Electric Power Fundamentals (Instructor-Led Training)

Course Description

This course introduces electric power fundamentals to technicians new to the natural gas industry. It includes discussions about basic electrical theory, test equipment, and grounding practices.

Course Prerequisites

- GTA Web-Based Training
  - Electric Power Fundamentals-AC Generation
  - Electric Power Fundamentals-Basic Electrical Theory
  - Electric Power Fundamentals-Controlling Motor Starting
  - Electric Power Fundamentals-Electrical Safety
  - Electric Power Fundamentals-Grounding Practices Fundamentals
  - Electric Power Fundamentals-Motor Control Fundamentals
  - Electric Power Fundamentals-RLC Circuits & Transformer
  - Electric Power Fundamentals-Test Equipment

Course Objectives

Upon completion of this course, the student will have received instruction designed to assist him/her in the following:

- Define Ohm's law.
- Describe the operation of AC generators.
- Describe the operation of inductors and capacitors in series and parallel circuits.
- Describe the operation and types of transformers.
- Describe the operation of AC and DC motors.
- Describe motor controllers.
- Describe the operation of full-voltage and soft-volage starters.
- Describe types of test equipment.
- Describe components of electric shock.
- Describe grounding systems and grounding problems.

Course Outline

1. Basic Electrical Theory
    a. Electrical Concepts
        i. Atom
        ii. Conductors and Insulators
        iii. Voltage
        iv. Current
    b. Resistance and Resistors
        i. Factors Affecting Resistance
        ii. Nature of Conducting Material
        iii. Length and Cross-Sectional Area of a Conductor
        iv. Uses of Resistance
        v. Ohm's Law
    c. Electrical Circuits
        i. Series Circuits
        ii. Parallel Circuits
        iii. Combination Circuits
            1. Reducing a Combination Circuit
            2. Finding Voltage and Current
    d. Kirchhoff's Laws
    e. Magnetism
        i. Basic Properties of Magnetic Flux
        ii. Magnetic Fields around Current-Currying Conductors
        iii. Right-Hand Rule for a Current-Carrying Conductor
        iv. Magnetic Field of a Coil
2. AC Generation
    a. Elementary AC Generators
        i. Development of a Sine Wave Output
        ii. AC Generation Analysis
        iii. AC Generator Components

1. Field
2. Armature
3. Prime Mover
4. Rotor
5. Stator
6. Slip Rings

b. Three-Phase Circuits

3. RLC Circuits
    a. Inductors and Inductance
    b. Inductive Reactance and Impedance
    c. Capacitors and Capacitance
        i. Capacitors in Series and Parallel
        ii. Capacitive Reactance and Impedance
        iii. Impedance of Series RLC Circuits and of Parallel RLC Circuits
    d. Power Factor
4. Transformers
    a. Theory of Transformer Operation
    b. Transformer Functions and Ratios
    c. Types of Transformers
        i. Distribution Transformer
        ii. Power Transformer
        iii. Control Transformer
        iv. Auto Transformer
        v. Isolation Transformer
        vi. Instrument Potential Transformer
        vii. Instrument Current Transformer
5. AC and DC Motor Fundamentals
    a. Direct Current Motors
    b. Counter EMF
    c. Effect on Starting Current

d. Armature Reaction
e. Direction of Rotation of DC Motors
    i. DC Motor Directional Connections
f. Series Wound Motors
    i. Direct Current Compound Wound Motor
g. Types of DC Motors
h. Alternating Current Motors
    i. AC Motor Theory
    ii. Rotating Fields
        1. Rotor Behavior in a Rotating Field
i. Induction
    i. Induction Motors
        1. Construction
            a. Stator
            b. Rotor
            c. Torque
        2. Starting Current
        3. Power Factor
        4. Speed Control
        5. Reversing Rotation
    ii. Connections and Terminal Markings for AC Motors
j. Single-Phase Motors
    i. Split-Phase Motor
    ii. Capacitor Start
    iii. Shaded-Pole
k. Three-Phase Wye Connection
l. Three-Phase Delta Connection
m. Two-Phase Double-Voltage Connection
n. Motor Protection
    i. Short-Circuit Protection of Stator Windings

ii. Stator-Overheating Protection
iii. Rotor-Overheating Protection
iv. Wound-Rotor Induction Motors

o. Undervoltage Protection
p. Thermal Protectors
q. AC Motor Nameplate
r. DC Motors Nameplate

