

AC/DC Fundamentals

This five-day course begins with a fundamental review of conductors and insulators, electric current, resistance, Ohm's and Kirchhoff's Laws, electrical power, and magnetism. AC circuit fundamentals are covered including inductive and capacitive circuits. Other topics include test equipment, semiconductors and diodes, transistors, and silicon controlled rectifiers.

I. Conductors and Insulators

- The Atom
- The Nucleus
- Electrical Charges
- Categories of Matter

II. EMF and Electric Current

- EMF
- Current Flow
- Voltage Potential

III. Resistance

- Characteristics of Resistance
- Ohm's Law

IV. Resistive

- Resistance in Series
- Resistance in Parallel
- Simplified Formulas
- Series-Parallel Circuits

V. Applying OHM's Law

- Current in Series Circuits
- Voltage & Current In Parallel Circuits
- Voltage & Current In Series-Parallel Circuits

VI. Kirchhoff's Laws

- Kirchhoff's Current Law
- Kirchhoff's Voltage Law
- Loop Equations

- Major Components
- Theory of Operation
- Common Applications

VII. Electrical Power

- The Unit of Power
- Power Equations
- Power Rating of Resistors

VIII. Magnetism

- Characteristics of Magnetism
- Magnetic Field Around a Current-Carrying Conductor
- Left-Hand Rule for a Conductor
- Magnetic Field of a Coil

IX. AC Power

- Sine Wave Generation
- Sine Wave Terminology

X. AC Phase Relationships

- Phase Concepts
- Phase Angle
- Phase Angle Diagrams

XI. Resistance in AC Circuits

XII. Inductance in AC Circuits

- Inductance
- Factors Affecting Inductance

- Voltage & Current in an Inductive AC Circuit
- Inductive Reactance

XIII. Capacitance in AC Circuits

- Capacitance
- Factors Affecting Capacitance
- Voltage & Current in a Capacitive AC Circuit
- Capacitive Reactance

Basic Electrical Safety

This two-day introductory electrical safety course is primarily designed for those who do not have a background in electricity but are required to have safety training.

As a prerequisite to understanding the concepts of electrical safety, students are first introduced to basic electrical principles. Students then learn valuable information regarding OSHA 1910 and electrical safety.

I. Introduction

II. Fundamental Concepts of Electricity

- Conductors and Insulators
- Voltage, Current and Resistance
- Common Electrical Terms

III. Effects of Electricity

- Factors Affecting the Severity of Shock
- Current and Voltage Levels
- Rescue and First Aid

IV. Hazard Awareness

- Hazards in Power Systems
- Maintenance Hazards

V. OSHA 1910

- General Requirements (1910.303)
- Qualified and Unqualified Work Training (1910.332)
- Selection and Use of Work Practices (1910.333)
- Use of Equipment (1910.334)
- Safeguards for Personnel Protection (1910.335)

Basic Protective Relaying

This five-day course is designed to provide the participant with a thorough background of power equipment protection using electromechanical relays. Topics include relaying philosophy and power system analysis at the block diagram level.

Also, operating and testing of overcurrent relays, voltage relays, instrument transformers, and synchronism check relays

I. Relay Systems

- The Power System
- Function of Relays
- Backup Relaying
- Definition and Basic Types of Protective Relays
- Relay System Requirements
- Relay Characteristics
- Relay Applications

IV. Transducers

- Description
- Typical Transducer Specifications
- Applications
- Adjustments

II. Relay Systems

- Functions of Protective Relaying
- Classes of Relays
- Basic Relay Requirements
- Bus Arrangements
- Line Arrangements

III. Voltage Relays

- Overvoltage Relays
- Sensitive Overvoltage
- Undervoltage Relays
- Combination Over/Undervoltage
- Undervoltage and Phase Sequence Relays
- Special Applications
- Voltage Balance Relay

Basic Soldering

This two-day class teaches students the available equipment used for soldering processes. Also covered are the different soldering techniques, and troubleshooting problems with solder.

