Power quality sensitivity and impact on industrial plants

- What is power quality for industrial plants?
- Sensitivity and impact
- Responsibility triangle
- The importance of quality monitoring

October 1st 2012 P.Marteijn

Power quality for industrial plants

Ensures continuous operation of a plant when:

- One of the two independent feeders failed and switched off

or

- An upset in the power network (power quality)

By having technology implemented for:

- Automatic transfer to another feeder or emergency generator

and

- Automatic restart or power dip protection on critical equipment and instrumentation

Power quality Sensitivity and Impact

Network:

Supply line is switched of, circuit breaker opened.

Minutes interruption time

Costumer:

Process that is driven by electricity stops or no longer performs as intended.

Number process stops due to power quality defects.

Quality issues:

- External and Internal power dips
- Loss of a feeders
- Black out and Load shedding

99%

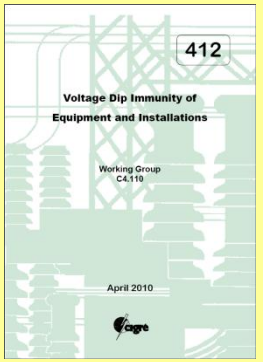
- Voltage stability
- Frequency stability
- Harmonics

1%

Power quality sensitivity

Loss of supply and black outs

- Redundant independent feeders
- Transfer systems and restart systems
- Local generation with island capabilities



Power dip immunity (Cigre C4-110 /UIE WG2: TB412)

www.uie.org

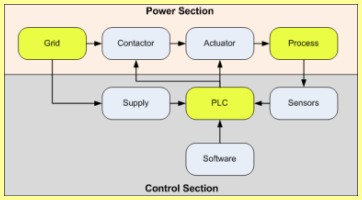
- Power dip characteristics (chapter 2)
  - Remaining voltage
  - Dip duration
  - Grounding system and type of fault
  - Cross country

- Process performance (chapter 3)

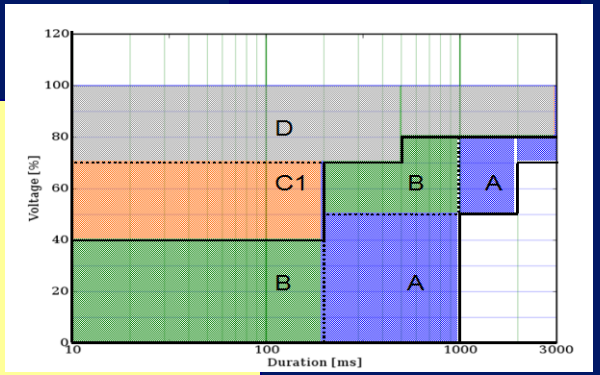
  Equipment immunity
  - UPS for control /protection items
  - VFD parameter settings;
  - Powerdip modules for LV contactors .

    etc

  Process immunity (PIT)
  - Restart capabilities



Practical examples of sensitivities



Dips

- Long severe power dips (> 300 msec < 50% remaining)

Electrical protection

- Sensitivity of ground fault protection or CT saturation
- Coordination of protection functions

Process system

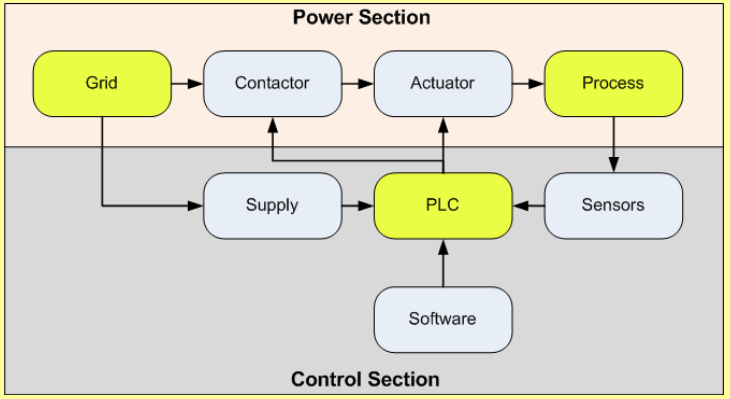
- Reacceleration of motors after transfer or power dip
- Drop out of contactors without restart
- Lack of coordination of restart and process protections
- Instantaneous trip on under voltage
- False trip of out of step protection of large synchronous motors
- Stalling protection of VFD
- Lack of flying start for VFD: reboot of processor
- Trip of critical equipment due to watch dog functions
- Sensitive process trips with DCS systems
  - pressure, temperatures, flow, signals from VFD, etc
- Behavior of powered instruments used in DCS trip functions
- Package unit systems with PLCs (e.g.refrig units)

