Powerful renovation

Rejuvenating the Scholven coal-fired power station to meet new market requirements

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Many of Germany's existing power stations will continue to operate well into the next decade, so it is very important to optimize and maintain existing installations. E.ON Energie, the largest privately-owned provider of energy services in Europe, recognizes the key role of process control systems as the data, information and nerve centers of its plants. Outdated technology and new operational requirements demand focused capital investment. E.ON Energie has, therefore, implemented a program to upgrade the process control infrastructure at the 2200 MW, six-unit Scholven power plant in Gelsenkirchen, Germany. This included replacement of the 345 MW Unit C process control system with ABB's System 800xA.

E.ON Energie is a multinational corporation, serving 15 million customers across Europe with gas and electricity. It relies on state-of-the-art control systems to ensure customer satisfaction on a local level and to maximize efficiency across the group. When the process control system at the company's Scholven power plant needed updating, E.ON approached ABB with a clearly-specified list of requirements. These included:

- fully automatic operation of the power station processes during normal load operation, start-ups, load ramps, shutdowns, standstills, and during upsets
- an ability to operate and monitor the entire system from one control console using individual displays and large screens
- straightforward process monitoring to be carried out by a single process operator
- fast and accurate fault analysis to minimize the risk of outages and to reduce downtime, should outages occur
- time- and fuel-optimized startup with full consideration of material constraints – changeover time from oil to coal firing to be as short as possible

Although originally designed to operate as a base load unit, the changed market conditions now require the Scholven power plant to serve as an intermediate load unit. The operating modes that must be supported when generating power are "turbine follow mode", in which the turbine controls the live steam pressure, and "boiler follow mode", in which the boiler controls the live steam pressure. Both modes must support the coordinated unit control for pure and modified sliding live steam pressure typical for one-through boilers. The unit must satisfy the UCTE grid code requirements for both primary and secondary frequency control. Primary frequency control is achieved by throttling the main steam valve. Secondary frequency control is accomplished while maintaining primary control capability. This means that the load changes resulting from increased demand may be ramped up by means of feed-forward control using the fuel flow only.

A further requirement was, that the unit had to be able to follow demands from dispatch control center, ie, to be able to accommodate frequent, highly dynamic load swings and triangles. E.ON also specified a need for partial load or island system operation; ie, load rejection to auxiliary systems demand (house load) or island network operation. Partial load operation at 33 percent (400 t/h of live steam) of the full rating of the unit was specified (recirculation).

Scope of the replacement program for the process control system

In addition to installing the new process control system, ABB redesigned the entire control room. The existing actuators and sensors had to be upgraded and, in some cases, replaced. All upgrades accommodate E.ON's need for the entire power production process to operate automatically during start-ups and shut-downs. Most of the existing field cabling remained intact, although some new wiring was required to accommodate the newly installed actuators and sensors.

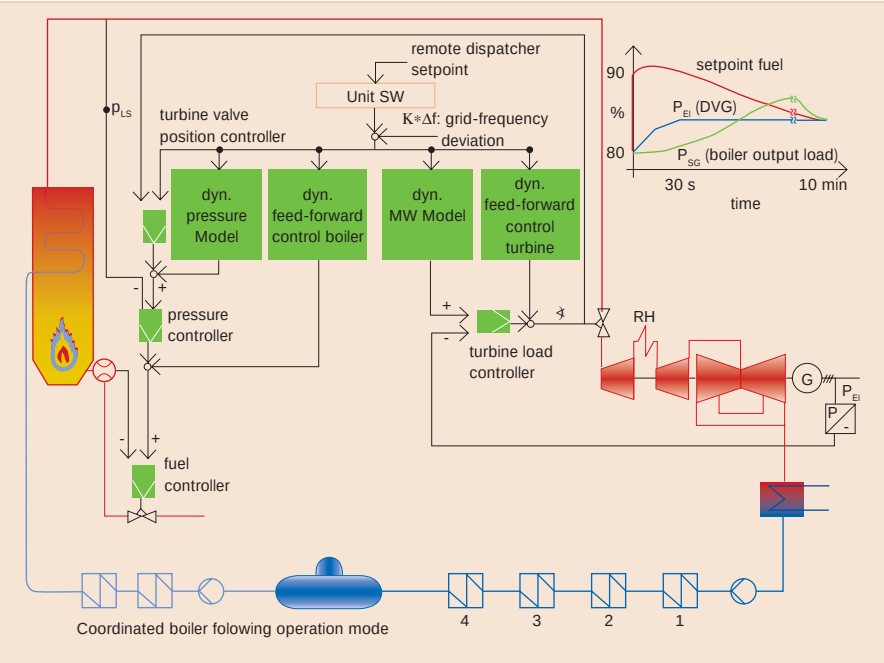
The plant's new turbine control system is based on the ABB's System 800xA with AC 870P controller. This was used to implement a Turbotrol® turbine control application package for the regulation and protection of the main turbine. The integrated turbine, the unit and the process control platform creates numerous synergies and advantages for users.

