Amreyah Cimpor Cement Co., Egypt

Create value
Integrated solutions for cement with ABB Industrial IT
**History**

The Egyptian Public National Cement Industry founded Amreyah Cement Co. (AMCC) in 1978. Egypt has a long tradition in the cement industry: its first industrial cement plant was constructed more than 100 years ago. During the last century, the country’s cement industry has grown tremendously and today is one of the biggest in the Middle-East. The nine Egyptian cement companies have a total capacity of approximately 32.5 million tpa. Consumption per capita in 2002 was approximately 392 kgs. Since the mid 1970s, this market has been of high importance to ABB, which has managed to supply all electrical equipment to nearly all the cement plants in the country. The latest example of ABB’s activities in this market is the complete electrification of ACCC’s cement production line, located approximately 30 km west of Alexandria, near the Mediterranean coast.

In the first phase of the project, two production lines, each with a kiln capacity of 3300 tpd, were built-up for AMCC between 1983 and 1987 by a consortium of Polysius (France) and ABB, then known as BBC Brown Boveri Ltd (Switzerland). The Business unit within ABB, specialising in the electrification of cement plants, was responsible for the supply and installation of the complete electrical equipment and process control for the two production lines.

In 2001, the new owner Cimpor (Portugal) decided to establish the new company ACCC to operate a new production line with a capacity of 1.5 million tpa of OPC, again built by Polysius (in consortium with Orascom). ABB was once again chosen by Polysius as subcontractor for the complete electrical equipment and process control.

The scope of ABB’s activities for this new production line covered supply, erection and commissioning of the 66 kV switchgear for the main distribution station; all power and distribution transformers; 6.3 kV switchgears etc. The project also extended to process control with optimisation systems and instrumentation, as well as the complete infrastructure equipment for the plant, such as emergency power supply; earthing and lightning protection; ventilation and air conditioning systems; lighting equipment; intercom system; all cables; and installation materials etc.

**Energy distribution**

In a cement plant, the electrical power received from the high-voltage or medium-voltage grid, and in some cases from the works’ own power plant, has to be distributed to the medium-and low voltage loads. The energy requirement for a cement plant with a capacity of 1 million tpa is in the range of 25 - 30 MVA. This power has to be transformed to the medium-voltage level, mainly for the large drives, and then further, by distribution transformers, to the low voltage level for smaller drives and auxiliary consumers. For operational and safety reasons, a plant is fed from the HV grid by at least two independent feeding lines.

The new ACCC production line is fed from the existing 66 kV distribution system through a 27 MVA power transformer with a stand-by 6.3 kV feeder from an existing 27 MVA power transformer. The new cement mill no. 5 receives power from the existing 6.3 kV distribution system.
High-voltage distribution system
The existing 66 kV distribution system for AMCC Lines 1 and 2, supplied by ABB in 1985, was extended by one additional feeder for the new 27 MVA power transformer for line No. 3. As the existing 66 kV switchgear was a SF6 gas-insulated panel (ENK) and the new one was modular (EXK-0), a set of adapters had to be installed to connect the two different types of switchgear. All electrical technical data for the two systems are identical.

Medium voltage distribution system
The voltage level of the MV distribution system in the Plant is 6.3 kV. The switchgear is a metal-clad type with SF6 circuit breakers or load break switches. The single busbar system is designed for 2500 A, the fault level is 31.5 kA.

There are three distribution centres:
- Main distribution for the kiln section; central power factor correction system; auxiliary consumers; and a feeder for the raw mill section. This main distribution is fed from the new 27 MVA power transformer, and as a stand-by, from an existing power transformer for AMCC line 2.
- Sub distribution for the raw mill section.
- Sub distribution for cement mill no. 5, fed from the existing main substation for AMCC line 2.

Connecting the existing plant and the new line
As previously mentioned, the 6.3 kV main distribution is also fed from the existing 27 MVA power transformer for line 2, as stand-by feeding in order to assure power and operational availability for the new line in case of maintenance or failure. To achieve this, a special change-over panel was installed, consisting of two circuit breakers which allow the feeding power to be switched to the new line from the new 27 MVA power transformer (standard operation) to the existing power transformer for line No. 2 (maintenance operation).

