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ATOMIC ENERGY IN CANADA

Canada's atomic energy establishment, popularly known as "Chalk River", is operated by the government-owned company Atomic Energy of Canada Limited. It is located in Ontario on the Ottawa River five miles from the village of Chalk River, about 130 miles from the city of Ottawa. A.E.C.L., which was formed in 1952 to take over the operation of the establishment from the National Research Council, has a seven-man Board of Directors that includes representatives of private industry, public and private power companies, and the universities. The company is engaged in four main activities:

1. development of economic atomic power
2. fundamental research
3. operation of nuclear reactors and separation of nuclear fuels (plutonium and uranium-233)
4. production of radioactive isotopes and associated equipment such as therapy units for cancer treatment.

It is estimated that government expenditure on atomic energy in Canada over the next five years will total $124,000,000. This will include mainly such items as fundamental research, the completion of the construction of the new NRU research and plutonium production reactor, the construction of an experimental atomic power station, and a preliminary design study, with associated development programs, for a 100,000 kilowatt (electric) power station. Atomic Energy of Canada Limited now has 1,900 employees, and a fairly large number of engineers and scientists employed by universities, publicly and privately owned power companies, and manufacturing firms are also working on various aspects of atomic energy development.

NUCLEAR POWER DEMONSTRATION

Detailed design has just begun on Canada's first atomic power station, known as the Nuclear Power Demonstration (NPD), which is expected to go into operation in 1958. The station will be located at the hydro-electric power station of the Hydro-Electric Power Commission of Ontario, near the village of Des Joachims on the Ottawa River, about 150 miles west northwest of Ottawa and 20 miles from Chalk River.

The cost of power produced by this station is not expected to be competitive with that produced by hydro-electric or conventional thermal stations that burn coal, oil or natural gas. The main objectives of such a station of low power rating are to prove economic feasibility, to gain practical data on the economics of power production with nuclear plants, to gain experience in design and operation, particularly on those aspects which differ from research reactors, and to train personnel, both in plant design and in operation.

The estimated cost of a 20,000 kilowatt station of the NPD design presently envisioned is just over $11,000,000. This figure does not include the cost of development work at Chalk River nor the cost of the land. Atomic Energy of Canada Limited will pay the major portion of the cost of the reactor, which has been estimated at about $8,000,000, will provide nuclear data and will be responsible for the nuclear performance of the plant. This company will provide the fuel (natural uranium) and the moderator (heavy water) and will process used fuel elements at Chalk River.

Canadian General Electric Company Limited is responsible for the detailed design and engineering of the reactor and for all construction, and will contribute $2,000,000 toward its cost. The conventional part of the plant (turbine, electrical generator, and transmission gear) will be disigned and paid for by the Hydro-Electric Power Commission of Ontario, an agency of the government of Ontario, which will also operate the plant and feed the electricity produced into its Ontario power network. The Commission will buy steam from Atomic Energy of Canada Limited at an agreed rate and A.E.C.L. will reimburse the Commission for the operating costs of the reactor.

LARGE-SCALE POWER REACTOR

While the design and construction of NPD goes forward, a preliminary design study for a 100,000 kilowatt (electric) station will be carried out by a group composed of engineers and scientists from various power companies throughout Canada and from the staff of Atomic Energy of Canada Limited. The detailed design and construction of such a station, and of future atomic power stations in Canada, will be the joint responsibility of private industry and of the various power companies.

ADVISORY COMMITTEE ON ATOMIC POWER

Complete information on the design and performance of the demonstration power station and on the preliminary design study for the larger station will be made available to the Advisory Committee on Atomic Power, on which are represented the various privately and publicly owned power companies throughout Canada. This committee has held two sessions at Chalk River where it studied the existing Canadian reactors and the preliminary plans for NPD.

CHALK RIVER REACTORS

Canada now has three reactors at Chalk River, two in operation and one under construction. The ZEEP reactor, the first to operate outside the United States, went into operation in 1945 and has a power of 10 watts, though for some experiments it has been operated up to 250 watts. The NRX reactor, which went into operation in 1947, has a power of 40,000 kilowatts. The NRU reactor, now under construction, is expected to have a power of 200,000 kilowatts. It will go into operation in 1956.

These reactors all use natural uranium for fuel and heavy water for moderator, and are fundamentally research reactors. Because of its high flux over a relatively large volume, the NRX reactor is being used by Canada, the United States and the United Kingdom for various experiments related to the development of atomic power. The high neutron flux of NRX enabled Canada to pioneer in the production of radioactive isotopes of high specific activity (which means that a given quantity of material gives off a large amount of radiation), wuch as cobalt-60 for therapy units used in the treatment of cancer. The replacement value of NRX has been estimated to be $11,000,000.

