Minutes of Meeting

VGB-Technical Committee:	**Generation and Technology**
VGB-Working Panel:	**PGMON**
	Power Generation Maintenance Optimisation Network
	31st Meeting on November 24-25, 2005 **in Neckarwestheim**

Agenda

Welcome (Stefan Wich-Schwarz)

Introduction to Neckarwestheim nuclear power plant
Plant visit to Unit 2.

Plant ageing and maintenance expenditure

TOP 1: Quantification of the impact of operating regime on equivalent forced outage rate
Alan Joslin

TOP 2: On-line data gathering and analysis hour
Joe Dalton

Technology

TOP 3: Bi-Corona, New technology for Dust Separation
Hajo Cürten

TOP 4: EPR, European Pressure Reactor
Claude Degrave

Maintenance Quality

TOP 5: Safety Assessment of Boiler Drum Level Control
Paul Thame

TOP 6: Practical use of bayesian methods to assess component´s reliability
Mr. Billy, EDF

Miscellaneous

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Neckarwestheim Nuclear Power Plant

Neckarwestheim is owned and operated by EnBW. It has two pressurised water reactor (PWR) nuclear units, both built by KWU. Unit 1 is a three loop PWR producing 785 MW. It started operation in 1976. Unit 2 is a four loop PWR producing 1,269 MW from a single turbo-generator. It started operation in 1988. Both units have an annual planned outage which typically varies between 2 to 4 weeks in duration and the plant has an excellent reliability record.

Mr. Wich-Schwarz’s introduction included additional operational and planned maintenance details and a very informative visit to Unit 2.

TOP 1: Quantification of the impact of operating regime on equivalent forced outage rate Alan Joslin

With the arrival of the New Electricity Trading Arrangements in England and Wales in 2001, costs of failure to meet generation contracts due to forced outages or load restrictions could frequently be very high. Also, the new arrangements caused significant changes in operating regime. Forecasting equivalent forced losses based simply on historic performance could be misleading, resulting in excessive costs due to losses or reduced earnings through being over cautious and keeping too much capacity in reserve. Innogy, which later became RWEnpower, had plentiful loss data, mostly from coal-fired stations we owned and operated or those we had previously owned. This presentation describes how RWEnpower quantify the expected relationship between forced losses and operating regime, hence improve the accuracy of our forecasting, and manage better the commercial consequences of availability losses.

Our primary objective was improve the costing of risk of commercial failure, thus improve marginal pricing under changing operating regimes. Overall portfolio commercial performance could be optimised, and financial planning could be improved by using the resultant failure rates to forecast commercial losses, enabling provision for such losses in business plans.

The loss data which was available to us covered more than 60 units ranging in size from 100MW to 660MW. Operating data (including generation, time on load, starts and type of starts) was also available. However, before undertaking the analysis the data was critically examined and some less-reliable data was filtered out of the analysis.

For the coal-fired units considered, the data covered a wide range of operating regimes. This allowed better correlation of forced losses with starts and generation. For other units, including CCGT plant, operating regimes had been generally base load since commissioning. The approach discussed here is not applicable to such units, but the presentation describes how we used a different process to arrive at factors for these units that can be used to forecast future losses.

The presentation describes the model we tested for coal-fired units to relate forced outage losses to generation and starts, and discusses how the model could be refined. Typical results are given for large coal-fired units, and the reasons for differences between such units are considered. Also discussed is a different approach used to model on-load restrictions, and how these vary with operating regime.

The results of this analysis, which are reviewed and updated annually, are now a key part of RWE npower’s business planning process and short-term planning process.

The presentation can be found in the closed user group.

TOP 2: Operations Monitoring in ESB Power Generation
Joe Dalton

Until recently, the majority of data acquisition was based on manual or semi automatic processes, and was not centralised. In 2001, ESB introduced an Operational Information System in key power stations. The expected benefits included automatic recording and compression of Data, Access to that data at all levels within the organisation, potential for “real time” analysis and trending. This paper indicates some of the uses that the data is being put to, and some of the difficulties and unexpected benefits of a Historian database.

The presentation can be found in the closed user group.

