Minutes of Meeting

VGB-Technical Committee:	**Generation and Technology**
VGB-Working Panel:	**PGMON**
	Power Generation Maintenance Optimisation Network
	42nd Meeting on 7./8. 4. 2011 in Dublin

Agenda

Welcome (Paul Thame)

TOP 1: Decreasing maintenance budget
Henning Lundstrom, Vattenfall

TOP 2: Experiences with a service company
Heinrich Grimmelt, VGB

TOP 3: Condition assessment & monitoring of generators
Willy Vanderelst, Laborelec

TOP 4: Design to cost
Miroslav Krpec, CEZ

TOP 5: Possibilities and impossibilities when using KISSY data to optimise spare parts
Henk Wels, Kema

TOP 6: Optimisation of investments for coal power plant reheaters
Pierre Bertrand, EDF

TOP 7: Control of process safety risks
Paul Thame, E.ON UK

TOP 8: Condition Based Maintenance
Nicky Codd, ESB

TOP 9: Benchmarking
Jason Bane, ESB

TOP 10: Place and date of next venue

TOP 1: Decreasing maintenance budget
Henning Lundstrom, Vattenfall

Background
Due to the actual financial crises and the following cuts in the maintenance, the working group had a discussion of measures and maintenance management during financially crises.

An introduction was presented in three aspects from points of view of:
Management/budget
Maintenance staff
ERM - including risk appetite

The discussions led to a number of conclusions/headlines to be taken into account when optimizing the maintenance during financial crises
- Long term planning of competences and the related outsourcing
- Management of deferred and omitted maintenance
- Identify education gaps
- Define reporting from external service companies and define penalties if reporting is missing
- Review of priority management for the maintenance
- Consequence reporting to the various management levels
- Staff reductions with a risk to loose the supply chain for technical experts

Due to differences in the organization structures the conclusions must be adapted to the company in question.

The presentation can be found in the closed user group.

TOP 2: Experiences with a service company
Heinrich Grimmelt, VGB

A bid invitation was made to five service companies for some overhaul works on two small steam turbines of a waste incineration plant according to special rules “VOB”.
One of the companies refused to offer, one company supplied their offer too late and one company insisted on their general terms. So only two of the offers were judged.

It turned out that the winning company had not enough personnel to handle the job. No responsible man on site, no commissioning engineer.
The project leader had to work himself on site to grant the time schedule.

The presentation can be found in the closed user group.

TOP 3: Condition assessment & monitoring of generators
Willy Vanderelst, Laborelec

Generator failures usually cause a long period of unavailability.

In order to avoid unexpected failures the condition of a generator needs to be followed up during its whole life time:

- Insulation components (especially the stator winding insulation)

- Mechanical integrity of the generator and his structure

- **<u>Stator windings</u> condition assessment & monitoring techniques:**
  - **Periodical off-line electrical testing:**
    - Follow up of insulation condition
    - Determine remaining life time of winding insulation is impossible!
    - Only method guaranteeing fitness for service is over potential testing on site -> test Udc = 2,3 Uac nom; Uac test in factory
    - Stator winding autopsy of a removed bar can give more information about the exact insulation condition
  - **On-line monitoring:**
    - <u>Air gap</u> monitoring permits to detect:
      - Rotor/stator circularity and rotor/stator eccentricity (hydro)
      - Rotor and stator structural related problems
      - Magnetic field unbalance and pull
      - Thermal related problems
    - <u>Partial discharge</u> (PD) measurements can e done on-line by use of permanent installed sensors; it allow to identify the on-going ageing mechanisms and to follow up the ageing evolution.
    - <u>Vibrations monitoring</u>
      - Together with the air gap monitoring, <u>vibration monitoring</u> helps to evaluate the mechanical integrity of the generators.
        - End Winding vibrations monitoring
        - Stator bar vibrations monitoring