The NRU reactor will produce significant quantities of plutonium and will have a neutron flux five times that of NRX, thus making possible advanced fundamental research and engineering studies. As it will have a high neutron flux over a relatively large volume and will have extensive experimental facilities, it will be the finest nuclear engineering test facility in existence.

Like NRX, the new reactor will "burn" natural uranium in rod form and will use heavy water for a moderator. But a major difference in the design will be the method of cooling. In NRX ordinary river water flows down over the uranium rods in the calandria -- the aluminum tank which contains the moderator and the fuel rods. As ordinary water is a much stronger absorber of neutrons than heavy water, the former has been kept out of the core of the NRU reactor. The heavy water in NRU will serve not only as the moderator but also as the coolant -- it will circulate through eight 17-ton heat exchangers outside the reactor core. River water will flow through the heat exchangers to take the heat away from the heavy water, which circulates back into the reactor core.

The NRU reactor is housed in a huge building that has three basements. The distance from the floor of the lower basement to the roof is 145 feet -- the height of a 12-storey building. The building is really a combination of buildings for it contains physics and chemistry laboratories and associated shops. The main room, which contains the reactor structure and experimental area, is about 90 feet high, 175 feet long and 100 feet wide. A large amount of space above the reactor is necessary to allow the removal of highly radioactive fuel rods, which are raised up into a 225-ton shielded container called a "rod removal flask". (The NRX rod removal flask weighs 25 tons.) The The estimated cost of this research and production facility is $40,000,000.

RESEARCH AND DEVELOPMENT

Research and development are carried out at Chalk River by four divisions: Reactor Research and Development, Chemistry and Metallurgy, Physics, and Biology.

The Reactor Research and Development Division is engaged in experiments and calculations required for the design of nuclear reactors for power stations. The ZEEP reactor is used to study various types and arrangements of fuel for power reactors. A large number of fuel samples have been tested in the NRX reactor under conditions simulating those of possible designs for future power plants. These experiments, carried out in collaboration with other divisons and in some cases with the United States Atomic Energy Commission contractors and with the United Kingdom Atomic Energy Establishment, are providing essential information on the behaviour and suitability of various physical forms of fuel, of different kinds of sheating to protect against corrosion, and of heat transfer characteristics. Other experiments are leading to methods which make it possible to extract more energy from the fuel.

The Chemistry and Metallurgy Division is working on problems associated with the preparation and the processing of reactor fuel. Fuel elements are being developed for the NRX and NRU reactors and for power reactors. The special equipment and services of the Mines Branch of the Department of Mines and Technical Surveys are used in this program. The disposal of radioactive wastes is being studied and various methods are being tested.

The Physics Division uses the experimental facilities of the NRX reactor and the particle accelerators to study the structure of atoms. The 3,000,000 volt Van de Graaf Generator is used to discover and measure specific properties of various atomic nuclei. To investigate atomic disintegrations produced by high energy protons, a mobile laboratory has been sent from Chalk River to the Inter-University High Altitude Laboratory at Echo Lake in Colorado. There the proton component of cosmic rays is some ten times as great as at sea level.

In the Biology Branch radioactive isotopes are used for such studies as the movements of phosphorus in lakes into organisms and vegetation, the activities of destructive forest insects, and the travel of nutrient solutions in trees. The branch studies the genetic and other effects produced by radiation in living organisms.

RADIOACTIVE ISOTOPES

As mentioned, Canada pioneered in the production of radioactive isotopes of high specific activity, particularly cobalt-60 for use in cancer treatment units. More than 100 different isotopes are produced for use in medicine, agriculture and industry and are distributed to many countries.

The marketing of radioactive isotopes produced at Chalk River is handled by the Commercial Products Division of Atomic Energy of Canada Limited. This division has its headquarters in Ottawa, Ontario, where it has processing laboratories and machine shops.

In the latter are produced the Cobalt-60 Beam Therapy Units for the treatment of cancer. Two units are in production and a third will be available within a few months. The first unit to go into production is known as the "Eldorado", and a larger unit, with facilities for rotation and oscillation, is known as the "Theratron". The third unit, known as "Theratron Junior", is now in an advanced stage of design. Twenty-nine therapy units have now been installed in hospitals and other treatment centres in Canada, the United States, England, Brazil, Italy and France.

Last year the Commercial Products Division made 1,200 shipments of various products.

ATOMIC ENERGY CONTROL BOARD

The Atomic Energy Control Act was passed in Canada in 1946 "to make provision for the control and supervision of the development, application and use of atomic energy." Under this Act was created the Atomic Energy Control Board which has two main functions: (1) it has the power to regulate the production and application of materials relating to atomic energy, particularly fissionable materials, and (2) it has the power to make and administer security regulations required by the Canadian atomic energy program.

URANIUM

By the end of 1957 uranium production in Canada will be over 20 times as great as it was at the end of the Second World War. The annual gross income from that production will be approximately $100,000,000, ranking uranium in fourth place in the gross dollar value of metal production in this country.

