Minutes of Meeting

VGB-Technical Committee:	**Generation and Technology**
VGB-Working Panel:	**PGMON**
	Power Generation Maintenance Optimisation Network
	37th Meeting on 11./12. 9. 2008 in Swindon

Agenda

Welcome (Paul Thame)

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Paul Thame, EON UK

TOP 2: Turbine Revision Experiences
Heinrich Grimmelt, VGB

TOP 3: Long Term Service Agreements
Hartmut Drogan, Michael Rindler, Siemens

TOP 4: Biomass Experience
Henning Lundstrom, Vattenfall

TOP 5: Are your reaping the benefits from your monitoring system?
Rob Herbert, RWE npower

TOP 6: Laborelec in the GDF group
Frederic Linard, Laborelec

TOP 7: CCGT Compressor Degradation - Does on-line blade washing help?
Dr. Lynn Gilbert, RWE npower

TOP 8: RAM Projects
Henk Wels, NRG

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Alan Joslin, RWE npower

TOP 10: Place and date of next venue

TOP 1: Wind Turbine drive train monitoring
Paul Thame, EON UK

E.ON UK have more than twenty wind farms, onshore and offshore, with turbine technologies ranging from early 250 kW machines to some of the most modern and largest machines in commercial deployment (3 MW). All of the machines have gearboxes and gearbox reliability is the biggest technical problem across the fleet at present, regardless of supplier. Failures affect both bearings and gears. Larger turbines (MW+) suffer twice as many failures as smaller turbines and the worst failure rate of all has been encountered offshore where the repair process is the most complex.

The gearbox reliability problem is not acceptable and E.ON UK are implementing condition monitoring strategies to provide advanced warning of failures. This is reducing downtime by allowing new parts to be procured whilst the machine is still able to run and by limiting the consequential damage that would occur if the machine were run right to failure.

Traditional gearbox monitoring is undertaken with vibration analysis. However, large turbines employ gearboxes with planetary stages and degradation is difficult to detect by vibration alone because of the poor vibration transmission path to external surfaces. To improve gearbox monitoring, E.ON UK have undertaken trials with oil debris monitoring, making separate counts of ferrous and non-ferrous particles in different size ranges. Combined with vibration monitoring, this has been successful in improving the ability to detect the onset of problems and gives a useful warning time before failure.

The presentation can be found in the closed user group.

TOP 2: Turbine Revision Experiences
Heinrich Grimmelt, VGB

One of the duties of the VGB is the collateral consulting service at the realisation of projects. This service is particularly utilised by „smaller“ operators.
In this present case it concerns a main revision on a 5 MW Siemens steam turbine. It was our duty to support the operator at the call for tender, which should be strictly realised according to the guidelines of the VOB.
According to these guidelines an extensive call for tender was first prepared. It includes the request for submitting the tender; the list of articles and conditions; the special conditions of contracts, as well as the additional conditions of contract. Basically the overhaul of the standby rotating blading as well as a 14 day revision of the turbine, gear unit and the generator was foreseen.
Five suppliers were contacted; amongst these, four submitted their tender.
After a second run the tenders were comparable. With the help of a criteria key the tenders have been evaluated. This key consisted of 40% supplier experience of implementing a revision of this type of steam turbine, and 30% was decisive on the price. The remaining 30% was distributed on the sufficiency of the tender etc.
According to this evaluation grid, the recommendation was given by the VGB to assign a company which was relatively new on the market.
The first part, the overhaul of the rotating blading, was implemented in Romania to everybody’s satisfaction.
The revision itself started well. The jobsite was always tidy and the necessary measures were agreed with the operator and the VGB for some additional work.

