

# Mission Critical Power Quality

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Norman Disney & Young

# Quality vs. Reliability

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*“Power quality problems don’t make headlines the way power reliability problems do ..... And power quality problems can be more difficult to understand, analyze and solve than reliability problems. But that doesn’t mean power quality should be ignored. “*

(Article: Avoiding Power Quality Headaches in Data Centers By K.L. Godrich November 2004)

# The PQ “System”

Source of supply



# The PQ "System"

## Consumers



# The PQ “System”

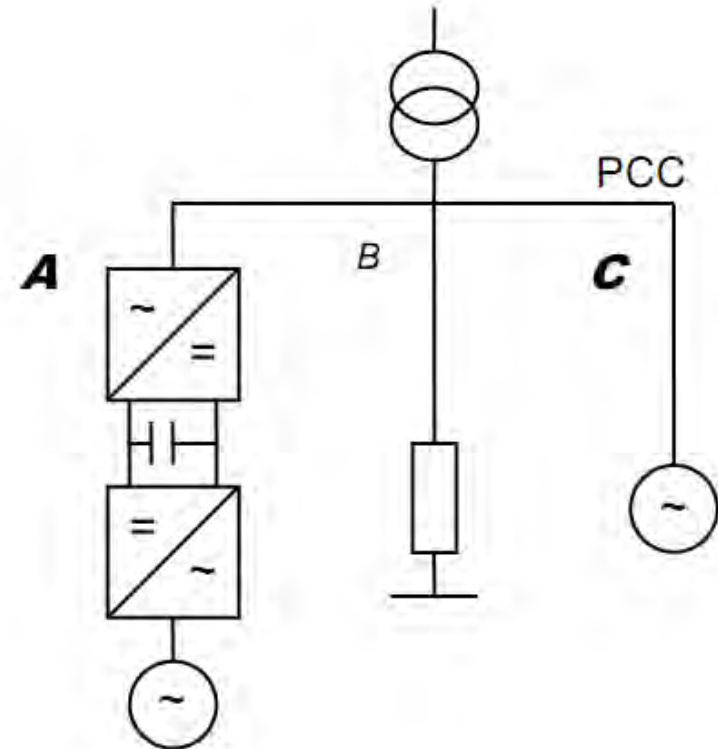
Emitters or polluters



# The PQ “System”

Electrical PQ system  
consists of:

- Supply
- A – Non-linear loads
- B – Linear loads
- C – Fluctuating loads e.g. Motors



# Agenda

- “Traditional” power quality issues
  - Where are they now?
- Developments in power quality management
- Power quality planning & strategies
- Configuration of electrical systems
- Future considerations
- Case studies

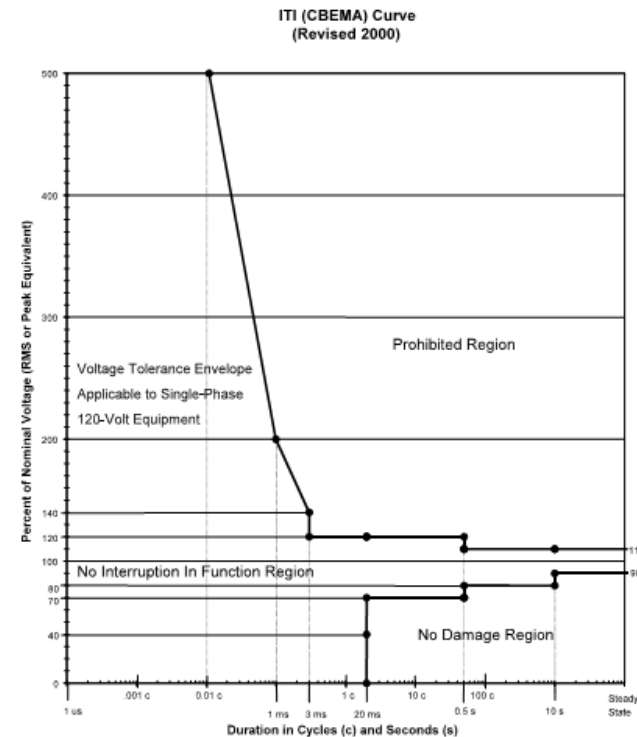
# Power Quality Issues

The good news.....



