Considerations of Shallow Underground Transmission Cable Installations for Use in Remote Locations Affected by Wildfires

Earle C. (Rusty) **BASCOM III;** Electrical Consulting Engineers, P.C., (United States), r.bascom@ec-engineers.com
Tiebin (Tom) **ZHAO**; Electric Power Research Institute, (United States), tzhao@epri.com

ABSTRACT

Changing climate characteristics and specific instances of forest fires have impacted overhead transmission lines at least by the fires or as a source of possible initial ignition. Undergrounding the transmission lines in the affected areas has been widely discussed as a way to reduce the impact. This paper discusses a concept of installing underground transmission cables in shallow trenches or berms. This installation approach may allow a lessened economic impact of using underground cables but remains resilient to fire that would otherwise affect an overhead line. While the installed underground cables can still be more costly than overhead lines, the added resiliency could make the cable technology desirable with lower customer impacts and greater reliability. The paper identifies and discusses design issues and environmental characteristics of such shallow underground cable installations, including cable system options, construction methods, trench configurations, cable, cable survivability in the presence of fire, cable ratings, and operation and maintenance.

KEYWORDS

Shallow Underground, Cable Design, Forest Fires, Design Considerations, Resiliency, Transmission, Distribution

INTRODUCTION

Climate change has impacted much of the world in a manner that has altered global weather patterns. In some areas, annual rainfall was greatly reduced for an extended period, leading to increased likelihood of dry conditions for fire in forested or grassland areas. Overhead transmission lines have been the predominant medium for long-distance power transmission in remote areas. In some cases, overhead transmission lines may be incompatible with the nuances of some climate change conditions. Right-of-way maintenance is also critical for overhead transmission lines since undergrowth encroaching on sagging overhead lines was considered a source of ignition of forest fire. [1]

Underground transmission lines have been considered as a more environmentally resistant alternative to overhead lines to most weather effects. Underground transmission lines are not often considered for installation in remote locations mostly due to their high material and installation costs. Much of the total cable line project cost is associated with civil work in creating and preparing a trench to receive the power cables either for direct burial or for installation of cable conduits. Utilizing relatively shallower trench configurations than that of conventional underground constructions may minimize the extent of excavation and therefore reduce the total civil work cost. The selective shallow installation of underground transmission cables would reduce the impact in the event of a fire and improve resiliency of the transmission system.

This paper describes various considerations of shallow underground transmission cable installations for applications in generally remote areas, and includes discussions of cable system options (e.g., AC versus DC), construction methods, trench configuration strategies, cable survivability in the presence of fire, cable ratings as possibly affected by a fire, soil properties, and operation and maintenance. The paper focuses on underground transmission line design adaptation to deal with the new operating conditions such as those influenced by wildfires.

SHALLOW CABLE INSTALLATIONS

The concept of shallow cable installations is to consider strategies that make the use of underground transmission cables more economically in remote areas where overhead transmission is usually considered and where forest fires or wildfires could occur.

Underground cables normally carry an economic disadvantage to overhead lines from the standpoint of higher material, civil and installation costs. There is limited opportunity to address the material costs. Civil construction costs can be significantly mitigated by using methods not often considered for urban cable system installations. An example of such methods for the remote areas is to install underground transmission cables in shallow trenches, berms, or a combination of both. Concepts of a shallow cable installation with a shallow trench and a soil berm covering the cables are shown in Figure 1.

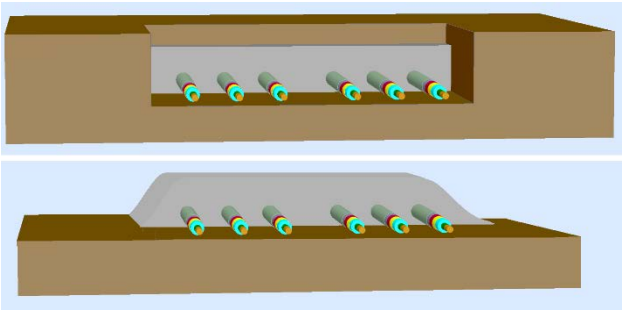

Fig. 1: Concepts for shallow cable installation with shallow trench (top) and soil berm (bottom)

The methods consider the following factors that impact underground construction costs.

- **Trench and Installation Depth** – The volume of material needed to be removed in creating a trench along with possible deep-trench safety requirements may be mitigated if the trench remains shallow to minimize backfill requirements or if the cables can be placed at the surface and protected by a soil berm.
- **Spoils Removal** – Usual construction practice requires hauling away spoils that could otherwise be stockpiles adjacent to the cable trench in remote settings unaffected by vehicular traffic.
- **Backfill** – In an urban setting, the backfill around cable conduits serves the purpose of providing good thermal