

DOI 10.36146/2026_06_27

Moving to next EAF digital furnace: first heat at Hybar with SMS's group X-Pact AURA

M. G.B. Lugnani, L. Bernardis

The paper presents the new EAF digital furnace implemented at Hybar's new 630,000 tpy rebar micromill in Osceola, Arkansas. The X-Pact® AURA was pre tuned before delivery using advanced development and testing methods with RTDS simulations (Real Time Digital Simulator), which allowed it to be commissioned in just two days and the EAF to be rump up in four heats only. The X-Pact® AURA family of IGBT based power modules is capable of feeding EAFs from 5 MVA up to 350 MVA. This fully modular technology provides the required efficiency, dynamic control, and flexible power to meet the needs of the green steel transformation and grid code requirements. Using this innovative technology and proprietary control algorithms, which take full advantage of power electronic capabilities, ensures the highest power transfer and the lowest impact on grid, especially regarding flicker limits. Hybar's steelmaking facility operates entirely on renewable energy, made possible by the seamless integration of a solar farm with X-Pact® AURA clean and flexible EAF power supply. Moreover, EAF performance has been improved by the addition of fault ride through capability, which demonstrated power supply resilience and enhanced plant availability by avoiding EAF stoppages.

KEYWORDS: EFFICIENCY; GREEN STEEL; ENERGY SAVING; DIGITAL EAF POWER SUPPLY; POWER QUALITY.

INTRODUCTION

Due to the increasing incorporation of renewable energy resources in power grids, which are becoming weaker, the efficient, dynamic, and flexible supply of power to Electric Arc Furnaces is a must. X-Pact® AURA (AURA in the text) help steelmakers to deal with this challenging environment.

The AURA system is designed to achieve efficient and stable power control to feed DC arc furnaces in all power networks configurations, including weak grids. Based on modern IGBT technology, the new design achieves world class performances in terms of high dynamics control, efficiency, reliability, redundancy and minimum impact on electric network quality.

The modular and redundant design allows also partial load operation in case of a module failure, without interruption of the process (fault ride through), which is increasing the availability and due to repetition of same components in the systems the number of spares is significantly reduced. In this case no SVC or Statcom was necessary to comply with grid requirements.

Massimo G.B. Lugnani,
Luca Bernardis
SMS group S.p.A., Italy



Fig.1 - AURA system at Hybar.

In view of digitalization of steelmaking power supply, SMS decided to implement a real-time digital twin for the AURA power conversion system. This high-fidelity platform is intended to work as demonstrating facility for process automation and power system simulator for the EAF. RTDS (Real-time digital simulator) offers a method to predict and later validate the system performances and to reduce the commissioning time. Other than special testing tools, it's worth mentioning that each power converter is type-tested at factory, including rated-load current temperature rise test.

AURA Power Supply

The AURA power converter is composed of a 24-pulse diode rectifier and DC-DC chopper converter: it includes a fast discharge circuit for DC-link capacitor discharging and a pre-charging circuit. The AURA power converter cabinet includes the control cubicle, the water-cooling cubicle and a small air conditioning cubicle, everything assembled in an IP54 enclosure. The AURA power converter output 16kA_{dc} with a maximum voltage of 1000V_{dc}. Figure 2 shows an open-door front view of the cabinet.



Fig.2 - AURA power converter.

Each power converter is fed by an AFWF dry-type transformer. The EAF power is fed by 6 AURA power converters connected in parallel through a high current busbar system with no additional reactor.

The AURA power conversion system adopts the N-1 con-

figuration, meaning that the system can deliver full power even if one of the power converters is out of service. This configuration is made possible thanks to Fault-ride-through functionality. An extremely high redundancy level is chosen by design: communication with process

PLC is redundant, redundant controllers with hot back-up configuration are adopted for each power converter and all the controllers can switch between two internal sub-networks. Of course, redundant cooling pumps and redundant sensors are applied to deionized-water cooling circuits.

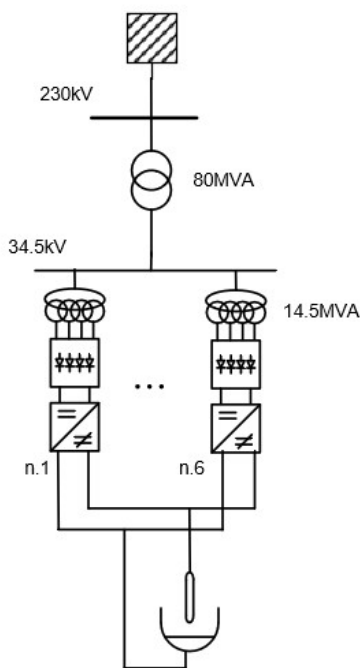


Fig.3 - Principle Single line diagram.

Project development roadmap

It's foreseen a model-based design approach for power system: it integrates the whole development procedure, from basic design to site validation, passing through control code development, laptop Electro Magnetic Tran-

sient simulation and in the end RealTime Hardware-in-the-Loop testing. This development procedure allows us to have both short-term and long-term performance figures first simulated, then measured at site for validation.



Fig.4 - Model based design process.

The design process started with a measurement campaign, with high sampling rate device, on an existing DC-EAF with a similar size and charge mix. This allows us to include the control action by the X-Pact® SynReg electrode regulator model.

