19th Annual PQSynergy™
International Conference and Exhibition 2019

Power Quality Workshops & Power Quality Practitioner™

Terence Chandler
Director of Engineering
Power Quality Inc., USA..

Mr. Chandler has more than 30 years experience in the Power Quality Industry. He has published more than 100 papers on the various aspects of Power Quality, conducted 100's of classes and seminars on Power Quality.

Power Quality Practitioner™ Workshops

By Terry Chandler

Power Quality Inc (USA)

Power Quality Thailand LTD

A Power Quality Practitioner™ for more than 30 years

March 2019

Power Quality Practitioner™ Workshops

- A practical approach for training engineers in all aspects of Power Quality, Quality of Supply (QOS), grounding (earthing), wiring and communication with suppliers, users and regulators.
- Information and mis-information on the technical details of the topics
- Facts and marketing claims on the technical details of the topics
- Resources available for advanced information on the technical details
- How to identify, document and troubleshoot PQ/QOS situations, problems.
- Suggestions for solution choices for the abnormal PQ situations

Note: Duration of each module varies from 4 hours to 14 hours. Most are $3^{1/2}$ to 7 hours. (1/2 day to 1 day)

Power Quality Practitioner™ Workshop topics

1. Electrical parameters of Power Quality as defined by IEC, IEEE, ANSI, EN other standards (practical explanations and actual data examples)
2. Harmonic voltage and current, transients (resonance)
    1. For utility engineers
    2. For facility engineers
3. Voltage transients, sags and surges, current transients
4. Performing physical inspections for Power Quality (reliability) and electrical safety
5. Testing and inspections for effective lightning protection (practical examples)
6. Reviewing and recommendations electrical drawings for Power Quality. (QOS)
7. DV7 ™ for Power Quality Data analysis and report writing (single and multi-site)
8. PQView ™ for Power Quality Data analysis and automatic report writing for multiple sites and large quantities of PQmeters any brand PQmeter
9. Using Power Quality Monitoring systems for semi-automatic and fully automatic fault location
10. PQdiff ™ the IEEE standard for Power Quality data

Electrical parameters of Power Quality as defined by IEC, IEEE, ANSI, EN, local regulations

- Source voltage parameters
- Load current parameters
- Grounding (Earthing parameters)
- Wiring parameters that impact the Quality of Supply
- 10 Parameters of Power Quality?

Harmonic workshop content

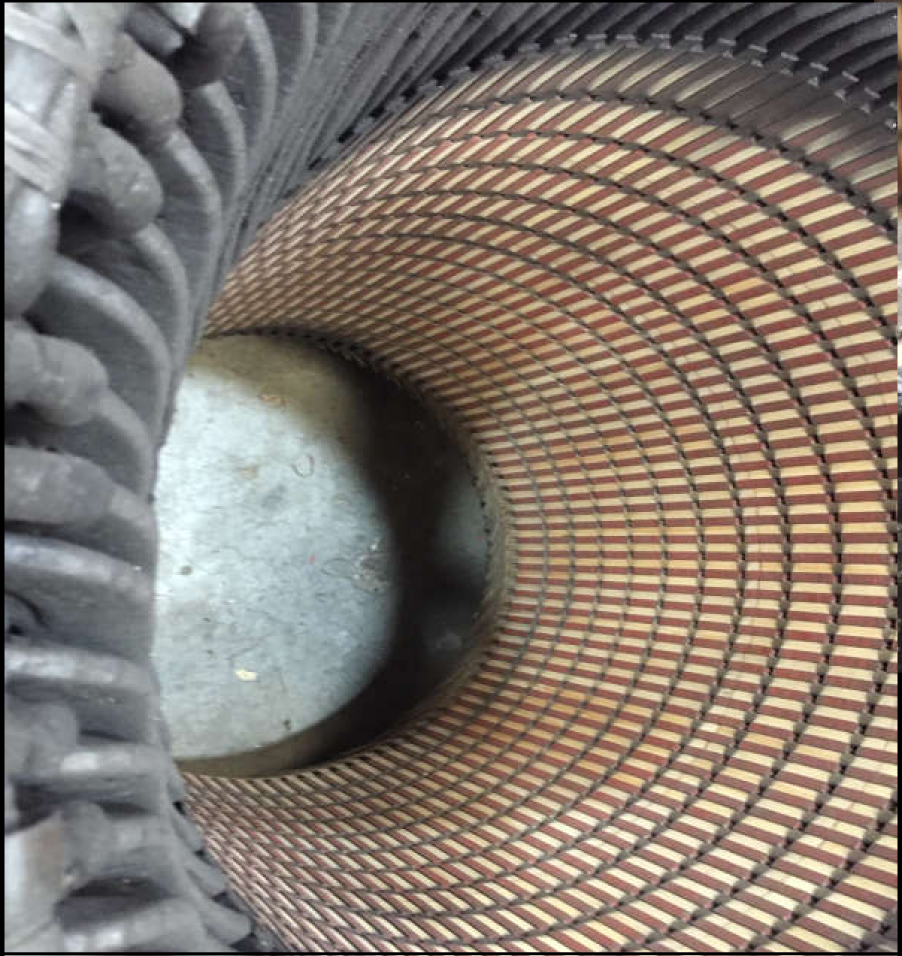
1. Definitions: IEEE, IEC, EN 50160, common definition of harmonics
2. Standards the define acceptable and unacceptable levels of harmonics
3. What are the causes distortion of voltage and current
    1. At the generation level
    2. At the transmission level
    3. At the distribution level
    4. PCC (Point of common coupling)
    5. Customer facility
4. What are the negative impacts of distorted voltage
    1. On loads
    2. On the source transformers
    3. On electrical system efficiency

Harmonic voltage, current and harmonic resonance transients workshop.

