concentrate conveyors, tailings disposal system, magnetic treatment plant and products therefrom.

4) Pelletizing Control Room — contains controls necessary for operation of the regrind ball mills, thickeners, disc filters, balling circuits, indurating machines, bentonite system, pellet handling and boom stacker systems.

Operators located in these control rooms look after the operation of their respective processes. They are assisted by attendants patrolling the equipement locations and are in contact with them by the use of public address systems.

Plant Engineering

This department provides the services of an on-site engineering group for the Concentrator and Pelletizing plants.

Large scale or long range projects outside the scope of this department are submitted to the Technical Services engineering group after some preliminary conceptual work has been completed by the Plant Engineering group.

Environment control within the plant is of prime concern and a continuous monitoring of plant heating, ventilating and dust collection units is made by this Department in conjunction with the safety and service departments.

A record of all Plant improvements and modifications is kept in a central filing library.

Maintenance

The Concentrator and Pellet Plant have self-sustaining maintenance facilities of their own but rely on the Main Repair Shops for major repairs to components.

ADMINISTRATION

Administration carries out different activities as follows:

COST SERVICES: — Is responsible for forecasting, and budgeting of capital and operating expenditures, for cost, financial and statistical data, for producing reports, special studies labour productivity reports, and trends, different payrolls, and for data processing of commercial and statistical information.

PERSONNEL: — Administers the overall company policy and practices, and controls the hiring of new employees and all records and reports pertaining to the work force.

LABOUR RELATIONS: — Controls all dealings with local unions and the day-to-day application of the collective agreement.

TRAINING: — Controls the training of all employees such as apprentices, learners, as well as the supervisory personnel.

ACCOMMODATIONS: — Controls the bunkhouse and staffhouse facilities as well as the townsite housing.

CATERING: — Operates a cafeteria to accommodate the residents of bunkhouses and staffhouses.

SECURITY: — Provides a security service for the I.O.C. complex and the bunkhouses and staffhouses. It also provides an ambulance service for both the town and I.O.C. complex.

TRANSPORTATION: — Controls the operation and maintenance of a fleet of vehicles and also co-ordinates a bus service to provide transportation for employees to and from the job site.

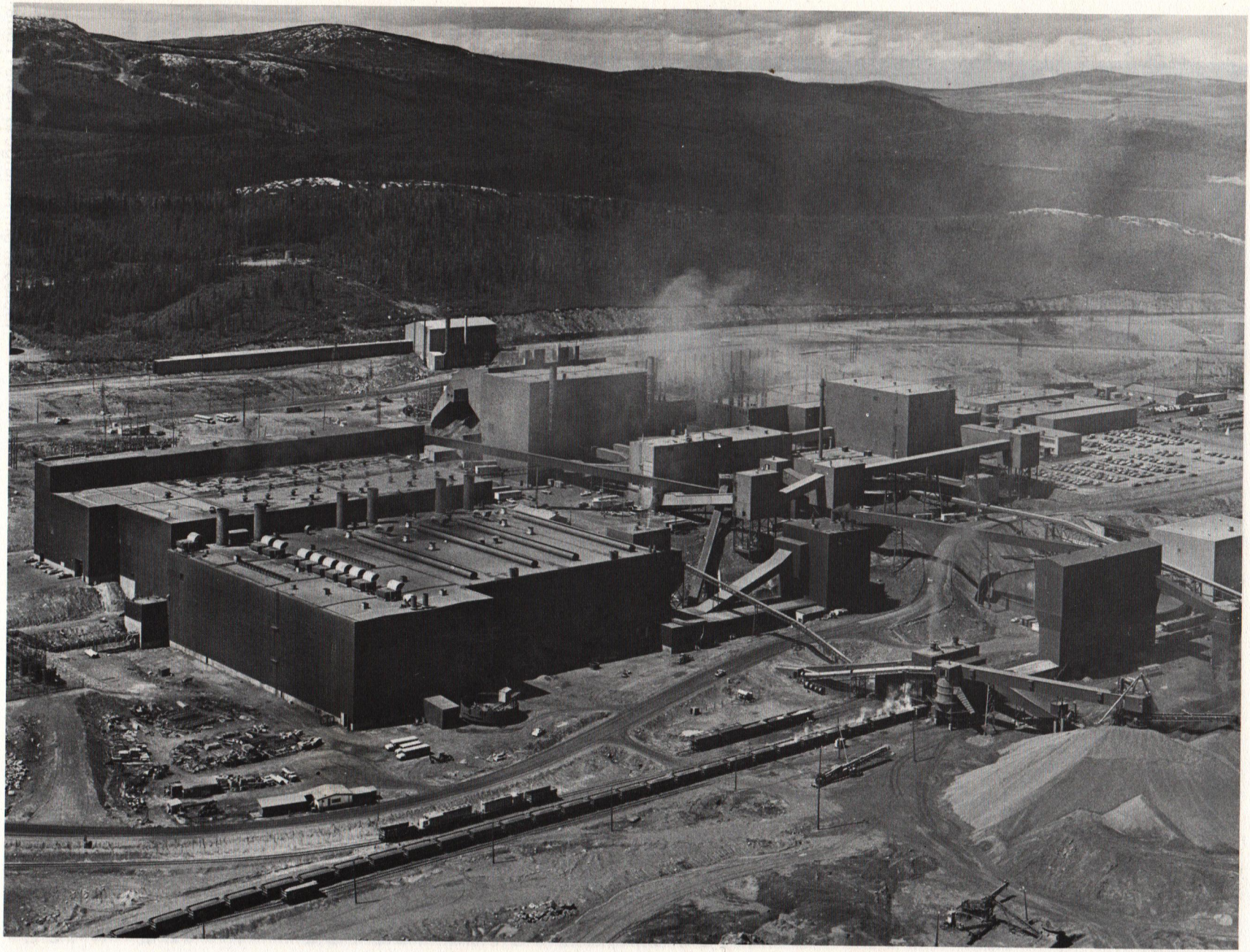
ENGINEERING: — Provides design, tendering, budgeting and construction supervision in housing and related infrastructure, which falls within the responsibility of the Company within the Townsite.

SAFETY: — Provides safety services to all levels which includes instruction and assistance in the areas of personal protective equipment, safe work habits and procedures, fire prevention and industrial hygiene.

