



Training Program:

**UPS Systems, Battery Chargers, BB Maintenance And
Troubleshooting**

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Introduction:

An Uninterruptible Power Supply (UPS) is a device that sits between a power supply (e.g. a wall outlet) and a device (e.g. a computer) to prevent undesired features of the power source (outages, sags, surges, bad harmonics, etc.) from the supply from adversely affecting the performance of the device.

Where a company regards electrical power as critical then there will be a need for a continuous or back up power system. The installation of a UPS will provide the necessary continuity. There are however problems with these installations when there is a need for maintenance especially the use of by-pass. Power Quality compatibility problems may cause failure, which was the reason for the original UPS installation.

The course is conducted as modular lectures with encouragement for the delegate to interact. Case studies are included to illustrate how the UPS can provide reliability and create possible problems when not installed and maintained correctly.

The theory of operation and standard testing, troubleshooting and maintenance of typical three phase industrial UPS supplies and batteries are thoroughly examined.

Who Should Attend?

Electrical power engineers and advanced operating staff of substations, factories, electrical distribution networks and transmission.

Methodology

This interactive Training will be highly interactive, with opportunities to advance your opinions and ideas and will include;

- Lectures
- Workshop & Work Presentation
- Case Studies and Practical Exercise
- Videos and General Discussions

Accreditation:

BTS attendance certificate will be issued to all attendees completing a minimum of 80% of the total course duration.

Course Objectives:

The course is intended to develop knowledge of the need for a UPS, types available, UPS components, batteries, generators and maintenance. . Further, participants will have enough knowledge to achieve reduced capital, operating and maintenance costs along with increase in efficiency.

During the duration of this course, participants will:-

- Understand the basis for the use of a UPS
- Understanding of the reasons for, and benefits of, a UPS and its battery system.

- Understanding how a UPS works.
- Analysis of critical loads and the benefits of supporting them with a UPS.
- Understand Critical Load Applications
- Be able to review the installation and maintenance requirements of a UPS & Batteries.
- Be able to improve reliability by improving the resilience of an electrical installation
- Power Quality analysis; maintenance of electrical installations & have an appreciation of Power Problems
- Understanding of resilience and reliability issues relating to power quality.
- Maintain and test Lead Acid and Nickel Cadmium Batteries
- Understand how to performance test lead acid and Nickel Cadmium batteries
- Identify the relevant hazards and apply safe working practice for UPS's and Batteries

Course Outline

Introduction to the Resilient System

- Introduction to Resilience
 - Definition of Resilience
 - Resilient Power Supply
 - Resilience
 - Redundancy

- Standby redundancy
 - Active or parallel redundancy
 - N+1 redundancy
 - Eliminating single points of failure
 - Maintaining a resilient system
- Introduction to Reliability
 - Early life or burn-in
 - Useful life or normal operating period
 - Wear-out or old age
 - Mean time to failure (MTTF)
 - Mean time between failures (MTBF)
 - Availability and mean time to repair (MTTR)
 - Measuring Reliability for UPS Systems
 - Mean Time Between Failure
 - Infant Mortality UPS Failures
 - Random UPS Failures
 - Wear Out Failures
 - Mean Time to Repair
 - Categorizing UPS Loads and Load Types
 - Uninterruptible Power Supplies (UPS)
 - Objectives of utilization of UPS
 - Specifications
 - Methods and Options of Technologies
 - Off Line or Standby UPS
 - On Line or No Break UPS
 - Line Interactive UPS
 - Installation and testing of UPS

- Maintenance of UPS
- Design criteria and selection of UPS
- UPS Design
- Selection of UPS
- The Importance of Site Surveys When Specifying Uninterruptible Power Supplies
- Site survey is integral to successful UPS selection
- Protection and Devices
- Uninterruptible Power Supplies and Harmonics
- UPS or Generator
- Generator Sizing for Compatibility with UPS
 - Power Rating For Standby Power Solutions
 - Synchronisation
 - Ambient Temperature

Common PQ problems – IEEE 1159 & IEEE 519

- Electromagnetic compatibility
- General classification of phenomena

Impulsive Transients

- Oscillatory transient
- Interruption
- Sags (dips)
- Swells
- Long duration variations

Power frequency variations

Voltage dip

Waveform distortion

- Harmonic
- Inter-harmonic
- Notching
- Noise
- Flicker

Voltage Unbalance

Introduction to Power Electronic Elements & Applications

- Introduction to Power Electronics
- Power Electronics Components
 1. The diode
 2. The two-wire thyristor (or PNP diode)
 3. The three-wire thyristor [or silicon controlled rectifier (SCR)]
 4. The gate turnoff (GTO) thyristor
 5. The DIAC
 6. The TRIAC
 7. The power transistor (PTR)
 8. The insulated gate bipolar transistor (IGBT)

- Ratings of Power Electronic Devices
- Definitions
- AC to DC Conversion
- 3-phase Diode rectifier bridge
- 3-phase Thyristor rectifier bridge
- DC to AC Conversion
- High-Power Semiconductor Devices

