LINE DESIGN & STAKING COURSE – LEVEL 3

Date:
Monday - Thursday
March 13-16, 2017

Time:
10:00 am–4:30 pm - Mon
8:00 am–4:30 pm - Tue-Thu

Location:
Colorado Rural Electric Assn.
5400 Washington St.
Denver, Colorado

Instructor:
Hi-Line Engineering

Fee:
$1,200 per student

To Register:
Contact Jen Hight at the CREA office (303) 455-2700 ext. 103 or e-mail at jenhight@coloradorea.org

Registration Deadline:
February 17, 2017

Confirmation:
A minimum of eight people must be registered for the course to be held. A letter will be faxed to all participants confirming their registration in the course.

Cancellation Policy:
Cancellations received on or before the registration deadline will receive full refunds. Cancellations received after the deadline may be billed the entire registration fee.

Course Description

UNDERGROUND LINE DESIGN AND SUBDIVISION LAYOUT: This domain will explain the components of underground distribution systems along with their application and limitations. The student will learn how to layout subdivisions, specify pad-mounted equipment, and design sectionalizing systems. This course will also cover conduit systems and the correct methods for calculating pulling tensions relative to conduit bends and cable runs.

1. Underground cable
   a) Solid, stranded, and strand-filled conductors
   b) The purpose and limitations of conductor shield
   c) Types and comparisons of conductor insulations
   d) Concentric neutrals, tape shields, and neutral ampacity

2. Components
   a) Separable connectors — 200 and 600 amp elbows, ANSI 386
   b) Cable terminators and potheads
   c) Joints — small and large cable splices
   d) Proper grounding of the cable and its components

3. Pad-mounted switchgear
   a) Purpose and types of switchgear in the complete underground system
   b) Insulating mediums — air, oil, gas, and vacuum
   c) Application of pad-mounted switchgear in vaults and open areas

4. Over-voltage protection
   a) Causes of cable failures due to treeing and lightning
   b) Controlling over-voltage and maintaining BIL with lightning arresters
   c) The phenomenon of ferroresonance and how to prevent its occurrence

5. Cable pulling in conduit systems
   a) Calculations for bending radius, clearance, jamming ratios, and pulling tensions
   b) The use of lubricants to reduce the coefficient of friction
   c) Designing a conduit pull for single and three-phase installations
   d) Using computer programs to calculate pulling tensions

continued

6. Designing underground systems
   a) Radial and looped primary cable layout
   b) Proper electrical loading of a looped single and three-phase system
   c) Correct fusing of underground cable systems
   d) The use of fault indicators and their application

CONSTRUCTION CONTRACTS: Accurate accounting of the materials, and close monitoring of the contractor's progress are essential to completing a project on time and on budget. In this domain, the student will learn how the construction contract affects every aspect of the project, how to prepare special conditions and units, and how to administer the contract terms and conditions for a successful outcome.

1. RUS construction contracts
   a) The anatomy of labor and materials contracts (RUS 830)
   b) The anatomy of labor only contracts (RUS 792)
   c) Holding pre-bid and pre-construction meetings

2. Plans and Specifications
   a) Specifying and using standard construction units
   b) Developing and identifying special construction units
   c) Preparing and adhering to special conditions and instructions
   d) Understanding and adhering to the specifications in the contract

3. Staking for a construction contract
   a) Need for accurate staking sheets and reliance on the units by the contractor
   b) Preparing well-defined drawings, notes, and marking the line route

4. Materials control
   a) The methodology of preparing material issue and return tickets
   b) Verifying and accounting for returned and salvaged materials

5. Contractor observation
   a) Submission of prices for construction units not included in the original contract
   b) Reviewing, accounting, and approving the contractor's invoices
   c) Establishing and tracking project milestones
   d) Making periodic inspections of the contract work
   e) Documenting changes, agreements, outages, and accidents

6. Contract closeout
   a) Performing the final inspection of the completed lines and facilities
   b) Preparing change orders including units, changes, and reasons
   c) Preparing the final inventory of the as-built remove and install construction units

continued

SIZING TRANSFORMERS AND CONDUCTORS: This domain will focus on basic electric theory and the methodology to correctly size transformers and service conductors for standard residential and small commercial loads. The student will learn how to perform basic calculations for current, voltage, power, and voltage drop.

1. Basic electric theory
   a) Voltage, current, and resistance
   b) Power and voltage drop equations

2. Transformers
   a) Theory of transformer operation
   b) Understanding ANSI C57.12 requirements
   c) Transformer connections and wiring
   d) Transformer construction and loading standards

3. Transformer sizing
   a) Sizing transformers based on panel size and/or load diversity
   b) Single phase and three-phase applications using lookup tables
   c) Using pad-mounted transformers for large industrial loads

4. Service voltage drop
   a) Voltage drop and flicker theory and calculations
   b) Sizing conductors based on amps and length

5. Computer programs
   a) Spreadsheet analysis
   b) Vendor programs

BASIC SECTIONALIZING AND LINE EQUIPMENT: This course will give the student a basic understanding of fault currents, sectionalizing devices, voltage regulators and capacitors. The focus of this section will be to teach the staking technician how to apply and locate these devices on the distribution system when the line is being staked.

1. Principles of over-current protection
   a) Isolation of faulted components
   b) Outage time benchmarking

2. Fault current calculations
   a) Basic equations and symmetrical components
   b) Maximum available fault currents (primary and secondary)

3. Over-current protection
   a) Breakers, reclosers, fuses, and sectionalizers
   b) Interrupting mediums (vacuum, gas, or oil)

continued

4. Transformer protection
   a) Peak loads and inrush currents
   b) Current limiting fuses

5. Line coordination
   a) Transformer/fuse, breaker/recloser, recloser/recloser, and recloser/fuse
   b) Duty cycles and minimum fault recognition

6. Regulators
   a) Basic theory of operation
   b) Placement in circuit

7. Capacitors
   a) Basic theory of operation
   b) Placement in circuit

SUPPLIES NEEDED:
Workbooks and manuals will be supplied for the specialized instruction. Each student will be required to supply a personal copy of the *National Electrical Safety Code* and RUS Specifications. Each student should bring a scientific calculator and note taking materials to each seminar. The students will work class problems both in groups and individually. These problems will involve both the lookup tables and calculations based on the material contained in the manuals. The instructors will answer questions and go through the solutions to the problems. The instructors will also be available to discuss ideas and questions to a reasonable extent after normal class hours.

CERTIFICATION:
The course of study leads to certification as a qualified staking technician. The certification will be awarded after the student accomplishes well-defined tasks and demonstrates a working knowledge of the subject material though observation and completion of comprehensive written tests. The classroom and field training is divided into three phases of four domains each to be taught in three separate five-day seminars (beginning at 1 p.m. on Monday and ending at 11 a.m. on Friday). To achieve certification, the student must attend all three seminars and pass a test for each of the twelve domains. Students may re-take any test if their first try is unsuccessful.