Minutes of Meeting

VGB-Technical Committee: **Generation and Technology**

VGB-Working Panel: **PGMON**

Power Generation Maintenance Optimisation Network

32nd Meeting on 30./31. 3. 2006 in Amsterdam

Agenda

Welcome (Henk Wels)

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Frank Scheuch, PFW Technologies

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Alan Joslin, RWE npower

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TOP 1: Precise assembly and condition related maintenance of bolted joint connections by means of PMTS
Frank Scheuch, PFW Technologies

The power industry uses large numbers of bolted connections in structures, piping, vessels, flanges, turbines, compressors, and pumps. They are used to facilitate assembly and provide access. In some cases large numbers of bolts, which may be up to 2 metres long, are used in critical components. Many require regular maintenance and in a world of increasing concern over safety, a documentary record of achieved clamp load is essential. As engineers develop equipment for more remote operation, the concept of intelligent fasteners, which at the touch of a button can provide their exact clamp load, is very attractive.
During the last 7 years, work has begun on using permanently mounted transducers to measure the clamp load on critical components in the aerospace and defence industry. Lead engineers are experiencing at first hand the benefits of knowing exactly what stresses are being maintained in flanges and lifting frames. A growing number of fitters are experiencing the savings in time, and the satisfaction of having a verifiable record of the clamp load they achieved on the assembly. An added benefit is the facility to return at any time to check whether relaxation owing to distortion or vibration, has occurred reducing the clamp load.
The main applications are in measuring the tensile stress in fasteners for turbines, diesel engines, gear boxes, cranes, pressure vessels, reactors, and heat exchangers in many different industries. In the automotive industry, there has been a long history of more than a decade of using this equipment for cylinder head bolts, transmission, and steering. In the petroleum and offshore industry there are critical applications such as crane slewing rings, flanges on compressed air reservoirs, and turbine and compressor maintenance.
The tightening of fasteners has traditionally relied on the force of a fitter using a torque wrench or exerting his strength on a length of bar. Where there are large numbers of, for example, 8 – 12 mm diameter bolts, the use of a transducer will ensure the fitter knows for certain what clamp load has been achieved. Start-up conditions: deformation, temperature, pressure pulses, and vibration can relax a joint. The errors resulting from relying on torque are frequently between 25% and 50% due to friction scattering under the bolt head and in the screw threads. The PMTS system can give better than +/-3% accuracy.

The presentation can be found in the closed user group.

TOP 2: RWE npower's approach to Plant Efficiency Monitoring and Improvement Strategies in the context of the European Emissions Trading Scheme
Alan Joslin, RWE npower

The value of power plant efficiency has increased markedly in the UK with recent fuel price rises, especially gas price, plus the cost of emitting Carbon under the Emissions Trading Scheme introduced in 2005. This has put far greater emphasis on the improvement of plant performance.

RWE npower are tackling performance improvement by:

- Plant modifications (e.g. steam turbine upgrades)
- Better efficiency management (strengthen specialist competency, raise non specialist awareness, monitoring and information systems)
- A “Focus on Leakage” initiative (including boiler casing, air heater seals, water and steam leaks)
- Off line monitoring using TEMP (Thermal Efficiency Monitoring Programme).

TEMP, now TEMPplus, has been developed from the old CEGB system and compares actual thermal efficiency with a target value derived from demonstrated performance maxima. TEMPplus has been extended to include biomass fuels and FGD, it provides better portfolio reporting and has a forecasting module to determine generation fuel costs and optimise portfolio performance.

The challenges that RWE have encountered in their efforts to improve efficiency are:

- Culture (e.g. availability v. efficiency)
- Competency (difficult recruiting.)
- Monitoring systems (especially instrument maintenance)
- Awareness and Ownership (Operations and Maintenance).

The presentation can be found in the closed user group.

TOP 3: Coal gasification at Buggenum plant, lessons learnt
Radoslaw Gnutek, NUON

NUON is an independent Dutch utility company, producing electricity both conventionally and from renewable resources, supplying gas and heat to domestic and institutional clients, trading in the Netherlands as well as other European countries. NUON is the third largest producer in the Netherlands. It has unique position in the energy business having in its portfolio one of the biggest IGCC plants in the world. Over the years, NUON has developed advanced experience in power generation based on syngas (Buggenum — IGGC, coal, 253 MWe, Velsen — conventional, blast furnace gas (BFG), 846 MWe, and IJmond — GTCC, BFG, 144 MWe).
Since several of its older units will come to the end of their lifecycle during the next decade, NUON is planning further development of a sustainable power generation fleet, based on Best Available Technology (BAT) and the possibility to fire biomass at high environmental and thermal efficiency.
IGGC is an important candidate for new power plant and a press announcement has already been made in September 2005 for an IGGC of 1200 MWe firing coal, biomass as well as natural gas. Thanks to utilizing of biomass, CO2 emissions in the Netherlands will be reduced. By using a multi-fuel concept, the plant can be operated more flexible than other Dutch power plants. Location is still to be decided, grid operation is planned to be around 2010/2011. The engineering will be based on NUON competitive edge: Buggenum is the first fully integrated gasification plant with a Combined Cycle. This unit was commissioned in 1994 as a DEMKOLEC demonstration plant, however has been developed by NUON into a fully commercial plant fuelled with up to 30 % biomass. Lessons learnt from Buggenum are to be implemented for the new MAGNUM project.