The special designed interlocking will prevent an overload of the existing power transformer and will also allow parallel operation of the existing and the new transformer for a limited time. The installation of this time limitation was necessary to prevent damage caused by the excessive short circuit current during parallel operation. This panel is designed for a fault level of 40 kA. The operation will be made from the front of the changeover panel.

Power factor compensation and filtering
For the improvement of the power factor $\cos \phi$ of the entire plant, as well as the reduction of the contribution of plant harmonic sources to the voltage harmonic distortion, a central power factor compensation and filtering system was installed at the 6.3 kV level of the plant. For the design of the system, the following assumptions were made:

• Short circuit power at 66 kV: 3500 MVA.
• Impedance (Z) of 27 MVA power transformer: 12.5%.
• Incoming voltage: 66 kV +/-10%.
• Line frequency: 50 Hz +/-1%.

The targets, which have to be reached with the installed PFC system, were:
• Power factor: 0.95......1.0.
• Voltage distortion at 6.3 kV: below the values stated in IEC 1000-3-6 environment class 2.

Therefore it was decided to install the central PFC system at the 6.3 kV main busbar of the new line, with a total capacity of 5.1 MVAr and to split it into three sections with individual tuning.

Further to this central PFC system, at the 6.3 kV level, the two cement mill No. 5 motors were each equipped with a capacitor bank of 450 kVAR including choke and damping resistor for direct compensation.

Motors and drives

HV motors
All constant speed motors with an output of more than 200 kW are connected to the medium voltage system of 6.3 kV. The slip-ring motors for the raw and cement mill drives, as well as for the cement mill filter fans are equipped with over temperature sensors in the stator windings and bearings, vibration detectors and space heaters. The rotor starters are of a liquid rheostat type.

Variable Speed Drives
In the last 15 years variable speed drives have been used more frequently in the cement industry. The main reason was to save energy in the production process. With its latest developments in power semiconductors for medium voltage applications, ABB can offer units with a capacity of up to 20 MVA.

In this new production line, two DriveIT ACS 1000 units were installed for the raw mill fan, with an output of 3000 kW, 100 - 1000 rpm, and for the preheater fan with an output of 2200 kW, 100 - 1000 rpm. Both units are fed from the 6.3 kV network. In addition, 20 DriveIT ACS 600 units with a range between 11 - 750 kW were installed. The rotary kiln is also equipped with a 750 kW, 150 - 1500 rpm AC variable speed drive unit.

LV fix speed motors
All fix speed drives up to 200 kW are squirrel cage motors according to IEC standards, with insulation class F, enclosure IP 55, and designed for an ambient temperature of 45 °C. The total number of installed motors is approximately 550.

Process control system
ABB Industrial is the industry’s first comprehensive and integrated enterprise management and control system. It offers enterprises the means to seamlessly link plant automation, asset optimisation and collaborative business processes in real time. It is designed to scales in both price and performance from small, low-level unit and area automation solutions to extremely large, vertically integrated plant-wide and multi-plant management and control applications. It addresses the requirements of both multi-plant economic and production control, as well as the more traditional process plant regulatory control and safety-related applications.

The architecture of the control system is organised into four functional groups, from field-oriented controls and supervision towards fully integrated engineering tools:
• Area management and control: providing a comprehensive set of traditional process, regulatory and sequence control services and I/O interfaces.
• Plant management and control: providing a powerful suite of products and services for plant management and control, communication networking and network management.
• Human system interface: providing, in a multiple operating environment, a range of products for viewing and accessing data from process control up to plant and enterprise information.
• System engineering and maintenance tools: providing an integrated set of engineering, implementation and maintenance tools designed to support the total automation project, including planning, configuration management, commissioning and system documentation.

The hardware structure of the process control system can be divided into three autonomous control areas, which are hierarchically organised into the following levels:
• Level I: process control.
• Level II: operator workstations.
• Level III: management and optimisation.

Control system configuration
The process control system has been configured in such a way that the entire plant can be operated from one central control room. For the packing plant, an additional local control room with fast Ethernet link over a fibre optic connection was installed, to offer local process control functionalities.