6. Motor Control Fundamentals
    a. Motor Control Functions
    b. Types of Controllers
        i. Semiautomatic Controller
        ii. Automatic Controller
    c. Control Devices and Symbols
        i. Primary Control and Pilot Control Devices
        ii. Contacts
        iii. Pushbutton Switches
        iv. Toggle Switches
        v. Indicating Lights
        vi. Coils, Relays, and Contactors
    d. Magnetic Contactors
        i. Types of Magnetic Contactors
        ii. Magnetic Coil Control Circuits
        iii. Holding Circuit Interlocks
        iv. Interlocks
        v. Overloads
            1. Melting Pot Type Thermal Overload
            2. Bimetallic Element Type Overload
            3. Magnetic Type Overloads
    e. Factors Affecting Selection of Overload Heaters and Thermal Units
    f. Control Circuits

i. Diagrams
ii. Circuit Analysis
    1. Three-Wire Control
iii. Common Control
    1. Control Power Transformers
    2. Hand-Off-Auto Controls

7. Controlling Motor Starting
    a. Full-Voltage Starters
    b. Control Power
    c. Soft-Start Reduced Voltage Controllers
    d. Soft-Start Applications
    e. Benefits of Using Soft Start Starters:
    f. Typical Fixed Speed Applications:
    g. Other Reduced Voltage Starting Methods
    h. Controllers and Starters: Theory and Application
        i. Soft-Start Controller and Starter
        ii. Benefits of Using Soft-Start Controllers and Starters
        iii. Basic Principles of Soft Start
8. Test Equipment
    a. Multimeters
        i. Resolution, Digits, and Counts
        ii. Accuracy
        iii. DC and AC Voltage
        iv. Resistance
        v. Continuity
    b. Diode Test
        i. Measuring Current
        ii. Input Protection
        iii. Voltage Testers
        iv. Continuity Testers

c. Ammeters
d. High Voltage Detector
e. Megohmmeters

9. Electrical Safety
    a. Electrical Shock and Emergency Response
        i. Shock Hazard Severity
        ii. Magnitude
        iii. Duration
        iv. Path
        v. Skin-Resistance
        vi. Contact Area
        vii. Skin Moisture
    b. Source Voltage
    c. Lockout/Tagout
    d. Electrical Safe Work Practices
        i. Arc Flash
    e. Emergency Response and CPR-Qualified Personnel
10. Grounding Practices
    a. Grounds and Grounding
        i. Grounding Requirements
        ii. Ground Fault Detection
    b. Life Protection (GFCI)
    c. Equipment Protection
    d. Solidly and Impedance Grounding Systems
        i. Installation
    e. Grounding Electrode System Requirements
        i. Testing the Grounding Electrode Resistance to Earth
        ii. Testing Ground Continuity Connections
        iii. Location and Sizing Grounded Conductors
    f. Bonding Jumpers

g. Grounding Conductors
    i. Enclosure and Equipment Grounding
h. Grounding Equipment and Enclosures
i. Motor Connections
j. Grounded Neutral
k. Ground Fault Circuit Interrupters
l. Common Grounding Problems
    i. Instrumentation Electrical Noise
    ii. Stray Circulating Currents in Grounding Systems
    iii. Grounding Corrosion
    iv. Cathodic Protection
m. Pipeline Coating

Recommended Resources

- GTA Electric Power Fundamentals Participant Guide
- GTA Electric Power Fundamentals Presentation.
- Internet sites related to basic industrial electrical Theory.
- Textbooks or other publications related to Industrial electrical theory and practice.