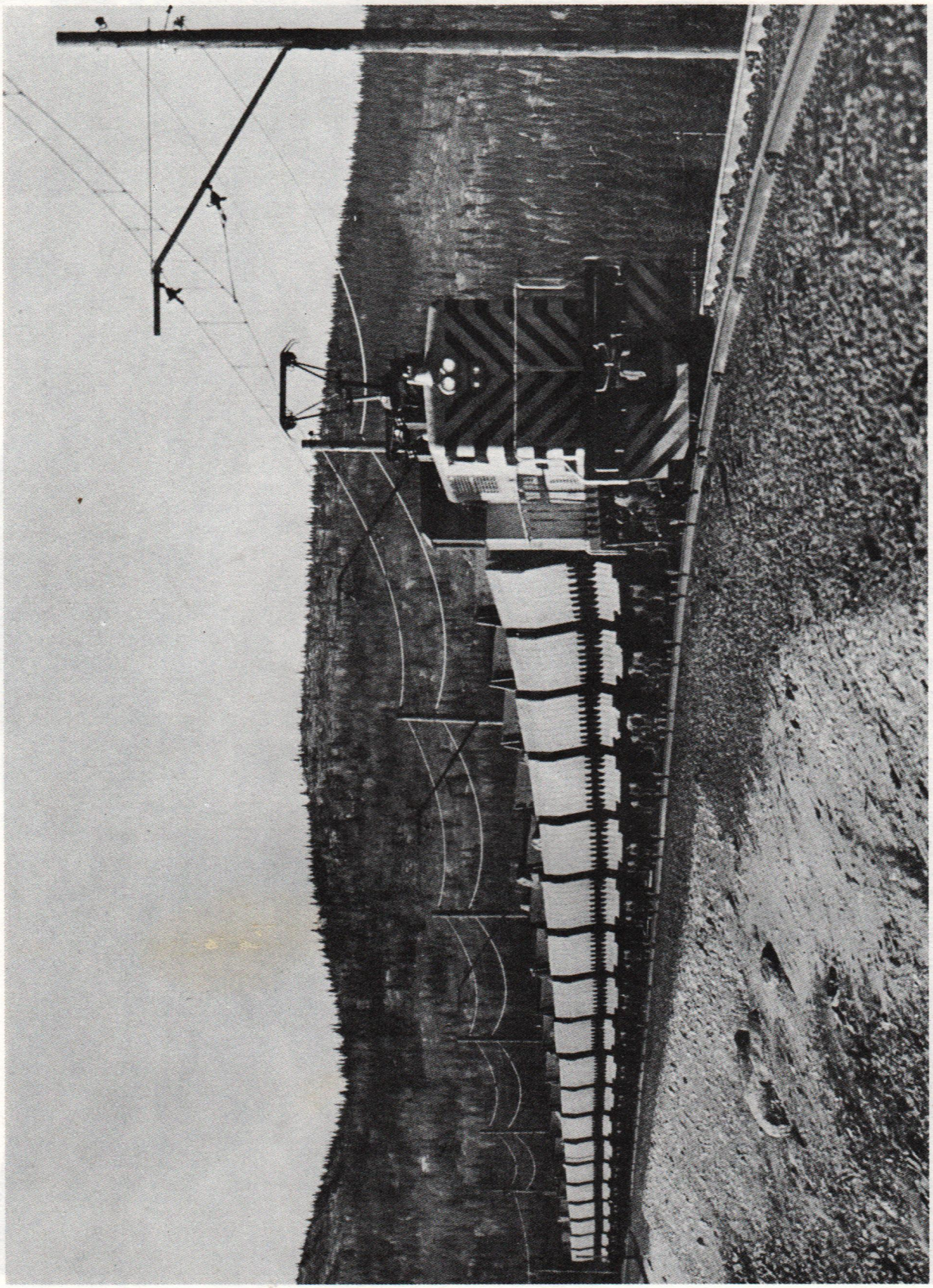
CHEMICAL LABORATORY: — Provides chemical and physical analyses on crude ore and plant samples to the respective departments.

WAREHOUSE: — The Warehouse facilities occupy some 53,000 square feet of floor area. All the necessary replacement parts for project equipment as well as hardware, construction, and office equipment items are kept here. Because of long distances between the site and equipment suppliers, it is essential that the warehouse inventory contain all items necessary to ensure continuous operation of major equipment.

Mines at Labrador City



Concentrator and Pelletizing Plant — Labrador City



Automated train — Labrador City

LABRADOR CITY

Labrador City is located in the southwestern portion of Labrador, Newfoundland; latitude 52 degrees 56 minues North longitude 66 degrees 55 minutes west, at an altitude of 1,750 feet above sea level. The town is situated west of the south end of Wabush Lake, immediately south of a range of hills which contain many large iron ore deposits. The town serves the mining complex of the Iron Ore Company of Canada, which is generally known as the Carol Project.

The town is situated in a climatic region characterized by cold winters and short, cool summers. The average July temperature is 16 degrees Celsius, ranging from 4 degrees Celsius to 27 degrees Celsius. Average January temperature is −18 degrees Celsius with possible lows of −35 or lower. Total annual precipitation as snowfall averages 470 cm.

Access to the town is most readily gained by air. Two commercial airlines serve the area — Eastern Provincial Airways from St. John's, Newfoundland (728 miles), and Quebecair from Montreal (600 miles) and Sept-Iles (200 miles). The Q.N.S. & L. Railway operates two passenger trains weekly between Sept-Iles, and Labrador City.

Labrador City is administered as a Local Improvement District in accordance with the Local Government Act of the Province of Newfoundland. A five-man Board is appointed by the Lieutenant Governor in Council acting upon names submitted by the Iron Ore Company. While the Board is not an elected body, is has all the authority of such a body. The town was started in 1959, and has grown from a temporary camp, with a few prefabricated buildings to a first-class modern town containing well over 2,600 family units, consisting mainly of single homes and 326 apartment units. The Harrie Lake Sub-Division, containing 510 mobile homes, was completed in 1975. The present propulation of Labrador City is 14,000.

The houses are all modern, well-insulated homes of three or four bedrooms with full concrete basements. While the majority are oil-heated, electric heat is now being used in all new construction. The mobile homes are constructed for sub-arctic conditions and all are 70 feet by 14 feet, containing three or four-bedrooms. All of the mobile homes are heated by electricity. The town together with the mobile home park, is completely serviced with water and sewer facilities, including a water pumphouse and sewage treatment plants. The town has street lighting, concrete sidewalks, paved streets and lawns.

Modern schools allow for the teaching of kindergarten to Grade XI. The Roman Catholic School Board and the Amalgamated School Board operate from kindergarten to Grade VIII in their respective buildings. The Labrador City Collegiate operates Grade IX to XI, first year university, commercial and industrial arts programmes in the High School. The High School and the Roman Catholic Elementary School have French sections, and French is taught in all grades in the Amalgamated School. Six religious denominations are represented in the community.

