Manitoba Hydro

Kettle Generating Station

Manitoba Hydro's Kettle Generating Station, built on the lower arm of the Nelson River in northern Manitoba, is the second largest hydroelectric generating station in the province. Each of its 12 turbine generators (called units) is capable of producing approximately 103 megawatts (MW), for a combined capacity of 1 228 MW. (The capacity of Limestone, the province's largest generating station, is 1 347 MW.)

Kettle is located north of the 56th parallel, roughly three kilometres (km) upstream from the Canadian National Railway's river crossing near the town of Gillam. The distance from the City of Winnipeg to Kettle is over 700 km by air.

By building Kettle where it is, a series of rapids along the Nelson River were consolidated into a 30-metre (m) operating head, which is a waterfall created by the generating station's structure. The falling water drives the station's turbines, each of which discharges up to 370 cubic metres of water per second (m^3/s) when running at full output.

Kettle, whose spillway structure is built adjacent to the powerhouse structure, is a "run-of-river" design, which means that water flowing into the generating station from upstream is used immediately, not stored for later use. Such a design makes the most efficient use of the existing river banks, and causes as little disruption to the environment as possible.

The construction of Kettle started in the spring of 1966 and the first unit went into service in December 1970. By the time the generating station was officially opened in June 1973, seven units were in service. The twelfth and final unit was up and running in November 1974.

The decision to build Kettle was based on an initial plan to harness the abundant hydroelectric potential of the Nelson River. The long range view was that Kettle would be the first in a series of generating stations intended for the river. In fact, Kelsey became the first to be built on the upper arm of the river in 1957, to supply electricity exclusively to INCO's nickel mining operations near the City of Thompson.

The initial plan also included a serious commitment to three other major construction projects: the high voltage direct current (HVDC) transmission line project, which was completed to the point of initial service in 1973; the Churchill River Diversion project, which has been in operation since 1977; and the Lake Winnipeg Regulation project, which was completed with the construction of Jenpeg Generating Station in 1979.

Inside Kettle Generating Station's powerhouse, maintenance work on the turbine generators ensures they will operate to maximum efficiency.

The powerhouse and spillway

Kettle's powerhouse measures 380 m long, 60 m wide, and 56 m high on the upstream, or forebay, side (a forebay is the lake-like body of water upstream of the dam which, because its level is higher than the downstream side, creates the waterfall). On the downstream, or tailrace, side of Kettle, the powerhouse measures 33 m high between the levels of the roof and the water.

The Nelson River is 885 m wide where the structures are located, with the powerhouse extending 43 per cent of the way across the river from the south bank. The spillway occupies the middle 22 per cent of the river, and an earth-filled dam blocks off the remaining 35 per cent of the distance to the north bank.

The station's construction

Kettle's construction was accomplished in a series of carefully planned phases. In the first phase, tonnes of rock were placed partway across the river to form a cofferdam — a temporary, watertight, island-like enclosure in which the generating station was to be built. Once the cofferdam was pumped dry, tonnes of bedrock were excavated and the site was prepared for building the foundation of the powerhouse.

When the powerhouse structure neared completion, the cofferdam was extended further across the river to create the site where the spillway would stand. The cofferdam was then breached upstream and downstream of the powerhouse, which allowed most of the river's water to pass through its structure (the generating station's units were not yet installed).

Finally, the cofferdam was extended all the way across the river, which meant its entire flow of water ran through the powerhouse. As soon as the spillway was completed, the flow was then diverted through it, and the powerhouse was again sealed off to permit installation of the generating units.

The transmission system

The electricity generated at Kettle, as well as at the Long Spruce and Limestone generating stations also built on the lower arm of the Nelson River, is transmitted to southern Manitoba over two identical HVDC transmission lines. One line, referred to as Bipole 1, starts at Radisson Converter Station, which is located about three kilometres south of Kettle. The other, called Bipole 2, extends 42 km beyond Radisson to Henday Converter Station, which is close to Limestone.

The Radisson line operates at direct current (DC) voltages of 900 000 V (±450 000 V), and the Henday line operates at voltages of 1 000 000 V (±500 000 V).

These voltages are among the highest in the world. The lines are also among the world's longest. They follow a 900-km route that takes them through Manitoba's Interlake region, until they reach Dorsey Converter Station which is located at

Rosser, 26 km northwest of Winnipeg.