Until recently the Great Bear Lake region was the only important uranium producing area in Canada. Milling plants now in production and under construction will, however, make an area north of Lake Athabasca, known as the Beaverlodge region, and an area in Ontario, known as the Blind River region, the two chief uranium producing areas in Canada. These regions all lie within the Canadian Shield, a great, wide, U-shaped area of ancient rocks. Pitchblende is the principal source of uranium in the mines now producing, but the major uranium-bearing minerals of several mines planning or approaching the production stage are brannerite or uranothorite.

Eldorado Gold Mines Limited put the Port Radium mine into production in 1933 and built a refinery at Port Hope, Ontario. The first ounce of radium was produced in 1936 and in the ensuing years the mine forced a reduction in the world price. But in 1940 this private company was forced to halt its operations owing to the wartime dislocation of radium markets. In the meantime, research aimed at the development of an atomic bomb moved steadily toward success. In 1942 the company was asked to quietly reopen the mine to produce uranium. Shortly afterward it was bought by the Canadian government and has since been operated by the government-owned company, Eldorado Mining and Refining Limited.

Guaranteed minimum prices were established for ores and concentrates -- these hold until March 31, 1962 -- and Eldorado Mining and Refining Limited became the government's agency for their purchase.

With the assistance of the Geological Survey of Canada over a four-year period, Eldorado had found more than 1,000 radioactive occurrences. The most important of these were in the region of Beaverlodge Lake, a few miles from Goldfields, which is on the north shore of Lake Athabasca. Along a deformation which was soon recognized to be a fault -- it became known as the St. Louis Fault -- were found veinlets of pitchblende. Though these were not particularly impressive in themselves, their position in relation to the fault led to a decision to do exploratory drilling and thus the Ace orebody was discovered. Within the Eldorado property, through which the St. Louis Fault has been traced for six and a half miles, are several other radioactive zones -- Fay, Eagle, Verna, Martin, and others.

The construction of a mining plant and concentrator on the Eldorado property was begun in April 1952 and the plants were in operation by May 1953 -- a considerable achievement in view of the fact that the property is 270 miles by water from the nearest railhead at Waterways, Alberta, and is inaccessible except by air for eight months of the year. A five-compartment shaft was sunk on the Fay zone and connected on the sixth level to the Ace mine, four thousand feet to the east. Another shaft, on the Verna zone six thousand feet to the east of the Ace shaft, was completed in 1954 and will be connected to the Ace-Fay system.

The Ace-Fay mill initially handled 500 tons of ore a day and is presently treating 700 tons. Provision has been made in the design of the plant to expand the ore treatment facilities to 2,000 tons a day should ore developments warrant this.

A large number of private companies have been active in the Beaverlodge region, which extends some 80 miles eastward from the Alberta boundary north of Lake Athabasca. The following privately-owned mines in the region began shipments to the Ace-Fay mill last year and early this year: Consolidated Nicholson, Rix-Athabaska, and Nesbitt LaBine. The development if numerous other properties is active.

The Gunnar Mines Limited property on the Crackingstone Peninsula, which juts into Lake Athabasca south-west of Beaverlodge Lake, was reported by the company in 1954 to have a deposit with a gross estimated value of $130,000,000. The company has a contract for delivery of precipitates to the value of $76,950,000. Gunnar has built a treatment plant with a rated capacity of 1,250 tons a day and production is scheduled to commence in 1955.

Recent diamond drilling and geological study have indicated that the Blind River region may be the greatest uranium field in the world. The region is in the vicinity of the town of Blind River, Ontario, on the north shore of Lake Huron. Pronto Uranium Mines and Algom Uranium Mines Limited are bringing three mines to the production stage. In 1954 it was reported that Pronto had outlined an orebody with a gross value of more than $70,000,000. Pronto has a contract for the sale of precipitates to the value of $55,000,000. A shaft has been sunk and a treatment plant with a capacity of 1,250 tons a day is under construction.

The Quirke Lake and Nordic Lake properties of Algom were reported in 1954 to have a total gross value of more than $300,000,000. For these properties Algom has a contract for the sale of concentrates to the value of $206,910,000. Work has started on a 3,000-ton treatment plant at each property.

Diamond drilling on several other properties in the Blind River region indicates deposits similar to the Pronto and Algom will be developed before the end of 1955.

A large number of uranium-bearing pegmatites have been found in Canada and, although they generally do not appear to be favourable for mining, a few are likely to become producers. One of the most active exploration regions in which pegmatites and related types of deposits occur is that in the vicinity of Bancroft, Ontario, about 100 miles north-east of Toronto.

