ABB Rectiformer Substation EPC Package for Qatalum

ABB Switzerland

Qatalum will be the first aluminium smelter to go into operating in Qatar and will also be the first smelter worldwide to operate with 1'750VDC. As ABB is also supplying the power plant substation, Qatalum will be world's first smelter with ABB's integrated blackout protection

The rectiformer substation for Qatalum's pot line 1 and 2 was awarded on an EPC (Engineering, Procurement and Construction) basis to ABB Switzerland in June 2007. As engineering and management resources have become increasingly scarce in recent times, the traditionally piece-meal project approach has been replaced by larger packaged EPC solutions.

Power requirements in new smelters have reached over 500MW per pot line, so an optimised overall power system concept is essential. An overall co-ordinated system approach eliminates cost overruns and guarantees on-time delivery as well as best technical solution.

When phase one of Qatalum becomes operational, over 1'000MW will need to be controlled and converted to DC power for efficient smelter operation. At Qatalum, the power plant and the rectiformer station are two separate EPC packages with the 220kV GIS (Gas Insulated Switchgear) in the scope of power plant package and the 1'500m 220kV cables in the rectiformer substation package.

As the power plant EPC contractor has awarded the 220kV GIS with its latest control and protection system based on IEC61850 to ABB Switzerland, the substation integration and interface co-ordination are simplified and an overall system approach is guaranteed.

Figure 1: 220kV cable-road crossing

Figure 2: GIS building cable entry

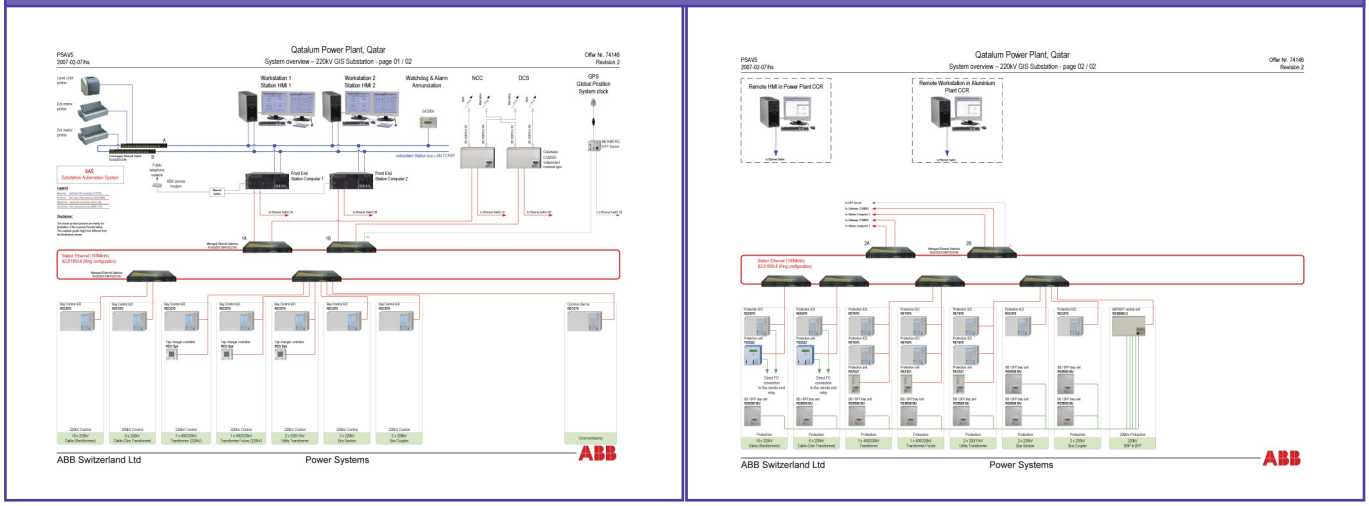
Scope of the rectiformer EPC package

The rectiformer substation package consists of the following turnkey elements:

- Overall system design, studies and performance calculations
- 220kV cable runs and termination to the GIS and the transformers
- 1'750VDC/85kA rectiformers
- DC collector busbar design, supply and installation
- 70Mvar harmonic current filters operated off the regulation transformer tertiary winding. Each filter can be energised via a synchronised 33kV breaker
- SCADA system
- 33/0.4kV distribution for the substation
- Fire detection and deluge system for the entire substation
- Detailed civil works design and supervision
- Interface to the 220kV GIS supplied by ABB Switzerland to the power plant EPC package
- Substation controls and protection with the new IEC61850 protocol.

The package also includes overall system integration and interface co-ordination with other EPC package suppliers.

Figure 4: Protection and controls with IEC 61850



220kV cable routing

Cable routing to the two pot lines has had to be interfaced with many different EPC package suppliers and to be integrated into the overall road concept. Cable road-crossing points had to be in place and cables laid in the ground well before many other activities could start. With 10 feeders and an average cable length of 1,500m, the excavation of the cable trench involves approximately 35,000m3.

220kV GIS with IEC61850 Enhanced Controls

The power plant is located close the smelter, so it is possible to have a single GIS serving both. On one side the GIS directly connects to the generator step-up transformers and, on the other, to the rectiformers. The interfacing of the GIS controls and protection is often a very demanding task for EPCM engineers, usually turns out to be a time-consuming and difficult exercise. At Qatalum the GIS controls and protection, as well as the rectifier control system, will be supplied by ABB Switzerland permitting a seamless operation.

