# Hands-On Central Office DC Power & Grounding





# **Course Description**

This extensive 2-day "Live" Instructor-Led (On-Site or Virtual) course is designed for Central Office Technicians or others with the responsibility for the installation, maintenance, troubleshooting, and repair of Central Office power equipment. NEW material has been added to reflect some of the latest tools available, including automatic power monitoring, infrared cameras, battery testers, plus sodium nickelchloride batteries.

The course provides a broad but detailed study of Central Office power systems, for both earlier and modern equipment. The course can also offer material on Data Center power, which typically uses AC-powered servers that are increasingly being used by telcos and service providers.

Basic electrical theory is effectively combined with a practical hands-on approach that enhances the students' learning experience. Examples include DC wattage versus reactive volt-amps, and how this affects surge currents and AC ground loops. Use of various testing equipment is demonstrated, showing how different vendors offer similar features. Multiple types of measurements are shown, including the use of DC current meters, battery resistance meters, ground field resistance meters, and automatic measurements made using continuously-monitored battery and power systems, showing on-demand measurements and trends.



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 components. A remote equipment cabinet example is also shown, showing options for site grounding, including grounding that is coordinated with the power company.

The course can be adjusted to suit the needs of a given group, including grounding of outside-plant copper and fiber optic cables, and grounding at the customer premise, like shields, messenger leads, and tracer leads, plus sizing of the conductors and minimum length of the ground bar. Grounding to other metallic structures like fences, towers and nearby plant can also be included.

# **Students Will Learn**

- CO Power concepts including electrical fundamentals of L, C & R
- Ground Return Paths How DC & AC grounds are the same
- Disconnects AC & DC interrupts to halt current flow

- Breakers & Fuses including primary & 'tell-tale'
- DC Wiring Schemes A/B Feeds, Wire Gauges, Fuse Selection
- Batteries & Their Connections including chemistries, charging vs. equalizing
- DC Rectifiers traditional vs. switching designs, features, load-sharing
- DC Grounding zones bus bar types, isolated/IGZ, etc.
- DC volt & ammeters high-current, clamp-on vs. in-circuit
- Dangers including high-amperages, open circuits, loose connections, margins
- Test & Maintenance battery maintenance, ground field, battery strap drop, etc.
- Troubleshooting with previous examples
- Telcordia, NESC and NEC best practices and requirements
- And much more

## **Target Audience**

Vendors and telecommunications personnel (incl. engineers, planners, supervisors and technicians) who are responsible for Central Office equipment installation, maintenance, troubleshooting & repair.

# **Prerequisites**

None. A 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
  - Power Factor
- Surge Current
- Decibel Measurements
  - dBrn & electrical Noise

#### Module 2 : AC Power & amp; 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 Surge Arrestors Generator Transfer Switch Rectifier Comparison: - early (non-switching) conversion - switching (early, modern, full-featured with monitoring) - settings: float, equalize, LVD, walk-in, surge current Inverters: - functions, efficiency - configurations for redundancy 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 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 : 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 6 : Power & Comparison of Terms Glossary & Dictionary of Terms Regulatory & Standards Agencies (US) Regulatory & Standards Agencies (Canada) Metric Prefixes

## Notes

This course is standard 2 Days but can be extended to a 3 Day course dependent on course options and lab requirements upon request.

# **Delivery Method**

On-Site or Virtual Live Instructor-led with numerous labs and exercises.

## **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**

2 Days