- **<u>Rotor windings</u> condition assessment & monitoring techniques:**
  - In operation, the rotor undergoes:
    - <u>Thermal stress</u>: high temperatures
    - <u>Mechanical stress</u>: high speed rotation (3000 rpm)
    - <u>Chemical stress</u>: contamination by grease and debris
    - <u>Cycling operation</u> (start/stop) is particularly stressing for the rotor winding due to successive dilatations and contractions of the copper winding.
  - On-line monitoring:
    - <u>rotor flux</u>
      - The rotor slot leakage flux is local to each rotor slot and its magnitude is proportional to the current flowing through the turns found in the slot and is therefore diagnostic of active turns in each slot
      - Sensing the magnetic flux from the rotor poles is possible to detect field imbalance, which can be provoked by short circuited windings
      - Allows to <u>detect</u> and <u>localize</u> the rotor winding <u>shorted turns</u> during the generator operation

- rotor insulation
    - Allows to measure the rotor winding insulation resistance during operation and to foresee the apparition of a ground fault. It also allows to localize the fault when it appears.

The presentation can be found in the closed user group.

TOP 4 Design to cost
Miroslav Krpec, CEZ

The current financial crisis creates further pressure on cash flow and efficient spending. Optimal spending on repairs and investment - solving the problem at a fair price is one of the big challenges these days.

More than 80 % of the cost of maintenance is spent in big projects (General Overhaul, repair or exchange of major parts of power units etc.). Reengineering of process preparing and executing of the projects can bring significant reduction of the cost.

CEZ applied methodology „Design to Cost“ on ten pilot projects in the area of maintenance last year. Using multidisciplinary team and involvement of the suppliers including using of preciously defined tools has brought cost savings by 30 percent. At the same time members of the team (from different departments of the company) takes more detailed knowledge how to prepare other projects which is very valuable for their future work.

The presentation can be found in the closed user group.

TOP 5: Possibilities and impossibilities when using KISSY data to optimise spare parts
Henk Wels, Kema

Three lines of analysis have been used to assess the optimum spare parts for newbuilding power plants:
a) Analyze the contents of spare part warehouses
b) Apply queuing theory and Poisson distribution modeling to calculate the sufficiency of spares
c) Apply Monte Carlo simulation
When analyzing the contents of spare part warehouses for strategic spares it was found that despite the enormous number of items simple sorting in Excel would allow finding typical spares per system and component. Definitions (consumable, strategic, etc.) are difficult to compare. Questions remain on the inventory being optimum, questions which need more analysis. Also limited info is present on how many components would need the spare. By investigating the number of spares used one is able to calculate the rate of application.

Simple queuing theory and Poisson distribution calculations can be used to assess the sufficiency, which is the probability that a spare is not present given a component failure that requires a spare. However, comparison with Monte Carlo simulation will show that such theories have their limitations. For instance, if more than 1 component in 1 power plant fails causing the plant out of operation and that component would need the spare, adding the remaining failure rates is too conservative since the remaining components are less likely to fail with the plant not running. Similarly, the number of customers waiting in queuing theory must be at maximum the number of components that call for the spare.

The VGB KISSY unavailability database was used to calculate failure rates and repair times at a 3 level KKS-code. A subset of raw unanimous failure data was supplied by the VGB. KEMA estimated that the free text would allow to sufficiently pinpointing components within that 3 letter KKS system code. However, this was only partly possible since the data quality and the amount of free text differs much between plants. Engineering judgment was applied to check if a spare part would be applicable based on the text and the repair time. Apart from instrumentation, spare parts were thought to be only applicable beyond a certain repair time (f.i. 24 hrs). Engineering judgment is certainly necessary to arrive at the estimates from the data.

To conclude: the 3 types of analysis show different views but are supportive in reaching conclusions with regard to optimum spares. Simulation provides the best guidance and understanding. The availability of documented failure data together with the use of spares to solve the failure is a limiting factor that has to be supplemented with engineering judgment.