# Standards

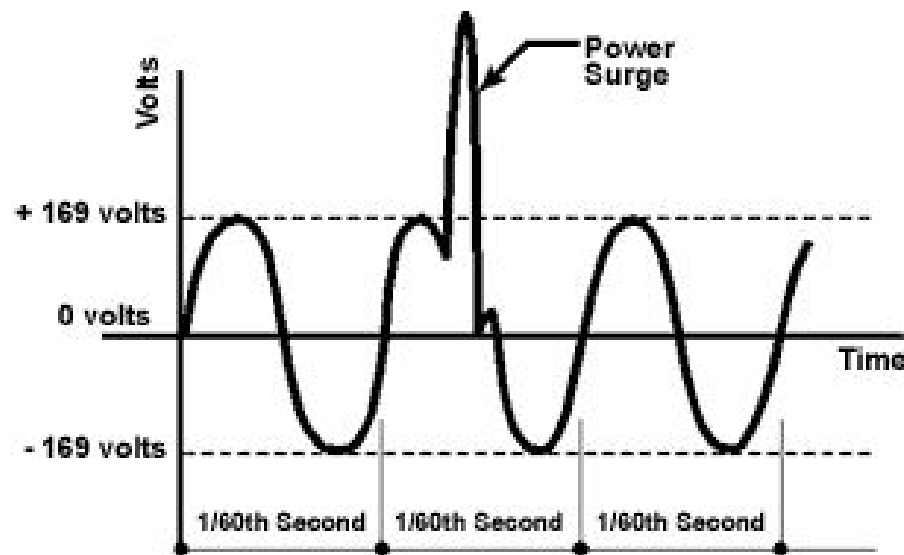
- CBEMA/ ITIC
- **NZECP 36:1993 (IEEE 519)**
- EN 50160
- IEEE 1159
- IEEE 1100
- AS/NZS (IEC) 61000 series



Big improvements in the past 10 years!!

# IT Equipment

- How sensitive is equipment to power quality?
- How is Power Quality of equipment improved?



