Hands-On

Central Office Power & Infrastructure

On-Site -or- Virtual Live Instructor Led

Course Description

This comprehensive "Live" Instructor-Led (On-Site or Virtual) course is designed for Engineers, Central Office Techs, and Installers, plus any others with the responsibility for the installation, maintenance, troubleshooting, and repair of Central Office infrastructure power and plant. NEW material is continuously being added to reflect some of the latest hardware and systems available in a mixed copper/fiber central office environment, including automatic power monitoring, infrared cameras, battery testers, and the new sodium-nickel-chloride battery.

The course provides a broad yet detailed study of Central Office power systems, common to both earlier and modern hardware, covering virtually all aspects of DC power, including the initial commercial AC-to-DC conversion, plus the common grounding between AC and DC. Racking, cable runs, and fasteners are important, particularly when isolated ground zones (IGZ) are required. Cable suspension and securing methods are investigated, along with concepts like separation, cable rating, seismic rating, and bend-radius. Some focus is placed on the varieties of rectifiers available today, with typical and premium features, and the relative benefits of an integrated system versus stand-alone components. Existing and improved battery designs are compared, including traditional wet-cell and newer absorbent-glass mat (AGM), plus different chemistries and float voltages. Different types of generators, transfer-switches, and disconnects are also discussed, with examples of traditional and newer offerings with improved user interfaces. Grounding via an SPG is a key emphasis, using various regulatory and standards for their recommendations and requirements, including the NFPA's NEC, the IEEE NESC, the federal CFRs, plus certain Telcordia requirements and best-practices like GR-63 (NEBS), GR-1275 (Installation) and GR-1502 (Engineering).

Test equipment is also featured, including how to select and use the correct type of DC clamp meter, plus the use of battery testers, ground field meters, infrared cameras, and automatic power system monitoring.

Multiple examples are shown for a typical central office with both earlier DC rectifier, battery, and BDFB components, plus newer systems that integrate some or all of these parts. A remote equipment cabinet example is also used, demonstrating various options for site grounding, including maintaining an IGZ, and ground connections coordinated with the power company.

The course can also include material as-needed, such as Outside-Plant to CPE connections like the grounding of cable shields, messenger leads, and tracer leads. More detail on remote site power can also be shown, using a mobile telephone-switching office (MTSO) example where on-the-spot power and grounding are needed. The course can also offer material on Data Center power and plant infrastructure, which typically uses AC-powered servers that are increasingly being used by telcos and service providers.

Students Will Learn

- **CO Power concepts - including fundamentals of L, C & R and Impedance**
- **Ground Return Paths - how DC & AC grounds are the same**
- **Breakers & Fuses - including primary & 'tell-tale', selection, ratings**
- **DC Wiring Schemes - A/B Feeds, cable selection**
- **Cable suspension systems - spacing, ceiling fasteners, bracing**
- **Practical design considerations - for power, signal and fiber optic cables**
- **Batteries - different chemistries, charging vs. equalizing, testing**
- **DC Rectifiers - traditional vs. switching designs, features, load-sharing/redundancy**
- **DC Grounding zones - bus bar types, isolated/IGZ, single-point-ground, etc.**
- **DC volt & ammeters - shunts, clamp-on vs. in-circuit**
- **Generators & transfer switches - improved interfaces, capacity, faults**
- **Dangers - high-amperages, open circuits, loose connections, safety margins**
- **Test & Maintenance - battery maintenance, ground field, test equipment**
- **Telcordia specs - GR-1275 (Installation), GR-1502 (Detail Engineering), GR-63 (NEBS)**
- **Telco-specific specs - Verizon IP72202, Lumen 77351, and AT&T TP-76xx**
- **NEC, NESC, and CFR - best practices and requirements**
- **Design Considerations - for future access for maintenance, additions, and decomms**
- **And much more**

Target Audience

Telecommunications and Data Center personnel (incl. engineers, planners, supervisors, technicians, and installers) responsible for equipment selection, installation, maintenance, troubleshooting & repair.

Prerequisites

None. Some basic understanding of electrical concepts, telecommunications equipment terminologies and OSP Bonding & Grounding may be helpful.

Course Outline

Module 1 : CO Power Concepts

Safety - What Could Go Wrong?
What Exactly Is Ground?
Ground as A Conductor
Voltage Potential: AC & DC Voltage
Ohm's Law
Series & Parallel Circuits

Reactance: Capacitance, Inductance
Impedance
- Resistance vs. Impedance
- Power: Watts vs. Volt-Amps
- Power Factor
- Surge Current

Decibel Measurements
- dBrn & electrical Noise

Module 2 : AC Power & Grounding

Commercial AC (supporting DC systems)
Conventions:
- Single-Phase & Three-Phase
- Wye & Delta Inputs
- Multi-Grounded Neutral (MGN)

Power Conversion
- Rectification
- Peak-to-Peak, Average, RMS

Ground Potential Rise (GPR)
Disconnects:
- purpose, manual versus automatic
- ACB, switch-gears

Surge Arrestors
- types, monitoring

Generator Transfer Switch & Generator:
- selecting, common settings

Rectifier Comparison:
- current vs. future estimates
- early (non-switching) conversion
- switching (early, modern, full-featured with monitoring)
- settings: float, equalize, LVD, walk-in, surge current, other settings

