CONCEPT

# Power Quality and Harmonics: Power Factor Correction, Filtering and Site Audits

**Power Quality and Harmonics: Power Factor Correction, Filtering and Site Audits**

## Introduction:

Power quality problems cost industrial and commercial sites through tripped processes, overheated transformers and neutrals, failed capacitor banks and reactive energy penalties, yet many sites have no measured picture of what their network actually carries. This Core Concept course equips electrical engineers to classify disturbances, trace harmonic sources, measure with power quality analysers, judge results against recognised limits and design power factor correction, harmonic filtering and sag ride-through solutions. Participants produce a Power Quality Audit Report and Mitigation Plan for a network from their own site.

## Course Objectives:

- Classify voltage sags, swells, transients, flicker, unbalance and waveform distortion from recorded events and link each to its likely cause on the network
- Quantify harmonic currents from drives, rectifiers, LED lighting and IT loads and calculate their heating effect on transformers, cables and neutral conductors
- Plan and run a power quality measurement campaign with a class-rated analyser and interpret the data against IEEE Standard 519 and EN 50160 limits
- Size capacitor banks and detuned reactors for power factor correction and check the design for parallel resonance with the supply
- Select between passive filters, active harmonic filters, UPS and dynamic voltage restorers for a given disturbance and justify the choice on cost and performance
- Calculate energy and reactive power tariff savings and assemble a power quality audit with prioritised mitigation actions

## Target Audience:

- Plant electrical engineers responsible for supply performance and nuisance tripping on process and utility networks
- Facility and building services engineers responsible for data halls, lifts, lighting and HVAC loads in commercial buildings
- Power quality and energy engineers who carry out site measurements and reactive power audits
- Electrical design engineers who specify capacitor banks, harmonic filters and ride-through equipment for new installations
- Maintenance engineers who investigate capacitor failures, overheated neutrals and unexplained equipment damage

## Course Outline:

### Day 1: Power Quality Phenomena and Site Disturbance Profiling

- IEEE 1159 Disturbance Categories: Transients, Short and Long Duration Variations
- Voltage Sag and Swell Magnitude-Duration Characterisation from Event Records
- Flicker Perception, Voltage Fluctuation and Arc Furnace and Welder Sources
- Voltage Unbalance Calculation and Its Negative-Sequence Heating Impact
- Site Power Quality Complaint Log and Sensitive Load Register

### Day 2: Harmonic Theory, Sources and Recognised Limits

- Fourier Spectrum, THD, TDD and Crest Factor Definitions with Worked Values
- Six-Pulse and Twelve-Pulse Rectifier, Switch-Mode Supply and LED Driver Spectra
- Triplen Harmonics in Four-Wire Networks and Neutral Conductor Overloading
- IEEE Standard 519 Point of Common Coupling Current and Voltage Distortion Limits
- EN 50160 Voltage Characteristics and EN 61000-3-2 Equipment Emission Classes

### Day 3: Power Quality Measurement and Analyser Data Interpretation

- IEC 61000-4-30 Class A Analyser Functions and Aggregation Intervals
- IEC 61000-4-7 Harmonic and Interharmonic Grouping Method
- Current Transformer, Voltage Probe and Logger Connection Plan for Three-Phase Surveys
- Trend, Histogram and Cumulative Probability Reading of a One-Week Survey
- Transformer Derating and K-Factor Estimation from Measured Harmonic Currents

### Day 4: Power Factor Correction, Resonance and Mitigation Design

- Reactive Power Demand Calculation and Stepped Automatic Capacitor Bank Sizing
- Parallel Resonance Frequency Check Using Supply Short-Circuit Level and Bank Rating
- Detuned Reactor Tuning Factor Selection and Capacitor Voltage Rating Uplift
- Passive Tuned Filters Versus Active Harmonic Filters and Hybrid Schemes
- Sag Ride-Through Options: UPS, Dynamic Voltage Restorer and Static Transfer Switch

### Day 5: Power Quality Audit Case Work and Mitigation Plan

- Manufacturing Plant Case: Drive-Rich Network with Failing Capacitor Bank
- Commercial Building Case: IT and LED Loads with Overheated Neutral and Transformer
- Reactive Energy Tariff Penalty and Loss Reduction Payback Calculation
- Power Quality Audit Report and Mitigation Plan Drafting
- Peer Review Panel and Mitigation Priority Defence

## Skills You Will Gain:

- Disturbance Classification
- Harmonic Spectrum Analysis
- Power Quality Survey Planning
- Analyser Data Interpretation
- Capacitor Bank Sizing
- Resonance Risk Assessment
- Harmonic Filter Selection
- Reactive Power Savings Appraisal

## Why Attend This Course:

- Return with a Power Quality Audit Report and Mitigation Plan for a network from your own site, tested in case work and peer review
- Stop repeat capacitor failures, overheated neutrals and nuisance trips by tying each symptom to a measured cause
- Specify correction and filtering equipment that will not create new resonance problems on your network
- Compare measurement data and mitigation results with engineers from manufacturing, commercial buildings, utilities, oil and gas and healthcare facilities

## Conclusion:

Power quality improves when disturbances are measured, traced to their sources and corrected with equipment chosen for the network it joins. The course moves from disturbance categories and site profiling, through harmonic theory and recognised limits, to analyser measurement and data interpretation, then to power factor correction, resonance checks, filtering and sag ride-through. The final day applies these methods to plant and building cases and produces a Power Quality Audit Report and Mitigation Plan ready for engineering and budget approval.