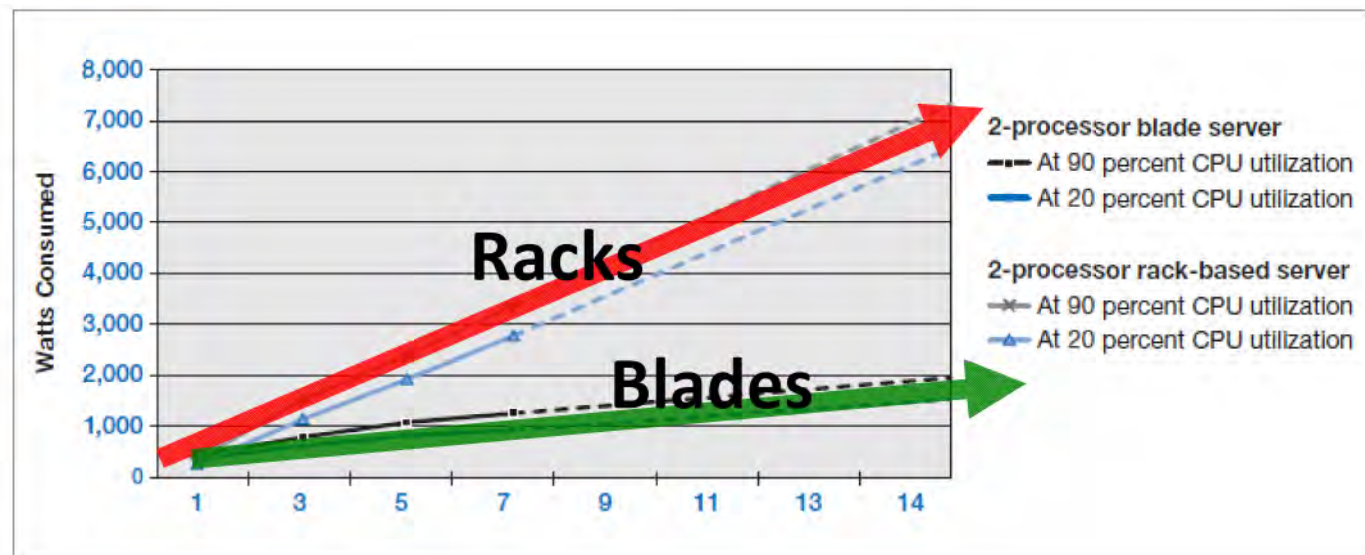
# Power Supplies

- Power Supply Unit (PSU's) power quality has improved - a lot! (mainly **AS/NZS 61000**)
- Better at:
  - Power Factor
  - Harmonics
  - Load matching for efficiency



# Racks vs Blades

- Improved power utilisation and performance
- Significantly improved power utilization of blade servers compared to rack mounted

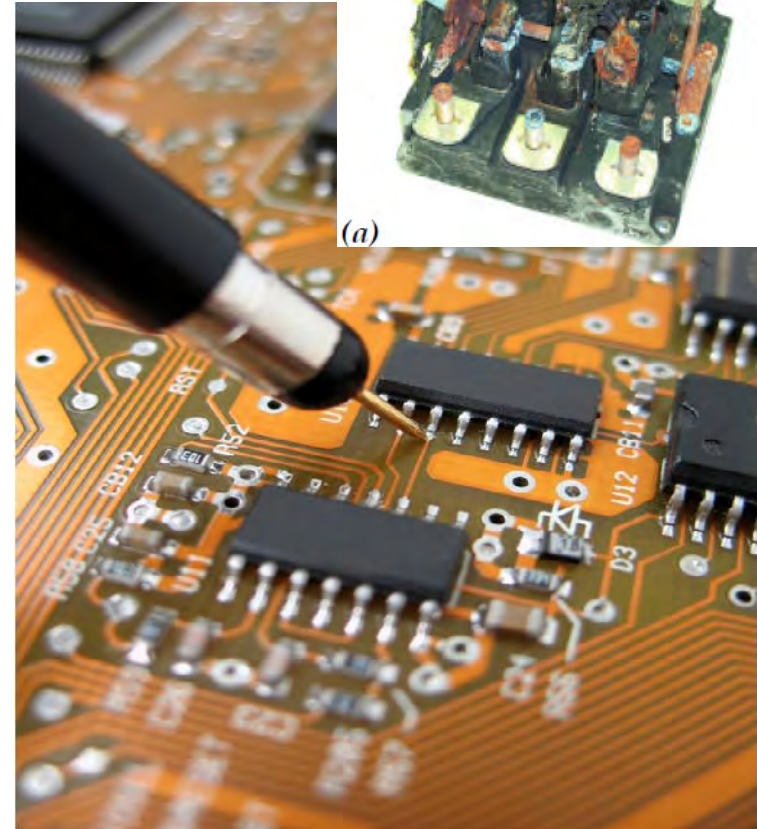
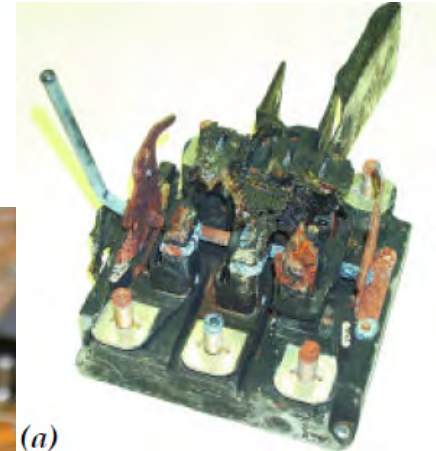


Courtesy: Intel White Paper – Blade Server Benefits

# Power Quality Issues

So why are we here now?

Because these guys still  
need TLC....