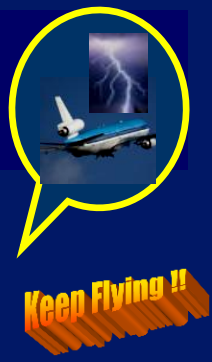
Process immunity

Process

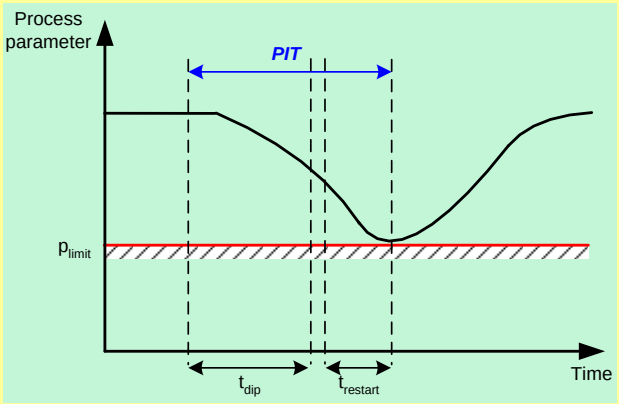
Immunity

Time

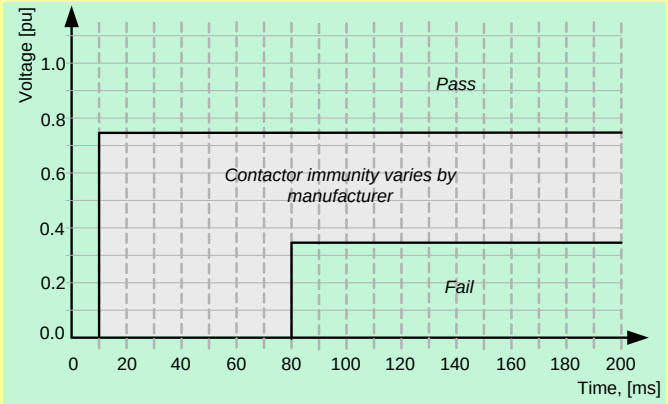




- Time interval between the start of the voltage interruption and the moment the process parameter goes out of the allowed tolerance limit (i.e. below the threshold).



Process immunity PIT >



Equipment immunity PIT <

Power immunity problems ?

1) Protection (30%)
   - Loss of both independent feeders external grid
   - Severity of external power dips
   - Sensitivity of applied ground fault or differential protection
   - VSD protections
   - Control circuits
   - Power dip protection

2) Transfer systems (5%)
   - Reliable design and operation
   - Generic design; coordination with process time constants

3) Restart mechanisms (65%)
   - Review and test capabilities
   - **Team effort process/process control / electrical**
   - VFD systems and related control circuits

Coordination of disciplines

Process technology

Process dynamics

Power quality details

Electrical technology

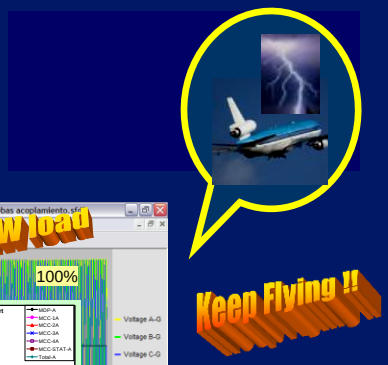
Process automation technology

Power quality impact

Process outages:

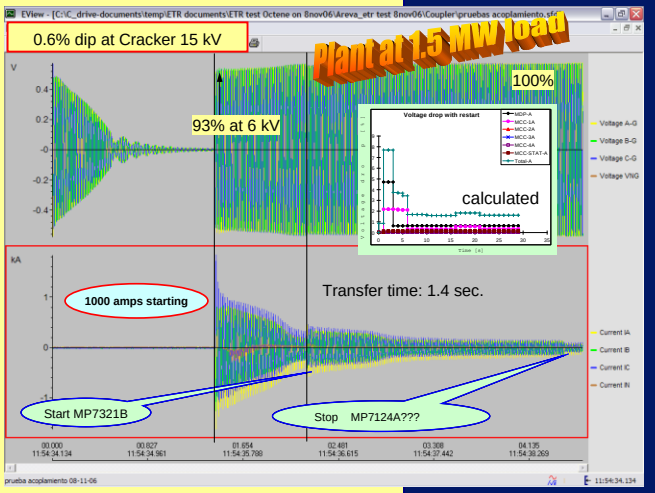
- Production loss
  - fixed amount losses per event (off spec etc)
  - additional amount of losses per hour downtime
    - minimum start up time
    - add time due to consequential damage
- Repair cost
  - Additional cost due to consequetial damage
- Permit issues

Process quality monitoring



- **Electrical data:**

  Effective use of
  fault recording equipment in power
  distribution and electrical equipment