I. Available Equipment

- Soldering Irons / Guns
- Solder Types

II. Soldering Techniques

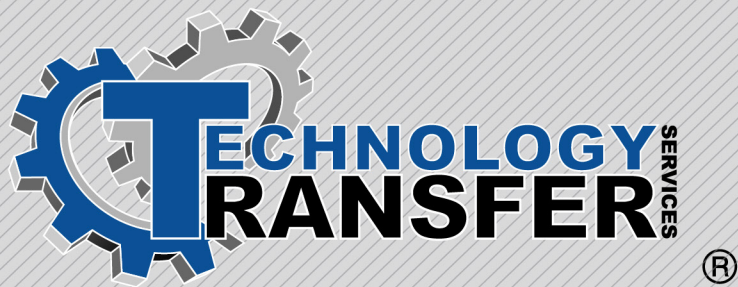
- How To Solder Effectively
- Desoldering
- Soldering Technique Summary

III. Troubleshooting Solder Problems

- Solder Will Not Take
- Joint is Crystalline or Grainy in Appearance

IV. First Aid

- Burns
- Abrasions



Batteries and Battery Chargers

Batteries and Battery Chargers

This five-day course begins by reviewing the principles of large battery operation. Battery terms are then explained, followed by battery safety topics, battery maintenance, and uninterruptible power supply operation.

I. Principles of Large Battery Operation

- Construction
- Electrolytes
- Chemical Reactions
- Battery Operations

- Loss of Normal AC Source (Role of the Battery)
- Power Conditioning

II. Battery Related Terminology

- Battery Voltages
- Specific Gravity
- Battery Capacity

III. Battery Safety

- Specific Battery Hazards
- Electrolyte Precautions
- Electric Shock Precautions
- Hydrogen Gas Precautions
- Battery Storage and Transportation

IV. Battery Maintenance

- Preventive Maintenance Requirements
- Battery Replacement/Removal
- Cell Jumpering

V. Uninterruptible Power Supply (UPS) Operation

- Purpose and Applications
- Role of the Battery
- Normal Operation

Digital Circuits for Electricians

This four-day introductory course begins with a look at fundamentals of digital electronics. A brief review of digital numbering systems and digital device construction is provided. An overview of basic logic gates is covered. The use of flip-flops, multivibrators, counters and decoders is emphasized. An introduction into the function of a microprocessor is also presented, as well as analog and digital converters. Troubleshooting digital circuits is also included in the course.

I. Introduction to Digital Electronics

- Analog vs. Digital Devices
- Number Systems
- TTL and CMOS IC's

II. Basic Logic Gates

- AND Circuit
- OR Circuit
- NOT Circuit
- NAND Circuit
- NOR Circuit
- XOR Circuit
- XNOR Circuit
- Boolean Expressions

III. Flip-Flops and Multivibrator Circuits

- Data flip-flop
- J-K flip-flop
- R-S flip-flop
- Monostable Multivibrators
- Astable Multivibrators

IV. Counters and Decoders

- Decade Counters
- Decoders

V. Solid State Switches and Drivers

- Solid State Switches
- Array Drivers

VI. Introduction to Microprocessor

- What is a Microprocessor
- Microprocessor Internal Construction
- Microprocessor Uses

VII. Interfacing Digital and Analog

- OPAMP Circuits
- Analog to Digital Conversion
- Digital to Analog Conversion

VIII. Troubleshooting Techniques

- Logic Probes and Pulsers
- Multi-Point Logic Testers

Electrical Fundamentals

This three-day seminar includes topics relating to industrial electricity.

Topics include concepts of electrical theory and math, electrical print reading, magnetism, and electrical safety. The course uses your plant's prints and diagrams to reinforce the print reading section. This course is designed for plant maintenance personnel.

I. Quick Math Review

- Manipulating Equations
- Exponents and Scientific Notation
- Metric Terms Used in Electricity
- Trigonometry

II. Basic Electrical Theory

- Atoms
- Conductors and Insulators
- Voltage
- Current
- Resistance and Resistors
- Ohm's Law Calculations
- Series Circuits
- Parallel Circuits
- Combination Circuits
- Kirchoff's Laws

III. Print Reading

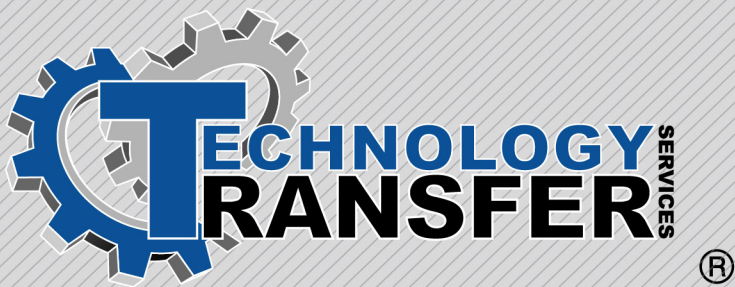
- Symbols and Abbreviations
- Switches and Controls
- Motor Starters
- Speed and Motor Controls
- Device Numbers and Suffix Letters