TOP 3: Bi-Corona, New technology for Dust Separation
Hajo Cürten

Hanjo Cürten, Marketing and Business Development Director of Balcke-Dürr GmbH, reports on the new electrostatic precipitator technology "Bi-Corona".

The development of this technology has the following goals:

1. Improvement of the dust collection efficiency, particularly in the range of smaller particle sizes. These particles are increasingly difficult to collect as their size decreases.
2. Reduction in energy consumption and thus increase in efficiency.
3. Applicability in existing electrostatic precipitators without great retrofit efforts.

A pilot unit installed in a German lignite-fired power plant has shown that the set goals are achievable.
This technology is characterized by the fact that the ionization zone is separated from the collection zone so that "electric wind", which is the cause of collection difficulties in the range of finer particle fractions, can be prevented.
Details on this are given in the attached presentations.

Furthermore, Mr. Cürten speaks about the other products and services from Balcke-Dürr, a company which has been manufacturing and supplying components as well as providing power plant service for more than 120 years.

Balcke-Dürr's range of products includes:

1. Components for the flue gas path (air heaters, electrostatic precipitators, gas/gas heat exchangers, static gas mixers for DeNOx units, heat displacement systems)
2. Components for the water/steam cycle (feedwater heaters, deaerators, turbine condensers, cold end system)
3. Membrane walls, pressure parts and superheater surfaces for steam generators

A product that attracts great interest is the SNAKE HP feedwater heater because it allows the feed-heating plant to be designed as single-train system and is particularly unsusceptible to load changes, startups and shutdowns.

For combined cycle power plants, Balcke-Dürr supplies heat recovery steam generators, air inlet filters and turbine condensers.

The range of products for nuclear power plants comprises moisture separator reheaters and the POWERSEP preseparator system, which can also be retrofitted in existing nuclear power plants.

The presentation can be found in the closed user group.

TOP 4: EPR, European Pressure Reactor
Claude Degrave

The EPR reactor is a PWR in the 1,600 MW class. Its design is based on experience feedback from several thousand reactors x years of light water reactor operation worldwide, primarily those incorporating the most recent technologies: the French N4 and the German KONVOI reactors. It integrates the results of decades of R&D programs, in particular, those performed by the CEA (French Atomic Energy Commission) and by the Karlsruhe Research Center in Germany. Regarding safety, the EPR features innovations to prevent core meltdown and mitigate any potential consequences. It also offers exceptional resistance to external hazards, specially airplane crashes and earthquakes. Thanks to a number of technological advances, the EPR is at the forefront of the state-of-the-art technology. Its main features benefit from this progress: the reactor core and its protection system, its flexibility in terms of fuel management, the large components such as the pressure vessel and its internals, the steam generators and the primary coolant pumps, as well as the I&C (instrumentation & control), the Man-Machine Interface and the plant control room. These innovations contribute to the high level of performance, efficiency, operability and economic competitiveness of the EPR.

From the start of the project, the Franco-German cooperation set up to develop the EPR brought together:
• power plant manufacturers, Framatome and Siemens KWU (whose nuclear activities have since been merged to form FramatomeANP, now AREVA);
• EDF, and the major German utilities, that merged to become E.ON, EnBW and RWE Power;
• safety authorities from both countries to harmonize safety regulations.
The EPR takes into account the expectations of utilities, as outlined by the European Utility Requirements (EUR) and the Utility Requirements Document (URD) issued by the U.S. Electricity Power Research Institute (EPRI). It complies with the joint recommendations (1993) and positions on major issues (1995) set up by the French and German safety authorities.

The technical guidelines covering the EPR design were validated in October 2000 by the French standing group of experts in charge of reactor safety (Groupe Permanent Réacteurs), assisted by German experts.

The EPR is a direct descendent of the well proven N4 and KONVOI reactors, guaranteeing fully mastered technology. As a result, customers are protected against any design, construction and operating risks.
Operator expertise acquired through the operation of nuclear power plants built using the same technology as the EPR is maintained. Another major advantage is that the existing industrial

capacities for design, equipment manufacturing and nuclear power plant construction can be easily deployed and utilized to build new power plant projects based on the EPR.