Then there was a change of foreman. Soon after, two cracks were identified at a parting joint of the lower part near the cross flange. A first inspection carried out by the contractor, using a dye penetration test, confirmed the cracks. The contractor charged a company called Schmidt to perform further inspections. The cracks were again detected via eddy current tests. After that, a company called Dreifeld was charged to perform ultra sonic tests. These tests showed a crack depth of 5 mm.
The contractor handed in an offer of repair (disassembly of the lower part, repair at a workshop and reassembly) at a price of 150.000 €.
The non-destruction test reports were handed in to the VGB for evaluation.
According to our opinion the inspector of company Dreifeld could not detect any crack depth with the used detector. After talking to him, he said the ultra sonic test was not only implemented from above but also from the sides. We doubted this.
Furthermore we gave the recommendation to repair the cracks in an assembled condition. This was rejected by the contractor vehemently. A statement of the AZT confirmed our recommendation.
A quotation was solicited by the operator at a boiler company called Wehrle. It amounted to 30.000 Euro. The contractor also handed in a quotation of repair in an assembled condition. This amounted to 50.000 Euro.

Thereupon the company Wehrle accepted the bid. We should undertake the supervision.
After the preparation works were finished, a new dye penetration test was implemented to show the exact path of the crack. This inspection showed no cracks. So the operator charged the TÜV, which worked at the boiler, to do an eddy current. This was also negative.
The operator instructed then to continue the revision.
With an interruption of five weeks the revision was completed.
The start-up commissioning took altogether two weeks and there are still the following items remaining:

Internal leakage at main steam valves
Stuffing box is leaky at the rear
Numerous oil leakages.

The presentation can be found in the closed user group.

TOP 3: Long Term Service Agreements
Hartmut Drogan, Siemens

Mr. Drogan presented the Siemens concept for O&M Contracts

The presentation can be found in the closed user group.

TOP 4 Biomass Experience
Henning Lundstrom, Vattenfall

VATTENFALL has a strong ambition to reduce the CO2 emissions, to be CO2 neutral in 2030.
VATTENFALL has a road map to CO2 neutral production in Scandinavia.
One of the means is to use more biomass.

Straw is one of the CO2 neutral fuels. A plus for the environment, but to get the full benefit in power production the 4 challenges of transporting, storing, burning straw and cleaning flue gas must be solved, and at the same time take working environment into consideration.

Danish power stations have more than 20 years of experiences with the use of straw and other biomass fuels.

More new techniques and designs have been taken into use to prevent the 4 challenges Based on the experiences VATTENFALL now has 2 new biomass units under construction in Denmark.

New techniques will be taken into considerations to reach the goal of CO 2 neutral power production in 2030.

The presentation can be found in the closed user group.

TOP 5: Are your reaping the benefits from your monitoring system?
Rob Herbert, RWE npower

The presentation can be found in the closed user group.

TOP 6: Laborelec in the GDF group
Frederic Linard, Laborelec

The presentation can be found in the closed user group.

TOP 7: CCGT Compressor Degradation - Does on-line blade washing help?
Dr. Lynn Gilbert, RWE npower

Gas Turbine recoverable losses caused by compressor fouling can be restored by off-line compressor washing. On-line washing is also conducted by many operators, in accordance with OEM guidelines and often warranty or LTSA requirements. Whereas the benefits of off-line washing can be clearly demonstrated, the effectiveness of on-line washing is not as straightforward to observe. Cleaning the compressor on-line at full speed, normally with a detergent solution, can be effective in the first stages but as a result of evaporation of the droplets during compression, the solution (and any entrained particles removed from the early stages) can be deposited further back.

In order to try and assess the effectiveness of on-line blade-washing at RWE npower CCGT plant, baseload output data was collected, which was fully-corrected for ambient conditions and other known influencers such as filter differential pressure and exhaust temperature control. The availability of this data is limited through operation in the flexible UK power market, where plant are seldom operating at baseload and the resulting data is noisy and has to be collected over extended periods of time before any trends can be observed. At one particular CCGT plant data was collected over a number of years to try and ascertain the effectiveness of on-line washing, the effectiveness of using a detergent solution to wash and to try and determine an optimum compressor washing regime. None of these trials showed statisitcally significant results and in

some cases were hampered by uncontrollable factors (such as a compressor bearing oil-leak increasing the rate of compressor fouling). However, it was possible to observe that, whatever the wash regime, output continued to degrade between off-line washes, but there was no evidence to suggest that reducing the frequency of on-line washing from every other day, to every three days, to weekly accelerated the degradation rate.
Currently at RWE npower CCGT plant, we operate a variety of on-line washing regimes at the operators discretion and continue to monitor the degradation of output. It is possible to observe at one plant that during winter periods when ambient temperatures prevent bladewashing and wash frequency reduces, degradation does accelerate. It can also be seen that recent improvements to the air-intake filtration system at another plant have had a significant impact on compressor degradation regardless of wash regime.