The six ControlIT AC 800M process controllers are located in cabinets in a room beside the central control room. In this way, the most production critical equipment is well protected from dust and high temperatures. Furthermore, the communication lines towards the servers and human machine interfaces are kept short. As this equipment is all located in the same building, it is also well protected from electrical noise. Each controller is connected over a Profibus-DP fibre optic link to the respective remote I/O panels in the different electrical rooms, which are close to the process.

The platform communications are based on two independent networks for optimised availability. The control network connects all controllers and the connectivity server. The plant network connects all operator stations, the connectivity, and the aspect server. The data transfer between the control network and the plant network is carried out through the connectivity servers.

For the operator workplaces, the OperateIT human interface portal for Windows 2000 is installed. OperateIT, which is used to supervise and control
The process and which is embedded into the client-server environment of IndustrialIT, consists of different packages for workplace management, graphical presentation, alarm and event handling, trend presentation, system status and reporting.

The new Aspect Object technology allows the user to connect different kinds of information to every type of object in the production process, be it a sensor, control loop, motor, drive, transformer or substation. This concept ensures that access to information for maintenance, system status, logical, diagrams etc is quick and easy.

A special ‘ABB Plant Explorer’ package allows the client’s engineers to build up their own plant model. The central control room incorporates four operator workplaces, three of which are equipped with dual high-resolution screens. From these working places, mainly raw grinding, kiln and cement grinding are operated. The workstation for the raw material transport requires only one screen. As workstation peripheral, a laserjet and a color inkjet printer are installed in the central control room. The engineering workplace, also located in the central control room, allows engineers to modify application programs.

The local control room for the packing plant is equipped with one operator workplace and a laserjet printer.

**Electrical infrastructure systems**

The efficiency of an industrial plant is not only influenced by major mechanical and electrical installations, the appropriate infrastructure also plays a significant role.

A reliable plant infrastructure consists of the following components:

- Optimised substation and electrical room layouts.
- Cable engineering.
- Installation engineering.
- Earthing and lightning protection.
- Process and streetlighting.
- Fire detection and protection.
- Communication systems.
- Air-conditioning and ventilation.

Correct dimensioning, smart positioning and adequate technology can help to save money not only in the investment, but also in operating costs, where cost savings add up to a significant enhancement of plant economy over the lifecycle.

![Figure 1. Control system configuration.](image-url)
Cabling

In the vast area covered by the new cement line, the energy distribution from the 66 kV, 6.3 kV and 380 V feeders down to the corresponding consumers, including the related process control, earthing and lighting, required an extensive cable network.

The overall length of installed power and control cables as well as installation material has reached the following approximate amounts:

- MV power cables: 19,000 m.
- LV power cables: 240,000 m.
- Control cables: 290,000 m.
- Special cables: 8,500 m.
- Cable racks: 24,000 m.
- Steel conduits: 52,000 m.

For the selection of the appropriate cable and cross-sections, several factors were considered, including ambient temperature; cable laying method; permissible voltage drop; nominal current; cable length; short circuit current; tripping times of protective devices; load flow calculations; harmonic distortion; and network grounding. The use of modern cable and installation engineering software by ABB, has allowed for the optimisation of the design. Barcode readers facilitate the monitoring of cable and installation material during construction.

Earthing/lightning protection

A meshed earthing network, consisting of earth electrodes, earthing and protective conductors, was installed in the plant. The surface earth electrodes up to

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**Table 1. Average illumination levels**

<table>
<thead>
<tr>
<th>Activity zone</th>
<th>Level (LUX)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor Electric and switchgear rooms</td>
<td>350</td>
</tr>
<tr>
<td>Central control room</td>
<td>250</td>
</tr>
<tr>
<td>Local control room</td>
<td>120</td>
</tr>
<tr>
<td>Grinding, burning, packing</td>
<td>200</td>
</tr>
<tr>
<td>Staircases, hallways</td>
<td>120</td>
</tr>
<tr>
<td>Platforms</td>
<td>60</td>
</tr>
<tr>
<td>Conveyor heads</td>
<td>50</td>
</tr>
<tr>
<td>Walkways, conveyors</td>
<td>30</td>
</tr>
<tr>
<td>Outdoor Street lighting</td>
<td>30</td>
</tr>
<tr>
<td>Surroundings of buildings</td>
<td>50</td>
</tr>
<tr>
<td>Loading and unloading ramps</td>
<td>60</td>
</tr>
</tbody>
</table>