Future nuclear power plants will have to be even more competitive to cope with the newly liberalized electricity market. Due to an early focus on economic competitiveness during the design process, the EPR offers significantly reduced power generation costs, estimated as being 10% lower than those of the most modern nuclear units currently in operation, and about 20% less than those of large combined-cycle gas plants. This advantage over fossil fuel plants is even more pronounced when power generation “external costs” are taken into account, i.e. the costs associated with the damage to the environment and human health. This competitiveness is achieved through:

- unit power in the 1,600 MWe range, i.e. the highest unit power to date;
- 36–37% efficiency depending on site conditions, the highest value ever for light water reactors;
- construction time from pouring of the first concrete not exceeding 48-months;
- service life increased to 60 years;
- enhanced fuel utilization;
- up to 92% availability factor, on average, during the entire service life of the plant, obtained through long irradiation cycles, shorter refuelling outages and in-service maintenance.

The presentation can be found in the closed user group.

TOP 5: Safety Assessment of Boiler Drum Level Control
Paul Thame

Standard IEC 61511 is a process industry interpretation of IEC 61508 (Functional safety of electrical/electronic/programmable electronic safety related systems). The title of IEC 61511 is “Functional Safety – Safety Instrumented Systems for the Process Industry Sector”. Its philosophy is based upon hazard identification and then risk assessment. A safety system is given a Safety Integrity Level (SIL) according to the level of safety risk that it protects against. The higher the SIL, the more reliable the safety system must be.

Power Technology (part of E.ON UK) are developing a process for implementing Standard IEC 61511. The standard has been accepted by the UK’s Health and Safety Executive as best practice and thus the measure against which companies will be assessed for their management of safety protection systems. As part of Power Technology’s development work, boiler drum level protection has been used as an example.

Boiler drum level is controlled by providing an in-flow of feed water equal to the out-flow of steam and then fine tuning based on the physical level of water in the drum. For the coal units in the example, the protection system consists of an extreme low level alarm and a skilled operator who acts upon the alarm. There are examples in the UK power industry of the protection failing and the boiler water level falling until furnace tubes overheat and blow out. In the examples, the tubes all blew inwards into the furnace and nobody was hurt.

The boiler drum level study concluded that the traditional UK reliance upon alarms and operators may not be adequate protection in some cases, especially where control room staffing levels have been reduced or alarm systems are not very clear. The options to reduce the risk to personnel are to add automatic protection that trips the firing when the boiler drum level falls below an extreme minimum or, otherwise, to reduce the number of incidents by designing away some of the root causes. Individual analyses need to be made to assess the requirements for each plant.

The presentation can be found in the closed user group.

TOP 6: Practical use of bayesian methods to assess component´s reliability
Mr. Billy

In reliability studies, when failure data is sparse, point estimates of the failure rate might be doubtful and uncertainties on the value very large.
Bayesian techniques, which enable the analyst to add a prior modelling, relying on feedback experience or expertise, is a good way to improve the quality of reliability studies.
Some examples, related to simple modelling cases (models with no aging) were presented and discussed.

The presentation can be found in the closed user group.

TOP 7: Miscellaneous

TOP 7.1: Summaries and presentations

Each member who is giving a presentation is asked to send the summary within 2 weeks after the meeting to VGB-HQ. The summary will be added to the Minutes and made available through the VGB web site to the public domain (unlike full copies of presentations which are restricted to the password protected member area). The length of the summary should be a third to a half side and it should be informative to readers outside of PGMON without divulging confidential material. For propaganda reasons the agenda should be ready 6 weeks before the next meeting. VGB will send a request 8 weeks before the meeting for presentation titles. All attendees are normally expected to offer a presentation.

TOP 7.2: Event Code System

Former code systems (8 of them) which described damages in power plants were replaced by a new system published by VGB. This code system provides a uniform, clear and systematic code for any event. This is necessary to enable computer analysis.
The code system is going to be translated into English language.

TOP 7.3: Topics suggested for next meeting

- Operation and information system (P.I. database)
- Plant efficiency monitoring and improvement
- Aging of PS, how to handle?
- Overhaul intervals, how do people decide?
- Overhaul duration, How long, can we benchmark?
- Maintenance strategy for high energy pipes
- Buggenum IGCC plant, lessons learnt
- Event coding system