Manitoba Hydro

Long Spruce Generating Station

Long Spruce was Manitoba Hydro's fourth generating station to be built on the mighty Nelson River, which flows in northern Manitoba from Lake Winnipeg to Hudson Bay. The generating station is about 745 kilometres (km) northeast of Winnipeg, 27 km east of Gillam and 16 km downstream from Manitoba Hydro's Kettle Generating Station.

Long Spruce, which was completed in 1979 at a cost of $508 million, has a capability of 1 008 megawatts (MW), making it the third biggest producer of electricity on the Nelson. Only Kettle, with a capability of 1 228 MW, and Limestone Generating Station, at 1 347 MW, are larger.

Like most of Manitoba Hydro's generating stations, Long Spruce is a "run-of-river" design, meaning that water arriving at the generating station is used immediately, and not stored for later use in the forebay (the lake-like body of water upstream). This design takes advantage of the natural structure of the river banks to hold water in the forebay. The design also minimizes the negative impact on the surrounding environment.

The water level in Long Spruce's forebay varies from an elevation of 109 metres (m) above sea level (ASL) in summer to 110.4 m in winter. A 26-m waterfall (called an operating head) created by the generating station drives its 10 turbine generators (called units).

The powerhouse and spillway

Long Spruce's powerhouse, spillway and dyke structures comprise a total length of 1 600 m and provide a river crossing for highway access to Henday Converter Station and Limestone Generating Station, linking provincial trunk highways #280 and #290. The concrete structures extend 495 m from the right bank northward to the centre of the river. The earthfill dyke is 1 105 m long.

Each unit in the powerhouse is capable of producing about 100 MW. The first unit went into service in 1977, the tenth in 1979. The 10 propeller-type vertical shaft turbines are similar to those installed at Kettle. About 458 cubic metres per second (m^3/s) of water flows through each unit when it runs at full capacity. The generator rotors are 12.4 m in diameter.

The water intake structure at Long Spruce, where water enters the powerhouse, consists of 30 intake gates, three for each unit. Each gate measures about 6.3 m wide and 14.7 m high.

The spillway, next to the powerhouse, has a total discharge

The interior of the powerhouse at Long Spruce Generating Station. Each of the square housings contains a turbine generator (called a unit). Canadian General Electric was the supplier of the 10 units.

capacity of 9 515 m^3/s through six gates, each measuring 14.1 m wide and 16.9 m high. The combined water discharge capacity of the spillway and powerhouse is approximately 14 160 m^3/s.

On the downstream side of the powerhouse, the river's elevation is 85 m ASL, varying from a maximum of 87 m to a minimum of 83 m. The tailrace, the channel through which water flows after leaving the powerhouse, is 265 m wide.

The construction

Building started in 1971 with the extension of an access road from Kettle Generating Station to the Long Spruce construction site. In 1973, a massive cofferdam — a temporary, watertight, island-like enclosure — was built partway across the river and construction of the spillway and powerhouse structures began. After a total of over 836 000 m^3 of earth and bedrock were excavated, the first concrete for the structures was poured in March 1974. By the time the generating station was finished, 544 300 tonnes (t) of concrete and 20 000 t of reinforcing steel had been used.

Because Long Spruce is located in what is called the discontinuous permafrost zone, its construction posed special challenges. The sites for the concrete structures had to be excavated down to the bedrock, and all of the dyke locations had to be pre-treated with sand drains.

Sand drains are an extensive series of sand-filled drillholes placed in the foundations of the dykes. The drains are necessary to prevent the heat created by the forebay's water from melting the underlying permafrost. This condition could damage the dykes. With sand drains in place, the melt seeps through them and into the pervious fill of the dykes, thus allowing a controlled settlement throughout their lengths. About 13 km of dykes flank Long Spruce.

During the winter months, while the forms were being built for the concrete draft tubes (which guide the water leaving the units back into the river downstream of the generating station), workers were protected from the extreme cold by a movable hoarding that was designed and built by the construction company. The hoarding was 23 m wide and made of a structural steel frame with aluminum siding and a vapour seal. The entire enclosure was column-free, enabling the forming and placing

operations to proceed quickly. Once the preparatory work was done, the roof of the hoarding was removed to allow rebar and concrete to be lowered into place. The hoarding covered three draft tubes at a time. When the three were completed, the hoarding was pulled by a powerful tractor along greased steel rails to the next three draft tubes to be constructed.

The Dominion Bridge Company Ltd. supplied and installed the six spillway gates. The gates and their associated equipment, valued at $4 million, were largely fabricated in the company's Winnipeg factory.

Dominion Engineering Works of Montreal supplied and installed Long Spruce's 10 turbines, and Canadian General Electric the 10 generators, which were manufactured in Peterborough, Ontario and assembled at the project site.

The transmission system

Half of the electricity produced at Long Spruce is first transmitted as alternating current (AC) to Radisson Converter Station, located near Gillam, where it is converted to direct current (DC). The other half is transmitted to Henday Converter Station, located near Limestone, where it is also converted from AC to DC.

After its conversion to DC, the power is transmitted about 900 km to southern Manitoba over the same DC transmission lines that carry the electricity produced at Kettle and Limestone. It arrives at Dorsey Converter Station, which is located at Rosser, 26 km northeast of the City of Winnipeg. There, it is once again converted back to AC.

The Nelson River Development

The rich hydroelectric potential of Manitoba's northern rivers has been recognized for a long time, but tapping their resources was not feasible until the development of high voltage direct current (HVDC) transmission technology — which could carry electricity long distances.

In 1966, following extensive investigations financed jointly by the federal and provincial governments, a commitment was made to proceed with the development of the Nelson River. The long range program was initiated with the construction of:

- The 1 228 MW generating station at Kettle Rapids.
- The ±450-kV HVDC transmission system from Kettle to Winnipeg.
- The Lake Winnipeg Regulation controls.
- The Churchill River Diversion.

With five generating stations — Jenpeg, Kelsey, Kettle, Long Spruce and Limestone — now operating on the upper and lower arms of the Nelson River, it is estimated that approximately 5 000 MW of power remain available for development in northern Manitoba.

During construction, one of Long Spruce Generating Station's 98 MW turbine runners is prepared for placement.

The 230-kV AC towers and switching station at Long Spruce Generating Station. One half of the power produced there is transmitted to Radisson Converter Station for conversion to DC, the other half to Henday Converter Station for conversion to DC. From Radisson and Henday, the power is transmitted along Bipole 1 and Bipole 2 to Dorsey Converter Station near Winnipeg, where it is converted back to AC electricity for distribution to Manitoba Hydro's customers.

Long Spruce Generating Station facts

Construction started	1971
Construction completed	1979
Cost	$508 million
Capacity	1 008 MW
Average annual generation	5 800 million kW·h
Waterfall drop	26 m
Powerhouse	Length: 300 m
Number of turbine generators (units)	10
First and tenth unit in service	1977 and 1979
Production of units	About 100 MW each
Units discharge capacity	458 m^3/s of water
Forebay's normal water level	110.033 m in summer 110.33 m in winter
Spillway with six gates	Length: 195 m
Spillway's discharge capacity	9 515 m^3/s of water
Transmission lines	230-kV AC to Radisson 230-kV AC to Henday ± 450-kV DC to Dorsey

Major contractors

General civil contract	Long Spruce Constructors 1973	
Turbines	Dominion Engineering Works Ltd.	Generators
	Canadian General Electric	

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