- Harmonic (voltage or current) distortion always have a negative impact on the facility, on the source voltage, on the source transformer, the loads and electrical system efficiency. The question is "how much impact"
- These workshop will provide the practical details of measurements, maximum limits, the sources and impacts of harmonic voltages and currents.
- Harmonic voltage, current and harmonic resonance for electrical utility engineers.
- Harmonic voltage, current and harmonic resonance for facility engineers.

Pumping station 3 600 hp motors in Arizona USA

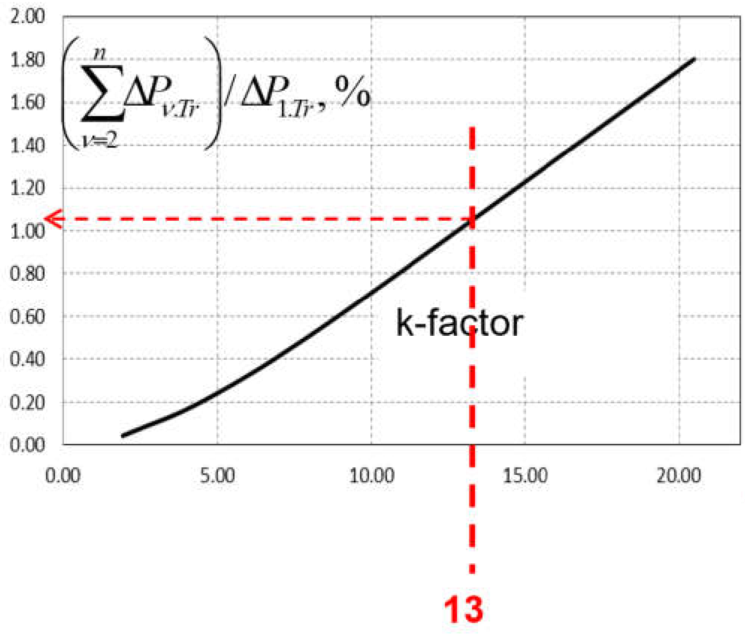
Resonance at 12kv 600 hp motor



Harmonics, Interharmonics, Supra harmonics

- Measurements harmonics vs Supra harmonics
- Identifying the source of harmonics
- Documentation necessary to select mitigation equipment
- Mitigation equipment
  - Utility side of the meter
  - Consumer side of the meter

K-factor



Graph of transformer loss versus current harmonics

Table 2

Load	K-Factor	I_{LK}
Incandescent Lighting	K-1	0.00
Electric Resistance Heating	K-1	0.00
Motors (without solid state drives)	K-1	0.00
Control Transformers/Electromagnetic Control Devices	K-1	0.00
Motor-Generators (without solid state drives)	K-1	0.00
Distribution Transformers	K-1	0.00
Electric-Discharge Lighting	K-4	25.82
UPS w/Optional Input Filter	K-4	25.82
Welders	K-4	25.82
Induction Heating Equipment	K-4	25.82
PLCs and Solid State Controls	K-4	25.82
Telecommunications Equipment (e.g. PBX)	K-13	57.74
Ups without Input Filtering	K-13	57.74
Multiwire Receptacle Circuits in General Care Areas of Health Care Facilities, Classrooms of Schools, etc	K-13	57.74
Multiwire Receptacle Circuits Supplying Inspection or Testing Equipment on an Assembly or Production Line	K-13	57.74
Main-Frame Computer Loads	K-20	80.94
Solid State Motor Drives (variable speed drives)	K-20	80.94
Multiwire Receptacle Circuits in Critical Care, Operating and Recovery Room Areas in Hospitals	K-20	80.94
Multiwire Receptacle Circuits in Industrial, Medical and Educational Laboratories	K-30	123.54
Multiwire Receptacle Circuits in Commercial Office Spaces	K-30	123.54
Small Main Frames (mini and micro)	K-30	123.54
Other Loads Identified as Producing Very High Amounts of Harmonics	K-40	208.17

Fig. 18.