The control system for the plant's soot blowers and burner had already been implemented using PLCs (program logic controllers). Both systems were integrated via Profibus (process field bus). The design of the interface ensured that the systems could be monitored and operated in accordance with E.ON's specified project standard.

Model-based unit control

ABB's Modan automation concept was used to meet the challenging specifications regarding primary and secondary control capability. This concept coordinates the two main control variables of the power plant; fuel set point and turbine control valves, on the basis of dynamic parallel models. It consistently applies a combination of model-based feed forward control and dynamic set point control. This is done for the turbine control as well as for the set points of the main steam valve pressure and fuel control. The Modan unit control is patented and uses the turbine control valve and the fuel set point value for the steam generator as control variables. The basic outline shown in 1 is greatly simplified and applies to „turbine follow op-

1 Outline of model-based unit control



eration“. The Modan concept also allows other operating modes such as „boiler follow operation”.

Control room design

The unit control console 2 was installed in a new twin control room that serves units B and C of the plant. The newly-designed room incorporates clearly defined work areas for the operators, shift superintendent, electricians (auxiliary systems) and the electrical equipment isolation management.

2 The new control room at Scholven

The control system changeover for unit B and the move into the new control room are scheduled to occur during the annual maintenance shutdown in 2007.

The display screens are only the external indication of a significant increase in the degree of automation at the plant. As a result of the enhancements, the operators' job description has changed from manually controlling the process to one monitoring and correcting a now fully automatic controlled process. It was therefore all the more important to design the control room environment to be stimulating so that employees would be better able to concentrate. The individual objectives that were achieved are as follows:

- Carefully designed control room architecture with clear separation of areas for units B and C.
- Central positioning of the screens for auxiliary services at the shift supervisor's workstation.
- An area that that allows shared use of the equipment isolation counter for the two units.
- Direct and indirect work area illumination; the ceiling is used as a reflector to provide an evenly lit work area.
- Ceiling, equipped with micro-porous acoustic panels, evenly distributes air and minimizes noise.
- Low-level lighting to improve visibility of larger screens.

A novel concept for operation and monitoring

In choosing System 800xA, E.ON selected a process control system that has a broad range of new functions, while maintaining a uniform user interface. The scope of the functions goes far beyond conventional operating and monitoring systems, encompassing both information management and engineering.

The underlying data access, storage and management system is based on ABB's patented aspect-object technology. The „objects“ represent process elements of varying complexities, such as drives and measurements, coal mills, feed pumps, turbines or boiler systems. The „aspects“ are characteristic data associated with these components that are required for system operation and maintenance.

Using this system, aspect data is stored only once and can be called upon from various objects. Examples of aspects include:

- Function diagrams
- Operation and diagnostic displays
- Maintenance management functions
- AutoCAD drawings (eg, connection drawings, P&I-diagrams)
- Monitoring camera images
- Files in PDF format for scanned-in, non-processable documents such as manuals
- Supplier web sites
- Microsoft Excel documents (tabular calculations, adapted protocols, etc.)
- Microsoft Word documents (operating and calibration instructions, data sheets, etc.)

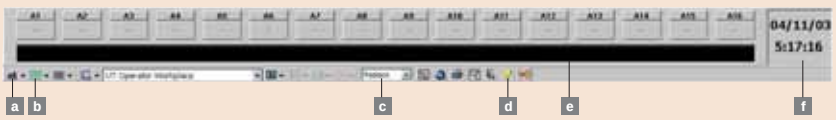
This ends painstaking searches for data that are distributed across various locations, computers and applications. Users navigate intuitively through the entire plant and are therefore able to maintain a constant overview.

Users can configure the process displays to suit their own particular responsibilities, setting their own preferences, allowing them to choose appropriate work methods. The fast, flexible, secure access to relevant information and data makes it possible for operators to carry out their monitoring and operating activities efficiently and accurately.

Alarm management for fast reaction to faults

A range of new features has been integrated into System 800xA. One example is a distinct plant overview in the header line 3. A summary alarm line appears underneath it. It shows the most recent unacknowledged alarm that has the highest priority. In System 800xA, users can jump directly from the header line to the associated plant diagram. Another key feature is that the header line indicates how many messages there are per plant sector and which has the highest priority.

