Novel Cooling Technique for Cables Crossing a Road Ramp

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ABSTRACT

The aim of this study is to perform ampacity calculations for a cable system consisting of three duct banks installed at a depth ranging from 20 to 29 feet crossing a 50 feet wide ramp, with 3 feet depth from the existing ground and 35 feet center-to-center separation. There are six cables in a duct bank. In order to assure required cable rating, the design team is planning to drill three 5' OD boreholes horizontally crossing the ramp with air flowing through the boreholes to take away the heat generated by the cable circuits crossing the ramp. The paper discussed the assumptions, the model and the results.

KEYWORDS

Cable ampacity, finite element method, cooling solution.

BACKGROUND INFORMATION

Where circuits are very heavily loaded, or it is expected that they will become heavily loaded in the future, cooling systems can be installed alongside the cables. Underground cable hot spots can be treated by:

- Use of low-thermal-resistivity corrective backfill,
- Insulating the heat sources near the cables,
- Forced circulation of fluid around the cables and pipes,
- Internal cooling by circulating insulating fluids in cables,
- External cooling, either forced or passive – cooling system installed adjacent to the cables in the hot-spot zone.

Forced cooling has been applied in pipe type cables in the United States since the first documented installation was commissioned at the Public Service Electric & Gas Co., Sewaren, New Jersey generating station in 1948 [1].

Early applications tended to use moderate levels of cooling on short tie lines, and in the 1970s, forced cooling was perceived as a means to substantially upgrade the capacity of major transmission lines of considerable length. Design optimization would require high confidence in thermal/hydraulic design parameters. This prompted a series of investigations. Full-scale tests were conducted by Commonwealth Edison [2] and Power Technologies. Inc. [3], and model studies were conducted by the Massachusetts Institute of Technology [4] and the University of Illinois [5]. Bulk power projects by Tokyo Electric also prompted investigations in Japan [6].

The results of these investigations were correlated, and generalized equations were presented in the *Designer's Handbook* [7-8].

Another technique, which found some applications in practice, uses water-cooled systems. This technique can be particularly appropriate for "hot spots" in cable routes, particularly at substations where a large number of buried cables are grouped together. When the cooling systems are installed for circuits where the load is expected to increase significantly at some time in the future, the water cooling system may not be operated until the load reaches a predetermined value.

The above techniques can be called active solutions whereby an external system is used to change the cable thermal environment. In the project described in this paper, a different passive solution was sought. The cables were installed in three duct banks under a road ramp as illustrated in Figure 1.

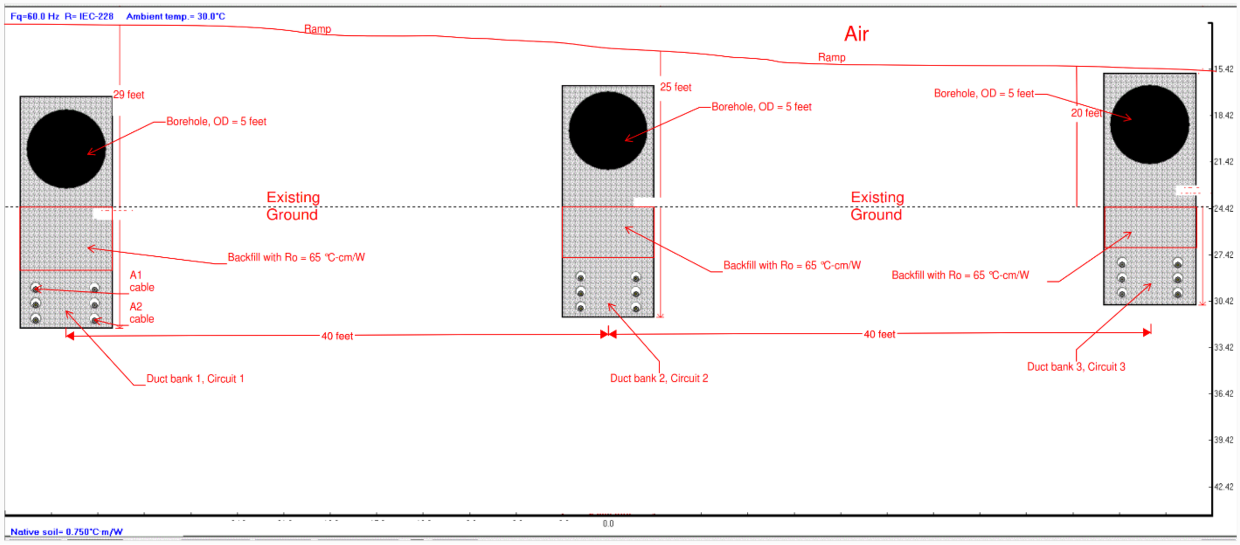

Figure 1 Geometry of the proposed design