Water under Control

THE CHALLENGE

Detzem, a small town in the middle of the wine-growing region about 25 km from Trier, is also the location of one of the four barrages on the Moselle. These systems usually comprise a lock, weir and power station. The barrage at Detzem is a "sector weir" composed of three approximately 40m wide and 8m high sectors, the levels of which can be adjusted by a system of water conduits in the head water and tail water.

In the autumn of 1997 the complete refurbishment of the electrical and control equipment for the weir was put under contract by WMA Coblenz with BEA TDL (Elektrotechnik und Automation Technische Dienste Lausitz GmbH). Automation & Software Günther Tausch GmbH was in turn given the job of developing the control section by BEA TDL.

The control equipment to be employed consisted of a number subsections. First, an OWQ controller (head-water discharge controller) had to be designed to fulfill a number of tasks. These included the maintenance of the head-water level to within a tolerance of +/- 5 cm, compensation of discharge variations due to head-water waves in the barrage chain, minimization of actuator stages and the monitoring of the minimum level. The controller should also not attempt to counteract the lockage waves.

Secondly, a sector controller was needed which was able to tame the non-linear characteristics of the sector and to provide stable sector conditions. Thirdly, a communications interface to the existing power station had to be established to enable interaction between the OWQ controller and the power station controller. This interface guaranteed reasonable controller management and increased safety during turbine failures.

Finally, a link to an existing level measurement system from the company OTT was required to read out the levels on the Moselle in the head and tail waters of the barrage via a serial RS232 connection and to pass this data to the OWQ and sector controllers via the PROFIBUS.

From these projected tasks specific requirements could be derived for the algorithms, engineering and software needed. WMA Coblenz insisted on the use of controller and software able to give many years of reliable operation with a high level of availability.

Reliance was placed on the well-proven balance controller from the BAW (Federal Office for Water Engineering) which fulfilled the specified criteria in a number of model trials and also in practice. This controller determined the exact incoming flow into the barrage and discharged it in line with the top water level demanded. This involved the employment of a high quality actuator system, giving the minimum of actuator stages.

Automation & Software Günther Tausch GmbH

Automation & Software Günther Tausch GmbH is firm of consulting engineers in Neubrandenburg in Mecklenburg West Pomerania. The company has accumulated many years of experience in the field of weir automation.

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The design of the sector controller proved to be a very complicated task because the sector represented a non-linear system in which conventional classical control methods could not be used. An answer to this problem was provided by the development of a control algorithm which was self-compensating and able to take into account the conditions in the head and tail waters which play such a crucial role in the sector stability.

The overall concept of the components consists of the following: A visualization computer (MMI) in CompactPCI technology, a standard PC (MAP-PC), both with Windows NT 4.0 as operating system and Citect (from CI-Technologies) as visualization software, an IUC32 with the RTOS OS-9 as the main control computer (includes the OWQ controller), a number of S115U PLCs (one PLC per sector) for the sector controller and two ET200s (power station interface, SABS).

Right from the start strict separation of the visualization and actual control activities was envisaged by employing two computer systems. This enabled the reaction of the opposite component to be guaranteed if one of the two components failed and the main controller could be protected against erroneous external intervention.

THE SOLUTION

It was decided against using a normal PLC as control computer because consistent floating-point arithmetic was needed for processing the control algorithm for the balance controller. Also, apart from the actual control and monitoring tasks, it had to provide fast communications via Ethernet and the link to the field level via PROFIBUS FMS. Furthermore, special emphasis was placed on uncomplicated, modular and economical expansion of the control system. For these reasons a CXC system with IUC32 (MC68E360) was selected from Kontron.

For the visualization and main control system, it was decided to use a CompactPCI system with the CP312 as CPU. This system also exhibited high operational reliability under harsh environmental conditions and guaranteed an uncomplicated replacement of cards when a failure occurred. In addition, simple expansion and modularity are other system features. Both components, CompactPCI and IUC32 were mounted in a 19" rack to form a unified automation device.

An Ethernet 10Base-T connection provides secure, high performance data interchange between both systems using the TCP/IP protocol. This type of communication offers high reliability and a reasonable data throughput even with large quantities of data. On the CompactPCI side a CP340 Ethernet card was used for this task and on the IUC32 side, which has an Ethernet interface (MC 68EN360) of its own, a PB-10BaseT. Coupling to the field level was implemented by a CXM-PFB12 card in the control computer and by a CP5431 FMS and an ET 200U on the PLC side. The CXM-PFB12, fitted with the Siemens ASIC ASPC-2, features high operational reliability and ruggedness. The card is supplied by Kontron with the Softing PROFIBUS stack (FMS/DP) which provides consistent performance and has proven to be very stable.

To guarantee high failure immunity and secure transmission, a redundant ring system with fiber-optic cable was set up and the coupling to the PROFIBUS cards carried out with an optical link module (OLM) from SIEMENS.

THE BENEFITS

The water levels are read out from the existing level measurement system and a SMART IO makes the data available via PROFIBUS FMS. This miniature controller is ideally suited to this task because the MC 68306 controller employed is an excellent communications controller and the main task is reduced to a serial conversion to PROFIBUS.

With the choice of the visualization and main control system, it was decided to use the program package Citect from CI-Technologies. Apart from superb graphics, this system offers high performance, simple networking and coupling of a number of Citect stations (MAP-PC coupling).

In addition, this system exhibits simple, intuitive and well structured programming techniques and an expansion of the functional features using a macro language.

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