The presentation can be found in the closed user group.

TOP 4: R & D Items in Netherland
Henk Wels, NRG

KEMA conduct a co-funded R&D programme on behalf of the power utilities operating in the Netherlands. The participants are NUON, Essent, E.ON Benelux, Electrabel and EdeA. There is an annual round at which ideas are assessed. The utilities buy into programme topic areas called clusters. The projects within the Maintenance and Integrity cluster were presented for illustration. Subject areas include:

- Life management and life extension
- Cold end power plant components. Inspection and maintenance.
- Preservation of principal electrical equipment
- Welding and Repair:

The presentation can be found in the closed user group.

TOP 5: Overhaul management
Santos Silva, Miguel Simas, EDP

EDP presented a method of setting overhaul interval by using reliability calculations to predict the probability of forced outage for a given maintenance interval. Probability of failure increases with interval time. The annualised forced outage cost (repair + lost generation) is then compared with the annualised overhaul cost.

The probability of forced outages is predicted per sub-system or major component using a two parameter Weibull model for each. This can show a deteriorating failure rate for parts that wear out and reflect shorter lives for parts more highly stressed, for example by the operating regime.

The presentation can be found in the closed user group.

TOP 6: IEC PS Maintenance Strategy and Planning of Overhaul
Reuven Nacht, IEC

A. <u>General</u>:

Israel Electric Company is the sole utility which provides electricity to a population of seven million in Israel. IEC is operating as an island, with no other generators (of significance) inside or out of the country to support it.

Fast increase in load demand (in decades) and constant lagging in the construction of new capacity caused constant lack of generation reserve margins.

Installed capacity of IEC currently is some what over 10 K MW. Consisting of some 50% coal firing units (360 and 575 MW units), 15% heavy oil steam units (220 MW ea.) 20% light oil (gas turbines + CCGT) and 15% natural gas (Steam + CCGT).

Units availability and reliability levels in general are kept in the range of 90% (and higher) available, 7% at planned maint., 3% at unplanned maintenance (and lower).

Winter and summer are peak demand seasons and spring and fall are low load demand seasons when the planned overhauls (outages) are performed.

IEC procedure requires that some 10% capacity reserve (hot and cold) is kept at all times. However this is not achievable, as mentioned above, during the years of 2005 and 2006.

Operation is mainly cycling (i.e.: full load during the day and part load at nights). Gas turbines and CCGT are two shifting.

B. <u>Maintenance Strategy</u>:

IEC maintenance strategy is Time Based Preventive Maintenance due to the lack of reserve capacity and Generation System Characteristics. This is necessary to assure and maintain the required very high level of availability and reliability of the generating units.

Major targets are to enhance availability, reliability, efficiency, flexibility, safety, life and low emissions.

Predictive Maintenance is also enhanced, where effective. This includes – visual inspections, DT, NDT, thermography, stresses and vibrations analyses, chemistry etc.

Unplanned Brake Down Maintenance is kept to a minimum.

Overhaul scope of work at the overhauls is based on manufacturer's recommendation, long term IEC experience and accumulated work orders (gathered during operation, between the outages). These that maintenance can not resolve during unit operation.

Overhaul intervals are based on - legal boiler inspection code requirements, manufacturer's recommendations, IEC accumulated experience, world wide experience (gained from USA, UK and Germany) and the Israeli system optimization requirements.

Overhaul duration is mainly based on the scope of work, costs of replacement fuel and the time necessary for the repair, as follows:

Overhaul detailed planning is achieved using computer project programs utilized by very experienced planners.

Critical path works are carried out based on two (10 hours) shifts six days a week. Work on Saturdays are allowed only for repair of failures. In general, steam units are shut down for 4-6 weeks once in 1½ - 2 years. Steam turbines and generators 6-8 weeks, once every 8-12 years.

Overhaul projects are managed by plant personnel trained and experienced. So are gas turbines, minors, CI, HGPI and Majors where Technical Advisor from the OEM is generally hired. For G.T. of "F" technology, we have long term maintenance agreements with GE and Siemens (LTSA) where IEC provides the local man power.

Overhauls are planned and are managed as projects, taking care of all the details, including scope of work, work packages, man power, tools and availability of spare parts and the budget are scrutinized, approved and closely controlled.

Spare parts are stored on site, where procured mainly as part of the initial contract bid by the manufacturers. Additional parts are added based on accumulated experience. The costs of spare parts vary between 18 $/Kw for coal fired units and up to 26 $/Kw for CCGT.

Optimal planning of the outages (Maintenance Scheduling) is made using special computer programs (developed in-house, at IEC). These are based on loss of load probability algorithms and are also based on least cost planning including direct costs and replacement fuels costs.

General plans are prepared three years in advance for the whole fleet of IEC generators (some 60 units) and they are updated at least four times in a year (early in a season).

