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A specific approach
How ABB helped to build up conceptual design and supply management know-how for the Thai Nguyen cement plant

VINAINCON's Thai Nguyen cement production plant, Vietnam, benefited from ABB's experience in executing large projects. ABB managed the supply and engineering of all automation and electrification equipment. In this task, ABB collaborated closely with the main contractor Fives FCB and different local and international suppliers. This close cooperation was key to the success of the project.

A Specific Approach

Introduction

In September 2005, Fives FCB, France contracted ABB Switzerland Ltd to supply various electrical equipment, including automation and quality systems for Thai Nguyen's new cement plant in Vietnam.

It is worth considering the history and background of this order, as it provides an interesting insight into ABB's reputation in Vietnam.

ABB Switzerland introduced its cement production-specific and common plant electrification products and services to an audience of Vietnamese cement producers, management and plant staff at a conference in 2004. A senior official of the Vietnamese Ministry of Industry contacted the lecturer after the presentation to indicate that the ministry wished to strengthen its industrial capabilities generally in Vietnam. ABB was asked to support them in verifying the capabilities of different suppliers in the country that can manufacture electrical equipment for use in the cement industry.

Gerhard Langenbach, ABB Switzerland Ltd, explains how the company helped to build up conceptual design and supply management know-how for the Thai Nguyen cement plant.

Vietnamese electrical equipment manufacturer evaluation

The ministry planned to build a greenfield cement production line to raise its capabilities in the country, independently from other local and foreign cement producers. This soon became ABB's challenge. The unusual situation came to pass that ABB was requested to visit and value different Vietnamese electrical equipment manufacturers, named by the ministry, which could become the company's competitors for the supply of electrical equipment for industrial plants. These visits, attended by the ministry representatives, demonstrated trust in ABB's evaluations and acceptance of the validation results.

Electrical plant design

VINAINCON, the state owned construction company, was assigned to build a cement production plant with 4000 tpd clinker production, close to Thai Nguyen city, about 100 km north of Ha Noi. Fives FCB, France was awarded the contract for the supply of the complete cement production line.

VINAINCON selected as many Vietnamese equipment manufacturers as possible, following the Ministry of Industry's requested improvement of local industrial strength. ABB Switzerland was awarded and sub-contracted by Fives FCB for the complete electrical plant design and supply of the electrical equipment that was not going to be supplied by local manufacturers or Fives FCB.

Thai Nguyen cement plant.

Twin Horomill (courtesy of Fives FCB).

In the 1990s, ABB Switzerland's minerals business unit educated and built up local resources and manpower for electrical engineering, commissioning and maintenance services. This early investment was important to the eventual realisation of this project.

This article will discuss the wide spectrum of ABB's activities in the overall design of the Thai Nguyen cement plant.

Plant conception

Fives FCB sized all mechanical equipment and related electrical motors, drives and required instrumentation, etc. ABB issued the following for all electrical and automation systems:

- The functional concepts and the supplier neutral technical specifications for the equipment supplies.
- The infrastructural concepts and the technical specifications for the plant and equipment earthing and lightning protection systems.
- The installation and cabling concepts, as well as the technical specifications for cable selection, cable routes and the installation and grounding details for all types of electrical equipment.

This comprehensive work, including the quality related documents for equipment tests before delivery to site, ensures that the client can expect a properly designed plant that will perform effectively after installation and commissioning.

In close cooperation with Fives FCB, ABB designed the size and shape of the electrical rooms with all details, floor openings, cable ways, etc.

Since the plant is split into different production areas, it is wise to break down the related electrical equipment into the same areas (electrical rooms). This ensures that different plant areas can be operated independently, while others are shut down for maintenance or operational reasons. It also shortens the cable ways from the e-room to the motors, instruments, safety and local operating devices, etc. The amount and lengths of the required cables can be kept to a minimum by placing the e-rooms in the most suitable locations.

Consequently, each plant area has a dedicated e-room for the required electrical energy distribution, medium voltage motor switchgear, low voltage motor control centres, automation systems with their digital and analogue inputs and outputs, auxiliary supplies for electrical subsystems that come with the mechanical equipment, as well as lighting and small power supplies to plant instrumentation units.

Beside the main station (MS) and the central control room (CCR), the plant's allocated e-rooms and areas are as follows:

- LS01: limestone crushing and shale crushing.
- LS02: gypsum, coal and additives preparation and storage.
- LS03: raw mill department.
- LS04: kiln department (including preheater).
- LS05: cooler department.
- LS06: coal mill department (together with LS04).
- LS07: cement mill department.
- LS08: packing expedition department.

- LS10: auxiliary services and offices.
- EM01: emergency diesel generator (adjacent power distribution in MS).

Electrical equipment deliveries

The plant voltage levels are defined to 6.3 kV (MV-power), 400 V (LV-power), 220 VAC (control voltage for contactors) 110 VDC (MV-switchgear control) and 24 VDC (digital input/output signals).

MV distribution system

The plant is supplied with electricity from two independent 6.3 kV incoming lines from the client's own 110 kV switchyard and transformer station to the 6.3 kV MS, divided in two busbar sections that can be connected by circuit breakers. The protection devices are microprocessor programmes integrated in the MV-distribution boards.

The main distribution feeds the different e-rooms via cables to an incomer panel in the rooms, where more than one distribution transformer and/or drive belongs to the assigned area. Outgoing feeders drive distribution transformers and/or MV constant speed motors form a small MV-sub-distribution. Small e-rooms with only one distribution transformer are equipped with a transformer isolator to visibly disconnect the load.

Each MV distribution in an e-room has its own 110 VDC control voltage supply with battery and battery charger.