IV. Magnetism

- Characteristics of Magnetism
- Magnetic Fields Around
- Current-Carrying Conductors
- Left-Hand Rule for Conductors
- Magnetic Field of a Coil

V. Electrical Safety

- Electrical Safety
- Magnitude of Current
- Let Go Current Value
- Duration
- Path
- Skin Resistance
- Emergency Response
- CPR-Qualified Personnel



Electrical Inspection

Electrical Inspection

This three-day course covers the codes and standards of the National Electrical Code and National Electrical Manufacturers Association, inspections for various electrical equipment, motor control center construction, controller fundamentals, circuit design, and an explanation

I. Introduction

II. Codes and Standards

- National Electrical Code
- National Electrical Manufacturers Association

III. Inspecting Electrical Equipment

- Wiring Methods and Materials
- Wiring Design and Protection
- Cable Trays and Raceways
- Conductor Ampacities
- Switchboards and Panelboards
- Circuit Breakers and Switchgear
- Equipment for General Use
- Transformers
- Lighting Circuits and Fixtures
- Fuses, Types, and Classifications

IV. Motor Control Centers

- Motors Nameplate Data
- Motor Controllers
- Motor Branch Circuits
- Motor Current Requirements per NEC
- Motor Protection
- Motor Classification
- Remote Control Circuits

Electrical Motors and Controllers

This five-day course covers AC and DC motor theory including three-phase and single-phase motors, motor inspection, and maintenance. The course also provides an overview of variable frequency drives.

I. AC and DC Motor Fundamentals

- Basic Magnetic Principles
- Electric Current and Magnetism
- Motor Operation Principles

II. Direct Current Motors

- DC Motor Principles
- Shunt Motors
- Series Motors
- Compound Motors
- Terminal Identification for DC Motors
- Determining Direction of Rotation for DC Motors
- Speed Control
- Field Loss Relay
- Horsepower
- Brushless DC Motors
- Converters
- Permanent Magnet Motors

III. Three Phase Motors

- Operating Principle
- Rotating Magnetic Field
- Connecting Dual-Voltage 3Ø Motors
- Squirrel-Cage Induction Motors
- Wound Rotor Induction Motors
- Synchronous Motors
- Seisyn Motors

IV. Single Phase Motors

- Operating Principle
- Split-Phase Motors
- Resistance-Start Induction-Run Motors
- Capacitor-Start Induction-Run Motors
- Dual-Voltage Split-Phase Motors
- Determining Direction of Rotation for Split-Phase Motors
- Capacitor-Start Capacitor-Run Motors
- Shaded-Pole Induction Motors
- Multi-Speed Motors
- Repulsion-Type Motors
- Single-Phase Synchronous Motors
- Stepping Motors

V. Motor Inspection and Maintenance

- DC Motors
- AC Motors

VI. Controllers

- Types
- Troubleshooting

VII. Introduction to AC Drives

- Power Section
- Logic Section
- Variable Frequency Drive Parameters

VIII. VFD Overview

- Drive and Option Identification
- Drive Firmware Identification
- Drive Schematic Overview

IX. VFD Operation

- Programming and Display Panel
- Control Inputs
- Drive Functions

Electrical Inspection

This five-day course covers the codes and standards of high-voltage electrical theory, rotating machinery, transformer testing and inspections, circuit breakers and relays, batteries, cable raceway inspections, and cable pulling and terminations.

I. Electrical Theory H.V.

II. Rotating Machinery

- DC Motors
- AC Motors
- AC Controllers
- DC Controllers
- Motor Inspections
- Motor Control Centers
- Generators
- DC Generators
- AC Generators
- Generator Cooling
- Insulation Testing of Rotating Machinery

III. Transformer Testing and Inspection

- Fundamentals
- Connections and Polarity
- Construction
- Classification
- Tap Changers
- Accessories
- Data
- Testing and Inspection
- Maintenance

IV. Circuit Breakers and Relays

- Circuit Breakers
- Maintenance Fundamentals

- Testing
- Protective Relays
- Switchgear Construction
- Switchgear Inspection Criteria

V. Batteries

- Characteristics and Types
- Components
- Specific Gravity
- Discharging and Charging
- Chargers
- Safety and Handling
- Checklist

VI. Miscellaneous Electrical Equipment

- Switches
- Temperature Measurement
- Valve Operators
- Motor Operators
- Setting MOV Limit Switches
- MOV Torque Switches
- Inspections for Limit and Torque Switches
- Valve Stroke
- MOVATS
- Valve Controller
- Indicating Devices
- Recording Devices

VII. Cable Raceway Inspection

- Definitions
- Procedures and Standards
- Tray Types
- Construction Specifications
- Separation Criteria
- Inspection Checks for Trays
- Tray Cover Inspection
- Conduit Types and Materials
- Inspection Checks for Conduit
- Raceway Supports
- Inspection for Anchor Bolts

Section X will be incorporated into each of the previous sections as applicable.