The commercial areas in the town include banks, a 600-seat theatre, restaurants, general department and grocery stores. Many smaller enterprises such as news stand, hairdressing salons, ladies and men's wear, jeweller, laundry and dry cleaning, etc., are located within these areas. Two service stations are operated by Imperial Oil and Shell. Automobile dealers include Ford and G.M.C. There is a Town Hall, with adjacent Police Station and Fire Station, also a Library and Post Office, together with social clubs and other facilities.

English radio facilities are provided by a local affiliate of the Humber Broadcasting Company, Corner Brook, and a satellite of the Canadian Broadcasting Corporation from Goose Bay. French radio programming is also supplied by the CBC. The CBC television service provides both English and French programming in colour.

The modern, fully equipped 70-bed Captain William Jackman Memorial Hospital, constructed by the Newfoundland Government and operated by the Salvation Army, was opened in 1965. Eight medical doctors and two dentists serve the area.

Community activities play an important role in life at Labrador City. In addition to the activities associated with the various churches, service and social clubs are active. Sports such as basketball, badminton, weight lifting, boxing, tennis, skiing, cricket, curling, fastball, soccer and hockey are available. A Ski Club, which in 1970 hosted the Canadian Alpine Championships, located four miles from town, has two poma lifts, and a chair lift and has a vertical fall of 1,000 feet and runs in excess of 3,000 feet in length. A nine hole Golf Course, with clubhouse facilities, is adjacent to the town. There is a heated Arena, with a regulation artificial ice surface and a seating capacity of one thousand, as well as other recreation facilities; a Trap and Skeet Club and a very active Snow Cart Club both have their own clubhouse and facilities. A large part of the surrounding country is abundant with lakes and rivers so that boating and fishing are popular during the summer months. Located approximately ten miles from the townsite, a provincial park area has been developed for recreational and camping activities.

Three miles from Labrador City is the town of Wabush (population 3,500), which provides additional interests and facilities to serve those residing in the area.

Labrador City is also connected by fifteen miles of road with the town of Fermont in Quebec. This town, with a 1975 population of 5,000 is the centre for Quebec Cartier Mining's Mount Wright mining and concentration project.

Aerial view of Labrador City

SEPT-ILES TERMINAL

At the Terminal in Sept-Iles, a highly mechanized system is used to receive direct shipping ore, plant feed, concentrate and pellets for stockpile or loading directly into ships.

The work of the Terminal is broken down among Operations, Maintenance, Chemical Laboratory and Marine Services with support from Administrative and Engineering Services and Ore Movements.

OPERATIONS

The Operations department, which is divided in 3 sections, Yard Operations (railway switching, track maintenance) Fixed Equipment (Dumper, Stackers, Shiploaders) and Mobile Equipment (Trucks, Loaders, Shovels) is responsible for the movement of ore within the terminal and the operation of related equipment.

a) Direct Shipping Ore and Plant Feed Ore

The ore cars, carrying an average of 87 long tons of ore, arriving from Schefferville, are individually weighed by a double electronic scale at the rate of 1 every 15 seconds and separated according to grade of ore in a 12-track classification yard with a capacity of 900 cars. From there, the cars are taken by sidearm pushers into a single — track barney lead. The blending of the ore in the shiploading system is accomplished by a computer program which indicates the proper sequence of ore cars to be brought onto the lead track from the 12 classification tracks to meet individual cargo and plant feed specifications. The cars are then pushed singly or in pairs into a tandem rotary dumper where the ore passes through grizzly beams which divert any oversize (frost chunks from stockpile) into roll crushers and the whole is then fed onto two 72″ conveyor belts. These belts transfer to two 60″ belts and the ore is carried to the mix-bins each of which has a capacity of 300 long tons. From the bins, the ore can be fed to either one of our two loading docks. On the original dock the ore travels by two 60″ conveyors with a capacity of 4,000 long tons an hour each, to the two travelling shiploaders which dump directly into the holds of the ships at the dock. On our new loading dock which was opened for shipments in February 1970, ore is carried by two 72″ conveyors which have a capacity of 7,500 long tons an hour each and is dumped directly in the holds of the ships by the same means mentioned above.

The original loading and mooring docks total 1,600 feet and afford a draft of 37 feet at low tide.

The new deep water berth is located 900 feet South East of the original dock and extends approximately 230 feet further into the Bay. This single berth is of open cell construction with nine cribs giving a total berthing face of approximately 875 feet. The cribs are guarded at the waterline by a double set of extra large truck tires and the dredged depth is 60 feet. The dock is fitted with two travelling shuttle boom loaders.

The ore to be stockpiled is taken from the dumper by two separate 48″ conveyor systems and dumped by two 60 feet high self-propelled stackers which cover a pile area of 120 x 5,000 feet on each side of each conveyor belt. About 6,000,000 long tons of ore can be stored in the stockpile.

When shipping ore from the stockpile, the ore is reclaimed into ore cars by six cubic yard shovels and front-end loaders. The contents are sampled and analysed and the cars go through the weighing and dumping cycles outlined above.

The Drying Plant is used to reduce the moisture content of certain ores to improve their handling characteristics. The plant consists principally of a rotary $13\frac{1}{2}$ x 110 cylindrical shell in which the ore is tumbled through a stream of hot gases supplied by an oil-fired burner.

The output of the plant averages 300 long tons per hour at 8% moisture with the feed at 14.5% moisture.

The Bentonite and Flux Plant located nearby is required to grind bentonite and limestone used as additives in pelletizing Knob Lake ores.

b) Pellets

Dumper #2 and related pellet handling facilities were completed in the spring of 1963 for handling Carol Pellets. The system includes a 250-car yard, a single-car dumper, and a 60" conveying system to a 60,000 long ton surge pile. Draw gates under the surge pile feed two 60" conveying systems which carry the ore to the dock conveyors and thence to the ship-loaders of either dock. The rated capacity of each system is 4,000 long tons per hour.

Pellets can also be withdrawn from the surge pile by a 48" conveying system and stock-piled. The capacity of the stockpile is 2,000,000 long tons. The pellets are reclaimed and put back into the surge pile by lowering the stacker boom, reversing the conveying system, and feeding it using a bucket wheel reclaimer. The system is rated at 2,000 long tons per hour for stockpiling and 2,500 long tons per hour for reclaiming.

c) Carol Pellets and Carol Concentrate, Knob Lake Pellets

Ore cars carrying an average of 100 long tons of ore, arriving from the Carol division at Labrador City, are emptied by Dumper #3 which is a tandem rotary dumper. The ore cars are equipped with rotary couplers which allows the complete train to be dumped without uncoupling any of the cars. The movement of the train through the dumper is under the control of the Dumper Operator who, after he has positioned the first 2 cars of the train within the travel range of the car positioner, allows the dumping of the balance of the train to continue automatically.

