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Restraining the migration of HV cables in duct

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Abstract: This paper deals with the development, testing and installation of special devices on Hydro-Quebec's underground high-voltage transmission system which limit the displacement of cables installed in individual ducts.

The devices are installed in manholes at the exit and/or entrance to the cable duct. The principle of two inverted cones is used to create a progressive restraining force applied to a axially-shifting cable. Several laboratory cycling tests were used to validate the performance of such a solution before its use on an existing 120-kV line.

Keywords: Restraining devices, HV Cables, Manholes, Installation, Tests.

Résumé : Le papier présent le développement, la validation du fonctionnement et l'insertion en réseau souterrain haute tension d'Hydro-Québec des dispositifs qui restreignent les mouvement migratoires des câbles installés dans des conduits individuels.

Les dispositifs, qui exploitent le principe de fonctionnement de deux éléments coniques inversés, ont été insérés dans les chambres de jonction à l'entrée et/ou à la sortie des conduits. La performance accrue de ces dispositifs a été préalablement validée par les essais au laboratoire, avant une première utilisation sur une ligne existante à 120 kV.

Mots clés : Dispositifs de blocage, Câbles HT, Chambres de jonction, Installation, Essais

1. Introduction

The technique used by Hydro-Québec for laying underground high-voltage cables involves installing the cables in ducts and manholes, where the cables are shaped into expansion loops. Though costly to implement, this technique has many advantages such as:

- easy access to cables and joints for purposes of inspection and maintenance;
- cable repairs or replacement can be done without the need for any excavation;
- the cost of modifying and upgrading the line can be partially offset by the possibility of recovering the cables and accessories;
- civil-engineering work is completely independent from cable installation.

However, the major drawback of this technique is that cables can move freely in the ducts and manholes. Such movement is mainly caused by:

- difference in level between successive manholes;
- vibrations caused by street traffic;
- thermal expansion and contraction due to the daily load cycling in the consumption of the electric power.

This results in increasingly smaller bending radii of the expansion loop in the lower manholes. However, the loop's bending radii should not be below the minimal values prescribed by the manufacturer. Extremely small bending radii would inevitably lead either to insulation failure, especially in the case of paper-insulated cables, or to fatigue failure of the metallic sheath.

On the other hand, as the cables move toward the lower manholes, the expansion loops in the higher manholes become increasingly less pronounced. Thus the mechanical stress in the joints increases along with the risk of failure.

The severity of this phenomenon and the risk of service interruptions, with all the usual inconveniences to customers increase over time and as loading nears the cable's maximum capacity.