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# MAINTENANCE AND TROUBLESHOOTING OF UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEMS AND BATTERIES

Also including high reliability power supplies



## YOU WILL LEARN HOW TO:

- Describe the basic building blocks of UPS and high reliability power supply systems
- Understand the construction and operation of the major commercial UPS systems
- Detail the operation of the popular UPS systems
- 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 systems and batteries

## WHO SHOULD ATTEND:

- Electrical Technicians and Engineers
- Instrumentation and Control Engineers
- Consulting Engineers
- Project Engineers
- Maintenance Engineers
- Power System Protection and Control Engineers
- Building Service Designers
- Data Systems Planners and Managers
- Maintenance Tradespeople and Technicians
- Electrical and Instrumentation Technicians

## The Workshop

This practical workshop will provide you with a basic understanding of the application, installation, operation and troubleshooting of UPS systems and batteries. It covers theory of operation and standard testing as well as troubleshooting and maintenance of typical single and three phase uninterruptible power supplies and batteries.

Day one commences with the fundamentals of UPS's and a comparison between the various topologies and how they operate. Typical issues with troubleshooting and maintenance of UPS's are also covered. The fundamentals of typical electrical components within a UPS are detailed as well as the operation of the conversion process from AC to DC and then back to AC. The second day focuses on how to work competently and safely with lead acid and nickel cadmium batteries. The initial discussions centre around battery theory, types of batteries, installation, testing and maintenance. The workshop is concluded by examining case studies of various configurations of batteries and UPS systems.

### Pre-requisites

Some working knowledge of basic electrical engineering principles is required, although this will be revised at the beginning of the course. Real-life experience in working with batteries and UPS systems will enable the workshop to be placed in context.

## Practical Sessions

There are eight practical exercises and demonstrations throughout the workshop.

## The Program

### INTRODUCTION

- Maintaining continuity of power and the role of the UPS in ensuring reliable power

### POWER QUALITY-BASIC FACTS

- What constitutes power quality?
- Sags and swells
- Voltage fluctuations and mitigation
- Interruptions
- Surges - their causes, effects and remedies
- Noise and harmonics
- Frequency disturbances and mitigation

### RELIABILITY AND CONTINUITY OF POWER SUPPLY

- Interruptions and their impact
- Deciding the requirements of your plant and equipment
- Uninterrupted power - how much and where?
- Improving reliability by redundancy and automation
- Uninterrupted power options available?
- Rotary UPS systems

### BASICS OF RECTIFIERS AND INVERTERS

- Solid state devices - diodes, transistors, thyristors and IGBTs
- Basic configurations of rectifiers and their output waveforms
- Ripples and control
- Rectifiers in static UPS systems
- Controlled rectifiers and their impact on power factor
- Why are rectifiers treated as sources of harmonics?
- Basic principles of an inverter
- Synthesizing the AC wave
- Pulse width modulation technique of synthesis

### STATIC UPS SYSTEMS

- Static UPS
- Basic components of the general UPS configuration
- Passive standby, line interactive and double-conversion type of UPS
- Preferred metering, indication and alarms in a UPS
- Power quality and UPS
- Need for isolation transformer
- Computer power supplies and comparison of UPS configurations
- Rating of UPS systems - pitfalls
- Redundant UPS systems
- Earthing of UPS systems - recommendations from the IEEE Green Book

### UPS SYSTEM TROUBLESHOOTING AND MAINTENANCE

- Critically apply the manufacturer's recommendations
- Basic use of test equipment and tools
- Rectifier and Inverter troubleshooting

### BASICS OF BATTERIES

- Types of batteries: primary and secondary
- General features of lead-acid and nickel-cadmium batteries
- Comparison of the chemistry involved
- Lead acid batteries - subtypes, construction and relative features
- Manufacture of batteries

### CHARGING AND DISCHARGING OF BATTERIES

- Float charging and boost (equalizing) charging
- Facts about charging of lead acid batteries
- Internal loss and the factors that affect it
- Current during charging cycle - variants
- Overcharging and undercharging
- Sulphation and hydration
- The discharge process
- Specifics about charging of UPS batteries
- Nickel cadmium batteries
- Charging strategy for nickel cadmium batteries

### SELECTION, CONFIGURATION AND SIZING OF BATTERIES

- Matching the battery type to the application
- Life cycle cost of battery
- Battery configuration - selecting the voltage
- Use of parallel battery strings
- Alternative approaches to sizing of battery for DC supply systems
- Battery sizing for UPS systems

### INSTALLATION OF BATTERIES

- Receiving, checking and storage
- Pre-installation planning and rack installation
- Installation of cells and inter cell connections
- Safety precautions

### BATTERY UPKEEP, FAILURES AND DISPOSAL

- Need for upkeep and monitoring
- Causes of failures and failure modes
- Periodic inspection and residual life assessment
- Test equipment and safety of personnel
- Predictive monitoring by conductance testing
- Disposal and recycling

### CASE STUDIES

- Selection and sizing
- UPS systems
- Batteries
- Combination of batteries and UPS systems