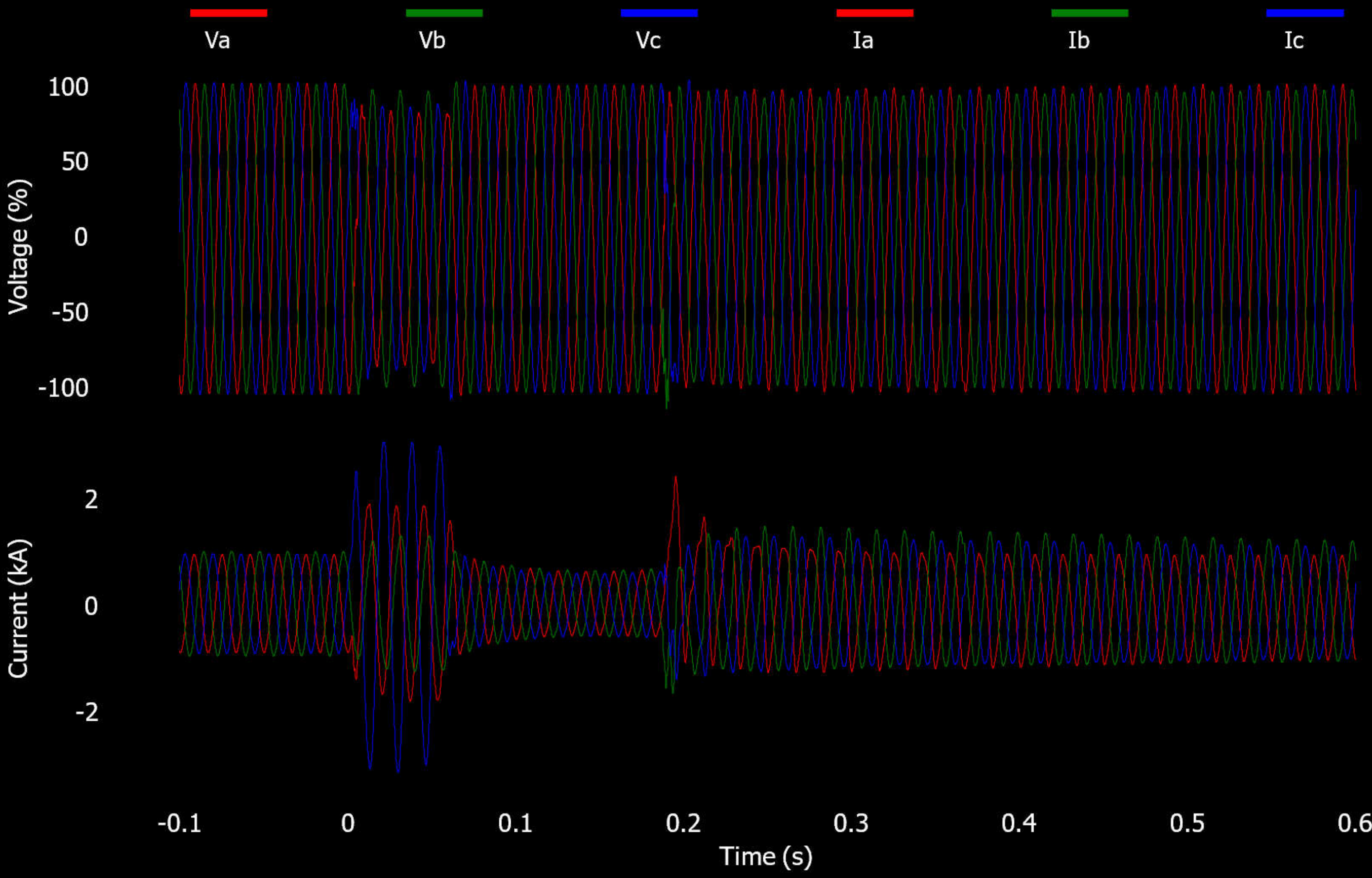
Voltage transients, sags and surges, current transients

- Definitions per the standards
- Practical definitions
- Sources of voltage transients with actual recorded transients at many voltage levelshe
- Causes of voltage sags utility side of the meter with examples
- Causes of voltage sags on user side of the meter with examples
- How to determine the source of the voltage sag or surge