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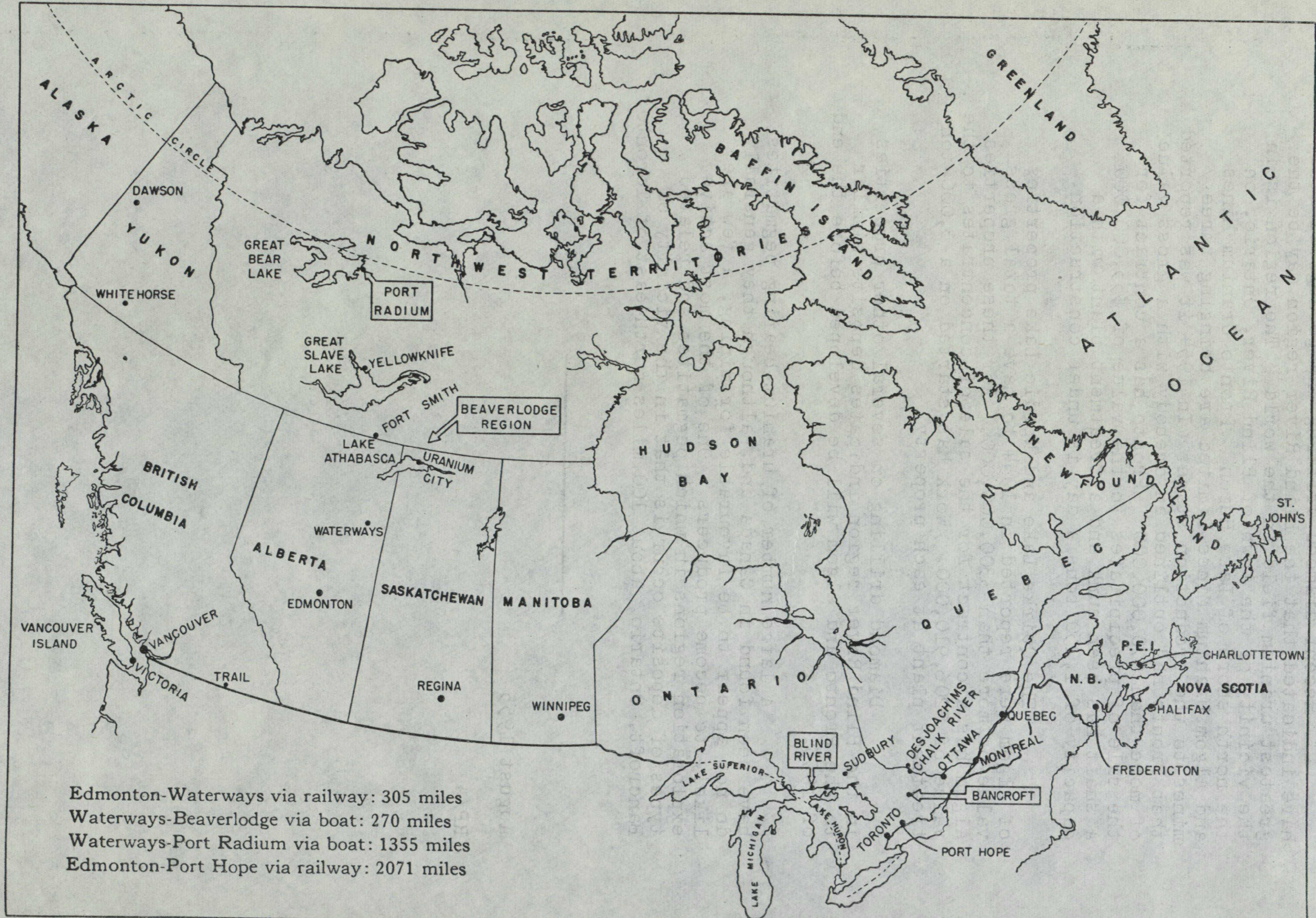
ARCTIC CIRCLE
ALASKA
GREENLAND
BAFFIN ISLAND
ATLANTIC OCEAN
DAWSON
YUKON
WHITEHORSE
GREAT BEAR LAKE
NORTH WEST TERRITORIES
PORT RADIUM
GREAT SLAVE LAKE
YELLOWKNIFE
FORT SMITH
BEAVERLODGE REGION
LAKE ATHABASCA
URANIUM CITY
HUDSON BAY
BRITISH COLUMBIA
WATERWAYS
ALBERTA
EDMONTON
SASKATCHEWAN
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CHALK RIVER
DESJOACHIMS
SUDBURY
BLIND RIVER
BANCROFT
TORONTO
PORT HOPE
LAKE SUPERIOR
LAKE HURON
LAKE MICHIGAN
Edmonton-Waterways via railway: 305 miles
Waterways-Beaverlodge via boat: 270 miles
Waterways-Port Radium via boat: 1355 miles
Edmonton-Port Hope via railway: 2071 miles