The ore from the dumper hoppers is fed onto 2-72" conveyor systems which take the ore to 2 self-propelled stackers which cover a stockpile area of 195 x 3800 on each side of each conveyor belt.

Knob Lake Pellets, which are produced at Sept-Iles, are stockpiled after production in a 20,000 long ton cooling pile prior to being conveyed to the main stockpile area by the 2-72" conveyor-stacker systems mentioned above.

About 5,500,000 long tons of ore can be stored in the stockpile area.

The dumping system has a capacity of 9,600 L.T.P.H.

Ore is reclaimed for shipping by 2-7500 L.T.P.H. bucket wheel reclaimers which feed the ore onto 72" conveyors for delivery to the 2-7500 L.T.P.H. capacity travelling shiploaders at Dock #2.

d) Bulk Unloading Facilities

Parallel to our mooring dock is a travelling tower which is used to unload bentonite, grinding balls (which are used in the processing of pellets) and salt. The bentonite and salt are unloaded by using a 9 cu. yd. clam bucket with an average unloading rate of 500 tons per hour. Grinding balls are discharged with an electro magnet and can either be loaded directly into railcars or stockpiled. The average lift for the magnet is 10 tons.

MAINTENANCE

The Maintenance Department which is divided into preventive, mechanical and electrical maintenance is responsible for the maintenance of all ore handling, shiploading and associated facilities.

The ore handling facilities consist of 2 tandem rotary dumpers, 1 single car rotary dumper, 2 barney hoists and an automatic car positioner for Dumper #3. Roll crushers for crude ore, pan feeders, 4 travelling shiploaders, 5 travelling ore stackers and 3 bucket wheel reclaimers, 1 oil fired rotary kiln ore drier and associated conveying systems, varying in width from 36″ to 84″, connect and feed the different operating units.

Associated with the ore handling facilities are 4-6 cu. yd. electric shovels, crawler tractors, front end loaders up to 10 cu. yd. capacity, haulage trucks up to 170 tons capacity, diesel electric sidearm pusher locomotives plus an assortment of pick-ups, trucks, cranes etc.

Ore Control

Ore Control develops ore movement plans throughout the system and coordinates the flow of ore from mine, to railway, to stockpiles and to vessels, insures that the tonnage, grade and quality of ore is available to meet vessel arrivals and also insures that the plant feed stockpiles are prepared.

Marine Services

Marine Services are responsible for all marine functions required for ships calling at Sept-Iles for ore cargoes. These services include tugs, pilots, crew requirements, line handling and agency. All ship moves are coordinated with Ore Control. Marine Services also act as agents for foreign general cargo ships and tankers and are responsbile for verification and maintenance of water depths alongside docks.

Chemical Laboratory

The laboratory is divided into two sections — Control and Special.

The control laboratory handles iron ore samples from the concentrator, pellet plant or the terminal, determining chemical analysis primarily by X-ray fluorescence and standard physical tests for size, strength, etc.

The special laboratory determines minor elements in iron ores and checks our raw material, bentonite, limestone, flotation chemicals, etc., to see they meet specifications. Water and air samples are also analysed for environmental purposes.

Samples for shipments are taken by mechanical means during loading of vessels and the sampling and analysis of these samples are supervised and certified by Lerch Bros. Inc., umpire chemists.

SEPT-ILES BENEFICIATION

Terminal facilities were expanded to include upgrading and pelletizing of Schefferville ores in 1973.

CONCENTRATION

a) **Stockpiling**

The lower grade ore fractions from Schefferville are dumped and stockpiled in the vicinity of the Concentrator by means of existing Terminal facilities. The ore is blended at the same time, to obtain an homogeneous plant feed.

b) **Grinding**

The stockpiled ore is reclaimed and trucked to the plant feed hoppers using 2-6 yard shovels and 3-170 ton trucks. The ore is then drawn from the hoppers by means of apron feeders and fed to the grinding mills via a dual system of conveyors. The rate of feed is controlled by monitoring the power drawn by the mills.

Grinding is done in two wet semi-autogeneous Nordberg Mills, each of which is 30 feet in diameter and has a design capacity of 511 dry long tons an hour. The ground ore is then put through two stages of classification to provide a product suitable in size structure for the flotation cells. Mineral liberation is complete at −100 mesh size.

The first stage of classification is done with cyclones, of which there are 5-30″ diameter cyclones per mill. They are set to classify in the 80-100 mesh range. The cyclone underflow is returned to the mills, while the overflow is fed to Rapafine screens for further classification. Each classification line is made up of 48 screens arranged in two stages of 24 each. Classification takes place in the 150-200 mesh range, with the oversize portion returning to the mill and the undersize going to flotation.

c) **Froth Flotation**

The plant's flotation section consists of two lines using 500 cu. ft capacity cells. Each line is arranged in three stages of concentration with 6 rougher cells, 2 cleaner cells, and 4 scavenger cells each. The cationic or reverse flotation process is used, whereby silica is floated and iron depressed. The overflow from each stage is recirculated to improve recovery. The reagents used include Aerofroth 71 (frother), WW81 starch (depressant) and Amine 83 (collector). Sulfuric acid and sodium hydroxide are also used for pH control.

Concentrate weight recovery is in the order of 74-78 percent with a silica reduction from about 14 to 5-6 percent. Iron recovery is +90%.

Slurried waste is pumped to tailing ponds located about one and one half miles away, and the water, reclaimed from the waste is returned for use in the plants.

Concentrate is pumped a distance of three quarters of a mile, as slurry, at 35 percent solids, to three 290 foot diameter thickeners, located next to the pellet plant. Feed for the pellet plant is dewatered to about 70% solids in the thickeners to prepare it for delivery to the plant feed surge tanks. Surplus water is returned to the concentrator for process use.

PELLETIZING

Pelletizing is essentially a physical process, whereby the concentrate is agglomerated into round balls (pellets), approximately 1/2 inch in diameter, and thus made more suitable for blast furnace feed.

The Sept-Iles Pelletizing Plant is made up of a wet and a dry section. The wet section includes the feed preparation and the balling operations; whereas the dry section includes, induration, and product handling.

Except for certain common dry storage and conveying facilities, the plant is further divided into two separate process lines, each with a rated capacity of three million tons of product a year.

a) **Feed Preparation**

The thickened concentrate (approximately 70% solids) is pumped to a mixing tank where ground limestone is added, to improve fired pellet quality. It is then pumped from there to a dual set of storage tanks, having a total capacity of 14 to 16 hours of feed at normal plant operating rate.

From there, the concentrate slurry is pumped to the filters via oil fired-thermal liquid heat exchangers which elevate the slurry temperature to about 100°F. At this temperature, filtration rates are significantly improved. A total of twenty disc filters arranged in two separate lines of ten each, are used producing a filter cake containing from 12 to 14 percent moisture.