X. Electrical Equipment Installation

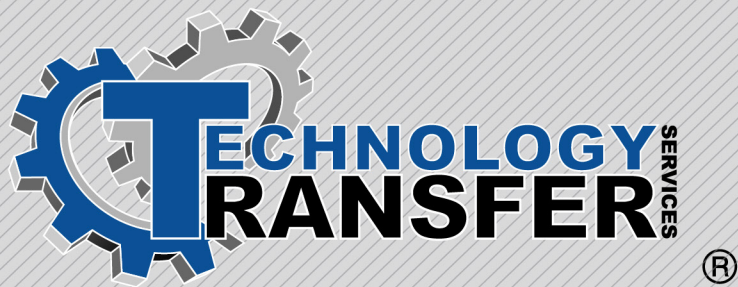
- State Requirements
- Codes Standards and Organizations
- Inspection Criteria
- Equipment Identification and Handling
- Grounding Requirements
- Equipment Installation Checks

VIII. Cable Pulling and Termination

- Cable Pulling Standards
- Cable Definitions and Standards
- Tray and Conduit Fill
- Cable Reels and Cable Marking System
- Bend Radius, and Temperature
- Pulling Devices and Cable Attachments
- Conduit Types and Materials
- Pulling Aids and Personnel Positioning
- Installation Procedure and Calculation Factors
- Inspection Points During the Pull
- Inspection Points after the Pull
- Testing and Documenting
- Types of Terminations
- Pre-Terminating and Splicing Inspection Points
- Steps in the Termination Process
- Splices
- Tests

IX. Quality Assurance Programs

- QA Regulation and Standards
- 10 CFR 50, Appendix b
- ANSI/ASME Standards



Electrical Safety Seminar

Electrical Safety Seminar

This three-day course covers all aspects of working safely around energized electrical equipment. Basic topics include safety policies, general safety rules, vehicle safety, ladder and scaffold safety, chemical safety, fire safety, general electrical safety, and emergency procedures. Following this safety discussion, the instructor covers electrical safety topics such as testing equipment for energization, work on energized circuits, overhead operations, clearances around energized equipment, substation operations, underground operations, equipment grounding, and lightning protection. Participants have found that the case studies and group discussions of electrical hazards enhance the safety of their operations.

I. Safety Policies

- Safety Tagging
- Safety Apparel
- Dress Code
- Vehicle Safety
- Ladder and Scaffold Safety
- Chemical Safety
- Fire Safety
- Emergency Procedures

IV. Underground Operations

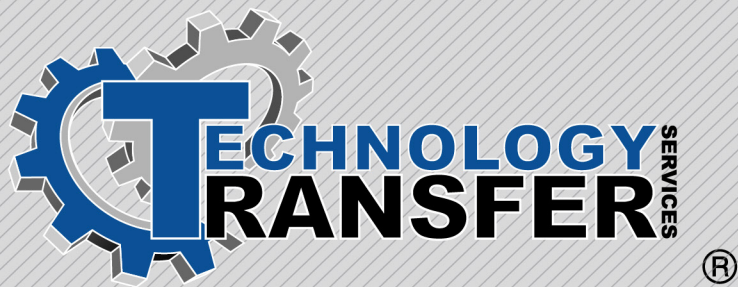
- Underground Hazards
- Confined Space Entry

II. Electrical Equipment Safety

- Electrical Equipment Safety Practices
- Testing Electrical Equipment for Energization
- High Voltage Electrical Safety
- Energized Electrical Equipment Safety
- Electrical Equipment Safety Grounding

III. Substation Safety

- High Voltage Electrical Hazards
- Substation Hazards
- Insulating Oil Handling
- Compressed Air Hazards
- Lightning Protection
- Confined Space Entry
- Battery Safety
- Switchgear Operations



Electrical Training Phase II

Electrical Training Phase II

This five-day course begins with a review of electrical safety topics. Next, substation equipment is explained followed by a description of 480V switchgear and 4.16 kV equipment. The final portion of the course explains grounding principles and applications and test equipment.