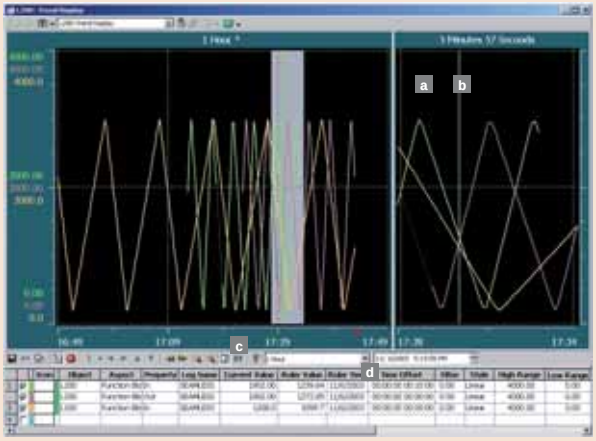
3 Plant overview header line, a new integrated feature of System 800xA



a Plant overview
b Plant event and alarm list
c Navigation strategy
d Online help
e Alarm line
f Date and time

The entire alarm list can be selected from the unit area or from a dedicated selection point at the top of the screen. It is possible to store individual notes for each alarm for the alarm list as well. The individual alarm list elements can be shown or hidden and be listed in any order. The alarm list can also be sorted by the individual elements. This can be very useful, for example, to sort according to time stamp, plant equipment tag or priority. The alarm list can be exported directly to Excel for further analysis using “copy and paste”.

4 Zoom function showing all data within a chosen time interval.



a Zoom window
b Ruler function
c X-Y plot
d Time off-set

Analyzing the process using trend curves

Processes can be reliably analyzed with the help of trend-chart displays. A wide range of functions, some quite innovative, are available in System 800xA to generate such trend charts. Both real-time data and historical data are presented seamlessly in these charts. The time interval can be selected by the user. Real-time trend characteristics can be compared to curves generated yesterday, last week or last month using the „time offset“ function. A zoom function is also available, which can be used to call up all data within a particular time interval to the exact minute 4. New functions for the chart displays include a magnifying glass and the ability to create horizontal lines or define horizontal and vertical areas.

Process quality monitoring

As a result of the liberalization of the energy market and changing environmental restrictions there is a need for detailed knowledge of the current and the historical quality of the process management in power plants.

As a consequence plant operators face a multitude of challenges. On the one hand, the liberalization of the energy market creates an ever-increasing cost pressure. On the other hand, environmental restrictions aim to reduce the output of carbon dioxide. Both challenges can be dealt with through reduced fuel consumption by increasing the efficiency of energy conversion in the power plant.

An alternative to cost-intensive construction of new power plants is to improve the quality of energy conversion in existing power plants. Even if the efficiency of the process cannot be ramped up arbitrarily by changing the way a plant operates, an attempt can be made to come as close as possible to the operational optimum.

The implementation of process quality management systems at the different power plants within E.ON is designed to allow plant personnel to monitor and optimize plant operation in order to achieve sustained improvements of the process quality.

E.ON’s decision to implement process quality monitoring in most of their plants was also driven by the requirement to have comparable operational key parameters of their main production units.

The process quality management system at the Scholven power plant’s Unit F consists of one server PC and several clients. The PIMS database for storage of analog and binary process values, calculation results and validated values is installed on the server PC. The process values are collected from different control systems sources (Siemens Teleperm, ABB 800xA). Processes such as the following also run on this computer

- Calculation of current performance indicators of all major plant components and the total plant.
- Simulation of load dependent reference data of all major plant components.
- Calculation of the quality factors of all major plant components and the total plant process data validation.

Calculations resulting in trends and process graphics can be viewed on various client computers located in the main control room and in the administrative building. Client computers can be used to create and modify the simulation or data validation model. A network license for the engineering software is for this purpose installed.

E.ON KGW1 plant management decided to implement a pilot project for the Scholven power plant’s 676 MW unit F. After successful implementation and acceptance in October 2005, an order followed for the implementation of process quality monitoring for units C and E.

Outlook

After Unit C had been successfully restarted on schedule, E.ON gave ABB the order to upgrade Unit E process control system to System 800xA. The changeover took place during the 2006 maintenance outage. E.ON also plans to upgrade the process control system for Unit B during the 2007 maintenance outage. These steps will make optimum use of potential synergies.

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