The presentation can be found in the closed user group.

TOP 6: Optimisation of investments for coal power plant reheaters
Pierre Bertrand, EDF

For several years EDF R&D has been developing a probabilistic methodology to optimize the lifecycle management of a given SSC (System, Structure or Component), i.e to help answer the following question : which investments have to be done, and when, to ensure a sufficient level of security, availability and performance of the SSC ?

That methodology consists of 3 main steps :

1. identification (mostly through FMECA) of the main risks (events) affecting the SSC and the actions available to mitigate those risks

2. quantification (through statistical analysis of feedback data and experts opinion) of :
   the probability of occurrence of the events
   the costs and efficiency of the mitigation actions

3. valuation and comparison of investments strategies defined by the decision-maker. The valuation and comparison of strategies is mostly carried out by computing the statistical distribution of a NPV (Net Present Value) through Monte-Carlo sampling.

This methodology has been used for several years to help EDF’s generation and engineering Divisions to make the proper investment decisions to optimize the life cycle management of their power plants and this presentation describes how it has been applied to the reheater of a 600 MWe coal-fired power plant.

The presentation can be found in the closed user group.

TOP 7: Control of process safety risks
Paul Thame, E.ON UK

In a tough economic climate when there are powerful pressures to reduce expenditure on asset management, it is important to ensure that the control of major process safety risks remains a clear priority.

Process safety risks are the result of upsets and failures in the power generation plant as opposed to hazards arising from work activities. Process safety incidents can be defined as uncontrolled releases of energy or hazardous substances with the potential to cause harm to people or the environment.

To control process safety risks successfully, it is first necessary to identify the relevant plant related hazards. For conventional power plant, these hazards typically include release of steam or other hot materials, explosions, projectiles, electrical blast, structural collapse or harmful spills. Individual process safety hazard scenarios for specific equipment can be identified using check lists, HAZID or HAZOP studies.

Having identified specific hazard scenarios with their causes and consequences, it is then necessary to identify the barriers that are used to help prevent the incident and limit the resulting harm. These barriers can be shown graphically using a bow tie diagram. Barriers include standards, operating procedures and operator training, automatic protection systems, inspection and testing, leak detection, fire fighting and emergency procedures.

Effective process safety risk management requires that barriers are well known, they are sufficiently effective, they are known to be working and they are improved with experienced.

The presentation can be found in the closed user group.

TOP 8: Condition Based Maintenance
Nicky Codd, ESB

ESB Generation Operations carried out a study of current Condition Based Maintenance, (CBM), practices in the Power Industry. It examined ESB Generation Operations practices against the best practices in the Industry.

Whilst the report concentrated on CBM, other maintenance approaches were also explored. It is acknowledged that CBM is not an overarching maintenance strategy; rather it is a technique which can be effectively employed in the overall maintenance strategy with good results.

CBM has been employed in Generation Operations for many years. Its application is more effectively utilised in some areas such as Generators and Turbines. CBM technologies are utilised broadly in Generation Operations, however our findings show that we are not always taking full advantage of the technique.....

The presentation can be found in the closed user group.

TOP 9: Benchmarking
Jason Bane, ESB

The Benchmarking process employed by ESB has assumed greater significance as the company competes in a commercial electricity market.

The process gives important information on both plant and component reliability and the relative cost of maintenance against peer group units.

The recent round of benchmarking has initiated a number of performance improvement projects, such as mill performance improvement and trips reductions. At the heart of these projects is the delivery of improved performance for lower cost.

ESB have decided to expand their benchmarking process to include Hydro and Gas fired plant the outputs of this process will feed into the 2012 budget cycle and performance improvement projects.

Whilst it is acknowledged that benchmarking is time consuming the identification of performance gaps with peer groups is an important business planning tool.

The presentation can be found in the closed user group.

TOP 10: Place and date of next venue

The next meeting will be held on 6./7. October 2011 in Paris.

Essen, April 2011