I. Electrical Safety

- Electrical Safety Standards
- Electrical Shock

II. Substation Basics

- Substation Overview
- DC Systems
- Introduction to Battery Maintenance
- DC Machine Maintenance
- AC Systems

III. 480 Volt Switchgear

- Functional Description
- Operating Procedures
- Installation Procedures
- Removal Procedures
- Breaker Operating Procedures
- Breaker Interlocks

IV. 4.16 KV Equipment

- 4160 Volt Switchgear
- Breaker Removable Element
- Bus Compartment
- Current Transformer Compartment
- Primary Termination Space
- Voltage Transformers

V. Grounding Procedures

- General
- Protective Grounding Principles
- Inspecting and Testing of Protective Grounding Equipment
- Switchyard and Substation Clearance Grounding

VI. Fluke Multimeter

- Fluke 787
- Measuring Electrical Parameters
- Using TouchHold
- Compensating for Test Lead Resistance
- Using the Current Output Functions
- Power-Up Options
- Maintenance

VII. Test Equipment

- Types of Test Equipment
- Safety Precautions When Using Test Equipment

Electrical Wiring

This five-day course begins by describing conductors and their characteristics, classifications, and terms. Next, the types of conduit and fittings are reviewed, conduit fabrication and wiring, terminations, soldering, insulation of connections, and crane and hoist wiring are explained.

I. Conductors and Characteristics

- Introduction to Conductors
- Conductor Classification and Terminology
- Identification of Cables and Conductors
- Conductor Insulation

II. Types of Conduit and Fittings

- Conductor Protection
- Fittings
- Supports

III. Conduit Fabrication and Wiring

- Conduit Installation
- Cable Installation
- Wire Pulling Standards
- Receptacle Wiring

IV. Terminations

- Cable Preparation
- Terminations
- Solderless Mechanical Connectors
- Terminal Block Connections
- In-Line Butt Splice Connections
- Bolted In-Line Connections

V. Soldering and Exothermic Connections

- Solder
- Wetting Process And Dihedral Angle
- Soldering Flux
- Component Removal
- Component Installation
- Soldering Conductors to a Turret Terminal
- Soldering Bifurcated Terminals
- Soldering Pierced Terminals
- Soldering IC's
- Soldering Flat Packs
- Characteristics of a Quality Solder Joint
- Solder Joint Defects
- Printed Circuit Board Repair
- Conductor Repair
- Exothermic Connections

VI. Insulation of Connections

- Low Voltage Connections
- Insulating High Voltage Terminations
- High Voltage In-Line Splice

VII. Crane and Hoist Wiring

- Festoon Wiring
- Main Contact Conductors
- Collector Shoes
- Typical Crane Wiring

Generators & Generator Voltage Regulation

This five-day course provides a thorough working knowledge of electrical power generators and their associated voltage regulation systems. This course concentrates on large utility equipment and backup emergency generator units, but also applies well to smaller (under 500kW) equipment. Emphasis is placed upon generator paralleling, generator/regulator response to changing loads, and VAR flows, maintenance, testing, and regulator settings and protection are covered in-depth. Generator theory is backed up by comprehensive lab demonstrations. Personnel who require an advanced knowledge of generator excitation systems will benefit highly from this course.

I. Fundamentals of AC Power

- AC Waveforms
- AC Phase Relationships
- Resistance in AC Circuits
- Inductance in AC Circuits
- Capacitance in AC Circuits
- Power in AC Circuits

II. Generator Excitation Theory

- AC Generators
- Generator Operating Characteristics

III. Semiconductor Fundamentals

- Atomic Review
- Semiconductor Conduction
- Extrinsic Semiconductors
- Diodes
- Transistors
- Silicon Controlled Rectifiers (SCRs)
- Thyrite
- Logic Review
- Operational Amplifiers (Op-Amps)

IV. AC Synchronous Generators

- AC Generators
- Generator Operating Characteristics

V. Alterrex Voltage Regulators

- System Overview
- Excitation System Components
- Alternator Field Control
- Additional Regulator Functions

VI. Westinghouse WTA Voltage Regulator and Excitation System

- System Overview
- Component Parts
- Excitation System
- Limiting Circuits
- Voltage Regulator
- Calibration, Maintenance, and
- Troubleshooting

