

Unique process visualization system for Schkopau power plant

The 900-MW lignite-fired Schkopau power station in Germany has a unique process visualization and management system that allows the plant to be operated exclusively via large-screen display terminals and mouse-controlled interactive communication. With the installed system – the first of its kind anywhere in the world – just two operators are needed to monitor and run the large dual-unit plant from a central control room. Three operator screens and two overview screens are provided for each unit. The large volume of process information can be handled with this small number of terminals thanks to appropriate data conditioning and the special design of the man/machine interface.

Schkopau power station was built by Kraftwerke Schkopau GbR, a joint venture set up by VEBA Kraftwerke Ruhr AG (VKR) and Saale Energie GmbH. The site of the plant is Korbetha, between Halle and Merseburg in eastern Germany.

The dual-unit plant burns locally mined brown coal and has a net efficiency of approximately 40 percent **1** [1]. It supplies electrical and thermal energy to chemical works owned by BSL (BUNA) as well as electricity to German Railway and the national grid.

Schkopau has been designed to meet the local requirement for competitively priced electricity and heat whilst complying with the highest safety, reliability and environmental standards. The total power output of 900 MW is generated by two units, each of which can be operated independently (*Table 1*).

Operating concept and control system functionality

Both plant units can provide process steam to industry plus electricity to German Railway and medium-load power to the national grid, in accordance with the requirements of the German authority that oversees the country's interconnected systems. The operating concept chosen for Schkopau is based on the two units being operated completely independently of each other and providing mutual back-up. This ensures a reliable supply of both traction power and process steam should one unit fail.

The chosen concept results in high operational flexibility for the plant, a characteristic which makes special demands

**Ludwig Herbst
Winfried Rieger**

ABB Kraftwerksleittechnik GmbH

on the control system [2] in the following areas:

- Unit control concept
- Automation level
- Availability

A look at some of the plant statistics gives an idea of the volume of process data that has to be handled by the control system:

6,300 analogue measurements

7,700 binary measurements

3,500 single-loop binary controls

600 function groups

440 analogue controls

160 electronic equipment cabinets

The control system that was installed is ABB's PROCONTROL P. This system is based on two intra-plant buses in a redundant configuration that link together the control equipment distributed throughout the plant. The buses guarantee full access to all of the plant data at any location.

The overall station has been automated in such a way that all parts of the installation are tied into the fully automatic operating mode. A distributed, hierarchical structure with the unit control system MODAKOND was chosen for the plant automation.

Control room concept chosen for Schkopau

The control room [3] in the Schkopau power station was designed by VKR in accordance with the dual-unit concept and is manned by two operators. In principle, each operator is responsible for supervising one unit and the more general installations allocated to it. However, since the process control system has been designed to also allow information to be exchanged between each unit's dedicated communication networks, the operators can give support to each other whenever necessary. Both the information systems and the processes can be accessed to this end.

Communication between the operators and the plant is via large-screen display terminals and a PC mouse **2**. The



900-MW Schkopau power plant in Germany. The plant's two units, which are fired with brown coal, operate independently of each other and generate electrical energy for the national grid and German Railway. Thermal energy is also supplied to chemical facilities nearby.

1

**Table 1:
Technical specifications of the Schkopau power plant**

<i>Overall plant</i>			
Power output			900 MW
Efficiency			40 %
<i>Steam generators</i>			
Heat output			2 × 1,265 MW
Steam output			2 × 1,360 t/h
Steam conditions	High pressure		285 bar/545°C
	Reheat		70 bar/560°C
<i>Turbines</i>			
Nominal rating	50 Hz		2 × 425 MW
	16 ⅔ Hz		1 × 110 MW
<i>Generators</i>			
Nominal rating	50 Hz		2 × 575 MVA
	16 ⅔ Hz		1 × 138 MVA

number of terminals – three operator screens and two dedicated overview screens for each unit – has been chosen for maximum user-friendliness. The large volume of process information transmitted in a power station the size of Schkopau can be handled with such a small number of terminals thanks to appropriate data conditioning and the special design of the interactive man/machine communication.

The unique feature of the control room is the complete absence of desk-top monitors. Instead there is a wall-sized visual display made up of large-screen terminals. The screens forming the lower half are user-assignable while those in the upper half are designed as permanent displays and provide an overview of the plant **3**.

The main information characterizing the process always appears in the same position on the screens. The design of the displays incorporates the latest ergonomic principles, ensuring that the operator is able to quickly inform himself of the current status and operational behaviour of the plant process. Moreover, the operator is kept 'aware' of the process through learning to assess whether or not the sequences taking place are correct.