As this is still too high for balling purposes, the filter cake is conveyed to a dual set of oil fired rotary dryers where moisture is further reduced to between 6 and 8 percent. To reduce dust losses to atmosphere, the off-gases from the dryers are passed through cyclones and electrostatic precipitators, where dust is removed and the cleaned gases are discharged into the air.

The dried filter cake is then conveyed to a storage bin with a capacity of 900 long tons. Two short feed conveyors draw the dried concentrate from the bin in controlled amounts. Bentonite is added at the required rate on top of the concentrate on these belts, and is blended with the ore by subsequent tumbling through several conveyor transfer points. The bentonite serves as a binding agent to provide strength to the green balls and to regulate moisture release during the induration process, the design rate calls for 9 lbs of bentonite per ton of concentrate.

b) **Balling**

The blended material is fed from the bins, by rotary table feeders and conveyors on to twelve 25 feet diameter balling discs, arranged in two separate lines of 6 each. As discs rotate, the loose mixture of concentrate and bentonite, to which a small amount of water is normally added, is agglomerated into little balls which gradually grow into larger ones as they pick up layers of concentrate through their rolling action in the rotating dics.

The discharge from the balling discs is fed to vibrating screens, where on-size green balls (between $^3/_8$" and $^5/_8$"), suitable for induration feed, are separated from the under and over size fractions, which are recirculated through the drying and balling circuits.

c) **Induration**

The indurating process consists of converting the wet green balls into hard finished pellets by first drying them and then cooking them at temperature of 2450 to 2500°F. At the Sept-Iles plant, this is done with two Allis Chalmers grate-kiln indurating machines, each capable of producing 3,000,000 long tons of pellets a year. Each machine is made up of three main components; the travelling grate, the rotary kiln, and the annular cooler.

1) *Travelling Grate* — The on-size green balls from the balling section of the plant are fed through a series of conveyors and deposited on the horizontal travelling grate of the furnace in a bed 6 inches thick. They are taken next through the two drying zones and the dehydration zone of the grate to remove the moisture and chemically-bound water of crystallization from them, so as to avoid crumbling and desintegration of the

green balls later on as a result of higher process temperatures. This is accomplished through heat transfer from the cross flow of process gases — with temperatures going from 550°F in the first drying zone, to 1000°F in the dehydration zone, — passed up and down through the pellet bed, in a countercurrent fashion.

In the next phase of the process, the pellets enter the preheat zone where the hot gases from the kiln are pulled down through the bed to raise the temperature of the pellets to approximately 1800°F and initiate the limestone calcination and actual ore induration process. At the end of the preheat zone, mineral bonding occurring within each ball has then progressed enough to give the balls the required physical strength for feeding into the rotary kiln without generating excessive dust.

2) *Rotary Kiln* — Final calcination and induration of the preheated pellets takes place in the $22\frac{1}{2}$ feet diameter by 150 feet long rotary kiln as the temperature of the tumbling bed of pellets is raised to approximately 2450-2500°F., by the radiation heat from the kiln burner flame and the additional heat it impacts to the cooler off-gas flows.

3) *Annular Cooler* — From the kiln, the fired pellets are dropped into an annular cooler which can be likened to a circular travelling grate. Cold air is forced up through the bed of red hot pellets to cool them sufficiently to be handled safely on conveyor belts, after discharge from the unit.

Heat recuperated from the pellets in the cooler provides a major source of the large amount required in the induration process thus helping to reduce fuel requirements.

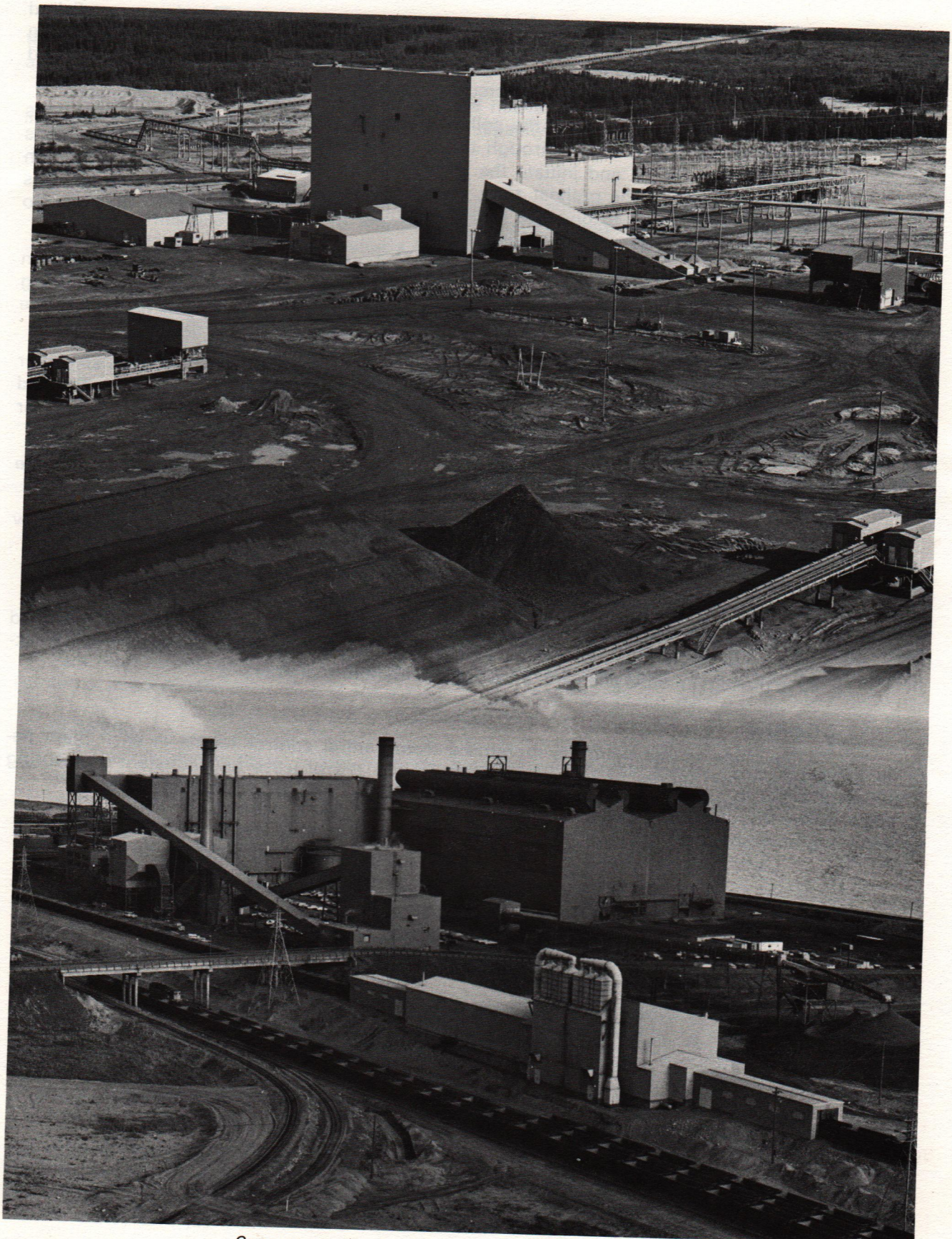
Large fans, located at strategic points along the machine, induce the counter current flow of hot gases that is required through the vacuum stages of the process.

