UPS & Clean Power for Data Centers + Data Center Cooling Systems

Comprehensive Table of Contents

Course Overview

Data centers are the backbone of modern digital infrastructure, and ensuring their continuous, efficient, and safe operation requires a robust clean power system and a reliable cooling architecture. This 5-day intensive training program provides participants with a comprehensive understanding of Uninterruptible Power Supply (UPS) systems, clean power technologies, and data center cooling solutions used in mission-critical environments.

The course combines foundational theory with practical design considerations, real-world case studies, and hands-on exercises. Participants will learn how to design, operate, and maintain high-availability power and cooling systems aligned with industry best practices, Tier classifications, and global standards such as IEEE, IEC, ASHRAE, and Uptime Institute guidelines.

Through detailed modules on power quality, redundancy, UPS technologies, airflow management, and energy efficiency, this program equips facility engineers, IT infrastructure teams, and operations personnel with the skills needed to ensure optimal uptime, sustainability, and operational resilience in data centers.

Prerequisites

Participants are expected to have the following knowledge/background to fully benefit from this training:

Technical Knowledge

- Basic understanding of electrical engineering concepts (AC/DC, voltage, current, power factor)
- Familiarity with IT or data center operations

- General knowledge of HVAC or cooling systems (helpful but not mandatory)

Professional Background

- Ideal for data center engineers, electrical technicians, facility managers, MEP engineers, IT administrators, and operations personnel
- Useful for individuals preparing for roles in data center design, operations, or maintenance

Recommended Skills

- Ability to read basic single-line diagrams
- Understanding of equipment monitoring or facility management systems
- Basic analytical and troubleshooting skills

Day 1 – Introduction to Data Centers & Power Fundamentals

Module 1: Data Center Overview

- Types of data centers (Enterprise, Colocation, Cloud, Edge)
- Tier classification (Uptime Institute Tier I–IV)
- Critical infrastructure ecosystem

Module 2: Electrical Power Fundamentals

- AC vs. DC fundamentals
- Power quality parameters (voltage, frequency, harmonics, THD)
- Power factor, load types, efficiency concepts

Module 3: Clean Power Requirements for Data Centers

- What is “clean power”?
- Impact of dirty/unstable power on IT equipment
- Standards & compliance (IEEE 519, IEC, ISO/IEC standards)

Module 4: Power Distribution Architecture

- Utility power, switchgear, transformer basics

- Single-line diagrams (SLDs)
- Redundancy models (N, N+1, 2N, 3N/2)

Day 2 – UPS Technologies, Designs & Operations

Module 5: Understanding UPS Systems

- Role & importance of UPS in mission-critical environments
- Online, Line-interactive, Offline UPS – comparison
- Double conversion, delta conversion technologies

Module 6: UPS Components & Architecture

- Rectifier, inverter, static bypass
- Batteries: VRLA, Li-ion, NiCd, emerging battery chemistry
- Flywheel energy storage systems

Module 7: UPS Sizing, Selection & Design

- Load profiling
- Efficiency, derating, runtime calculations
- Selecting UPS for Tier II, III, IV data centers

Module 8: UPS Installation, Testing & Maintenance

- Commissioning tests
- Preventive & predictive maintenance
- Battery testing, thermal scanning, monitoring tools

Day 3 – Clean Power Systems, Redundancy & Power Quality Management

Module 9: Clean Power Infrastructure

- Power distribution units (PDU, RPP, STS)
- Harmonic filters, power conditioners
- Isolation transformers & surge protection

Module 10: Ensuring High Availability & Redundancy

- Bypass systems
- Dual-corded equipment
- System resilience and fault tolerance

Module 11: Diesel Generators & Backup Power

- Generator sizing
- Fuel systems
- Synchronization & ATS operations

Module 12: Monitoring, Automation & BMS/EPMS

- Energy monitoring systems
- SCADA & real-time dashboards
- Alarm thresholds & logging best practices

Day 4 – Data Center Cooling Systems

Module 13: Fundamentals of Heat & Cooling

- Heat transfer basics
- Sensible vs latent heat
- Cooling load calculations

Module 14: Cooling Technologies in Data Centers

- CRAC & CRAH units
- Chilled water systems
- DX systems
- In-row & in-rack cooling
- Liquid cooling (immersion, direct-to-chip)

Module 15: Airflow Management & Efficiency

- Hot aisle / cold aisle containment
- Raised floor systems
- Rack layout optimization
- CFD analysis overview

Module 16: Cooling Redundancy & Reliability

- N, N+1, 2N design strategies
- Cooling system failure scenarios
- Integration with BMS for cooling management

Day 5 – Integrated System Design, Efficiency, Safety & Case Studies

Module 17: Integrated Power & Cooling Design

- Power and cooling matching
- Capacity planning
- Modular data center design

Module 18: Energy Efficiency & Sustainability

- PUE, CUE, WUE metrics
- Green cooling technologies
- Renewable integration & UPS eco-modes

Module 19: Risk, Safety & Compliance

- Electrical hazards, arc-flash safety
- Fire suppression & monitoring
- Compliance: ASHRAE TC9.9, TIA-942

Module 20: Case Studies & Practical Workshop

- UPS failure case analysis
- Cooling failure impact scenarios
- Designing a Tier III power & cooling layout (group exercise)
- Assessment & Q&A