Process management system

The process management system comprises a network of components installed in a redundant configuration **4**. The main system components are the data servers, the bus coupling modules, the local area network (LAN) and the monitor control units. Due to the redundant configuration, failure of a single component has no consequences for the control as a whole.

The combination of networked system and special user authorizations has resulted in a highly flexible process management concept which can easily be adapted to different application requirements. In Schkopau the entire plant is operated and monitored from the process management desk in the central control room. On the other hand, the local control stations, which are not permanently attended, provide only limited access to certain areas, for example to the supply and disposal services and to the water treatment plant. The shift engineer's station is only equipped to receive information; intervention in the actual process is not provided for.

The heart of the process management system is the interactive man-machine communication with advanced user interface. Its main features are:

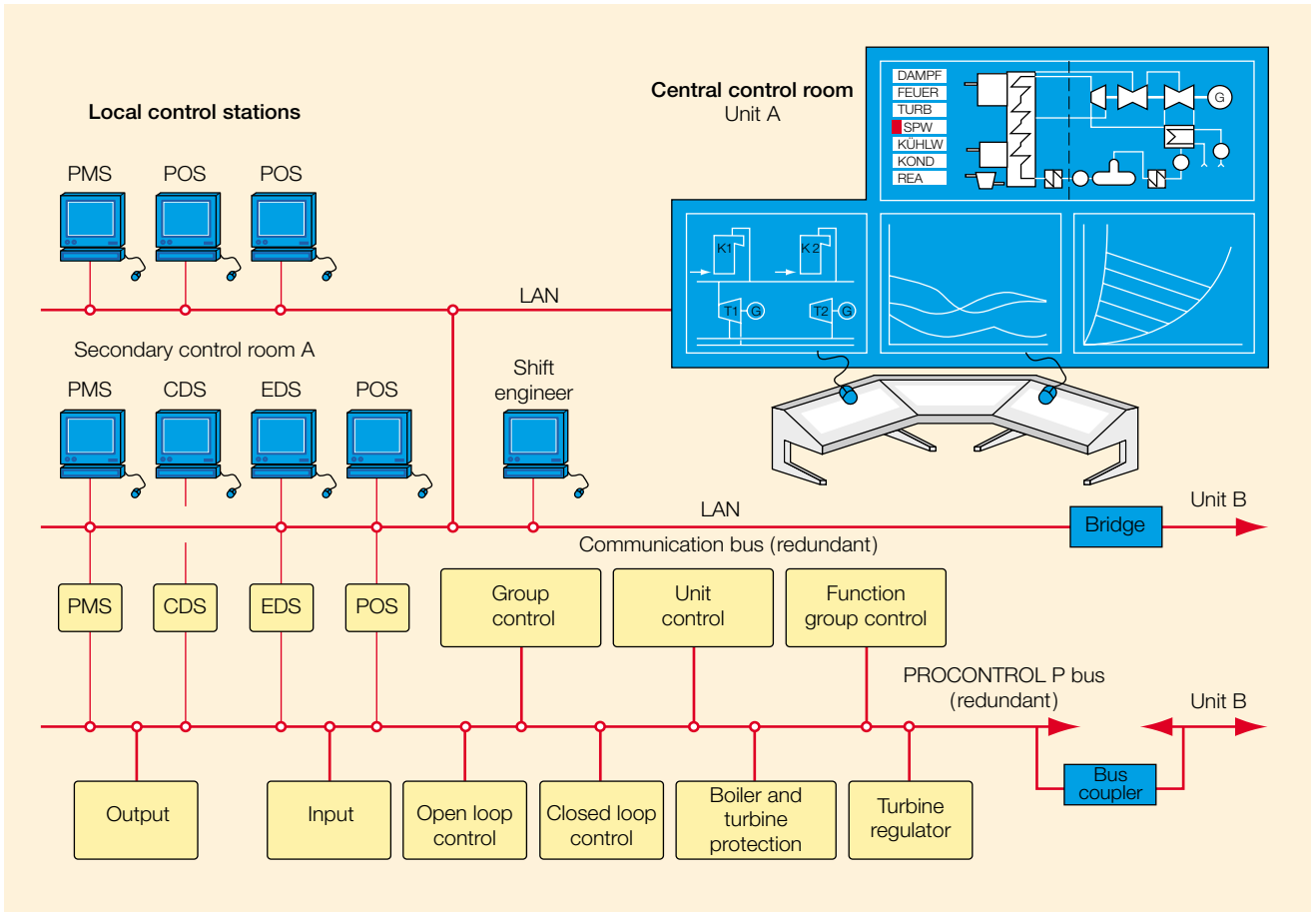
- Mouse-controlled interactive communication for display selection and intervention in the process.
- Object-oriented display windows which are shown on the screen close to the selected object **5**. Objects of this type