d) **Product Handling**

Upon leaving the cooler, the pellets are screened to remove lumps and are conveyed to an outside cooling pile, which has a capacity of 20,000 tons. From there, they are stockpiled in the regular stockpile yard, awaiting shipment to customers.

e) **General**

Operation of the plants is monitored from central control rooms in each plant because a large degree of integration is built into the process and constant monitoring and adjustment of the process parameters is critical to optimum production levels.



Concentrator (top) — Sept-Iles — Pellet Plant (bottom)

Aerial view of Terminal — Sept-Iles

SEPT-ILES

Sept-Iles is situated on the North Shore of the St. Lawrence, 400 miles from Quebec City on route 138. The city, situated on the shores of a large circular bay, is protected from the waters of the Gulf by a rampart of seven islands which have given it its name.

In 1951, Sept-Iles was a fishing village of about 1,200 people. Today Sept-Iles has a population of 37,000. Its port is among the busiest in Canada and is now the second in tonnage handled with annual tonnage of 30 million tons. Today workers of Sept-Iles are rated among the highest paid in Canada.

Sept-Iles is the nerve centre of air traffic on the North Shore. Sept-Iles airport is the liaison point between the big centres of Montreal and Quebec City and all other towns of Northern Quebec and Labrador, namely: Churchill Falls, Labrador City, Wabush, Schefferville, Gagnon, Havre Saint-Pierre, Natashquan. Altogether some thirty-five flights arrive and depart from Sept-Iles daily. Ferry service with the South Shore is in operation year round from Godbout and Baie-Comeau to Matane.

The port of Sept-Iles is open twelve months a year. The bay does not freeze sufficiently to interrupt maritime traffic.

Private enterprise flourishes in Sept-Iles. The city is growing in two directions, industry northwards while the residential areas extend westwards. A few miles from the city is a trailer park of nearly 500 units. Business is concentrated in two principal areas, one near the bay shore, the other on Laure Boulevard. The two include hotels, commercial centres, boutiques, restaurants, banks, theatres, offices, medical centres and all the other services required for a city of 37,000. The industrial section north of the city contains the suppliers and light industries necessary to a flourishing city.

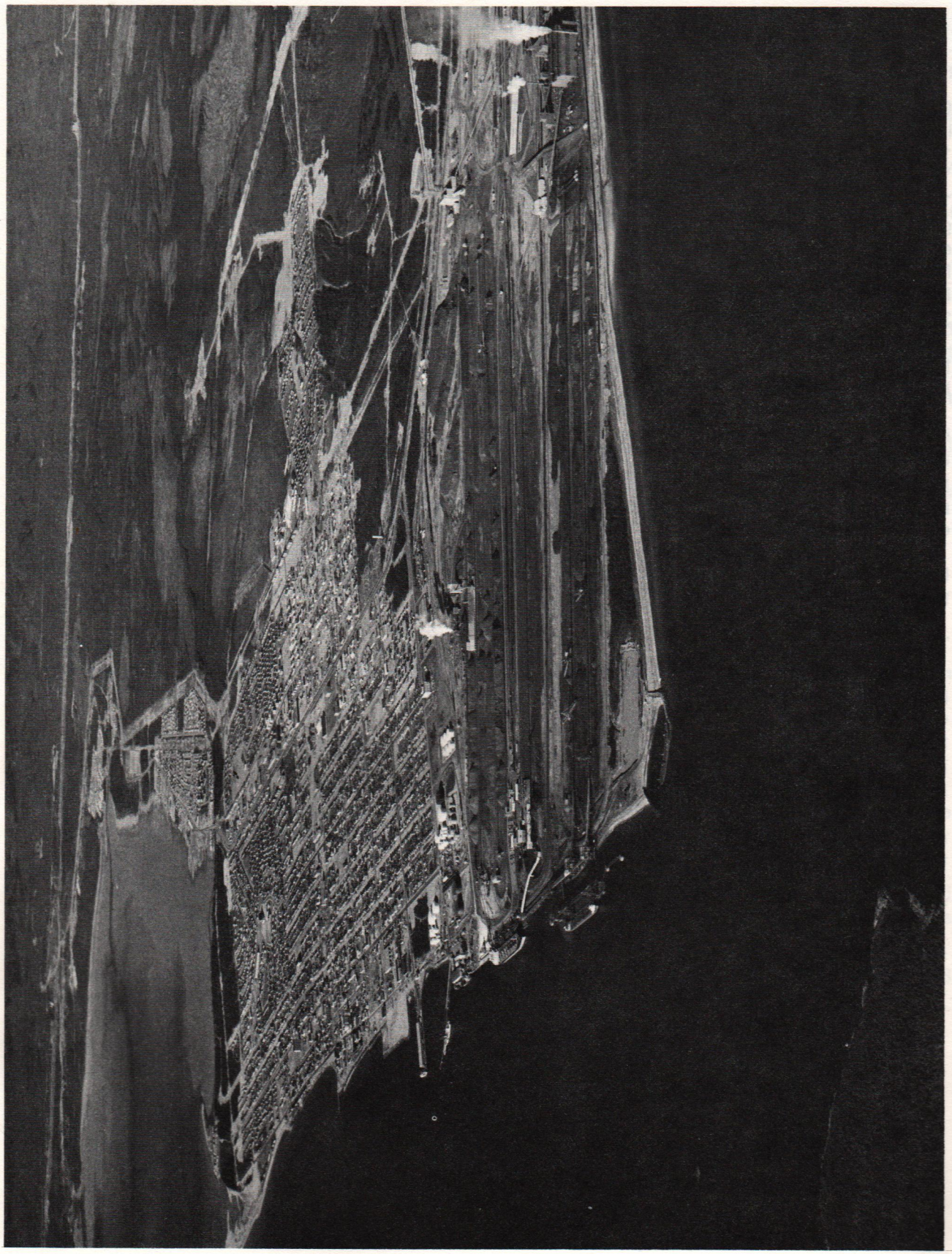
Churches cater to Catholic, Anglican, United and Baptist faiths, while children attend English or French schools from Kindergarten to 12th grade. There are thirteen public schools, two high schools, one of them bilingual, residences, and a junior college. An adult education service completes the extent of the educational section of Sept-Iles. A 255-bed modern hospital serves the area.