Before any electricity from the Kettle, Long Spruce and Limestone generating stations can be transmitted, it must be converted from alternating current (AC) to DC at the Radisson and Henday converter stations. From there, the power is transmitted via the HVDC lines to Dorsey, where the power is converted back to AC before being fed into the province's southern distribution line system at lower voltages, suitable for use by consumers.

DC transmission lines are used by Manitoba Hydro because they lose less power than AC lines over long distances and are more stable.

Also, DC transmission line systems are about two thirds the cost of AC transmission line systems. The major expense for DC lines is building the converter stations.

During part of Kettle's construction — between 1966 and 1973 — the water flow of the Nelson River was diverted through the spillway while the powerhouse was being built on the cofferdam, a dry area created in the middle of the river.

The Lake Winnipeg Regulation project

A huge volume of water is needed to produce electricity at Manitoba Hydro's hydroelectric generating stations, and the highest demand for power is during the winter months. But the natural water outflow of Lake Winnipeg into the Nelson River is greatest in the summer and least in the winter — just the opposite of what the utility requires. Therefore, to more closely match the province's energy use pattern, the Lake Winnipeg Regulation (LWR) project was developed to alter the annual flow pattern.

In its natural state, the winter outflow of Lake Winnipeg was impeded by narrow and shallow outflow channels. To improve the lake's outflow capability, three wider and deeper channels were built:

1. The 2-Mile Channel, which bypasses the natural outlet at Warren Landing.
2. The 8-Mile Channel, which allows more water to flow from Playgreen Lake to the south end of Kiskittogisu Lake.
3. The Ominawin Channel, which bypasses the Ominawin Rapids at the natural junction of Playgreen Lake and Kiskittogisu Lake.

In order to control the Nelson River's water flow, the Jenpeg Control Dam was built at the point where the west channel of the Nelson River flows into Cross Lake. Lake Winnipeg thus acts as a reservoir, supplying water as needed to the generating stations further downstream.

Part of the LWR project was to separate Kiskotto Lake from the west channel of the Nelson River. The lake is now operated as a wildlife habitat.

The Churchill River Diversion

In Manitoba, the Churchill River has a hydroelectric potential of more than 3 000 MW. But instead of harnessing this potential by building generating stations on the Churchill River itself, a considerable economical advantage is gained by diverting most of its flow for power generation on the Burntwood River and the Lower Nelson River.

Three major components accomplish this diversion:

1. A control dam at Missi Falls, which is the natural outlet of Southern Indian Lake, regulates the outflow, and also raises the lake level by three metres.
2. An excavated channel from Southern Indian Lake to Issett Lake allows the Churchill River water to flow into the Rat, Burntwood, and Nelson rivers.
3. A control dam at Notigi on the Rat River regulates the amount of water being diverted.

The Town of Gillam

Gillam was named after an early fur trading father and son team — Zachary and Benjamin Gillam. The town is an old railway community located about halfway between

Churchill and Thompson (the railway was well used by traders to carry their goods to and from the Port of Churchill). A one-time divisional point on the Hudson's Bay Railway, Gillam used to boast a roundhouse, a water tower, and a sizeable contingent of railway employees.

With the start of construction of Kettle Generating Station, the community received a new lease on life. Water, sewer, and electrical systems were built, and a new school, paved streets, an airport, a hospital, a shopping centre, a community recreation centre, and television reception were supplied. All arrived in short order as the community literally exploded in size. With an original population of only a few hundred people, the number burgeoned to 3 000 during construction projects. At the present time, about 1 900 residents live in Gillam.

Kettle Generating Station facts

Construction started	1966
Construction completed	1973
Cost	$240 million
Capacity	1 228 MW
Average annual generation	7 070 million kW·h
Waterfall drop	30 m
Powerhouse	Length: 380 m
Number of turbine generators (units)	12
Production of units	103 MW each
First and last unit in service	1970, 1974
Intake gates for water inflow	36 measuring 5.9 m by 12.2 m
Units' total discharge capacity	4 333 m^3/s of water
Forebay area	337 km^2
Forebay's normal water level	141.1 m (winter), 140.2 m (summer)
Spillway	8 gates measuring 11.4 m by 14.4 m
Spillway's total discharge capacity	8 349 m^3/s of water
Transmission lines	138-kV AC to Radisson Converter Station ±450-kV DC to Winnipeg

Major contractors

General civil contract	Kettle Constructors
Generators	Toshiba-Mitsui & Co. Ltd. (Japan)
Turbines	Dominion Engineering Works
Intake gates	Mitsubishi Canada Ltd.
Spillway gates	Dominion Bridge Company Ltd.

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