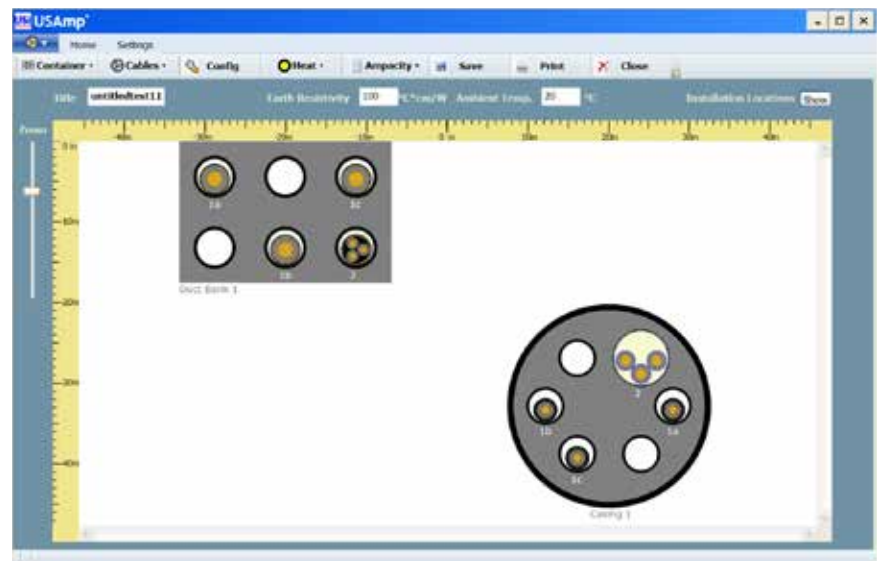
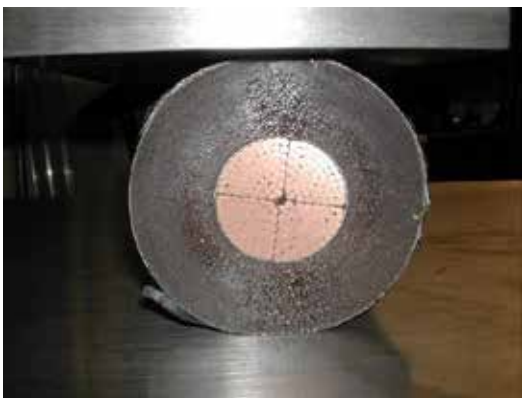


Underground Systems, Inc. (USi) specializes in providing engineering services and advanced technology products for electric power transmission and distribution systems and has been successfully supporting the utility industry for over 40 years. USi has the largest and most experienced technical staff in North America for underground hv power cable system and accessory design and engineering.

Our technical specialists are recognized experts with extensive experience in the various aspects of underground high voltage power cable system design, installation, rating and operation. We work directly with electric utilities, power producers, cable manufacturers, high voltage cable installation and service companies, architect engineers and high voltage transmission cable asset operators to provide advanced solutions and engineered products to optimize the operation and performance of their power cable system assets.

TECHNICAL DISCIPLINES

- ✓ Heat Transfer: Heat exchangers, flow systems, field analysis, soils, porous media mixed phase
- ✓ Fluid Mechanics: Pressure drop, natural & forced convection, pressure transients
- ✓ Thermodynamics: Refrigeration, cooling Systems, energy recovery
- ✓ Electrostatics: Field Analysis, terminal design, splice design
- ✓ Magnetic: Field Analysis, Induced Voltages, shielding
- ✓ Mechanical Engineering: Piping system design, code compliance, structural, cable support/clamping design
- ✓ Instrumentation: Error, reliability and failure analysis, systems integration, communication systems.
- ✓ Fluid Dynamics: Wave propagation, pressure transients, sensors and instrumentation
- ✓ Environmental: Noise codes, environmentally friendly coolants, refrigerants
- ✓ Integrated systems: Customized software, Networks, LAN, WAN, communication systems and protocols, SCADA interfacing, server-based applications



ANALYTICAL CAPABILITIES

USi has in-house software and analytical capabilities in the following areas:

Ampacity Ratings:

- ✓ Self-cooled: Continuous, transient and dynamic simulations
- ✓ Forced Cooled: Continuous, transient and dynamic simulations. Surface cooled, parallel pipe cooling, oil, water, air circulation, equipment design, refrigeration
- ✓ HPFF, SCFF, Solid Dielectric, 5kV to 800kV, AC, DC
- ✓ Short circuit rating of cable conductors, metallic shields

Thermal:

- ✓ 2D, 3D, analytical, finite difference, hybrid, finite element
- ✓ Extraneous heat sources, oblique crossings
- ✓ Forced and natural convection, heat pipes, vent chambers

Electric Fields:

- ✓ Terminal design
- ✓ Splice design
- ✓ Gas or Oil Filled

Magnetic Fields:

- ✓ Magnetic field calculation
- ✓ Magnetic shielding analysis

Hydraulic:

- ✓ Pressure plant tank/pump sizing
- ✓ HPFF pressure drop
- ✓ SCFF reservoir size, demand
- ✓ Cooling plant design, heat exchangers, refrigeration

Installations:

- ✓ Pulling tensions
- ✓ Fluid filling and pressurization schedules

Electrical/Power:

- ✓ Impedance calculations
- ✓ Failure energy calculation - hydraulic pressure surge
- ✓ Induced voltages

Environmental:

- ✓ Hydraulic equipment noise estimates, abatement
- ✓ Environmentally friendly dielectric fluids, coolants

USI ENGINEERING AND FIELD TECHNICAL SERVICES INCLUDE:

- ✓ Condition assessment
- ✓ Remaining life estimation
- ✓ Ampacity Studies
- ✓ On-line monitoring and diagnostics
- ✓ Forced-Cooling Analysis
- ✓ Hydraulic System Analysis
- ✓ Sheath bonding system design and operations
- ✓ Soils Thermal Surveys
- ✓ Trench design
- ✓ System Feasibility and Cable Alternatives Studies
- ✓ Spill Prevention Program Development
- ✓ Leak Location - PFTs
- ✓ Cable Failure analysis
- ✓ Equipment inspections, testing, and evaluations
- ✓ Asset reclamation and contingency planning studies

Laboratory Analysis:

- ✓ Dielectrics
- ✓ Materials
- ✓ Soils
- ✓ Cable failure and remaining life evaluation
- ✓ Dissolved Gas Analysis

Project Oriented Services:

- ✓ Turnkey Cable Projects
- ✓ Design A/E
- ✓ Procurement
- ✓ Installation
- ✓ Commissioning
- ✓ Emergency repair engineering, materials, installation

Seminars and Training:

- ✓ Cable System Hydraulics (HPFF and SCFF)
- ✓ Ratings, self-cooled, forced-cooled, dynamic rating systems
- ✓ High voltage cable sheath bonding system design and operations
- ✓ Leak detection and location
- ✓ Pressurization and cooling system operator training
- ✓ Splice schools
- ✓ Cable system standards, designs and principles for utility engineers