Voltage sags vs Rapid voltage change

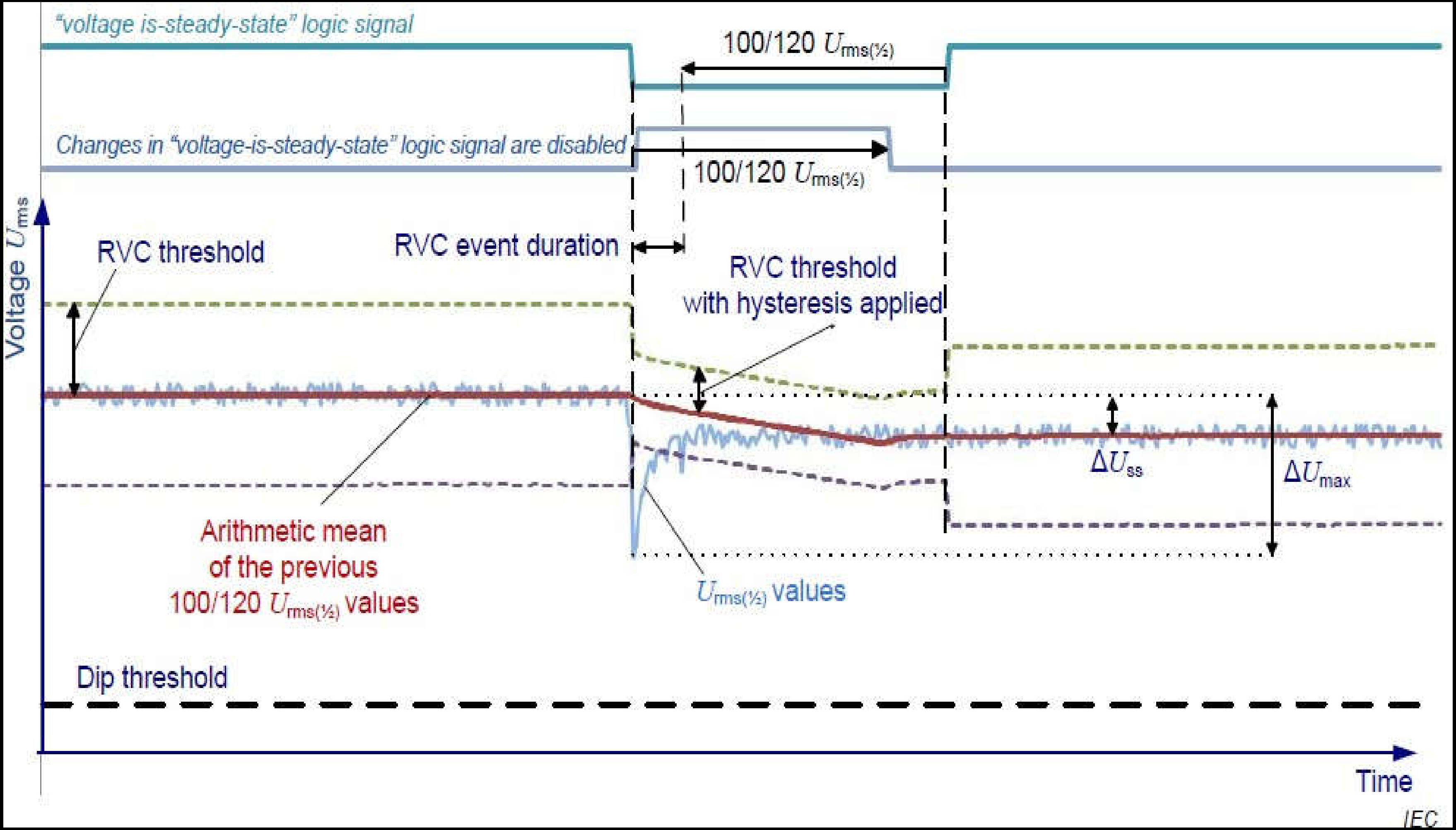
- Definitions per the standard
- Practical explanation of RVC
- Examples of voltage sags vs rapid voltage change
- Mitigation of voltage sags
- What can utilities do to reduce the impact on customer loads