VII. Generator Protection

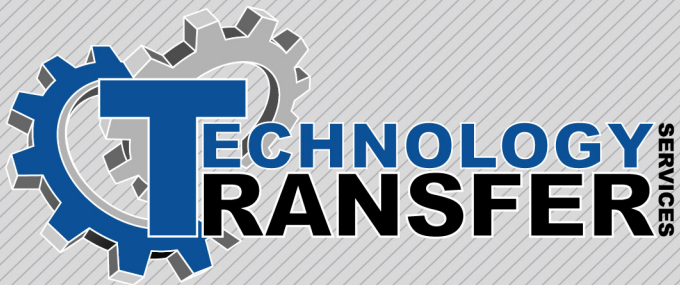
- Short Circuit Protection
- Ground Fault Protection
- Overload Protection
- Thermal Protection
- Overspeed Protection
- Low Field Excitation or Loss of Field
- Excitation Protection
- Generator Monitoring Protection
- Protection Against Unbalanced Faults
- Overexcitation Protection

Inverters

This three-day course begins with fundamental concepts common to all inverters such as electronic components, voltage regulation, static switching, and auxiliary circuits. The course then concentrates on the specifics of the inverter installed at your facility. As such, it will be necessary to submit to TTS all documentation, prints, manufacturer's literature, maintenance records, and information pertaining to the type of inverter you want covered in the class.

I. Introduction

- Static Inverters
- Voltage Regulation
- DC Voltage Regulation
- Static Switching
- Auxiliary Circuitry
- Overview of the Inverter System



Lighting Systems

Lighting Systems

This two-day seminar begins with a fundamental review of incandescent lighting. Other topics include fluorescent lighting, high intensity discharge lighting, and the power requirements for lighting systems.

I. Incandescent

- Types of Incandescent Lamps
- Troubleshooting and Repair

II. Fluorescent

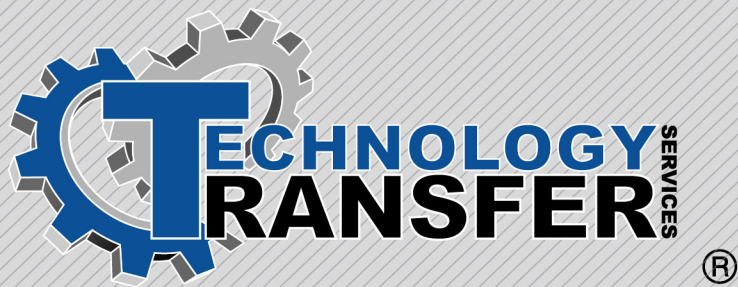
- Lamps
- Ballasts
- Troubleshooting and Repair

III. High Intensity Discharge

- Lamps
- Ballasts
- Troubleshooting and Repair

IV. Lighting Systems Power Requirements

- Balancing a System
- System Controls
- Automatic Controls



Low & Medium Voltage Power Systems

Low & Medium Voltage Power Systems

This three-day course reviews the 1999 NEC and an overview of the significant changes from earlier editions. Topics relating to industrial applications including grounding, overcurrent protection, wiring methods, and working clearances are given. This course includes class exercises working through typical calculations and determinations that require participants to search and find information in the Code.

I. Introduction

- Course Overview
- NEC & Local Electrical Code
- Compliance

II. Electrical Power Systems

- Fundamentals and Theory:
- One Line Diagrams
- Drawing Standards & Symbology
- Sound Engineering Practices

III. Power System Calculations

- Limitations
- Bus Sizing and Ratings.
- Feeder, Neutral and Ground
- Conductor sizing.
- Metering and Protective Relay Trip Calc.
- Relay Settings
- Time-Current Curve Plotting
- KW & KVAR Meter Instrument
- Transf.Calc.

IV. Metering

- Three-Line Diagram Review (Using Client Diagrams)
- Potential Transformers, Voltage Switches, Voltmeters
- Current Transformers, CT shorting Switches, Ammeters
- KW, KVAR & PF Meter Connections

V. Protective Relaying

- OC (50/51), Rev Pwr (32), Diff OC (87), and Grd Fault (51G)
- Resistance Grounding Systems

VI. Breaker Control

- Low and Medium Voltage Switchgear
- Low and Medium Voltage Circuit Breakers
- Trip and Lockout Circuits
- Local and Relay Tripping
- Remote/Automatic Tripping

VII. 480V and 4160V Procedures

- Lockout/Tagout Procedures for Low and Medium Voltage Circuit Breakers (OSHA Requirements)
- Rackout Procedures for Stored Energy Breakers
- Medium Voltage Cable Terminations Principles and Practices

VIII. Maintenance and Troubleshooting

- If/Then Matrix (Electrical & Mechanical)
- Typical Problems and Solutions
- Preventive Maintenance

National Electrical Code

This three-day course reviews the 1999 NEC and an overview of the significant changes from earlier editions. Topics relating to industrial applications including grounding, overcurrent protection, wiring methods, and working clearances are given. This course includes class exercises working through typical calculations and determinations that require participants to search and find information in the Code.

