Monitoring & Diagnostics potentials

- Life time evaluation
- Soot blower optimization
- Performance monitoring
- Wear & tear evaluation
- Vibration monitoring
- Plant Performance monitoring

- H2-leakage
- Partial discharge
- DGA
- Stepup switch

- FÜ Main steam heaters
- ZÜ Reheaters
- VD Evaporators
- MA Coal conveyors / mills
- TU Turbine
- HS Generator / HV gear
- PA Pumps, fans, motors
Monitoring & Diagnostics: Examples

**Example 1: Condenser pressure**

Condenser pressure difference detected: 7 mbar  
Additional fuel: 6 MJ/s reaching 140,000 €/month

**Example 2: Minimum load stabilization**

Set points:  
Secondary air  
O2 surplus  
Mill load  
Burner angle

Source: SR:EPOS, STEAG
O&M: Maintenance overhaul periods

- $T_a \sim 25\,000$
- $K/M = 50\,000$
- $K/M = 75\,000$
- $G = 100\,000$
- $K/M = 125\,000$
- $K/M = 150\,000$
- $K/M = 175\,000$
- $G = 200\,000$

$T_a = \text{equivalent operating hours}$

- $K = \text{minor overhaul}$
- $M = \text{intermediate overhaul, module overhaul}$
- $G = \text{major overhaul}$
KISSY – power plant information system

KISSY provides the opportunity to benchmark power plants by:

- Compiling availability data and evaluating performance indicators
- Comparing the indicators of single plants with indicators of peer groups

**Characteristics:**

- Size of power plant capacity
- Fuels by capacity
- Furnace type by capacity
- Units by single or dual boiler operation
- Units by sub-critical or supercritical pressure

Benchmarking is a good way to assess the O&M performance of the own plant(s). It provides necessary transparency about focus areas for maintenance interventions.
TOP 20 components with highest unplanned unavailability
Evaluation of 3,633 incidents without external influence
Collective: fossil fired units; commis. date ≥ 2000; ≥ 200 MW gross capacity; all countries
Time Period 2000 to 2013
KISSY – root cause analysis for all plants

TOP 20 components with highest unplanned unavailability

Evaluation of 66,330 incidents without external influence
Collective: fossil fired units, ≥ 200 MW gross capacity, all countries
Time Period 2000 to 2013

- Miscellaneous: 29.07%
- Conventional fuel supply and residues disposal: 6.92%
- Conventional heat generation: 6.83%
- Evaporator system: 5.82%
- Pressure system, feedwater and steam sections: 5.78%
- Main machine sets: 5.49%
- HP superheater system: 2.93%
- Steam turbine plant: 2.67%
- HP turbine: 2.22%
- Generator, complete: 1.90%
- Reheat system: 1.71%
- Gas turbine plant: 1.53%
- LP turbine: 1.44%
- Generator plant: 1.01%
- IP turbine: 0.92%
- Feedwater conveyance: 0.90%
- Steam system: 0.88%
- Pulverizing system (incl. classifier): 0.77%
- Bearings: 0.70%
- Air heating system (flue-gas-heated): 0.67%

Unplanned unavailable energy
unplanned UA-Energy by KKS-Codes of reporting years
of lignite and hard coal power plants > 450 MW

Meldejahr = reporting years
The organization of a power plant usually comprises seven hierarchical levels. Besides the size of the plant, the number of employees depends on the subcontracting philosophy.
New requirements for power plant personnel

**Technical challenges**
- reduction of full-load hours
- increased number of start-ups and load changes
- potential of reduced economic viability due to reduced life time
- technical development is focussed to ensure:
  - more flexibility (load changes)
  - reduction of minimal load
  - high availability and reliability
  - possibility of island operation and fast cold start

**Skill challenges**
- less predictability and seasonal variations and shut-down periods
- flexible working hours schemes
- variable areas of working with different technologies
- increased complexity

→ continuous learning and skill enhancement
The Kraftwerksschule is the benchmark for power plant training in Germany. The training of operators is in the focus of the skill program.
VGB Standards and Guidelines

Documentation of best practices, expertise and lessons learnt

- not binding
- proven industry standard
- >300 standards, guidelines and instruction sheets, 100 available in English; 10-20 new/updated releases per year

Structure of a standard or guideline

- **Originators of the standard**
- **Introduction** (technical basics and scientific fundamentals)
- **Technical details** and recommendations (80% of the guideline)
- **Literature and publications** (mainly articles in technical press)
- **Related standards and norms** (ASME, ISO, VdTÜV, DIN etc.)
VGB Standards and Guidelines: Example Electrical

AK EMA / WP Electrical Equipment
Bagert (E.ON), Emmerich (EnBW)

PG Generatoren / Generators
Bomba (E.ON), Dr. Lauter (Steag)