# Power Quality Issues

- Surges / transients
- Brown Out/ Black Out
- Sustained Low Voltages
- Frequency Variations
- Power Factor
- Harmonics & Distortion
- Fault Clearance of Equipment
- Earthing

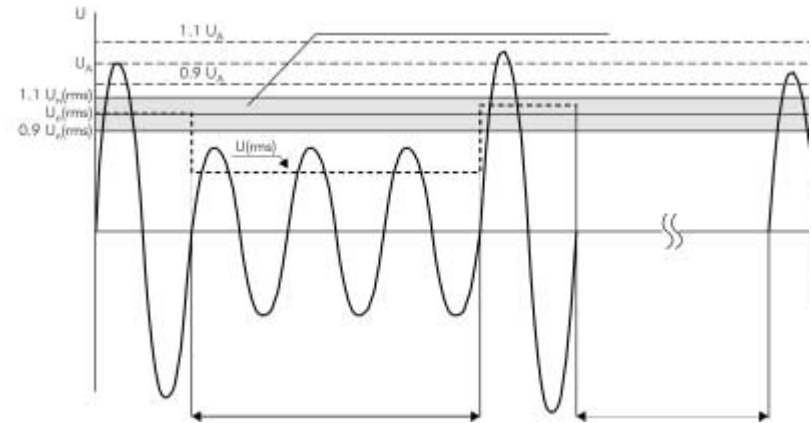


Figure 1 - Illustration of a voltage dip and a short supply interruption, Courtesy: Copper Development Association

# Power Quality Issues

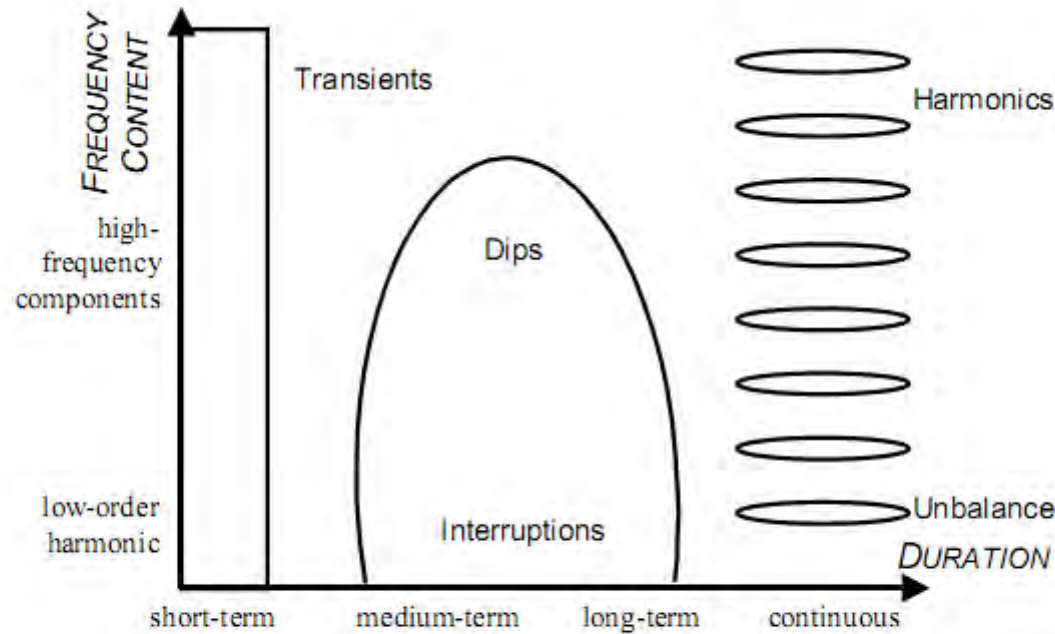


Fig. 1. Schematic division of the distorting emissions in the electromagnetic environment of an electricity distribution system.

# Impacts



## RED FACES ALL ROUND

|  |  |
|--|--|
| <b>Yesterday</b> LSE trading doesn't open until 12.15pm after technical glitch | <b>Feb 9</b> LSE announces planned merger with Canada's TMX                    |
| <b>Feb 22</b> Borsa Italiana exchange closed until mid-afternoon               | <b>Nov 2</b> Postpones Millennium launch after trading disruption on Turquoise |
| <b>Feb 14</b> New super-fast Millennium trading system goes live               | <b>Oct 5</b> Computer glitch delays Turquoise trading for more than an hour    |



