



**WACKER**

## VOLTAGE QUALITY MONITORING IMPACT OF VOLTAGE DISTURBANCES AND THE NEED OF VOLTAGE QUALITY MONITORING

Harald Hüwel, Wacker Chemie AG, Electrical Power Supply, 18. November 2009

CREATING TOMORROW'S SOLUTIONS

### AGENDA.

- Introduction WACKER Chemie AG
- Facts of power supply at the Burghausen plant
- Definition of voltage quality
- Examples of voltage disturbances
- Influences on WACKER`s electrical energy supply
- Need of voltage monitoring
- Summary

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## PRODUCTS AND SOLUTIONS FOR KEY GLOBAL SECTORS.



- WACKER is a technology leader in the chemical and semiconductor industries.
- We forge ahead with technical innovations and the development of new products for the world's key industries.
- We offer solutions and innovations for a broad range of sectors.

### WACKER Group (2008)

- Sales: €4.30 billion
- EBITDA: €1.06 billion
- Net income: €438 million
- Net cash flow: €22 million
- R&D: €163 million
- Investment: €916 million
- Employees: 15,922



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## GLOBALLY PRESENT AND CLOSE TO CUSTOMERS: THE WORLD OF WACKER.

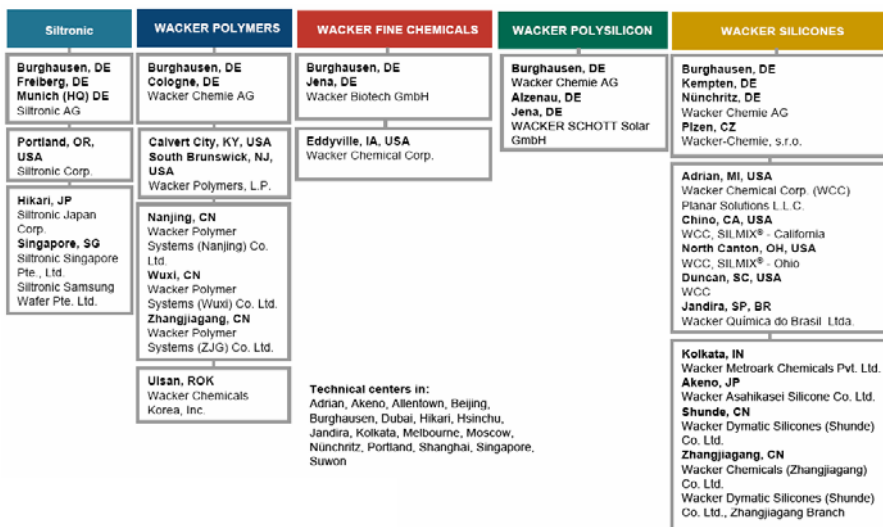
Our entrepreneurial activities are customer-centered to help meet customer goals and needs.

With 27 production sites and some 100 subsidiaries and sales offices worldwide, we are close to our customers no matter where they are.



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## PRODUCTION SITES AND COMPANIES: OUR GLOBAL VALUE-CREATION NETWORK.



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## WACKER CHEMIE AG PLANT BURGHAUSEN.



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Burghausen is located at the Austria border between Munich and Salzburg. The site was founded in 1914.

**WACKER** employs approx. 10.000 people at the Burghausen plant.



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## WACKER CHEMIE AG BURGHAUSEN PLANT ELECTRICAL FACTS.

- Electrical energy demand (2010) 2.800 GWh/year
- Maximum load 340 MW
- Sources of electrical energy in Burghausen:
  - Alzwerke, hydroelectric power plant 40 MW
  - Cogen power plant 120 MW
  - Steam power plant 50 MW
  - Public power grid 130 MW
- Voltage levels: 110kV, 10kV, 3kV, 690V, 500V, 400V, 230V

**Electricity is one of WACKER`s main resources and therefore voltage quality is very important.**



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## CHARACTERISTIC NUMBERS OF VOLTAGE QUALITY.