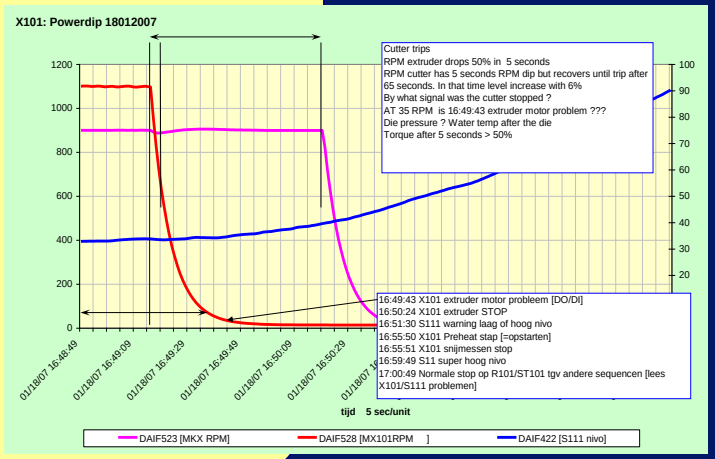


Root cause investigation

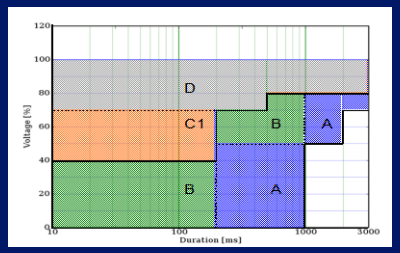
Test and commissioning

- **Process data:**

  Effective use of DCS applications
  - Create selective list of Process Tags
  - Set up fast data logging



The importance of power quality monitoring



Network

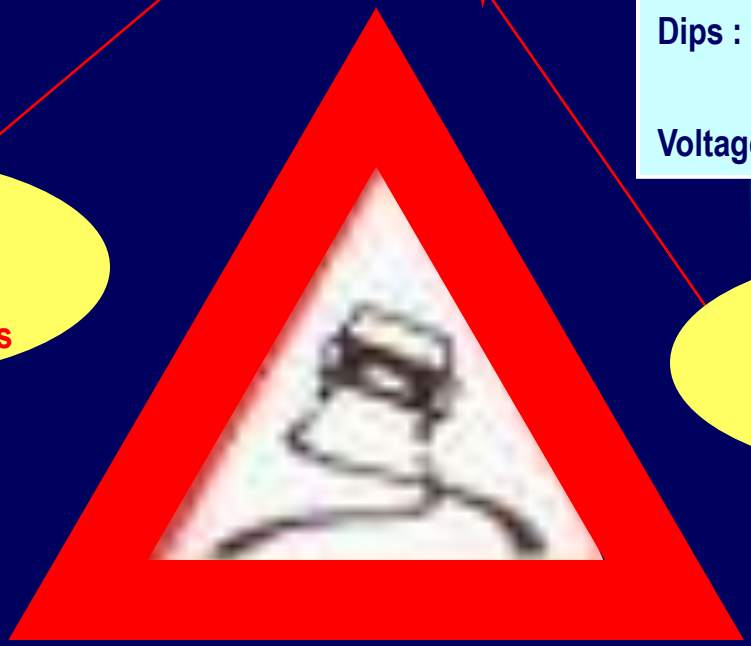
Power dip information is available on the internet

Dips : % remaining voltage; type, fault clearing time

Voltage wave shape of the event

Information on power quality
Feedback on process capabilities

Information on power quality



End User

Manufacturer

Determine PIT of critical equipment

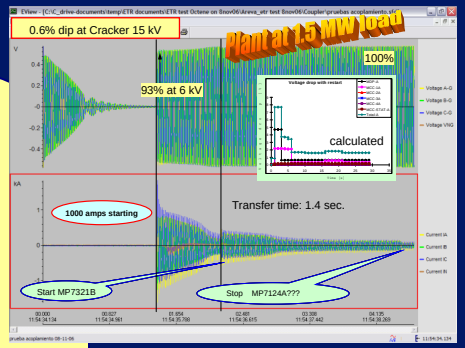
Make economic analysis of mitigation plan

User needs vs equipment protection

Mitigation capabilities for Equipment.

What is standard, what is optional?

Why Power quality monitoring?



- Agreed level of reliability between consumer and network operator
  What could we expect on a specific consumer connection point?
- Root cause investigation and reliability improvement
- Differentiate between on-line monitoring and more detailed monitoring in the field for specific root cause investigation
  For example, in the case of protection coordination problems
- Use power quality monitoring to validate power models
  Power models are needed since quality monitoring is not available at all levels where equipment is connected

How?

- Report voltage trace when monitoring is triggered
  -trigger on 90% voltage on one of the phases
- Each modern protective relay has fault recording capabilities
- At 150kV and above fault recording equipment is available and should be used to inform end users
- Data could be used to validate PQM results at macro level
- Power quality data is needed to justify and implement reliability improvements and standards within the industry and power distribution networks