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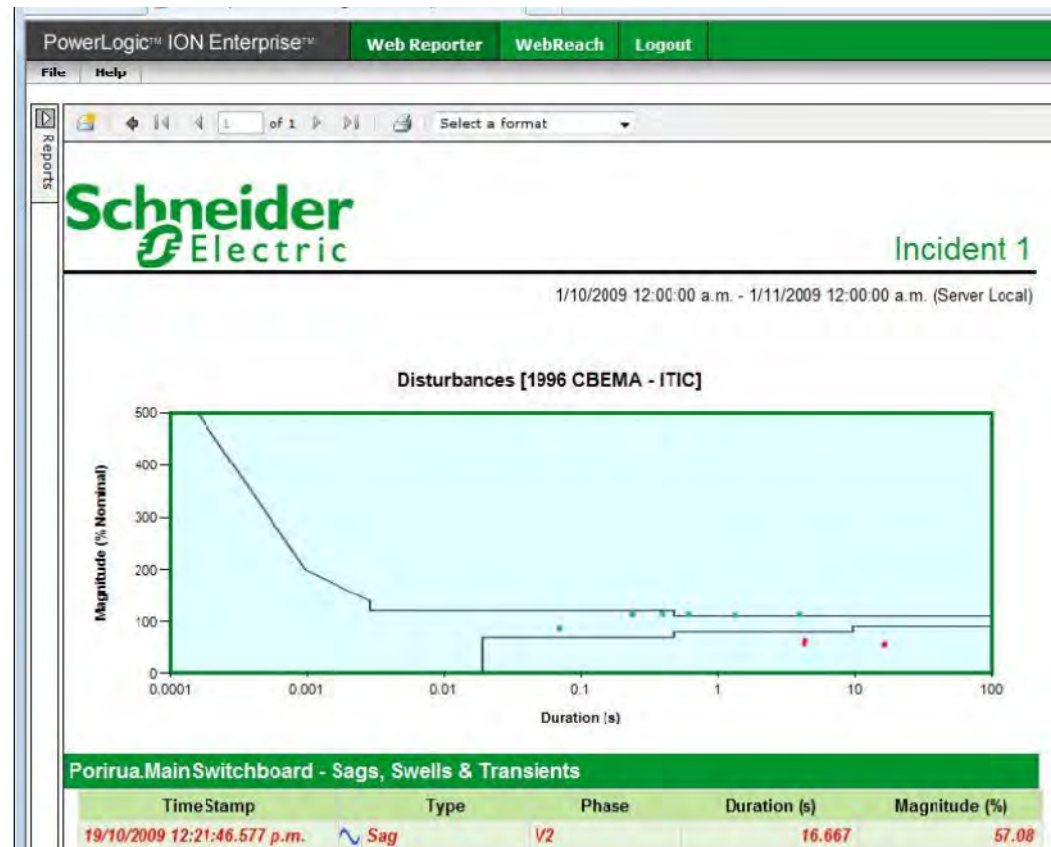
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### Technical glitch hits NAB net banking

# Mitigation

- How is power quality managed?
  - Centralised
  - Distributed



# Mitigation

- Solutions:
  - Integrated power quality management
  - Surge Protection
  - Filtering (Active & Passive)
  - Environmental Monitoring