PG QS Generatoren
QM Generators

Revision VGB-S H2-Sicherheit Generatoren
Revision VGB-S H2-Safety generators

VGB-S Konservierung von Turbosätzen
VGB-S Preserving of turbine sets

PG Trafos / Transformers
Stach (E.ON), Dr. Lauter (Steag)

PG Motoren + Frequenzumrichter (R168)
Motors and frequency converters
Lübke (enercity)

Betriebssicherheit in der ET
Operational Safety EE

VGB-S-166 DE
VGB-S-166 EN 05/2014
VGB-S-165 08/2014
Zuarbeit für den Teil Generatoren
Partial work for the section generators

VGB-S-XXX Leitfaden zur Qualitätssicherung Trafoöl
Guide for Quality assurance of transformer oil

VGB-S 164 02/2015
VGB Standards and Guidelines: Example I&C

(VGB-R 170) new: VGB-S-170
Leittechnik in Kraftwerken / I&C in power plants
Status: 2014-04-30

(R 170A) / VGB-S-170-10
aktuelle Themen der LT
current subjects in I&C

(R 170B) / VGB-S-170-20
Auslegungsstandards für die LT
Design standards for I&C

(R 170C) / VGB-S-170-30
Betriebsgerechte funkionsbezogene
Dokumentation der Kraftwerksleittechnik
Function-related documentation of power plant I&C in line with operation requirements

VGB-S-170-40
Auslegungsstandards für die Feldtechnik
(Übernahme und Anpassung aus R123C)
Design standards for the I&C field technologies
(takeover and revision of R123 series)

VGB-S-170-41
Mess- und Probenahmeleitungen
Impulse pipes and sampling lines

VGB-S-170-42
Entnahmestellen für
verfahrenstechnische Messungen
an Wasser- und Dampfsystemen
Extraction point of process measurements in water-steam-systems

VGB-S-170-43
Messtechnik
Measurement technologies
VGB Standards – examples for thermal power plants

<table>
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<tr>
<th>Engineering</th>
<th>Procurement &amp; Manufacturing</th>
<th>Construction &amp; Commissioning</th>
<th>O &amp; M</th>
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<td>VGB-S-166</td>
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<td>Recommendations for the SIL classification of safety-related systems and systems in the water circuit</td>
<td>Quality Assurance in the Manufacture of Generators</td>
<td>Construction and installation supervision in the manufacture and assembly of water-tube boilers and associated systems in thermal plants</td>
<td>Condition Monitoring and Inspection of Components of Steam Boiler Plants, Pressure Vessel Installations and High-Pressure Water and Steam Pipes</td>
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<td>Feed Water, Boiler Water and Steam Quality for Power Plants/Industrial Plants</td>
<td>Guideline for Ordering High-Capacity Steam Boilers</td>
<td>Internal Cleaning of Water-Tube Steam Generating Plants and Associated Pipework</td>
<td>Guidelines for rating the microstructural composition and creep rupture damage of creep-resistant steel for high pressure pipelines and boiler components and their weld connections</td>
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<td>Design standards for instrumentation and control equipment</td>
<td>Guide for Procurement of Steam Turbine Plants, Part A, B and C</td>
<td>Inspection and Testing of Large Forgings and Castings for Steam and Gas Turbine Generators</td>
<td>Overhaul recommendations for turbo-generators</td>
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Example: Internal Cleaning of water-tube steam generating plants and associated pipe-work issued in 2015 (revised version)

- aims at cleanliness of the inner surfaces
- includes all kind of cleaning procedures: flushing, acid cleaning, blow through, alkaline boiling
- reflects recent experiences made in commissioning of new built plants
  - new materials are included like Ni-based alloys and austenitic steels
  - completely revised chapter about blow-through
  - comprehensive quality and preparing recommendations

Best Practices in applying inhibitors during acid cleaning
# VGB Standards – overview of cleaning applications in new builds

<table>
<thead>
<tr>
<th>Country</th>
<th>Name of Plant</th>
<th>Name of Company</th>
<th>No. Units</th>
<th>Unit Cap. MW (gr.)</th>
<th>Main Fuel</th>
<th>Life/RH Steam Temp. (°C)</th>
<th>COD (Y)</th>
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Summary

→ Excellence in operation is a lot about transparency of the plant status.
→ Modern I&C equipment and analyzing instruments are useful tools to identify improvement potential.
→ To sustain the improvement process benchmarking provides useful information to assess own performance.
→ Fleet management is a good way to optimize maintenance costs.
→ Guidelines and standards that are based on industrial best practices document valuable experiences.

Transparency of the plant status, skilled personnel and the application of best practices are key to excellence in O&M.
धन्यवाद

Thank you for your interest!

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