Inverters:
- functions, individual vs. net system efficiency
- configurations for redundancy
- integrated features & solutions

Examples
Exercise

Module 3 : DC Power Components

CO DC Components
- Rectifier, Charge Bus, Discharge Bus, Battery String, Power Board, Inverter
- Points of Failure

Rectifier Operation
- Non-Switching vs. Switching Comparison
- Review of Rectifier Types

Negative Voltage Systems
- Wiring Conventions

Battery Types
- Wet Cell: LA, LC, VLRA, NaNiCl
- AGM

- Mounts

DC Power Boards
- Main Disconnect, LVD, Shunt, meters
- A&B distribution

DC Power Distribution
- primary & secondary distribution buses
- BDFB
- bar types - Cu vs. Al, coated vs. non-coated

Fuse & Breaker Types
Wire Derating Charts
Testing
- Reconciling Currents - potential & return leads
- Voltage Drops: battery-to-power board, to equipment
- How to take a measurement

Examples
Exercise

(Optional: DC-AC Inverters for Video Head-End or Data Center Servers)
(Inverter examples, redundancy configurations incl. cost vs. benefit, surge & efficiency specs)

Module 4 : Bonding & Grounding

RUS, AT&T, other standards
Ground Bar Types: MGB, OPGP
Wiring
- RUS: "PANI", CEGB, FGB, GWB, IGZ, etc.
- AT&T: OPGP, CVGB, COGB, MGB, IBN, etc.

Isolated Grounds
- Ground Window Theory: when and when not required
- Noise fault locating, mitigation

Grounding Rods
- size, depth, angle
- chemical grounding (GEM, ground wells)

Bonding Methods
- Exothermic Welds
- Compression/Crimp Connection
- other connection types

Grounding Standards:
- Remote Site Example, MGE ground options
- Ground cable types: cable-entrance, AC pedestal/MGN, DC equipment, etc.
- Grounding at the Prem: ground bar depth, ground cable sizing

Measurements
- OSP cable shield
- Ground Field Resistance: multiple-electrode fall-of-potential & clamp-on meters

Exercise
(Optional: Customer Premise Grounding Examples: aerial or buried ground, detached-home BET, trailer park, telco & power company grounds, citations from agencies like the NEC/NESC/CFR, etc.)

(Optional: MTSO antenna tower grounding, fence and hut grounding)

Module 5 : Specifications & Standards

Organizations:
- NFPA NEC, IEEE NESC, Federal CFR/eCFR, Telcordia, telco-specific

Telcordia GR-1502:
- fastener types
- supports
- ASTM specifications
- Seismic zones II & IV

Telcordia GR-1275:
- Installer Skill Levels 1 thru 4
- CLEC access - physical, power, grounding, signal interconnections
- Safety, Hazmat, Warnings
- Planning & Communication

Telcordia GR-63:
- NEBS standards
- Examples

Telco-Specific:
- Verizon IP72202
- AT&T TP-76xx
- CenturyLink/Lumen 77351
- others (as provided)

Module 6 : Hardware Examples

General: Types, safe loads, selection of hardware
Assembly: J-hooks, brackets, bolt/washer/nut assembly, grades, isolation
Frames: Securing a bay, securing line-ups, maintaining the IGZ, bonding
Cabling: Support types: grid, ladder rack, troughs, waterfalls, etc.
Distance: Work space, power space, signal space, ventilation, plenums, etc.
Labeling: Required fields (Telcordia), examples of incorrect labeling, longevity, etc.
Inspections: Testing, verification (operational, safety), changes, optimization, fire
Examples

Module 7 : CO Power-Related Routines

Battery String Maintenance
- Specific Gravity, electrolyte level, voltage measurements
- Frequency, common problems & solutions
- Strap Continuity Test example

Rectifier & Powerboard
- Voltage & Current Readings
- Automatic power monitoring (Alpha Cordex example)
- Floating vs. Equalizing
- Common problems & solutions

Breakers & Fuses
- Primary vs. GMT 'tell-tale'
- Oxidized or current-inhibiting contacts
- Possible problems

Smoke & Fire Prevention
- Symptoms - What to do
- Firestopping

- Causes of previous fires

Equipment List
- Calibration vs. equipment that cannot be calibrated
- Digital Multimeters: minimum capabilities, tolerances, data-logging
- Ground Field Resistance Testers
- Specific-Gravity/Hydrometer/Battery Density testers
- Battery Internal Resistance Tester
- Infrared Camera

Battery & Power System Monitoring
- per-cell & system measurements
- on-demand & trend measurements (Generex BACS & Emsys examples)
- alarm history

(Optional: Power Monitoring System In-Depth Example: Enersys, Generex, Benning, etc.)

Module 8 : Power & Grounding Terms

Glossary & Dictionary of Terms
Regulatory & Standards Agencies (US)
Regulatory & Standards Agencies (Canada)
Metric Prefixes

Delivery Method

Instructor-Led with numerous Hands-On exercises throughout.

Equipment Requirements

(This apply's to our hands-on courses only)

BTS always provides equipment to have a very successful Hands-On course. BTS also encourages all attendees to bring their own equipment to the course. This will provide attendees the opportunity to incorporate their own gear into the labs and gain valuable training using their specific equipment.

Course Length

4 Days