The average cost of electricity generation in IEC including Capital Fuel Costs and O&M is approximately 3.5 ¢/Kwh.

C. Summary:

IEC maintenance strategy is preventive, planned, time based maintenance. This is directed at maximizing availability and reliability of the generating units.

Safety and longevity of life are also enhanced. These are mainly determined from the lack of spare capacity and the high costs of replacement fuels (i.e.: light oil).

Predictive maintenance is promoted, where effective, in order to optimize machine shut down to a minimum.

Unplanned (Break Down) maintenance is kept at minimum. Detailed planning of the Scope, Schedule, budget and quality are enhanced. Project management of the overhauls is of the highest standard.

Optimized planning and Scheduling of the overhauls is considered as a major goal.

The overall operational and maintenance efforts result in relatively low cost of electricity supplied at high quality.

The presentation can be found in the closed user group.

TOP 7: EDF Component (and their failure modes) Generic description
Claude Degrave, Antoine Despujols, EDF

A generic equipment breakdown was undertaken by EDF in order to carry out RCM studies on nuclear and fossil fired stations. About 100 generic equipment so-called “functional groups” were split into sub-sets and components (e.g. motor driven pump ->pump -> moving parts -> bearing). Associated with, generic failure modes were identified at the equipment level and dispatched at the suitable lower levels. This set of generic data, collected in a database, is now used as a basis in several steps of the RCM process and especially in FMEA, operation feedback analysis and maintenance task selection.
In addition this generic description can serve as a starting point for other studies as for example a Preventive Maintenance Basis. A pilot study was carry out on fossil fired stations to list all the preventive maintenance tasks covering a given equipment failure mode. Based on the generic equipment breakdown, tasks coming from PWR’s PM programmes and R&D monitoring techniques catalogue are proposed. This kind of PM database could be a way to improve the PM programmes and to share expert knowledge about best maintenance practices to avoid critical failure modes.

The presentation can be found in the closed user group.

TOP 8: Managing the integrity of low temperature pressurized pipework
Paul Thame, EON-UK

In the UK, there has been an increase in the rate of failures of pipework containing steam and water at temperatures below main steam conditions. The pipework is typically made from carbon steel and the generating units concerned have been operating for 35 – 40 years, including several years of two-shifting. The failures are potentially dangerous to personnel and a new strategy is being developed to manage the risk.

Examples of the pipework at risk include cold reheat steam, LP steam, bled steam, feed water, drains, feed heater systems and the boiler circulating water. Failures have been caused by a number of different mechanisms, some causing wall thinning (e.g. flow accelerated corrosion, droplet erosion) and some cracking (e.g. corrosion fatigue). It is not realistic to inspect all of the pipework because there is so much of it. A risk based inspection strategy has therefore been developed to target higher risk locations. The risk criteria include the nearness of personnel, history of previous failures and physical parameters specific to each failure mechanism (e.g. pipework geometry, pH, temperature, material composition).

TOP 9: New regulations for cooling water
Rudie Heling, NRG

In 2005 in the Netherlands a new approach for cooling water regulations has been introduced. The reason of this new approach is that the previous emission-based regulation led to the need to tolerate cooling water discharges exceeding the threshold temperature of 30^{o}C in hot summer periods. This constraint combined with the fact the volumetric river flow rates are decreasing due to climatologic changes led to a critical situation with respect to sustainable production of electricity. The previous regulation was also based on the temperature difference between the inlet and outlet water. Especially for chemical plants, less for power plants, this was an extreme condition. The new regulation, currently implemented in the permits of existing and new power plants is merely based on the thermal impact of the cooling water discharges. Difference with the previous regulations, is that now the discharge criteria are based on isotherms in the received water body, both in the near - and in the far- field; for the near field, a 30^{o}C isotherm is allowed in 25% of the vertical cross section, for the far field, a daily- and cross-section-averaged temperature 28^{o}C is the maximum allowed impact of the discharge. To evaluate these criteria complex thermo-hydrodynamic models are required to get insight into the behaviour of the cooling water plume in environments varying from lakes, reservoirs, rivers, tidal rivers, estuaries, and coastal areas. In a large number of case studies, the 3D model THREETOX has been applied on these types of water bodies to investigate the impact of the cooling water - including brackish and saline water. The general conclusion derived from these studies, is that major discharge water is stratified significantly and therefore the 25% of the cross section is in none of the cases exceeded. Even more, the heat capacity allowed to discharge is significantly higher than under the previous regulations. The most sensitive water bodies cases are rain rivers, - Meuse- and shallow harbours. At present a model-based advice system is under development for weekly justification of the cooling water discharges in hot summer periods.

TOP 10: The needs of maintenance during the planning of a new PS
Heinrich Grimmelt, VGB

In Germany a lot of new power stations are going to be built in the next years. There should be made efforts from the maintenance people to influence already the planning of these power stations to get plants where the maintainability is rather high. The committee installed a working group under the leadership of Dr. Thomas from RWE Power which will create an instruction manual with recommendations for the maintenance departments. First ideas can be seen in the presentation in the closed user group.