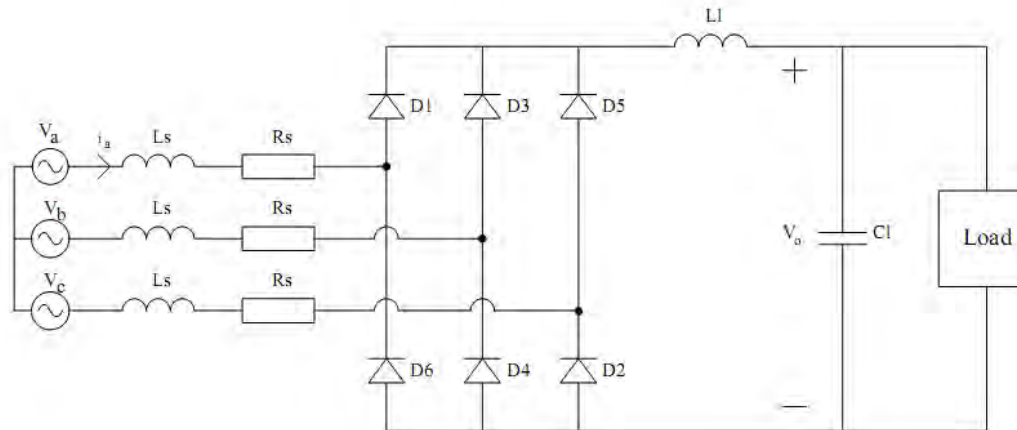


# Planning

- Data Centre Power System Considerations
  - Supply configuration (A/B supply, backup power)
  - Power density within the technical space
  - Upgrading capabilities without service interruption
  - Power quality management
  - Cost benefit of fixing power quality
  - Commissioning & Testing

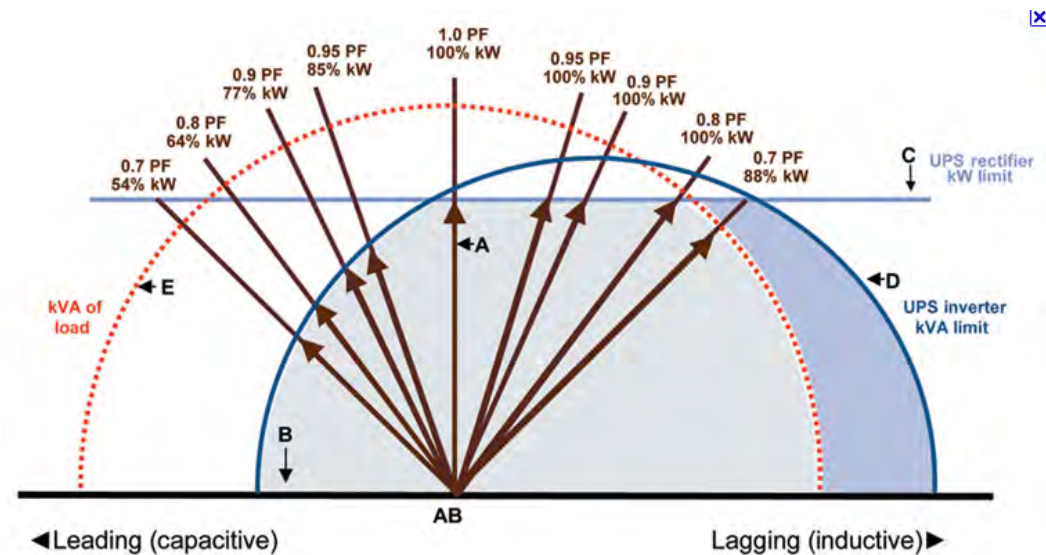
# Planning

- Understand the loads
- Predictive models
- Cost/benefit of equipment selections



# UPS Considerations

- Power factor management
- Fault clearance capabilities
- Testing of UPS/ validation of system capabilities