- **EN 50160 Voltage characteristics of electricity supplied by public distribution networks**
  - regards only to voltage levels < 35kV
  - limits don't fit to industrial needs
  - is only due to household customers
- **Statistics of national or international agencies**
  - Statistic of VDN regards only to outages > 3 minutes
  - Flickers, harmonic distortion, short interrupts are not recorded
  - numbers are not significant to industrial customers

This characteristic numbers don't reflect the industrial needs.



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## REASONS FOR VOLTAGE DISTURBANCES.

At the WACKER plant in Burghausen mainly three types of failures may have an impact on voltage quality:

- Automatic reclosing on overhead lines (short interruptions).  
**Single pole automatic reclosing** (e.g. clearing of earth faults) normally don't have impacts to WACKER.  
**Three pole automatic reclosing** (necessary by short-circuits) may cause massive voltage interruptions.
- Short circuits at overhead lines or distribution equipment
- Harmonic distortions



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## EXAMPLE 1: SHORT CIRCUIT ON 110KV OVERHEAD LINE.



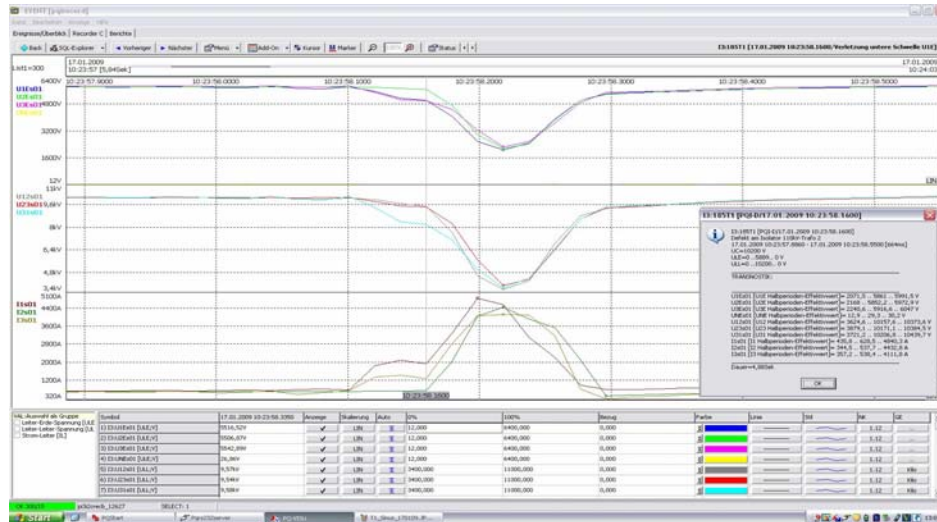
- The picture shows a 110kV short circuit in an outdoor switchgear close to WACKER site
- the voltage dropped from 116 kV to 60 kV
- interruption lasted 200 milliseconds
- after the short circuit was cleared by protection units, energy supply was ready for operation again



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## EXAMPLE 1: VOLTAGE AND CURRENT DIAGRAM (10KV).



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## EXAMPLE 1: IMPACT OF VOLTAGE DISTURBANCE ON 10KV INDUSTRIAL GRID.

- The diagram shows a voltage dip from 10.2kV to 3.4 kV for about 200 milliseconds
- Due to the voltage dip about 60% of the load was shut off
- Financial losses due to:
  - costs for damaged equipment
  - additional personnel expenses
  - reduced production proceeds



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## EXAMPLE 2: IMPACT OF VOLTAGE DISTURBANCE ON 10KV INDUSTRIAL GRID.

- In our 10kV grids voltage dropped from 10.2 kV to 6.4 kV for 150 Milliseconds
- 30% of the load was shut off
- Financial losses due to:
  - costs for damaged equipment
  - additional personnel expenses
  - reduced production proceeds



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## EXAMPLE 3: THERMAL OVERLOAD CAUSED BY HARMONICS.

