ELECTRICAL CONSULTING ENGINEERS, P.C.

Ampacity Principles & Soil Characteristics for Underground Power Cables

Joint Presentation with GeothermUSA

Description

As with any transmission and distribution equipment, calculating the power transfer capability of a cable system is ultimately the most critical part of designing or specifying the cable construction and trench configuration and for continued operation. Analytical methods from the early 1900s were first formalized in the 1957 paper by J.H. Neher and M.H. McGrath and have seen ongoing refinement through the International Electrotechnical Commission's subsequent development of IEC 60287 and related ampacity standards.

A critical part of cable rating calculations is the soil thermal environment, since most insulated power cables are buried below ground or under the sea bed. For this reason, a thorough understanding of how to measure and consider soil characteristics – thermal resistivity or "rho" and ambient soil temperature – special backfills and grout materials is critical to accurately develop cable ratings. Rating methods and soil characteristics go hand-in-hand.

This course serves power cable users by providing an in-depth evaluation of the basic technical concepts related to cable ampacity including cable and trench constructions as well as background on soil and backfill characteristics and thermal testing. This background is the basis for a presentation on the analytical methods for performing ampacity calculations including worked examples that will be discussed and presented in class.

By attending this 2-day short course, students will gain an understanding of the important considerations for calculating the ampacity, or rating, of underground cable systems and a general understanding of specialized circumstances that should be considered when evaluating ratings (load shape, emergency considerations). This electrical engineering basis is complimented with a thorough discussion of soil thermal resistivity and stability, *in situ* and laboratory soil testing, sourcing and design of special thermal backfills (FTB, granular fill, etc.) commonly used with power cables.

Attendees

This course is for the engineer interested in a focused discussion on underground cable ratings with an emphasis on calculation procedures and environmental parameters affecting ampacity such as native soil and backfill characteristics and ambient soil temperatures. No prerequisites are necessary; the student taking this course should have a background in electrical, mechanical or civil engineering.

Geotherm USA

Presentation Format and Continuing Education

This 12-14hour course will be presented over two days in a classroom setting using lectures, in-class discussions, project slides and example calculations. Each student will receive a notebook containing copies of the instructor's presentation material along with additional material deemed relevant. Each student will receive a course certificate indicating the number of continuing education hours presented.

Detailed Course Agenda

Day 1

- Introductions, Summary of Course Goals
- Overview of Cable System Types
- Ampacity History and Principles
- Calculation Methods for Determining Ampacity
- Effect of Design and Installation Variables on Ampacity
- External Thermal Environment
  - Native Soil, Corrective Backfills
  - Thermal Resistivity & Stability
  - Instrumentation (TPA, TR Probes)
  - Route Thermal Surveys
  - Ambient Earth Temperature (Thermocouples)

Day 2

- Special Thermal Environments
  - Submarine Thermal Environment
  - Cables in Ducts, Grouting
  - Trenchless Installations
  - Renewables (Wind/Solar Farms)
  - Data Centers
- Crossing Cable Considerations
- Considerations for Ampacity of "Deep" Installations (Trenchless)
- Uprating Methods, Dynamic Ratings
  - Distributed Temperature Sensing (DTS)
- Worked Examples
- Software Demonstrations / Questions

Instructors

Earle C. (Rusty) Bascom, III, Principal Engineer with Electrical Consulting Engineers, P.C. has over 20 years of experience focusing on the analysis, design, research and education on underground T&D cable systems. He has performed numerous ampacity and uprating studies, has developed numerical methods for cable ratings, was the principal developer of the ampacity module in the Electric Power Research Institute's Underground Transmission Workstation and author of Chapter 11 on ampacity of the 2006 edition of EPRI's *Underground Transmission Systems Reference Book*. He is a member of the CIGRE Working Group B1.35 that is focused on ampacity topics as well as being active in working groups of the IEEE Insulated Conductors Committee. Mr. Bascom holds a B.S. and M.E. degrees in Electric Power Engineering from Rensselaer Polytechnic Institute and an M.B.A. from University of New York at Albany. He is a licensed professional engineer in NY, FL and TX.

Deepak Parmar, Principal Engineer with GeothermUSA has over 45 years of experience specializing in geotechnical, rock and soil mechanical testing in both laboratory and field settings including developing instrumentation for evaluating material characteristics and evaluating tunnels and shafts in soft ground and rock. While with Ontario Hydro, he performed some of the industry's fundamental research into soil thermal property analysis relating to the power cable industry and developed the soil Thermal Property Analyzer which he later commercialized. Since founding Geotherm in 1980, he has performed hundreds of field and laboratory tests on soil samples and sourced backfill materials for cable systems. Mr. Parmar holds a B.S. degree in Civil Engineering from Wolwich Polytechnic in the U.K. and a Diploma in Management Studies from Slough Polytechnic.

Expected Learning Outcomes

- Understand the basic ampacity calculation procedures and perform a hand calculation
- Appreciate the basic characteristics of soils and backfills that affect thermal resistivity and the impact on cable ratings