Leisure is well catered for in Sept-Iles. More than sixty associations and social clubs make communal life agreeable and interesting. Thanks to its unique geographical situation on the shores of the St. Lawrence and its easy access to hundreds of lakes and rivers, of which the river Moisie has a reputation second to none in North America for salmon, the region of Sept-Iles has long been known as a hunting and fishing paradise.

Nearby Ste Marguerite's Golf Club caters to followers of the game, while in town the social-recreational centre offers a wide selection of cultural activities and recreation. The centre includes a swimming pool, gymnasium, theatre, library, nursery, boxing ring, and dance studios. There are also games rooms, a boîte à chansons and studios for art, photography, cinema and physical training.

The Palais des Sports which holds nearly 3,000 people and a participation arena are used principally for hockey and skating in winter, while in summer it is the location for various activities such as wrestling, expositions and shows.

Two cinemas, a drive-in, a baseball stadium, bowling lanes, a ski club, a curling club, a swimming club, an aero club, tennis courts, two ski-doo clubs, a stock car course and camping grounds complete the picture of sports and recreation in Sept-Iles.



Aerial view of Sept-Iles

QUEBEC NORTH SHORE AND LABRADOR RAILWAY

The QNS & L is a common carrier subject to the jurisdiction of the Canadian Transport Commission, and provides the link between the iron ore mines and the terminal facilities in Sept-Iles. The contract for construction of the 356 miles of main track was awarded in September 1950 and the Golden Spike marking its completion was driven in February 1954.

Starting at tidewater at Sept-Iles, the line rises to a maximum elevation of 2,066 feet at Mileage 150 before dropping to an average elevation of 1,700 feet on the balance of the line. Maximum grade against southbound loaded ore trains is approximately 11 miles at 0.5 percent, compensated for curvature and against northbound empty ore trains approximately 17 miles at 1.35 percent. Maximum curvature is 8 degrees, and 40 percent of the total mileage is on curved track. At Mileage 12 and Mileage 65 are tunnels, 2,200 feet and 1,050 feet in length respectively. There are 36 sidings on the line, all equipped with power operated switches.

The main track is laid with 132 pound rail with 14" and 18" tie plates on 8' and 8'6" treated ties, these ties being replaced as required by 9'0" ties. This track structure is supported by rock ballast on a subgrade 24 feet wide.

Paralleling the track is a 23,000 volt power line extending the length of the railway, which is used to provide power for the signal locations, communication system, lighting of campus and tunnels, along the length of the railway. The same pole line also carries landline carrier and physical communication circuits which are used in conjunction with a microwave system which provides communications throughout the entire project. Radios are installed on locomotives and cabooses providing direct communication from dispatch office to trains.

The Railway does its work through four main operating departments: Train Movements, Maintenance of Way, Car & Locomotive Maintenance and Signals and Communications. Serving these is Administration.

TRAIN MOVEMENTS

This department runs the trains, most of which are engaged in carrying ore of various types in trains of 165 cars to 260 cars. All trains over 165 cars are operated as radio controlled trains with locomotives about two-thirds of the way back in the train controlled by radio from the lead locomotive. Gross weight of the loaded trains varies from 18,000 tons to over 36,000 tons depending on the type of ore and number of cars. Most of this traffic is hauled during the summer season, July — November, but beneficiated ore in the form of pellets or concentrate is handled throughout the year. Regular passenger and freight service is provided the year round. All train movements are directed by signal indication, the position of switches and the signals governing their use are handled under a Centralized Traffic Control System through a dispatcher's control machine at Sept-Iles which automatically provides block protection safety. Average speed between terminals of all ore trains, loaded and empty, is about 23 miles per hour.

MAINTENANCE OF WAY

This Department, maintains the roadbed and track, constructs new track for revisions and extensions, improves drainage on and adjacent to the line. Due to severe weather conditions most track maintenance work must be confined to a seven month season, which is also the peak traffic season. This makes it essential to highly mechanize this work. In a typical year the track has to withstand traffic totalling 9 billion ton miles. The Bridges and Buildings section maintains some 2,500 culvert pipe installations and 7 steel bridges, one 711 feet long crossing 150 feet above the Moisie River. This section also provides for the construction and up-keep of all railway buildings.

CAR AND LOCOMOTIVE MAINTENANCE

This Department is responsible for the maintenance of all motive power which consists of 18 — 1750 HP GP-9 locomotives, 21 — 3000 HP SD-40 and 44 — 3000 HP SD-40-2 locomotives. The

rolling stock consists of 3600 100-ton ore cars plus an assortment of 1000 cars such as box cars, flat cars, passenger cars, gondola cars, tankers and hopper cars. In addition to this fleet, the Department is responsible for all track maintenance equipment required to maintain 400 miles of trackage such as shovels, cranes, tampers, spreaders, snow ploughs, tractors, ballasters, do-all, etc.

The Department also handles the inspection of trains before departure and on arrival at Terminals.

The Department operates a shop comprising four main sections: Locomotive, Car, Machinery Section and Machine and Wheel Shop which serves all sections. Due to the Railway's location, it has to be self-sufficient and the shops are equipped to handle both light and heavy repairs of all kinds.

The Locomotive shop includes an inspection bay with two through tracks fitted for ready access with elevated tracks and depressed floors, each sufficiently long to accommodate a three-unit locomotive. A heavy repair bay has a drop table for changing locomotive trucks.

The Car shop has three sets of through tracks of ten car capacity each. These are equipped with a 30 ton overhead crane as well as a semi-automatic shunting system to bring equipment to and from the work stations. Each work station is equipped with a 5 ton overhead crane, hydraulic jacks, oxygen and acetylene, grease guns and parts for the various types of equipment serviced.

The Machinery section occupies one bay and handles the maintenance and overhaul of all work equipment: power shovels, tractors, track raising machines, and the like.

Adjacent to the Shop is the Warehouse section which maintains stocks of thousands of items ranging from locomotive components down to tiny radio parts.

COMMUNICATIONS AND SIGNALS DEPARTMENT

This department is responsible for the construction, operation and maintenance of the following:

Railway Systems:

All Locotrol, VHF & UHF radio, hot box detectors, switch heaters, wayside telephones, open wire carrier and cable distribution along the 400 mile right-of-way.

Signal System:

All Centralized Traffic Control equipment used for the governing of signals and power switches.