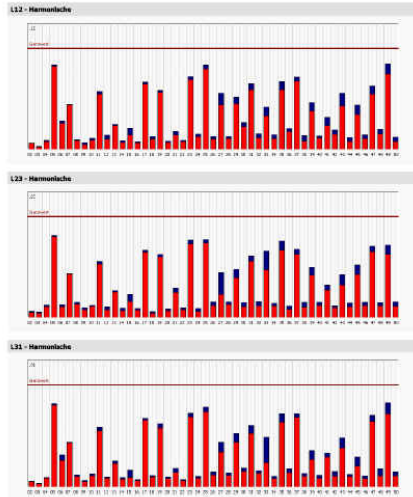


- In one of our switchgears a current transformer got overheated and caused to an earth fault with a following short circuit.
- Protection units cleared the arc. Current transformers and switch unit got damaged.
- The result of the analysis together with the manufacturer of the current transformer showed thermal problems caused by harmonics.



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### EXAMPLE 3: ANALYSES OF HARMONICS.



Rising numbers of frequency inverters and thyristor controllers for industrial use are causing a wide variety of harmonics.

In combination with capacitances and inductances resonant circuits are possible and may lead to damages.

Monitoring and compensation of harmonics may prevent failures in supply grids.



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### EXAMPLE 3: IMPACT OF VOLTAGE DISTURBANCE ON 10KV INDUSTRIAL GRID.

- Voltage dropped from 10.2 kV to 8.8 kV for 150 milliseconds.
- 8 % of the load was shut off
- Financial losses due to:
  - costs for damaged equipment
  - additional personnel expenses
  - reduced production proceeds
- Delay in starting new production                      3 weeks



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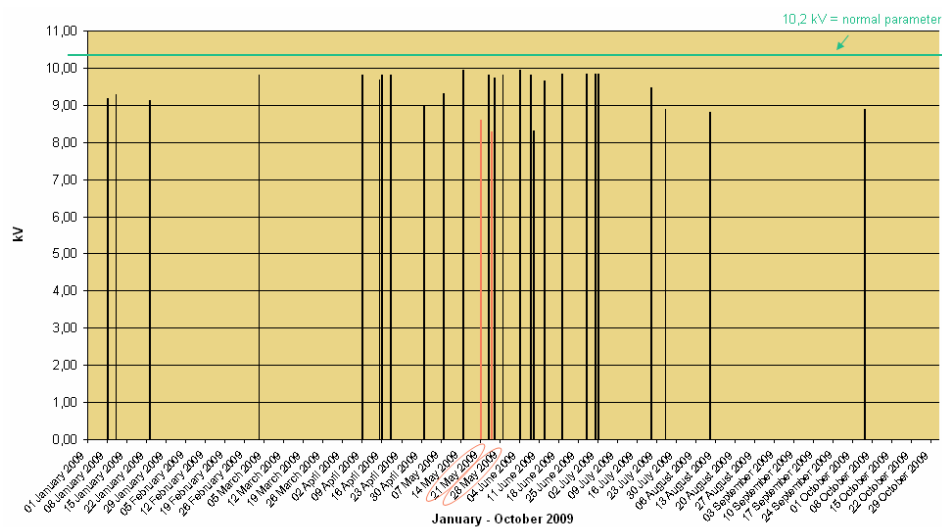
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## STATISTIC OF 110KV AUTOMATIC RECLOSINGS IN 2009 VOLTAGE DIPS IN 10KV GRIDS.



