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

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**Abstract**: Hydro-Québec has introduced thermal monitoring and dynamic rating systems for its new HV underground cable circuits. The Beauharnois power station is the first major application. This station is presently undergoing a major rehabilitation program. Fiber optics were pulled along 120 kV XLPE insulated cables for 4 transformer circuits and 10 overhead line circuits, to obtain a distributed temperature profile (DTS) along the cable route. A dedicated software, based on the finite element technique, combined with current measurement in the cables, evaluates rapidly and accurately the conductor temperature at the hot spot. Furthermore, the software gives a dynamic load forecast in case of emergency overload, or in case of an increased load demand for exportation.

**Keywords**: Temperature Monitoring, Finite Element, Dynamic Rating, Ampacity, DTS, Fiber Optics

**Résumé**: Hydro-Québec a développé un système de surveillance thermique et d'évaluation de charge admissible en temps réel pour les nouveaux projets de lignes souterraines à haute-tension. La centrale de Beauharnois constitue la première application à haute-tension. Plusieurs circuits de câbles XLPE sont en cours d'installation dans cette centrale qui subi actuellement une réfection majeure. Des câbles de fibres optiques ont été tirées en même temps que les câbles isolés à 120 kV pour 4 circuits de transformateur et 10 circuits de lignes aériennes afin de réaliser une mesure distribuée de température (DTS), permettant ainsi d'obtenir un profil thermique tout le long des circuits. Nous avons développé un logiciel, basé sur la méthode des éléments finis, dédié à l'installation qui, combiné à une mesure de courant dans les câbles, permet d'évaluer précisément et rapidement la température du conducteur au point le plus chaud. De plus, le logiciel permet d'obtenir une prévision de charge dynamique en cas de surcharge d'urgence, ou en cas de demande de charge additionnelle pour l'exportation.

**Mots clés**: Suivi de Température, Éléments Finis, Charge Dynamique, Ampacité, DTS, Fibre Optique

## 1. Introduction

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 started using thermal monitoring and dynamic rating systems for its new HV underground cable circuits. These systems use fiber optic cables coupled with DTS [1] [2] (Distributed Temperature Systems) units and dedicated computer software based on the 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 [3].

## 2. Software development

### 2.1 Cable conductor temperature monitoring

The environment of a cable installation is changing continuously: ambient temperature, air drafts, external heat sources, etc. The actual cable installation may not behave as planned because of unpredicted environment changes. The use of the DTS helps to pinpoint the location of the hot spot along the cable route that serves as a reference temperature which gives the software the possibility