I. Introduction

- Purpose of Workshop
- Areas of Study
- Introduction to the National Electric Code

II. Definitions

- Terms
- Equipment
- Circuit Classifications

III. Wiring Design and Protection

- Circuit Types
- Branch Circuits
- Feeders
- Branch and Feeder Circuit Calculations
- Services
- Overcurrent Protection

IV. Wiring Methods and Materials

- Conductor Classification
- Identification of Conductors
- Conductor Insulation
- Conduit Installation
- Cable Installation
- Fixture Wiring
- Fittings
- Supports
- Enclosures

V. Electrical Equipment Wiring

- Switchboards and Panel Boards
- Lighting Branch Circuits
- Illumination
- Air Conditioning
- Motors and Motor Controls

VI. Special Circuits

- Data Processing
- Isolation Techniques
- Backup/Surge Protection
- Hazardous Locations

VII. Grounding and Bonding

- Circuit and system Grounding
- Ground Locations
- Equipment Grounding
- EMI

OSHA Safety Awareness

This three-day course is a refresher course concerning OSHA requirements on environmental excellence, asbestos and non-asbestos insulation, PCB's, lead, mercury, respiratory protection, excavations, confined spaces, atmosphere testing, fire safety, hearing conservation, personal protective equipment, and personal safety and preventive actions.

I. Environmental Excellence

- Historical Prospective
- Definitions and Acronyms
- DEC Consent Order
- Environmental Managers
- System Environmental Issues
- Monitoring
- Training
- Company Policies
- Laws and Regulations

II. Asbestos

- Health Effects
- Operations That May Result in Exposure
- Asbestos Awareness Program Overview
- Respirators
- Fit
- General OSHA Requirements
- Medical Surveillance
- Personal Protective Equipment
- Air Monitoring
- Asbestos Coordinators
- Clear Access Policy

III. Non-Asbestos Insulation

IV. PCBs

- Common Terms and Definitions
- Effects of Exposure
- Protective Equipment
- PCB Handling Procedures
- Reportable Spill Quantities and Concentrations

V. Lead

- Common Terms and Definitions
- Lead Hazards
- Effects of Exposure
- Exposure Limits
- Protective Equipment
- Lead Handling Procedures
- Medical Surveillance
- Procedure for Lead Work in Underground Manholes
- Lead Procedure- Construction Work

VI. Mercury

- Common Terms and Definitions
- Hazards of Mercury
- Routes of Entry
- Effects of Exposure
- Exposure Limits
- Mercury Handling Procedures

VII. Respiratory Protection

- Terms and Definitions
- General Guidelines
- Respirator Types, Selection and Classification
- Fit
- Medical Surveillance
- Protection Factors
- Chemical Cartridges and Filters
- OSHA Respiratory Protection Standard

Servo Mechanisms

This three-day course is designed to familiarize technicians with the use, types, and operation of servo mechanisms. Various types of servos are covered, along with the associated encoders and resolvers used to drive the servos.

I. Servos

- Function
- Operation
- AC
- DC
- Installation
- Feedback Loops
- Acceleration Control
- Deceleration Control
- Braking
- Torque Control
- Boost

II. Encoders

- Function
- Operation
- Types
- Installation
- Feedback
- Positioning
- Common Problems

III. Resolvers

- Functions
- Operation
- Types
- Installation
- Feedback
- Common Problems

Substation Maintenance

This five-day lecture and demonstration course is a comprehensive overview of the maintenance requirements of power and distribution substations. It begins with an introduction to power distribution schemes and explains the purpose of substations in these schemes. The course features a large variety of modern test equipment, including circuit breaker high current test sets, cable fault locators, hi-pots, polarization index testers, micro-ohmmeters, oil dielectric testers and other common test gear. The course covers the maintenance and inspection requirements of station relays, transformers, breakers, station batteries, and grounding.