Voltage Sag Measurement with Voltage and Current Waveform Samples



Electrotek/EPRI

PQView®

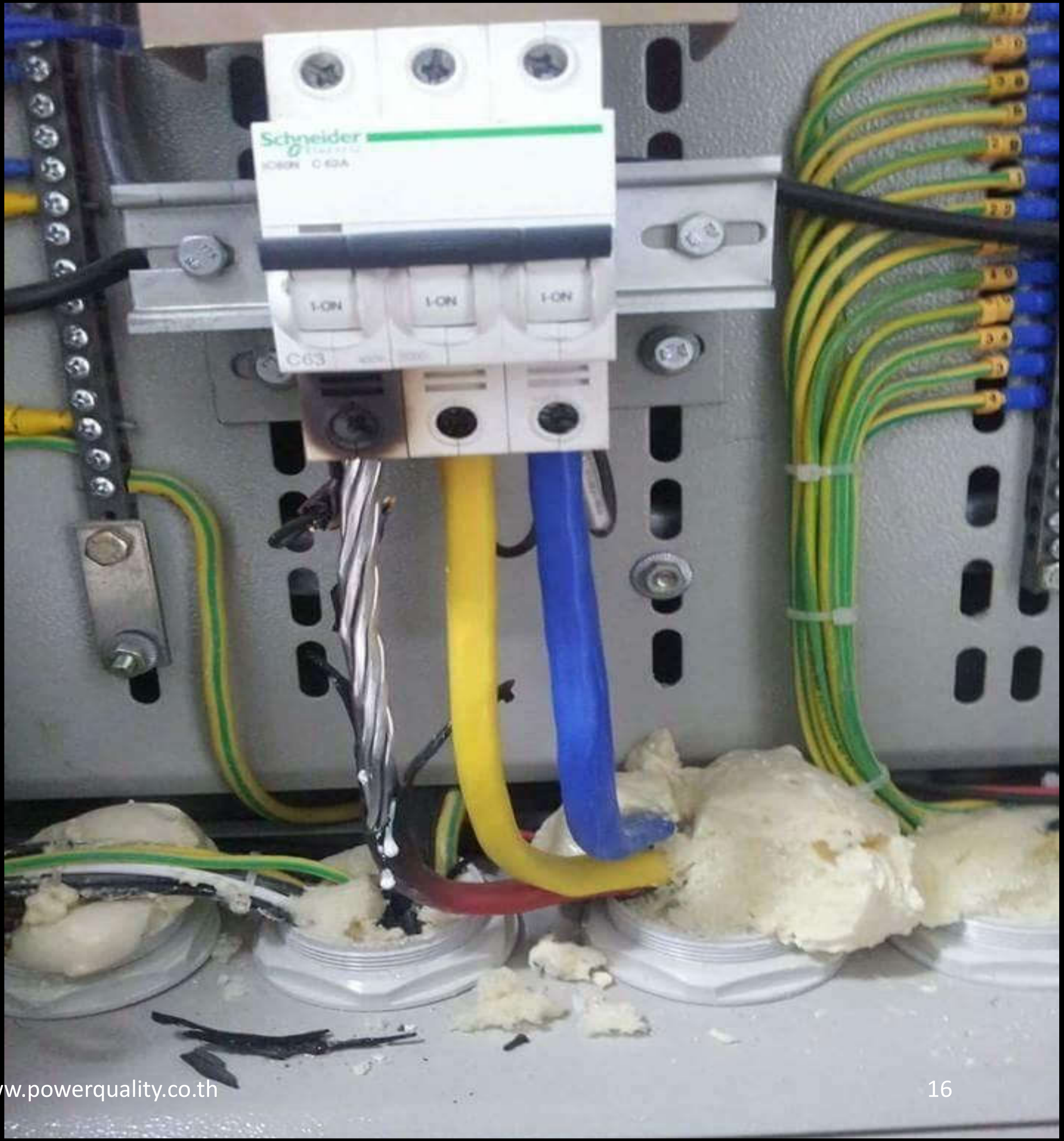


"voltage is-steady-state" logic signal
100/120 $U_{rms(½)}$
Changes in "voltage-is-steady-state" logic signal are disabled
100/120 $U_{rms(½)}$
Voltage U_{rms}
RVC threshold
RVC event duration
RVC threshold
with hysteresis applied
ΔU_{ss}
ΔU_{max}
Arithmetic mean
of the previous
100/120 $U_{rms(½)}$ values
$U_{rms(½)}$ values
Dip threshold
Time
IEC

Performing physical inspections for Power Quality (reliability) and electrical safety

- Electrical safety codes in various countries
- Human safety
- Fire safety
- Arc Flash safety with practical examples
- Basic operation of electrical safety devices

Can you explain what's happening in this picture?
Is this a harmonics issue?



Testing and inspections for effective lightning protection (practical examples)

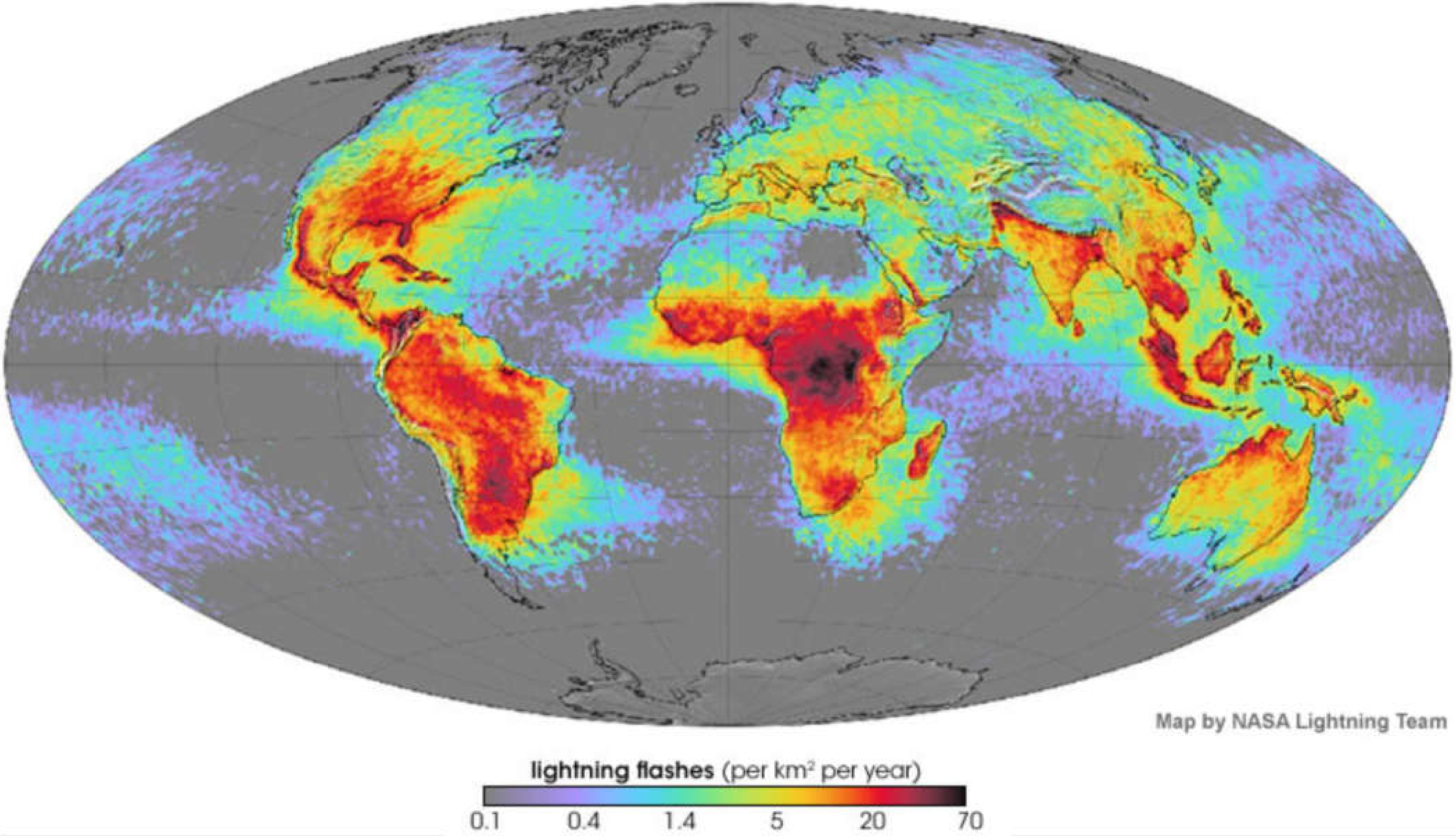
- Fundamentals of lightning protection
- Step potential
- Myths about lightning
- Testing examples
- Lighting rod grounding
- Protection technologies for lightning
- Most dangerous outdoor activity?