2'000VDC rectifier design

Having reached 1'650VDC at Sohar Aluminium, Qatalum specified 1'750VDC as the maximal smelter operation voltage. Following detailed rectifier design studies and type testing on ABB's standard proven rectifier design, only minimal alterations were required to adapt the design for this HV DC application. The Qatalum rectifier frame is designed for 2'000VDC with semiconductors and fuses suitable for 1'750VDC.

Rectiformer bay and substation layout

Traditionally rectiformer units are arranged in line with the front of the pot room allowing the most efficient pot room connection to the substation. The larger footprint of the 200MVA capacity units required a new arrangement with them facing each other. This required an in-depth study of the forces applied by the DC collector busbar as well as the effect

Figure 3: ABB's ELK-14, 300KV GIS

Figure 5: 2'000VDC rectifier design

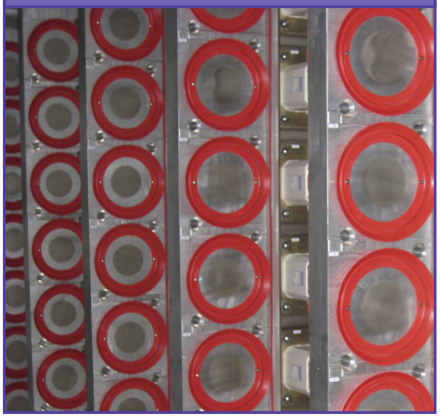
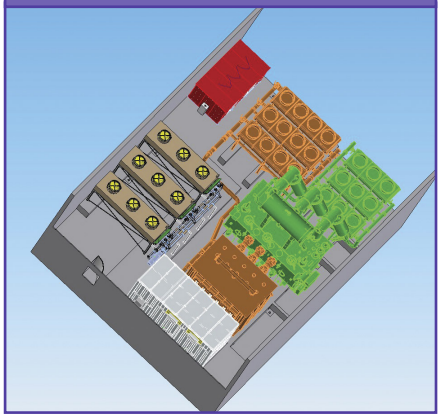


Figure 6: Rectiformer bay



of having different length of busbars between the rectiformer and the pot room.

Rectiformer control system

The rectiformer station consists of five units with the possibility of adding a sixth unit at a later stage. The rectiformer units can be controlled from the central control room via the SCADA (System Control and Data Acquisition) system or from the master controller. From the master controller as well as the SCADA system it is possible to connect to the power plant via a fibre optic cable to link the power plant and smelter substation together for load control. This interconnection is required as the power plant will not be connected to the Qatari utility grid. Qatalum will possess the most modern control room visualisation system with large screen mimics based on the ABB extended working station 800xA

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Power quality control

With each pot line requiring over 500MW, power quality is critical. Many different operational scenarios need to be accommodated to allow the smelter to operate without power quality restrictions. Power factor control and minimal harmonic current distortion are two of the many parameters to be addressed.

At Qatalum power quality targets have been set at the very highest levels of any industry worldwide. These power quality levels can only be met by an overall system approach. For example, ensuring a suitable transformer design and specifying tolerances so that the rectiformer and power quality equipment are a perfect fit. A team of experts in transformer, rectifier and harmonic currents filtering technologies simulated the power grid at different operation points as well as the pot line operational behaviour and then selected suitable parameters for the power quality system.

Figure 7: Rectiformer control system architecture

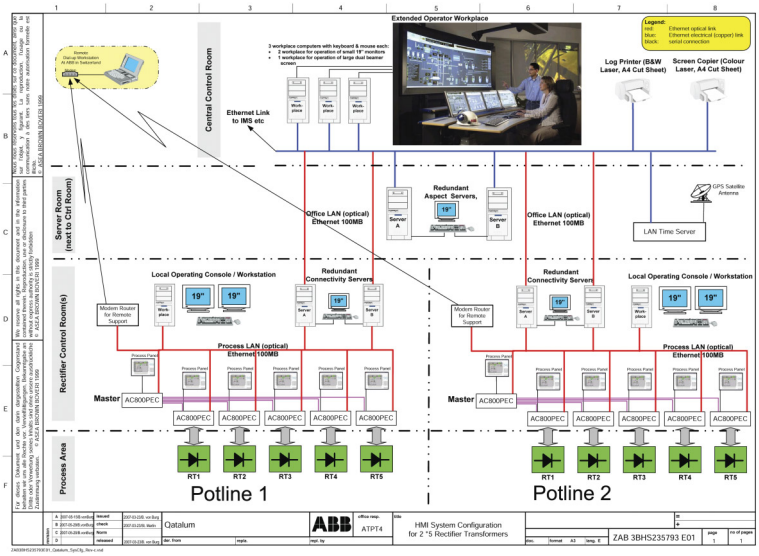

Figure 8: Typical 33kV harmonic current filter

Summary

Qatar's first smelter will have, in many respects, the most advanced rectiformer substation in the world and it will seamlessly interface with ABB's electric power plant and the EPC substation package. Environmental and power quality levels will also set a new benchmarks for aluminium smelters. ■

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