# UPS Considerations

- Off line
- Line Interactive
- On Line

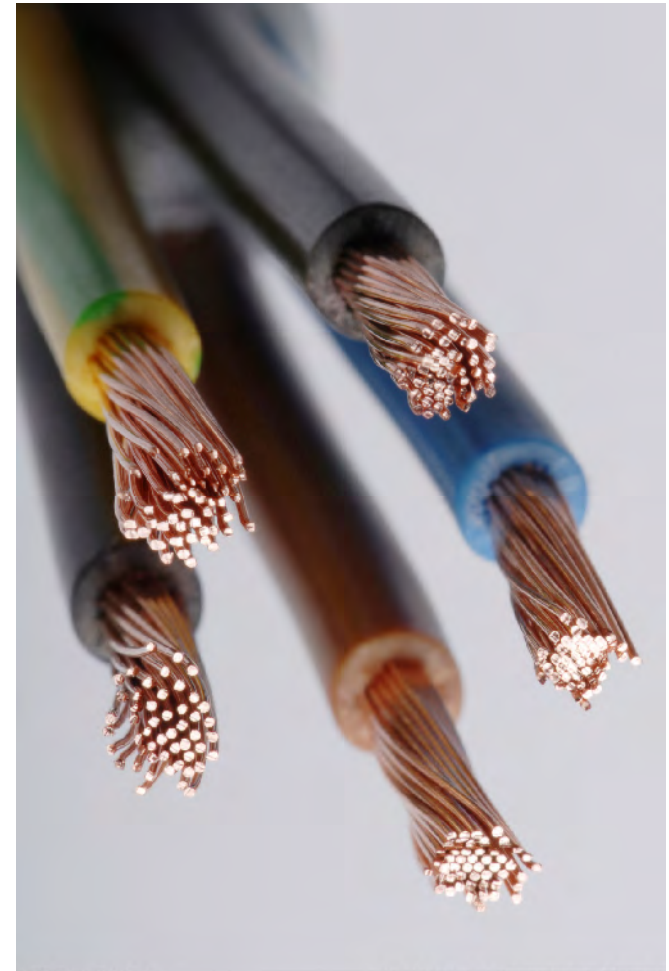
| Feature                              | True Online | Line-Interactive | Standby |
|--------------------------------------|-------------|------------------|---------|
| Zero Transfer Time                   | YES         | NO               | NO      |
| Frequency Regulation                 | YES         | NO               | NO      |
| Generates New Sine-wave Continuously | YES         | NO               | NO      |
| Internal Filtered Dynamic Bypass     | YES         | NO               | NO      |
| Power Factor Correction              | YES         | NO               | NO      |
| Harmonic Distortion Correction       | YES         | NO               | NO      |
| Voltage Regulation                   | YES         | SOME             | NO      |
| Eliminates Noise & Transients        | YES         | SOME             | SOME    |
| Power Outage Protection              | YES         | YES              | YES     |

*Courtesy: Liebert Power Quality Consultants*

- Some new UPS designs are responding to the Line-Interactive issues

# Switching

- Break Before Make Switching
  - Earth referencing
  - 3 pole vs 4 pole switching
  - Overlapping neutrals



# Switching

- Static Switch configuration/settings
  - Tolerances must be set correctly & fully tested
  - Voltage and frequency implications



# Equipment Selection

- Matching equipment to loads
- Impedance matching for paralleling systems
  - Generators
  - UPS



# Commissioning

- Integrated System Testing
- Simulating load
- Day 1 vs Ultimate load configuration



# Case Studies

- Generator paralleling
  - Multiple set operation, mismatching impedances
- UPS System operation
  - Heavy circulating between parallel UPS units
- Harmonic Assessment
  - Assessment of total site harmonics to assess PQ

# Future Considerations

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The good news continues....

- Further improvements in equipment power quality
- Less of an issue for UPS backed loads
- Simplified system configuration

....but:

- Still need to plan for power quality

# Questions

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[www.ndy.com](http://www.ndy.com)

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# Case Studies

- Generator paralleling
  - 2 parallel generators working OK, 3<sup>rd</sup> one ordered and installed to match but didn't – alternator pitch differed due to some issues with as built info, and the result was about 1000 Amps flowing in the neutral of what should have been nearly nothing, circulating between the alternators.

# Case Studies

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- UPS Installation
  - Heavy circulating HF (3000hz) current between parallel UPS units on the output side , resulting in the failure in UPS Output MSB's ACB CTs. Power quality problem leads to power loss.
  - Issue was a slight phase difference in the chopping wave between units

# Case Studies

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- Harmonic Assessment
  - TIA 942 Tier 3 Corporate DC, 2010 build
  - ALL load is UPS backed (Mechanical, IT)
  - Design to IEE 519
  - Modeling done - extensive:
    - Design: 3% THDV at source; 2% at IT load supplies
    - Construction: 2% THDV, 12% THDI (worst case)
    - As Built: So far so good. Waiting on load migration.

# References

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- <http://www.facilitiesnet.com/datacenters/article/Avoiding-Power-Quality-Headaches-in-Data-Centers--2260>
- [http://ecmweb.com/mag/electric\\_commissioning\\_mission\\_critical/](http://ecmweb.com/mag/electric_commissioning_mission_critical/)
- <http://www.scribd.com/doc/16688803/Power-Quality-Issues-Problems-and-Related-Standards>
- [http://www.leonardo-energy.org/webfm\\_send/130](http://www.leonardo-energy.org/webfm_send/130)