Schkopau power plant is operated exclusively via large-screen display terminals and mouse-controlled interactive communication. **2**

Wall with large-screen display terminals for controlling and monitoring the process **3**





Fully networked process management system in redundant configuration

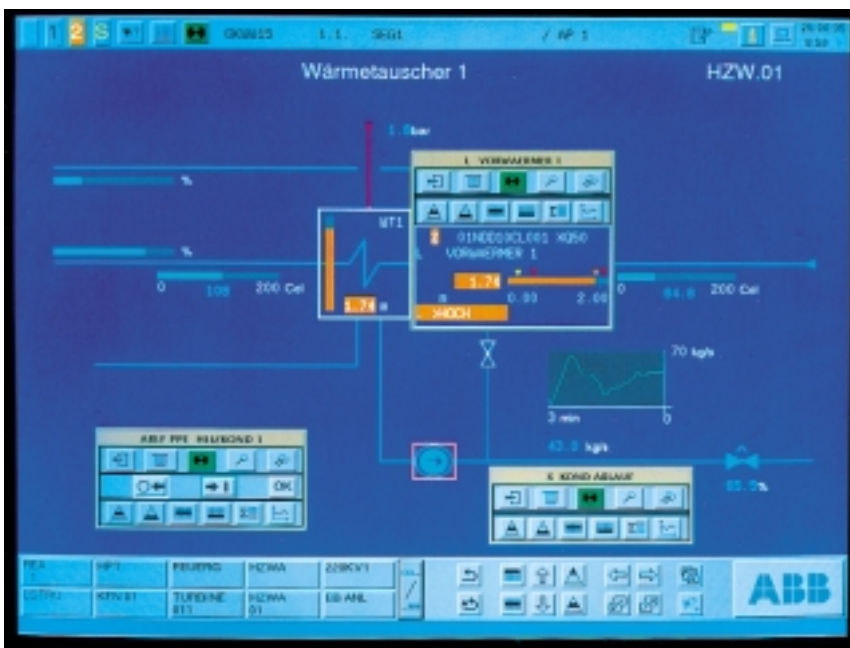
4

EDS Engineering, documentation and service system
 CDS Control diagnostics system

POS Process operator station
 PMS Plant management system

Mimic diagram with windows for process control

5



include measuring circuits, drives and controllers.

- Object-specific icons and tools involving only those functions required for the selected object.

Additional information can be called up via windows opened by the operator. As a rule, all of the display types belonging to the object can be selected. This option and also others for selecting display pictures ensures that the operator can always access the information he requires direct; there is no need to search through menus or work through display hierarchies except in special cases. In the event of disturbances a special search routine guides the operator to a message giving the cause of the disturbance or to a detailed mimic diagram to enable him to quickly take cor-

rective action. The operator can also design and modify his 'own' standard screen configuration for certain operating phases (start-up, load operation, etc). The design procedure is user-friendly and the new configuration only has to be entered by the operator once to 'export' it to all of the screens belonging to his workstation. The same applies to the operator's preferred displays.

Thus, the adopted method takes full advantage of the core ergonomic benefit of video display systems by making use of appropriate display selection strategies to guide the operator in every situation to the information he requires as quickly and directly as possible (ie, via the smallest number of steps).

Information and operating concept at Schkopau

Both the power plant units and their ancillaries are highly automated. This high level of automation is a precondition for one-man operation of the units. An operator can start a unit by giving just a few commands via the plant overview. The same terminals also monitor the start-up sequences and on-load operation.

The parameters and performance characteristics of a unit are shown as bars in the top left-hand corner of the relevant overview 6. These allow irregularities to be easily and quickly identified. Also displayed by the overviews are general fault messages applying to the main plant areas. The display fields indicating disturbances are further used to select the corresponding area overview, which appears on one of the three user-assignable screens in the lower half of the visual display. One more input is all that is required to obtain, via the automatic trouble-shooting program, the detailed mimic diagram with the dedicated message.

In addition to the two fixed overview displays, each unit has assigned to it 30 area mimic diagrams and 200 detailed mimic diagrams. These mimic diagrams

can also be used by the operator to intervene in the process. Additional information in the form of trend curves (220), characteristic curves (7) and profile diagrams (10), can also be accessed by the operator direct.

The operator can select displays and intervene in the process using just his mouse. Ergonomically, the mouse offers the best coordination between hand and eye, making it the universally preferred tool for this kind of work. There is no need for the operator to take his eye off the screen to search for keys on a keyboard. This is especially important in view of the broad functionality of Schkopau's process management system – a keyboard would necessarily have to have a large number of keys.

