PSL
Power Standards Lab
1201 Marina Village Pkwy #101
Alameda, California 94501 USA
TEL ++1-510-522-4400
FAX ++1-510-522-4455
www.PowerStandards.com

1-day Professional Advancement Seminar

Practical, hands-on Power Quality

Alex McEachern

"This is a practical, hands-on, how-to-solve-the-problem seminar for practicing electrical engineers, with just barely enough theory and math, but lots of real-world examples."

Who should attend: **Facilities engineers** who are responsible for sensitive manufacturing equipment.
Utility engineers who are responsible for major commercial/industrial accounts.
Electrical engineers who design continuous process equipment.

Alex McEachern is known world-wide for his practical, straightforward, good-humored seminars on power quality. As a Senior Member of the IEEE and a Convenor of the IEC, Alex has written many of the most important international power quality standards. He is the founder of both BMI and Power Standards Lab, has been awarded 29 patents, and has created companies that have provided more than 2000 man-years of employment. Versions of this seminar have been taught by Alex in 17 countries.

I. Practical power quality – a brief hands-on introduction
   a. Voltage sags and swells – real-world examples
   b. High frequency impulses – real-world examples
   c. Frequency variations – real-world examples
   d. Harmonic voltages and currents – real-world examples
   e. High-frequency noise – real-world examples
   f. Earth / ground problems – real-world examples
   g. Problems that were incorrectly blamed on power quality

II. A deeper understanding, using free Power Quality Teaching Toy program
   a. Fundamental power flow
   b. Three-phase sequence vectors (unbalance)
   c. Voltage sag/dip effects on electronic equipment
   d. Harmonic concepts, power flow, and sequence
   e. Source impedance – what it is, and how to estimate it

III. Power quality standards
   a. Immunity-based standards – the basic idea of compatability
   b. Voltage dip/sag immunity – SEMI F47, IEC 61000-4-11, IEC 61000-4-34, CBEMA, ITIC
      - Which standard should you use?
      - Unbalanced vs. balanced sags on 3-phase systems
      - Pass-fail criteria – some practical problems

- Planned revisions to these standards

c. Revenue meter standards and power quality
   - The power-factor definition debate
   - Planned revisions

IV. Voltage sags / dips
   a. Why sags and dips happen – the practical explanation
   b. Why it is impossible for electric power companies to fix the problem
   c. Brief discussion: impedances on the power grid
   d. Typical characteristics of sags and dips
   e. How to fix the problem
      - Figure out exactly what the "problem" is
      - Sag correction devices
      - 'Increased immunity' solutions
      - How to use a voltage sag generator

V. Harmonics
   a. Practical introduction to harmonic concepts
   b. Causes of harmonic currents
   c. Causes of harmonic voltages
   d. Interaction between harmonic currents and voltages, and harmonic impedances
   e. Effects of harmonic currents
   f. Effects of harmonic voltages
   g. Practical solutions to harmonic problems
      i. Is it a problem?
      ii. Reducing impedance
      iii. Eliminating resonances
      iv. Harmonic filters – active and passive

VI. Earthing and grounding
   a. World-wide practices – surprisingly different from country to country
   b. Typical industrial and commercial problems
   c. The physics of earth/ground connections
   d. Searching for earth problems (almost never shown on drawings)
   e. Simple solutions

VII. DC power distribution – serious proposal for data centers
   a. Brief history of AC and DC power distribution
   b. Typical 48 Vdc distribution systems
   c. Proposed 400 Vdc distribution systems – data centers
      i. Supporters – IBM, Sun, etc.
      ii. Advantages
      iii. Disadvantages
   d. Impedances and interesting power quality issues

VIII. The economics of power quality
   a. Studied by CIGRE/CIRED JWG C4.104 and C4.110
      i. Challenges in measuring economic effects
         I. Data required on power and economics
         II. The lack of data at end-use points
         III. The "top-down" approach
         IV. The "bottom-up" approach
         V. Uncertainties in economic measurements
      ii. Expected reports
   b. Power consumption and power quality
      i. Harmonics and power consumption

ii. Watts, volt-amps, and VAR's – not as simple as they told you in school
iii. Harmonics and metering – definitions and errors

IX. Power quality measurement and monitoring
  a. Common mistakes and problems
  b. Practical rules of thumb: how long should you monitor? How do you choose thresholds? What should you do with the data?
  c. IEC 61000-4-30 – Power quality measurement methods
    i. Why PQ measurements often don't agree
    ii. How -4-30 fixes this problem
    iii. Practical difficulties with -4-30
    iv. Planned revisions to this standard
  d. Big changes coming in power quality monitors – cheaper, easier, and simpler

X. Discussion and questions about specific local problems