The presentation can be found in the closed user group.

TOP 8: RAM Projects
Henk Wels, NRG

The Nuclear Research & Consultancy Group NRG and KEMA work together to improve the Reliability Availabilty & Maintainability (RAM) of conventional power plants. The cooperation with regard to methods, reliability data and technical expertise is being applied in a number of projects, 3 of which are described below.

Project A: RAM-specification of the Dutch utility NUON's Magnum coal gasification plant. RAM-specification is the process of functional and numerical specification of RAM and proof by the manufacturer(s) that this is delivered by design and realization. Magnum is a 1200 MWe gasification plant that is being build at Eemshaven in the Netherlands. A RAM-specification program containing a Failure Mode Effect Analysis FMECA and analysis of reliability data, plant availability, spare parts and maintenance (RCM) is being carried out by the manufacturer.

Project B: analysis of the probability that Blast Furnace as a fuel is not converted to electricity by 2 existing conventional plants, an existing Combined Cycle unit and a new Combined Cycle units at a NUON site. Since the conventional plants have been in operation for over a decade, the right balance between generic data from literature, databases and plant specific data had to be found. Also, condition of the plant components as well as equipment troubled by root cause problems were taken into account. Detailed models were constructed per plant and were simplified to super-models to described the site. It was found that the combination of analytical Reliability Block Diagrams and Monte Carlo simulation is an ideal trade-off between the calculation speed of an analytical model and the ability to model the complexity of reserve plant by simulation but at the expense of long calculation time. Also, using both models for the same situation allowed a thorough check on results.

project C: analysis of Dissolved Gas in Oil (DGA) for transformers. Analysis of degradation trajectories in general allow to prevent failure and to optimize maintenance & inspections. DGA is a mature technique to monitor developing faults in transformers. A project has recently been started using KEMAs large DGA database to analyze the degradation patterns as a function of time depending on the type of fault that develops. It is envisaged to model these patterns by Markov Decision Analysis in order to optimize maintenance and optimize replacement of ageing transformers.

The presentation can be found in the closed user group.

TOP 9: Post-Outage Commercial Optimisation
Alan Joslin, RWE npower

Unplanned extensions to planned plant overhauls can be expensive, and this is particularly evident for utilities operating in a commercial market environment. Generation that has been contracted forward must be purchased from the market, and the shorter the notice given when buying back the generation the higher the cost tends to be. The commercial impact can be mitigated to some extent by early identification of possible outage overruns.

Common practice is to forecast the most likely date of return to commercial service, and for this to be reviewed as the overhaul progresses and the certainty about the extent of the work scope increases. A model has been introduced by RWE npower which enables project managers to quantify the risks of not being available at the end of the outage over a range of dates. This in turn allows optimum decision making about when to offer the unit as available to the market, taking into account the risk profile.

The model works by breaking the project down into a relatively small number of elements, and requires the project manager to answer a few simple questions about duration and duration risks for each stage. Answers should be based on credible levels of risk, preferably using risk scenarios drawn from experience. The model uses a power law probability distribution to extrapolate from the input levels of risk (the "known unknowns" as Donald Rumsfeld would put it) towards high-impact, low-probability areas (the "unknown unknowns"). This models the long tail effects of the risk distribution, although the degree to which the distribution used accurately corresponds with the real distribution of risk profile will only become evident with experience. Elements of the project are combined with a Monte-Carlo simulation to produce a risk profile for the project.

The project completion risk profile is then used in combination with market data to optimise hedging strategy.

TOP 10: Place and date of next venue

The next meeting will be held on March 26/27, 2009 in Arnhem.

Essen, December 2008