All of the binary and analogue process variables are recorded and stored for fault analysis and evaluation of overall plant performance. All of the information can be displayed on the monitors; hard copies can be printed out on request.

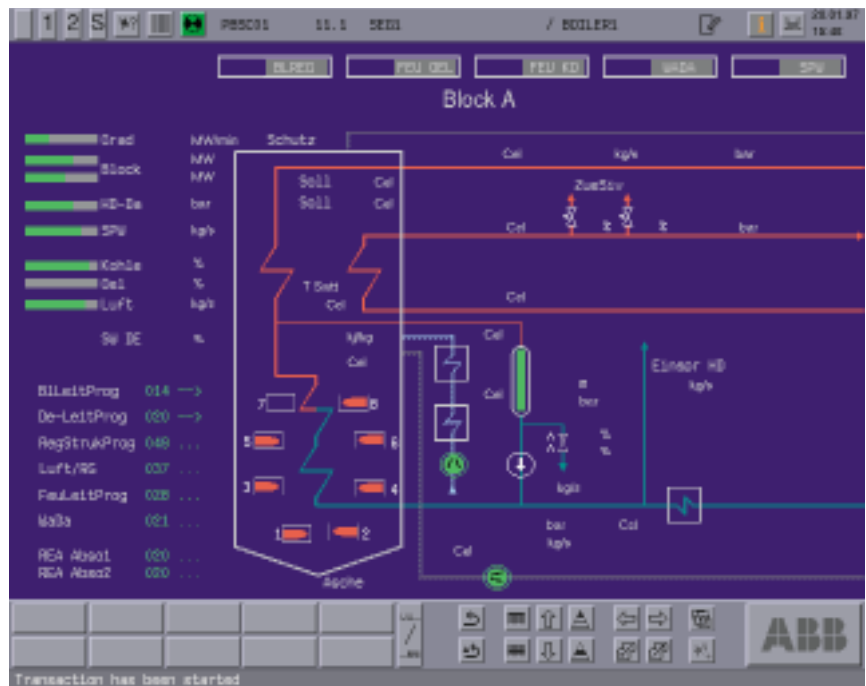
Control room layout

The circular control room is dominated by the wall with the large-screen display terminals. It is approximately 7 m wide by 2 m high and stands in the center of the room 7. In front of the wall is the process control desk, which is also circular. Due to the absence of desk-top monitors, the lower row of terminals could be positioned in the preferred field of view – an important aspect, since these are the freely assignable displays used to execute processes and procedures, any of which can last a long time.

The new process visualization concept therefore unites in the same plane the plant overview, which has to be permanently visible, and the freely assignable working areas. This arrangement is particularly user-friendly, especially as the operator can use his mouse to move freely from screen to screen.

Being able to show every type of process information on the large-screen terminals is also useful for group discussions, since several people can view the same information at the same time. Also, it is

General overview of unit B. Parameters and performance characteristics are shown as bars in the top left-hand part of the display. 6





Control room in the 900-MW dual-unit Schkopau power plant

7

useful for demonstrating the new system's capabilities. In such cases, use of one of the freely assignable monitors during normal steady-state operation is possible without interfering in the actual running of the plant.

The layout of the control room and the communication equipment is based on proven ergonomic principles. For example, the chosen concept features:

- Reliable process control, thanks to the task-oriented design of the picture contents, picture selection and operating procedures
- Colour codes for presenting information in accordance with people's natural cognitive responses
- Anthropometric design of the workplaces

Attention was also paid to the general design of the control room. For example,

windows offer the operators a view beyond their immediate surroundings, while the acoustics, air-conditioning and lighting systems are designed for maximum operator performance and comfort. These and other incorporated design features help to create a working environment that is pleasant and motivating at the same time.

References

[1] Braunkohlekraftwerk Schkopau. eb Elektrische Bahnen, vol. 93 (1995) 9/10, 290–298.
 [2] PROCONTROL P: Leitanlage für das 900-MW-Kraftwerk Schkopau. ABB Kraftwerksleittechnik. Publ. no. D KWL 661596
 [3] D. Karweina: Perspektiven der Leittechnik am Beispiel des Kraftwerks Schkopau. VGB Kraftwerkstechnik 6/96.

[4] H. G. Thierfelder: Modernisierung bestehender Kraftwerke. VGB Kraftwerkstechnik (offprint).

Authors' address

Ludwig Herbst
 Winfried Rieger
 ABB Kraftwerksleittechnik GmbH
 P.O. box 100 351
 D-68128 Mannheim
 Germany
 Telefax: +49 621 381 2267