Power factor compensation

A decentralised power factor compensation was connected to the bigger loads (the MV constant speed motors). The targeted power factor of ≥0.95 lagging is realised at the 6.3 kV level by three phase capacitor-reactor units, calculated and sized to filter the possible harmonics. They are directly connected and switched with the motor.

At 400 V, each low voltage distribution connected to a distribution transformer includes a power factor unit that is controllable in several steps.

LV distribution system, emergency power system, UPS system

All LV distribution panels have front side operated withdrawable feeder modules, whereas the incomer circuit breakers are motor controlled.

A 1250 kVA diesel generator unit will feed different consumers that require emergency power for the safety of equipment, or emergency operation during network shutdowns. Since the emergency consumers are connected to different motor control centre groups that are connected to the LV distribution, the emergency power from the generator is connected to the LV distribution busbar by a circuit breaker. The incomer circuit breakers for the distribution transformer and the emergency power are both feeding the LV busbar, but are interlocked. As such, it is only possible to use either one of the power supplies, not both.

A main UPS system with an output of 220 VAC is installed in the CCR building to maintain power for process computers, central control systems and the X-ray analyser in the laboratory.

A further 220 VAC UPS systems are installed in different e-rooms to maintain power for the control systems, as well as some essential lighting.

Raw mill with raw mill motor.

Intelligent motor control centre.

Motor control centres

The motor control centre is an ABB modular low voltage switchgear type MNS, with intelligent motor controllers type UMC22. Each withdrawable motor starter module is fitted with a coordinated short-circuit breaker protection, contactor and programmable microprocessor based motor control unit. The motor control unit is a completely self-contained unit with a non-volatile memory. No battery back-up is required. The UMC22 detects the actual motor current information, utilising the built-in current transformer unit. The communication with all other field units within the system is achieved via a fieldbus plug.

Close up of the Thai Nguyen cement plant.

Motors and drives

ABB's MV-slipring-motors with liquid starters are directly connected and switched by the MV circuit breaker. They are protected by built-in PT100 resistance probes in windings and bearings, as well as by a built-on vibration detector.

The kiln, the ID fan and the separator in the cement mill department have a higher power demand to be driven speed controlled. These units of the ABB ACS 800 drive family are connected to the MV-distribution panel via a transformer with two secondary windings, ensuring a low voltage distortion (low harmonics content) at MV level.

Some smaller speed controlled drives are directly fed from the 400 V LV-distribution panels.

Instrumentation

Many instruments for the production process are installed for a safe and secure plant, as well as a stable process operation. These include:

- A video system.
- Gas analysers.
- Temperature measurement devices, including pyrometers.

> Only a well prepared design of the cable ways to minimise the cable lengths can help to manage and optimise the respective installation work of cable ladders and cable trays, differing cable types and fixation materials.

Central control room.

- Pressure and differential pressure measurement devices.
- Flow measurement devices.
- Level measurement devices.

For all of these devices, a comprehensive documentation was prepared for installation.

Infrastructure

The efficiency of the cement plant is also defined by the appropriate infrastructure in the plant, including the following:

- Optimised electrical and control rooms.
- Air-conditioning and room ventilation.
- Indoor and outdoor lighting.
- Fire detection and protection.
- Process and street lighting.
- Communication systems.
- Earthing and lightning protection.

Cabling

Each electrical consumer or device has to be connected to the switchgear, power feeders or controls. Only a well prepared design of the cable ways to minimise the cable lengths can help to manage and optimise the respective installation work of cable ladders and cable trays, differing cable types and fixation materials.

ABB used its own local resources for the complete cable engineering. All MV and LV power cables and normal control cables are locally procured by the client, but the company supplied the special control cables.

Process control

The complete cement plant is controlled by ABB's 800xA control system, configured in three levels.

Level I: process control

The process control and the I/O cabinets are installed in the different e-rooms, where the motor control centres are also connected via fieldbus.

Level II: operator workstations

The operator stations are located in the central control room, where the connectivity serves as the main connection between levels I and II. The control room is also where other servers are located. Both the control and the plant networks are redundantly connected to the different systems. Process control and operator interface are based on the ABB System 800xA Minerals Library. This unique object oriented software module allows the design of process control and power applications in a modern, efficient and fully parameterised fashion. The technology significantly increases the standardisation, functionality and quality of the process control software over the complete lifecycle of a plant.

A kiln shell scanner supervises the temperature of the kiln shell to discover an early surface hotspot coming from damaged kiln lining.

Where plant operation required a local operation, a local control room was designed with an operator station and reporting printer, i.e. for the crusher area, gypsum and additives control, and also for the packing area.

Level III: management and optimisation

The management and optimisation systems are also installed in the central control room.

A raw material proportioning (RMP) system, based on ABB's Expert Optimizer system, serves firstly for a consistent raw material quality using an online gamma ray analyser signal to calculate the required percentage of limestone and shale.

The second function is to mix the raw material components according to the required clinker/cement qualities by calculating the required additives of high grade limestone, quartzite and iron ore to the main mix raw material. The raw material analysis is carried out in the laboratory by an X-ray spectrometer, for which special tablet probes are prepared (fine grinding of raw material, tablet pressing). The result of the analysis enabled the RMP system to calculate and control the amount of additives to be added continuously.

A further installed system is the ABB Knowledge Manager system, collecting data from the whole plant, preparing production reports for the operators and the plant management.

Conclusion

Not all of the plant's electrical parts and equipment are mentioned above, but all were engineered and managed by ABB and put together in close cooperation with the main contractor Fives FCB, France, and different equipment suppliers in Vietnam and abroad. This close cooperation was key to the success of the project.

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