Lake Maracaibo: The world's top lightning hotspot is over Lake Maracaibo in northwestern Venezuela. Here, nocturnal thunderstorms occur on average about 297 days per year and produce an average of about 232 lightning flashes / square kilometer / year. Local people have called

World Lightning Map

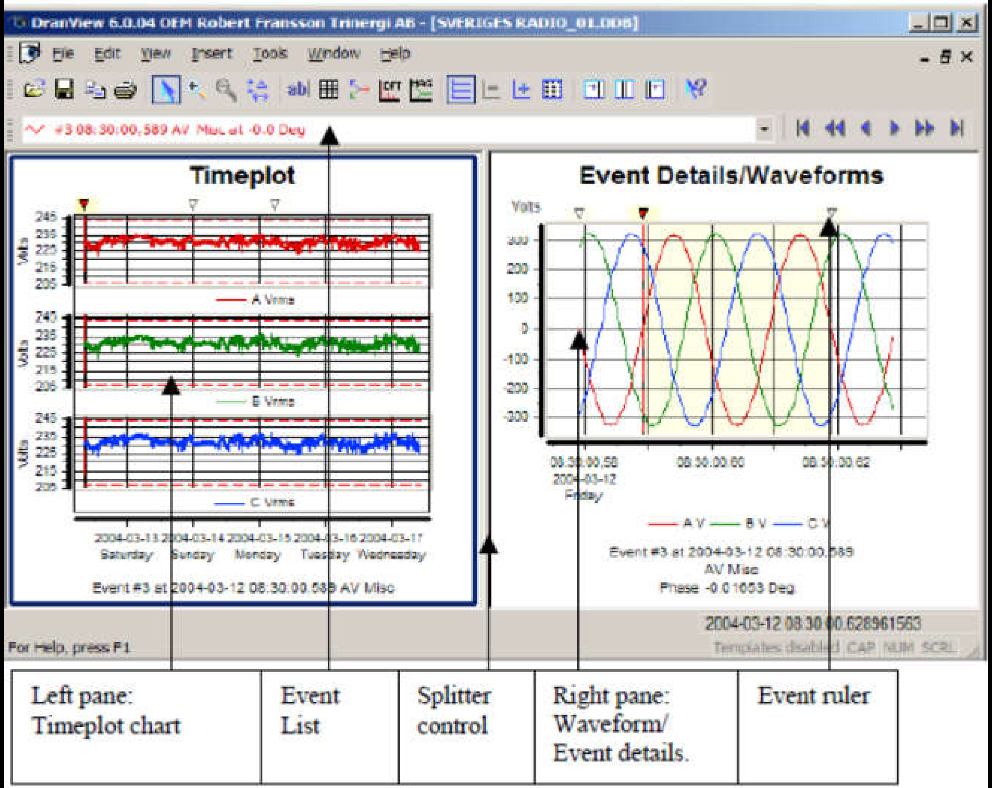
Lightning is not uniformly distributed across the Earth.

Article by: Hobart M. King, Ph.D., RPG



Dranview 7 ™ for Power Quality Data analysis and report writing (single and multi-site)

- Data analysis of PQ data
- Sorting the data for significant events
- Preparing reports for regulators
- Preparing reports for PQ studies
- Use of math channels
- Use advanced harmonic calculations
- Importing data
- Exporting data



PQView ™ for Power Quality Data analysis and automatic email reports

- Multiple sites and large quantities of PQmeters any brand Pqmeter
- Capabilities for Power Quality Monitoring systems
- Importing data from various brands of meters
- Generation automatic reports for regulators
- Data analysis tools
- Examples of importing data from various brands of meters