**Table 2. Lighting installed at ACCC**

<table>
<thead>
<tr>
<th>Type</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lighting fixtures (FL)</td>
<td>2185 pcs</td>
</tr>
<tr>
<td>Projectors 250/400 W</td>
<td>261 pcs</td>
</tr>
<tr>
<td>Lighting poles (conveyors)</td>
<td>500 pcs</td>
</tr>
</tbody>
</table>
a distance of 20 m were interconnected for potential equalisation.

All points of the electrical circuits which require earthing for correct and safe operation, as well as all electrically conductive parts of the installation which do not belong to the electrical operating circuit, were connected to this meshed network by means of earthing conductors and/or protective conductors. All earthing conductors are made of bare or insulated copper. The main purpose of this earthing system is the protection of personnel and property, as well as protection against transient over-voltages, static discharges, effect of lightning strikes, or stray currents, as well as to create a defined network condition for protection and metering purposes.

The installed external lightning protection system consists of a number of collecting devices, mounted to the highest points of the plant, or the usage of the metal parts on the structural works as collecting devices and lightning conductors. These conductors are used to connect the collecting devices to the earthing network and are equipped with a test point arranged above the entrance point in the ground.

**Lighting system**

Depending on the location, lighting systems must fulfil a broad range of requirements, including:

- In rooms, offices, workshops or laboratories for example, higher illumination levels are needed than in production areas, storage zones or roadways.
- In production areas, it is necessary to differentiate
between lighting for access and escape routes or for maintenance purposes. By establishing optimised illumination levels, the foundations for optimal energy savings can be laid at an extremely early stage in the project.

The responsibility for illumination standards rests with ISO and CIE (International Commission on Lighting). Requirements for illumination levels have increased during recent years and key figures for the plant are indicated in Table 1.

Lighting systems today are often designed for the worst case scenario, i.e. for troubleshooting purposes. No account is taken of the fact that purely for lighting, a medium-sized cement plant requires an installed capacity of approximately 500 kW. During the night, the lighting is switched on by an automatic system, using photoelectric cells. Installations of such dimensions consume a considerable amount of energy. Since energy is a predominant cost factor, it is worth treating lighting installations as an energy-saving concept. However, the correct design and layout of lighting installations in an industrial plant requires process know-how and experience.

For the new production line, the internal and external lighting installations were designed according to the average illumination levels shown in Table 1. The quantities of lighting required to meet these requirements are shown in Table 2.

In addition, obstruction lights for air traffic and a complete, independent emergency lighting system, fed from the emergency generator set, were installed.

**Ventilation/air conditioning**

The site conditions required the installation of an appropriate ventilation and air-conditioning system. Heat losses, especially from semi-conductor elements of high current frequency converters, have to be removed from the power circuits, to prevent damage to electrical equipment. The high ambient outside temperature of +45 °C; high relative humidity of maximum 95%; the location near the Mediterranean Sea; and the dusty environment of a cement plant had to be taken into consideration when selecting the appropriate system to protect the installed equipment against failure during operation.

For all electric rooms, a combined ventilation/cooling system was installed, to assure a room temperature of a maximum of 35 °C and to create over-pressure in the E-rooms. The system for each E-room consists of a number of split type air-conditioning units (outdoor condensing unit plus indoor air-handling unit) and a ventilation unit with filter for the overpressure.

For the controller room and the central control room an air-conditioning system was installed to maintain the room temperature for the operator staff in the range of 21 - 26 °C, independent from the outdoor temperature.

A special cooling system was provided for the two ACS 1000 frequency converters. The heat is removed from the power circuit using water-cooling units, which transport the heat losses, via water-to-water and air-to-water heat exchangers, to the exterior.