

Development of explosion-proof joint for retrofitting pipe-type cable

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ABSTRACT

North America utilities have many pipe-type cables in operation on their power transmission systems. While these pipe-type cable systems continue to provide long-term reliability in service, some utilities are facing the great expense of maintenance, spare parts and repairing work for pipe-type cable and the risk of oil leakage due to the deterioration. Therefore, some of the existing pipe-type cables have already been or are planned to be replaced by XLPE cable by utilizing the existing pipe and manhole, so-called retrofitting. This paper shows the development of explosion-proof joint for retrofitting of existing double feeder pipe-type cable system.

KEYWORDS

Retrofitting pipe-type cable system, Explosion-proof joint, Shared manhole, Double feeder, XLPE cable, Triplex cable

INTRODUCTION

In North America, a large number of HPFF and HPGF pipe-type cable feeders are still in service and good operation conditions, and these pipe type cables have provided long-term reliability in power transmission, with relative aging. However, there has been a significant reduction in the number of manufactures and resources for the pipe-type cable. Therefore, it is anticipated that its availability might be limited in the future, providing a likely challenge for supply and in-kind replacements or upgrades. Some of the aging pipe type cable system face oil leakage that can cause serious environmental problems and performance issues. As a result, the cost of maintenance, spare parts and repairing work for the pipe-type cables is expected to increase.

Then, some of the existing pipe-type cable have already been or are planned to be replaced by XLPE cable. XLPE cable has become common technology for power transmission and is considered to have lower maintenance than pipe-type cable system.

Utilizing the existing pipe/conduit, so-called retrofitting, is a useful method in terms of construction cost and permitting for upgrading the pipe-type cables to XLPE cables, particularly when constructing a new traditional XLPE transmission line, including new duct bank and manholes, is not feasible, considering site limitations, among others restrictions. However, given the diameter limitations of the existing pipe, one of the challenges is how to maintain the same or equivalent conductor size for the required transmission capacity. XLPE cables generally require thicker insulation and have a larger overall diameter compared to pipe-type cables.

In order to maintain the equivalent conductor size or transmission capacity of the existing pipe-type cable system, the authors have worked on several pipe-type cable retrofitting projects and developed a new compact design of high-capacity triplex cable. Figure 1 shows the

design of the compact triplex cable. The unique triplex cable is characterized by

- Increased conductor size by eliminating copper wire shielding.
- Maintaining standard insulation maximum stress level.
- Incorporation of aluminum pipes and ECC to manage fault current distribution.
- Lower thermal expansion in the longitudinal direction by relaxing twist formation.

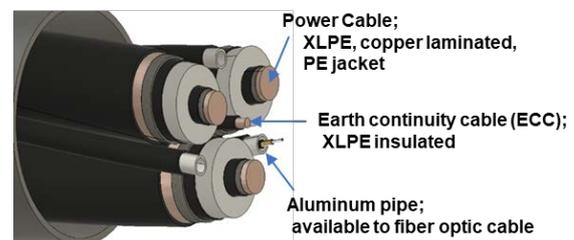


Figure 1: Triplex cable design

This triplex cables have been applied in North American retrofit pipe-type cable projects for 230 kV and 115 kV circuits, which were commissioned in 2018 and 2020 respectively [1] [2]. In these retrofitting projects, standard/regular insulated straight-through joints for XLPE cable were installed in the conventional single feeder designed manhole.



Figure 2 : Joint in manhole for single feeder

When retrofitting double feeder systems, there is a challenge to overcome in utilizing the existing manhole. The existing double feeder pipe-type cable manhole has generally been constructed with a shared manhole to minimize the footprint. The existing joints of pipe-type cables in the shared manhole were made with a steel pipe for three phase conductors and the steel pipe is quite robust, providing protection against any internal fault occurrence event, which allows installation of two joints in a shared manhole while ensuring some flexibilities of maintenance from the safety aspect.

On the other hand, for XLPE cables, the joints generally have to be installed in a manhole built for each feeder for safety reason and twice as many manholes are needed for double feeder. Most of XLPE cable feeder adopts