Automatic E-Mail Notifications

- Inrush Events

From: PQView Infonode RTF <pqview@coned.com> Sent: Sun 9/21/2014 2:00
To: hofmannp; washingtonw; dl-RTFInrushManhattan
Subject: Inrush Event Notification: Parkview TR4

This email has been sent to you by rule from PQVIEW Substation_Nodes

Site Name	Local Time	Hyperlinks	Fault Type	RMS Dur	Time Offset(s)	XTF (Ω)	Va (V)	Vb (V)	Vc (V)	Ia (A)	Ib (A)	Ic (A)	I0 (A)	k1	Relay Channels	Operations			
Parkview TR4	9/21/2014 13:58:08.4410	Waveforms One-Line	Inrush 2CA		0.05279		7389	7636	7319	**1050**	1048	**1405**	2	2.500		2014-09-21 13:58:12	PABX13A.DX	PARKVIEW BKR 13A (44M04)	TRIP-CLOSE

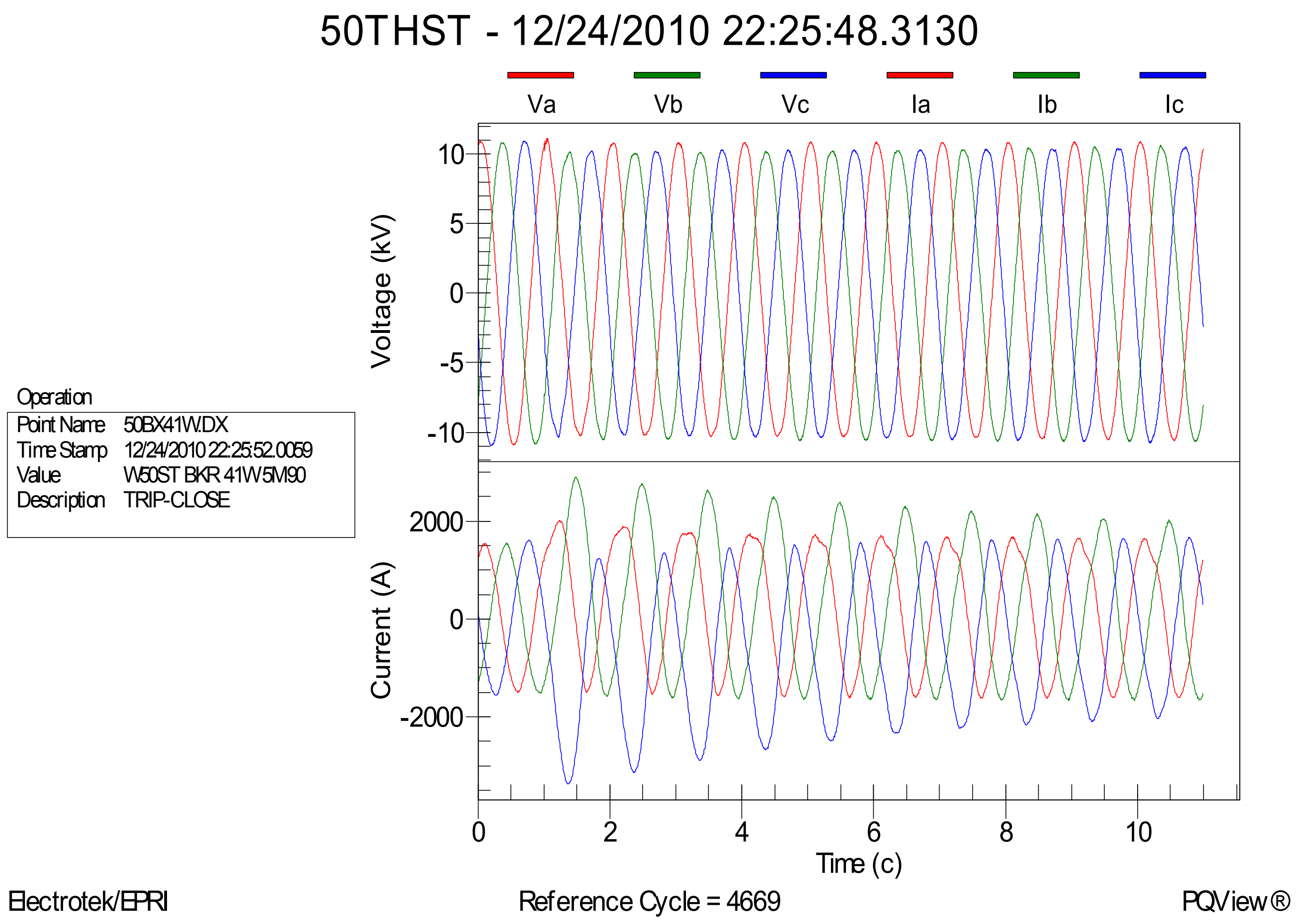
- Fault Events

From: PQView Infonode RTF <pqview@coned.com> Sent: Fri 9/5/2014 10:58
To: dl-RTFNotificationManhattan
Subject: Fault Notification: Parkview TR4