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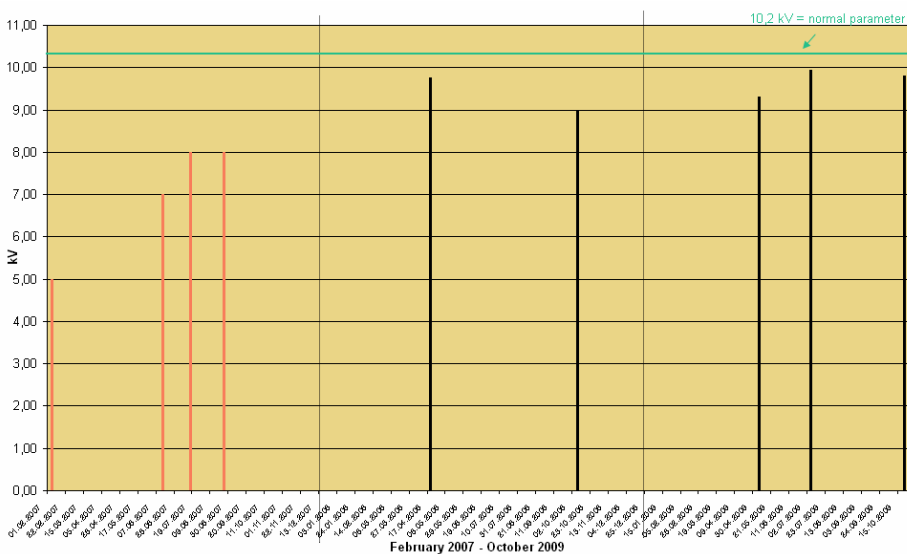
## STATISTIC OF 110KV AUTOMATIC RECLOSINGS IN 2009 VOLTAGE DIPS IN 10KV GRIDS.

- In 2009 WACKER recorded 29 voltage dips in the 10kV grid system, which were caused by automatic reclosing on 110kV overhead lines from outside the site. Interruption time in each case was not longer as 150 milliseconds.
- 10 automatic reclosings had an amplitude of  $< 95\% U_c$ .
- 2 of them had negative impacts on WACKER`s power supply. This short interruptions with maximum 150 milliseconds were responsible for facilities shut downs.



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## STATISTIC OF 110KV SHORT CIRCUITS OR OUTAGES FROM 2007 TO 2009.



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## STATISTIC OF 110KV SHORT CIRCUITS FROM OUTSIDE 2007 TO 2009.

### Short circuits from outside WACKER:

- 9 short-circuits occurred in the 110kV supply grid of the energy provider since 2007 .
- 4 of this short interruptions had massive negative influences to WACKER`s energy supply.  
This short interruptions with a duration of maximum 200 milliseconds were responsible for facilities shut downs.



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## IMPACTS OF VOLTAGE DISTURBANCES SINCE 2007.

### Since 2007 we recorded on the feeding 110kV grid:

- 86 automatic reclosings on overhead lines.  
11 of them had massive negative impacts to our energy supply.  
Reasons were: - Birds (6)  
- Storm (12)  
- Unknown (68)
- 9 short circuits on feeding overhead lines or switch yards.  
4 had impacts on WACKER`s energy supply.  
Reasons were: - operating errors (2)  
- component failures (4)  
- unknown (3)

The last total black-out happened 30 years ago!



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## NEED OF VOLTAGE MONITORING.

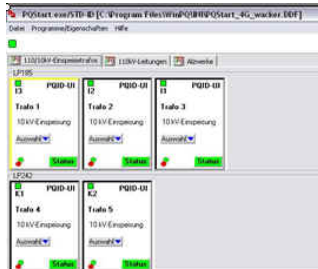
- **Voltage monitoring by customers offers:**
  - Useful statistic information about reliability of feeding grids
  - Possibility to make improvements
  - Better position for discussions with energy suppliers
  - Cost-savings by more reliable feeding
- **Voltage monitoring by European or state regulators leads to:**
  - Reliable characteristic numbers for power quality
  - Improvements in supply grids
  - More efficient and economic power supply



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## INSTRUMENTS FOR POWER VOLTAGE QUALITY MONITORING.



For power quality monitoring at the Burghausen site we use a system that continuously controls secondary voltage of each of our fifteen 110 / 10kV transformers. We get information if there is a off-limit condition (voltage, harmonic, frequency, etc.) and we have the possibility to react.



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## MOBILE POWER QUALITY FACILITY.



Field measurements are possible by using a mobile power-quality system.

If somewhere in our grids a voltage or harmonic problem occurs will get information about voltage quality derivations.

This tool is also necessary for designing new supply grids.



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## SUMMARY.