I. Introduction

- Review of Electrical Power Systems
- Types of Substations
- Substation Components
- Maintenance Considerations
- Electrical Equipment Testing

II. Protective Relay Maintenance

- Power System Faults
- Relay Operating Principles
- Instrument Transformers
- Relay Testing
- Overcurrent and Voltage Relays
- Directional Overcurrent Relays
- Transformer and Bus Differential Relays

III. Transformer Maintenance

IV. Circuit Breaker Maintenance

- Circuit Breakers
- Switchgear
- Arcs and Arc Interruption
- Circuit Breaker Contacts
- Operating Mechanisms
- Air Circuit Breakers
- Vacuum Circuit Breakers
- Oil Circuit Breakers
- Gas Circuit Breakers
- Circuit Breaker Maintenance
- Circuit Breaker Testing

V. Substation Battery Maintenance

- DC Auxiliary System Design
- Battery Maintenance and Testing

VI. Substation Safety

- Safety Philosophy
- Switching Practices
- Safety Grounding

VII. Instrument Transformer Testing

- Testing Current Transformers
- Testing Potential Transformers

VIII. Insulating Oil Testing

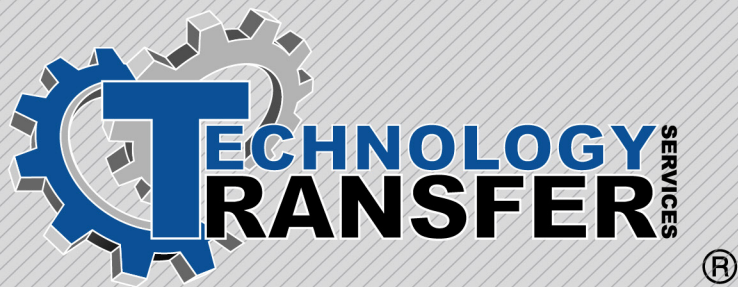
- Insulating Oil
- Oil Sampling
- Insulating Oil Testing
- Insulating Oil for Circuit Breakers
- Dielectric Breakdown Voltage Testing
- Power Factor Testing
- Color Testing
- Acidity Testing
- Moisture Content Testing
- Gas Testing

IX. Insulation Resistance Testing

- Transformers
- Circuit Breakers
- Cables

X. Maintenance Records

- Initial History
- Routine Maintenance Records



Test Equipment

Test Equipment

This three-day course begins with an in-depth review of various types of electrical test equipment. The seven-step troubleshooting methodology, as it applies to electrical systems, is thoroughly described.

I. Test Equipment

- Multimeters
- Megger
- Oscilloscopes
- Clamp-On Ammeter
- Phase Sequence Meter
- High-Voltage Detector
- Wiggins (Voltage Detector)

II. Troubleshooting

- Troubleshooting Philosophy
- Seven-Step Troubleshooting Procedure

Uninterruptible Power Supplies

This five-day course begins by reviewing the fundamental concepts of power inverters, converters, and UPS systems. Other major topics include power conditioning, basic UPS applications, principles of battery operation, power inverters and waveshaping, voltage regulation, static switching and auxiliary circuits, and UPS troubleshooting and maintenance.

I. Fundamental Concepts of Power Inverters, Converters, and UPS Systems

- Alternating Current
- Inductors and Capacitors
- Relays
- Transformers
- Atomic Review
- Transistors and Transistor Applications
- Silicon Controlled Rectifiers (SCR)
- DV/DT Snubbing
- Triac and Diac
- Logic Gates
- Operational Amplifiers
- Metering Equipment

II. Power Conditioning

- Characteristics of Electrical Noise
- Causes of Electrical Noise
- How Electrical Noise Enters Sensitive Circuits
- Effects of Noise on Equipment Performance
- Solutions to Electrical Noise Problems

III. Basic UPS Applications

- Static Inverters
- Inverter Systems
- Basic UPS Layouts

IV. Principles of Battery Operation

- Battery Electrochemical Action
- Battery Components
- Storage Batteries
- Battery Charging Fundamentals

V. Power Inverters and Waveshaping

- Theory of Operation
- SCR Gating
- SCR Commutation

VI. Voltage Regulation

- DC Voltage Regulation
- Voltage Regulator Transformers
- Load Tap Changers

VII. Static Switching and Auxiliary Circuits

- Static Switching
- Auxiliary Circuitry

VIII. UPS System Troubleshooting and Maintenance

- Troubleshooting
- Preventive Maintenance