This email has been sent to you by rule from PQVIEW Substation_Nodes

Site Name	Local Time	Hyperlinks	Fault Type	RMS Dur	Time Offset(s)	XTF (Ω)	Va (V)	Vb (V)	Vc (V)	Ia (A)	Ib (A)	Ic (A)	I0 (A)	k1	Relay Channels	Operations			
Parkview TR4	9/5/2014 22:56:02.6500	Waveforms One-Line	1C	5.496c	0.09163	0.5893	10325	8605	4052	1223	1102	**3327**	**913**	2.500		2014-09-05 22:56:04	PABX42B.DX	PARKVIEW BKR 42B (44M24)	CLOSE-TRIP

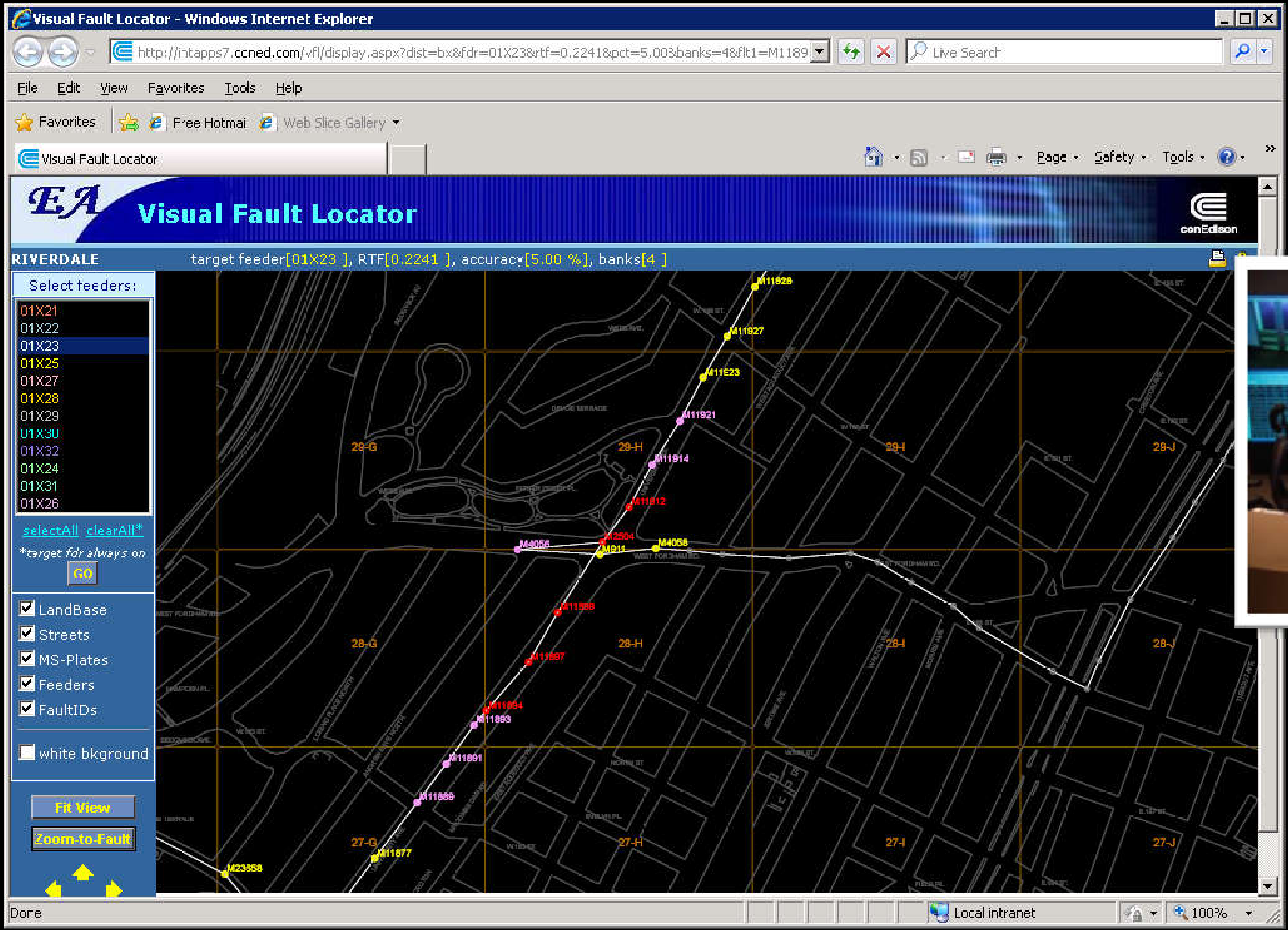
Example Correlation of Feeder Reclose Event with PI Event from SCADA Operation



Automatic fault location using PQview^{TM}

- Evaluating the requirements for underground electrical network fault location
- Evaluating the requirements for above ground electrical network fault location
- Determining the feasibility of automatic fault location.
- System elements for automatic fault location

Visualized Location of Fault



Power Quality Practitioner TM workshops

- Designed and presented by a Power Quality Practitioner TM with 30+ years experience in Power Quality
- Attendees are encouraged to bring examples of PQ data or situations they have encountered or are currently working on.
- Practical information with real case studies of 30 years PQ examples
- Workshop environment attendees sharing experiences
- PQ situation practical investigation techniques
- Practical communication techniques on all aspects of Power Quality