Introduction to AC UPS

- What UPS stands for?
- UPS - Uninterruptible Power Supply
- Single UPS Block Diagram
- Single UPS System with Mains Bypass (typical Gutor)
 - Configuration
 - Principle Diagram
 - Description of Operation
 - Normal operation
 - Battery operation
 - Bypass operation
 - Standby/Off
 - Common Power Problems
 - Types of UPS
 - Offline UPS or Standby Power Supply

- Line-Interactive UPS
- Double-Conversion On-line UPS
- Comparison of Prominent UPS Topologies
- UPS Selection Criteria
 - Output Power
 - Batteries Life
 - Cost
 - Vendor Warranty and Onsite Service Options
 - Additional Features

Parallel redundant static UPS unit

Dual static UPS configuration

- Load Sharing
- Unit rating
- AC UPS System Description (Typical Gutor)
- Static Switches
 - Function of ATS & how it works
- Sizing of Inverter
 - Combined Critical Load Power Factor
 - Combined Inrush Current
 - Critical Load Growth Factor
 - Harmonics
- AC UPS Battery Sizing

- Battery Calculation
 - Calculating on-battery runtime
- UPS Hazards
 - Pre work considerations
 - Working on a functioning UPS
- General Information - As Data Sample for UPS

Introduction to DC UPS

- Battery Chargers/DC UPS
 - C. Supported Systems
 - Battery Charger Theory
 - Trickle charge
 - Rapid-charging/boost
 - Battery Charger Output Regulation
- DC UPS Battery Sizing
 - Charging Capacity (Amp-Hour Rating)
 - Battery Voltage
 - Application Voltage Levels
 - Load Classification
 - Battery Sizing
 - Maximum system voltage
 - Minimum system voltage
 - Correction factor
 - Duty cycle

- Fault diagnosis on battery charger & replace faulty components

DC Storage Batteries

- Purpose & Function of Batteries
- Batteries Construction & Applications & Expected locations

Primary and Secondary Cells

- Lead-Acid Batteries
 - Specific Gravity
 - Capacity of Storage Batteries
 - Nickel-Cadmium Alkaline Cell
- Alkaline Batteries
 - Chemical Action in a Nicad Cell
- Construction of the Nicad Cell
 - NiCad Cell Characteristics
- Comparison between Lead Acid and Alkaline Batteries
- Sealed Batteries
- Batteries Charging
 - Principles Of Battery Charging
 - Initial Charge
 - Normal Charge

- Equalizing Charge
 - Trickle Charge
 - Emergency Charge
 - Boost Charge
 - Freshening Charge
- Sulphation of plates
- Importance of good ventilation
- Specifications & ratings of Batteries
- Capacity of Storage Batteries

Battery sizing

- How much of the charge energy of a battery you would expect to recover in use
- Requirements of International Standards for Eye washing
- Emergency Shower Drench Checklist
- Exhaust Fans

§ Battery Safety Hazards

- Maintenance of Al-Cad batteries in service
 - Recommended maintenance procedure
 - Measuring the specific gravity
 - Battery Test Discharge

Replacement of a defective battery in a battery bank

Preparation of new battery

- Requirements of Battery Rooms
- Requirements of switchboard that will be installed on battery room
- Cell Failures

§ General Corrective Actions

- Mixing Electrolyte
 - Mixing sulphuric acid electrolyte
 - Mixing Alkaline Electrolyte

Battery Installations Requirements

- Battery Installations Requirements
 - Physical Requirements
 - Battery Room Size
 - Working Space
 - Interior Walls and Floors
 - Battery Room Doors
 - Lighting Fixture Requirements
 - Ventilation Requirements
 - A/C Requirements
 - Battery Racks
 - Grounding
 - Drains
 - Safety

- Battery Installations
 - Battery Installation Basics
 - Operation
 - Battery Electrochemical and Construction Types
 - Battery Installation Readings and Tests.
 - In-Service Energized Readings.
 - Out-of-Service Energized Tests

UPS & Batteries Maintenance & Troubleshooting

- UPS Maintenance Procedures
 - Safety
 - Preventive maintenance
 - Records
 - Use of records
 - UPS system in dedicated UPS rooms
 - Major system inspections
 - Major system inspection - general
 - Corrective maintenance
 - Recognizing impending problems
 - UPS Troubleshooting
 - Spare parts availability
- UPS Battery Maintenance Procedures
 - Maintenance costs.
 - Maintenance access
 - Preventive maintenance

- Weekly battery inspection
 - Monthly battery inspection
 - Quarterly battery inspection
 - Annual battery inspection
- Battery Maintenance procedures
- Maintaining flooded lead-acid cells
 - Maintenance considerations
 - Visual inspections
 - Cell inspections
 - Excessive gassing
 - Mossing
 - Sediment
 - Hydration
 - Frozen electrolyte
 - Cleaning
 - Temperature readings
 - Specific-gravity readings
 - Voltage readings
 - Capacity tests
 - Connection resistance
 - Battery rack
 - Water quality
 - Test equipment
- Maintaining valve-regulated lead-acid cells
- Ni-cad cells.
- Safety of UPS & Batteries
- Troubleshooting of UPS
 - Possible failures and corrective actions of the UPS system

Sample of Preventive Maintenance Work Instructions.