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### Monitoring and dynamic rating of 120 kV XLPE insulated cable circuits at Hydro-Quebec

J. Leduc, M. Chaaban, M. Choquette

IREQ, Research Institute of Hydro-Québec, 1800 boul. Lionel-Boulet,  
Varenes, Québec, Canada, J3X 1S1

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Due to the continuously varying ambient and environmental conditions that greatly affect the ampacity of HV cables as well as to the stringent performance and reliability requirements brought by the recently deregulated electricity market in eastern North-America, Hydro-Québec has designed thermal monitoring and dynamic rating systems for its new HV underground cable circuits. These systems use fiber optic cables coupled with DTS (Distributed Temperature Systems) units and computer software based on finite element technique.

The objective of such a system is to operate HV cable circuits in the most efficient and reliable manner. Hydro-Québec is actually in the process of extending this type of monitoring system to all its generation, transmission and distribution strategic equipment. Back in 1990, Hydro-Québec was among the first utilities in North-America to use a DTS unit to achieve temperature monitoring on the 450 kV DC cable circuits of the St-Lawrence river crossing.

The system pinpoints the location of the hot spot along the cable route. It computes the maximum conductor temperature at the present load, the maximum steady load that can be transmitted at present conditions, the maximum overload that can be transmitted within a given short period of time until the maximum temperature is reached and the maximum period of time that a prescribed overload can be transmitted through the cable link.

The system was recently introduced at the Beauharnois hydroelectric power generating station. This station ranks second for its energy output among all Hydro-Québec stations and is presently undergoing a major rehabilitation program since 1990. The total power of 1673 MW, generated by 36 turbine-generator units, is transported by 36 - 120 kV insulated cable circuits from the step-up transformers to the 2 newly erected SF<sub>6</sub> substations on the east and west ends of the power station as well as by 20 cable circuits between the stations and the outgoing overhead lines.

On the west side, 14 cable circuits are installed in a common cable route in ducts rigidly clamped together in a trefoil configuration (figure 1). Because of a space constraint, the remaining 22 cable circuits on the east side are installed in a special concrete duct bank of 66 conduits, on the roof of the power station (figure 2).

Due to the complexity of this latter installation and the large number of 120 kV cables involved in a single duct bank, the powerful finite element numerical technique was selected rather than the conventional analytical method to determine the cables ampacities. This approach enabled Hydro-Québec to carefully select the conductor sizes as well as establish the cable configuration and the thermal characteristics that were required for the concrete envelope.

Fiber optic cables were pulled in the ducts along with some strategically selected HV cable circuits. Some discrete temperature measurement stations using thermocouples were also installed around the cable circuits as well as in the duct bank itself.

This paper gives an overview of the development and the validation procedures of the monitoring and dynamic rating system developed at IREQ. It also describes the installation at the Beauharnois station and reports on some of the preliminary results obtained since the beginning of operation last year.



Fig. 1. Cables installed in special ducts rigidly clamped in a trefoil configuration (west side)

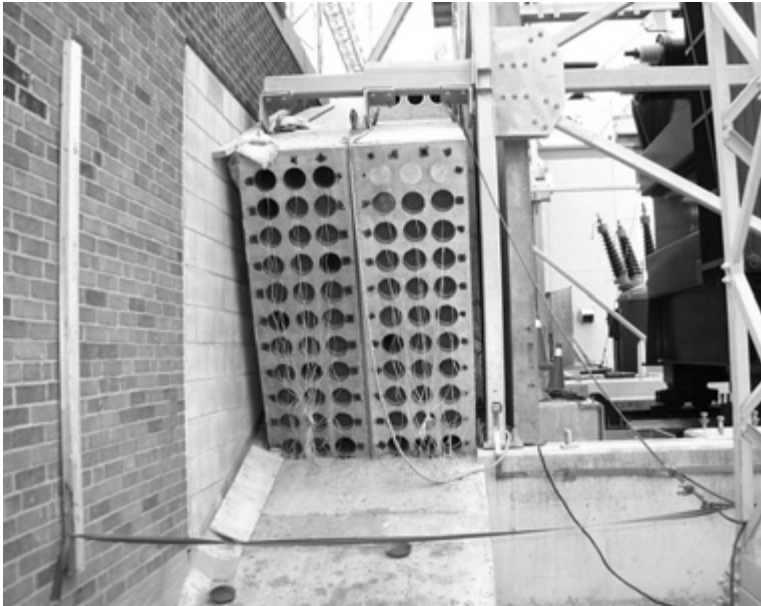


Fig. 2. Cable duct bank during construction on east side at the Beauharnois power station