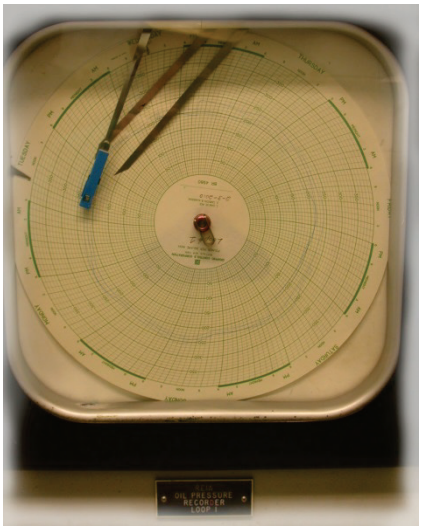
ELECTRICAL CONSULTING ENGINEERS, P.C.

Hydraulic Design Considerations for Fluid-Filled Power Cable Systems Course

Description

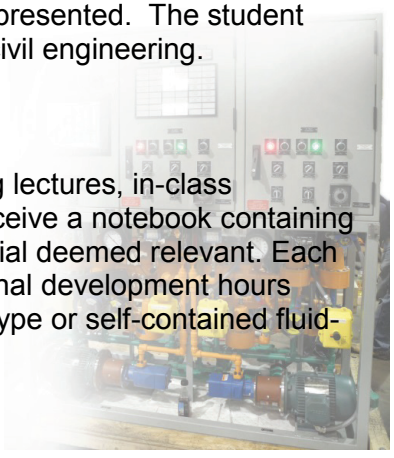


Dielectric fluid hydraulic systems are an integral part of self-contained fluid-filled (SCFF) and high-pressure fluid-filled pipe-type (HPFF) cable systems that require careful consideration and evaluation for the continued successful operation of these systems. A detailed design of the hydraulic system is critical for new circuits, and operating characteristics of older fluid-filled cable systems must be carefully understood to properly pressurize and alarm these systems. Engineers and operators must understand the operating characteristics of the affected cable types. Understanding the fundamental components of the pressurization systems, including pumping plant characteristics and functions, hydrostatic elevation factors for placement of fluid reservoirs, configuring alarm set points, etc., must be carefully evaluated through a study of the plan and profile of a given circuit and locations of the pressurization systems.

By attending this 2-day course, students will gain an understanding of the basic components and theory of operation for pipe-type cable pumping plants and fluid reservoir systems used on self-contained fluid-filled systems. Considerations for electo-mechanical versus solid-state control systems for pumping plants will be presented. Gravity and pressure fed systems for self-contained cables will be discussed, and the control, monitoring and features including the concepts of pressure drop will be presented for static pressure, oscillated, and forced-cooled pipe-type systems. A summary of the required design calculations (fluid tank sizing, pressure drop, fluid expulsion and demand, reservoir calibration, etc.) will be discussed, with worked examples presented. Low- and medium-pressure fluid-filled systems will be discussed and compared, and considerations for the application of normal, semi-stop and full stop joints to manage hydraulic flows within a pipe-type cable system.

Attendees

This course is for the engineer interested in a focused discussion on pipe-type and self-contained cable systems with an emphasis on hydraulic systems and related topics. No prerequisites are necessary though students should be generally familiar with underground power cables before attending this focused course topic to get the most benefit from the material that will be presented. The student taking this course should have a background in electrical, mechanical or civil engineering.



Presentation Format and Continuing Education

This one- or two-day course will be presented 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 professional development hours presented. One-day courses are focused on one cable type (either pipe-type or self-contained fluid-filled).

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Detailed Course Agenda

Day 1

Introduction
- Summary of Course Goals
- History and Theory of Paper Insulated Cable Systems
- Description of Cable System Types
  - Self-Contained Fluid-Filled (SCFF)
  - High-Pressure Pipe-Type (HPFF)

Self-Contained Fluid-Filled Cable Systems
- General System Description
  - Cable
  - Accessories
  - Fluid
  - Hydraulic Features of Cable Design
- Circuit Arrangement
- Reservoirs and Plants
  - Gravity Feed Reservoirs
  - Pre-pressurized Reservoirs
  - Pumping Plants
- Hydraulic Design Considerations
  - Requirements
  - Profile/Elevations
  - Fluid Demand/Expulsion
  - Reservoir Requirements
  - Reservoir Alarms and Settings
  - Transient Pressures
- Flow Test
- Expulsion & Impregnation Tests
- Repairs / Hydraulic Isolation
- Maintenance Activities
  - Reservoir Calibration
  - Adding Fluid
  - Management of Spare Cable Reels

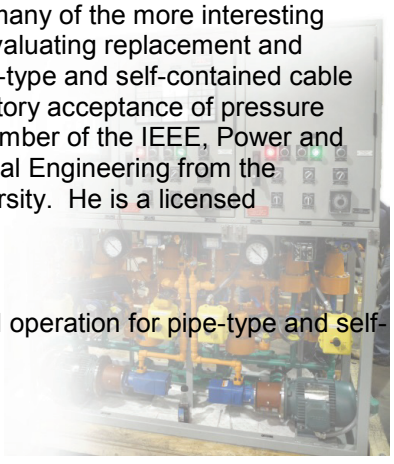
Day 2

High-Pressure Fluid-Filled Pipe-Type Cable Systems
- General System Description
  - Cable
  - Accessories
  - Fluid
  - Hydraulic Features of Cable Design
- Circuit Arrangement
- Pressurization Plant
  - Operation
  - Hydraulic System
    - Tank / Nitrogen System
    - Pumps & Pressure Control
    - Outlets
  - Control & Monitoring Systems
  - Enclosures
- Circulation & Forced Cooling Systems
  - Oscillation
  - Circulation Pumps
  - Heat Exchangers
  - Cooling Units
- Hydraulic Design Considerations
  - Requirements
  - Profile/Elevations
  - Fluid Demand/Expulsion
  - Storage Tank
  - Pressurizing Pumps
  - Plant Settings and Alarms
  - Pressure Drop Due to Flow
- Repairs / Hydraulic Isolation
- Pumping Plant Maintenance

Common Maintenance Functions
- Dissolved Gas-in-Oil Analysis (DGA)
- Screen Tests

Instructor

Victor D. Antoniello, Principal Engineer with Electrical Consulting Engineers, P.C. has over 30 years of experience with underground transmission and distribution systems initially developing a working knowledge of the design, operation and maintenance of pipe-type and self-contained cables and their associated hydraulic systems from 17 years as a utility engineer. As a consultant, he has addressed many of the more interesting design and operational challenges of power cable hydraulic systems, including evaluating replacement and reconditioning of pressurization plants, and re-conductoring projects on both pipe-type and self-contained cable circuits where new hydraulic set points, alarm settings, quality assurance and factory acceptance of pressure plants, and commissioning were important considerations. Mr. Antoniello is a member of the IEEE, Power and Energy Society and Insulated Conductors Committee. He holds a B.S. in Electrical Engineering from the University of Maine and a M.S. in Electrical Engineering from Northeastern University. He is a licensed professional engineer in Rhode Island, Massachusetts and New York.



Expected Learning Outcomes
- Understand the fundamental importance of the hydraulic system purpose and operation for pipe-type and self-contained cable systems
- Describe the basic components of a pumping plant including alarm set points