Power System:

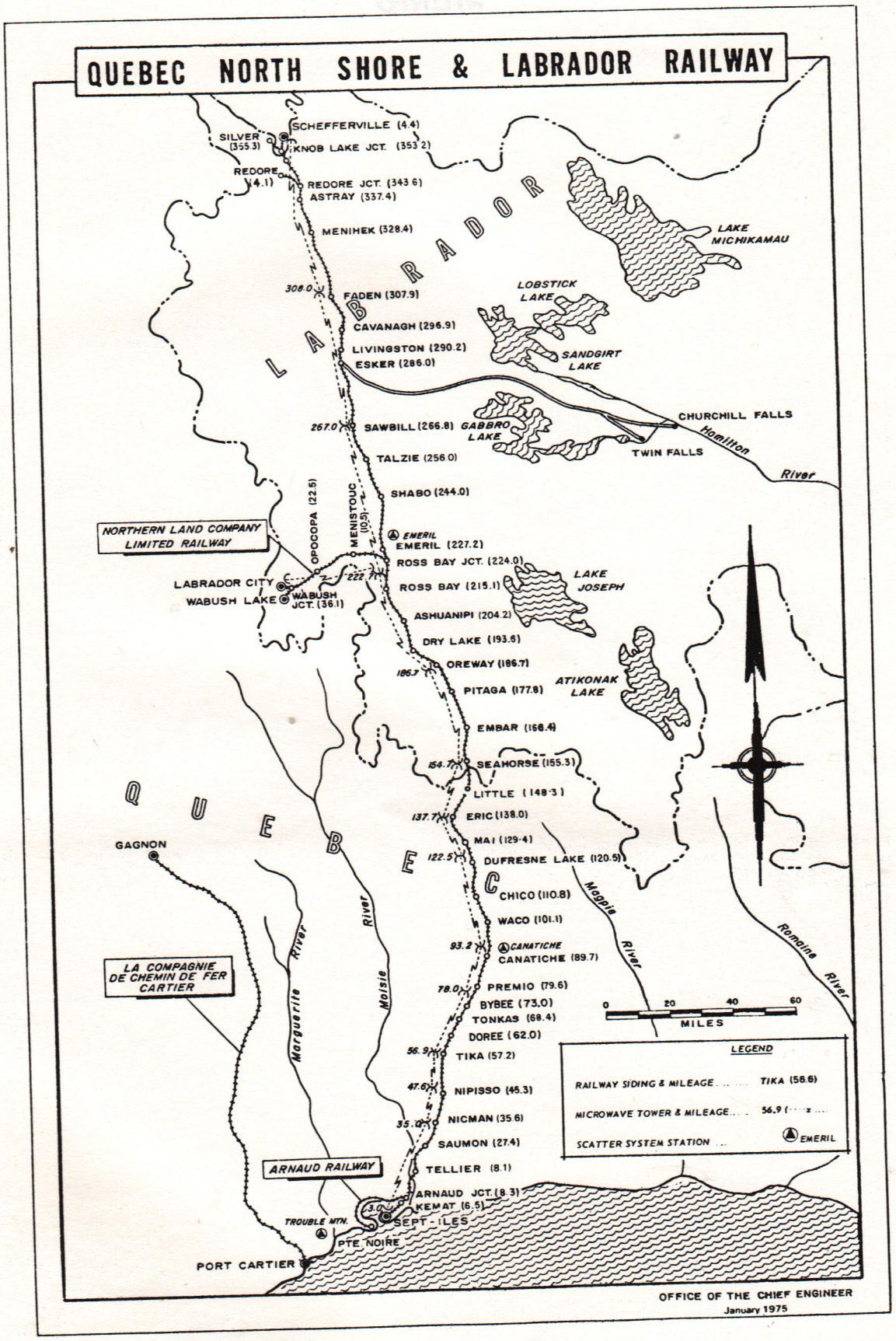
The 23KV distribution from Sept-Iles, Menihek and Labrador City, used to supply power to all installations along the railway.

Other Systems:

Business machine maintenance in Sept-Iles and Schefferville and the radio, electronic and public address systems used in conjunction with the pellet plant and concentrator in Sept-Iles and the mines in Schefferville.

Corrective and minor maintenance along the railway is carried out with the help of four 206B helicopters, equipped with three-men maintenance crews.

Ore train — Q.N.S.&L.


QUEBEC NORTH SHORE & LABRADOR RAILWAY
SCHEFFERVILLE (4.4)
SILVER (355.3)
KNOB LAKE JCT. (353.2)
REDORE (4.1)
REDORE JCT. (343.6)
ASTRAY (337.4)
MENIHEK (328.4)
LABRADOR
LAKE MICHIKAMAU
308.0
FADEN (307.9)
LOBSTICK LAKE
CAVANAGH (296.9)
LIVINGSTON (290.2)
ESKER (286.0)
SANDGIRT LAKE
CHURCHILL FALLS
267.0
SAWBILL (266.8)
GABBRO LAKE
TWIN FALLS
Hamilton River
TALZIE (256.0)
SHABO (244.0)
OPOCOPA (22.5)
MENISTOUC (10.5)
NORTHERN LAND COMPANY LIMITED RAILWAY
EMERIL
EMERIL (227.2)
ROSS BAY JCT. (224.0)
222.7
LABRADOR CITY
WABUSH LAKE
WABUSH JCT. (36.1)
ROSS BAY (215.1)
LAKE JOSEPH
ASHUANIPI (204.2)
DRY LAKE (193.6)
OREWAY (186.7)
186.7
PITAGA (177.8)
ATIKONAK LAKE
EMBAR (166.4)
154.7
SEAHORSE (155.3)
LITTLE (148.3)
137.7
ERIC (138.0)
MAI (129.4)
122.5
DUFRESNE LAKE (120.5)
QUEBEC
CHICO (110.8)
Magpie River
Romaine River
GAGNON
WACO (101.1)
93.2
CANATICHE
CANATICHE (89.7)
LA COMPAGNIE DE CHEMIN DE FER CARTIER
Marguerite River
Moisie River
78.0
PREMIO (79.6)
BYBEE (73.0)
TONKAS (68.4)
DOREE (62.0)
56.9
TIKA (57.2)
47.6
NIPISSO (45.3)
35.0
NICMAN (35.6)
SAUMON (27.4)
ARNAUD RAILWAY
TELLIER (8.1)
ARNAUD JCT. (8.3)
3.0
KEMAT (6.5)
SEPT-ILES
TROUBLE MTN.
PTE NOIRE
PORT CARTIER
0 20 40 60
MILES
LEGEND
RAILWAY SIDING & MILEAGE ..... TIKA (56.6)
MICROWAVE TOWER & MILEAGE 56.9
SCATTER SYSTEM STATION ..... EMERIL
OFFICE OF THE CHIEF ENGINEER
January 1975