- Voltage quality is very important for the industry.
- Quality has direct impacts on manufactured products.
- If the power quality of supply grids is out of limits, for example overvoltage may damage equipments. High financial risks are possible.
- Industry and energy providers have to work together to achieve a high reliability, high quality and at last, a cost-effective electrical energy supply.
- Voltage-Monitoring is a necessary tool to reach this goal.



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THANK YOU FOR YOUR ATTENTION!



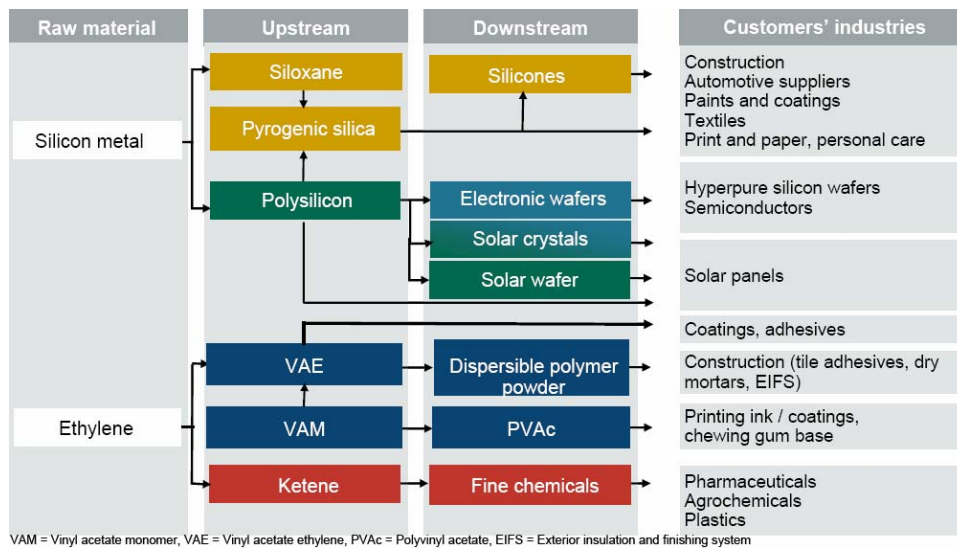
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BACK-UP.



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## WACKER: HIGHLY INTEGRATED OPERATIONS BASED ON TWO KEY RAW MATERIALS.



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## VOLTAGE CHARACTERISTICS OF ELECTRICITY SUPPLIED BY PUBLIC DISTRIBUTION NETWORKS DIN EN 50160 FOR MIDDLE- AND LOW VOLTAGE GRIDS <35KV.

- Frequency 49,5 - 50,5 Hz (+-1%) during 99,5% in a year
- Slow Voltage dips  $U_c \pm 10\%$  95% of the average voltage during 1 hour
- Quick Voltage dips  $U_c + 6\%$  more times a day
- Flicker  $Plt=1$  during 95% a week
- Voltage dips  $U_c < 90\% - 1\%$  for not longer than 1 Sec.
- Short time Voltage Interruptions  $U_c < 1\%$  for not longer than 3 Min.
- Longtime Voltage Interruptions  $U_c < 1\%$  for more than 3 Minutes

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## VOLTAGE CHARACTERISTICS OF ELECTRICITY SUPPLIED BY PUBLIC DISTRIBUTION NETWORKS DIN EN 50160 FOR MIDDLE- AND LOWVOLTAGE GRIDS <35KV.

- Overvoltage with Gridfrequency 1.7 x Uc (Groundet )
- Transient Overvoltage
- Voltage unbalance 2% of 95% of all average metered values a week
- Voltage Harmonics individual values

**Most of this values are not suitable for industrial grids!**



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## POWER QUALITY STATISTICS.

- In reliability statistics, for example from the German VDN, only outages longer than 3 minutes are regarded.
- This offers a picture, energy supply in transmission grids is high reliable.
- This may fit to household customers but not to the industry.
- An voltage dip longer than three minutes may be for industry customers similar to a total black out.
- For giving characteristic numbers of power supply reliability there have to be regarded all voltage dips below 10% of nominal voltage, even if they last only a few milliseconds.



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