Particularly, the following models are introduced in a laptop environment, adopting PSCAD software for ElectroMagnetic Transient simulation: direct-current arc, high-current busbar system, power converters, transformers and grid equivalent model.

In the laptop environment, the power converter control as well as electrode regulator control are part of the model; instead, in the RT-HiL simulation, real power converter controllers and electrode regulation PLCs are included in the loop, while power system is modelled. In figure 5, there is a principle scheme showing the difference between laptop and RT-HiL simulation: the power of RT calculator is deployed, since power electronics part is running with a smaller simulation time-step than the conventional power parts.

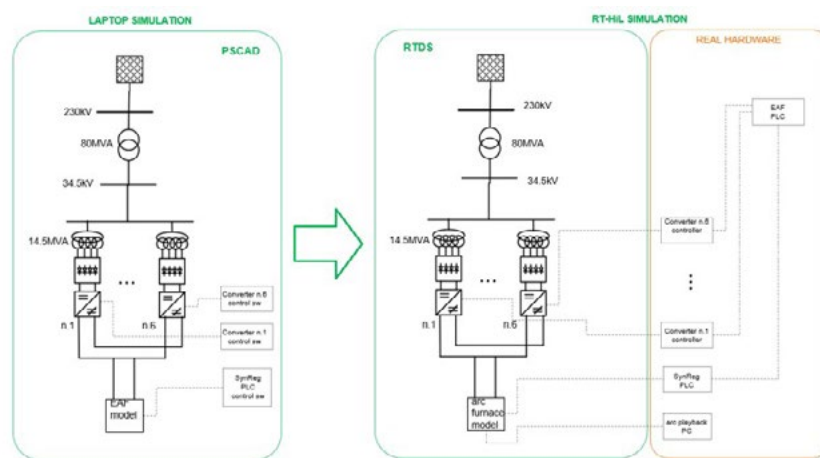


Fig.5 - From laptop simulation to Real-Time HiL simulation.

In the graphs below, it shows 5-seconds simulations comparing laptop and RTDS simulations. We can observe red traces for laptop simulations and red traces for RT simu-

lations in the following order: top-left, arc current; top-right, arc voltage; bottom-left, medium voltage active power; bottom-right, medium voltage reactive power.

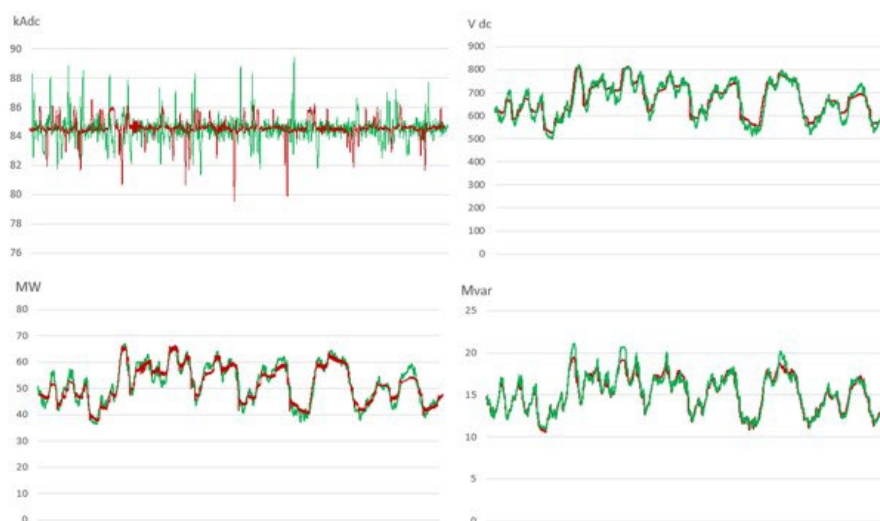


Fig.6 - Laptop vs RT-HiL simulation waveforms.

It can be also observed from both simulation environments that power factor is stable above 0.96 level.



Fig.7 - Laptop vs RT-HiL simulation waveforms.

The RT-HiL method allowed us to test and reproduce a perfect digital twin of the system that would be later installed at site. Therefore, it is adopted to verify additional functionalities of AURA system listed below and particularly some of them have been validated with site records.

Low-Voltage-Ride-Through. In the case of mains high voltage network, AURA system is running through the voltage sag specified by grid-operator and restriking the Arc furnace once the voltage is established again without tripping or abnormalities.

Fault-Ride-Through. In the case of one of the power converters trips during the heating period, it is online excluded and the system keeps delivering the requested power to the furnace without any downtime.

Hot back-up of redundant controllers. Since every power converter controller is redundant, the hot back-up functionality is first factory tested and then site-tested.

Other than power conversion system performances, process benefits were observed during the RT-HiL simulation: especially increase rate of average power transferred to scrap determined to be in the range 10÷15% and consequent reduction of energy consumption in the range of 8÷10%.

HOT COMMISSIONING AND RESULTS

EAF hot commissioning planned an arc and burners test before running the first heat at reduced power of 25MW maximum with the purpose of fine tuning of the controllers. Following, a ramp-up to run up to full power of 56MW in just 4 heats, during which all the EAF equipment

was monitored including stoppages to carefully check the status of EAF.

At the end, it took only 3 heats to reach full design power. No further fine tuning of AURA controllers was required, meaning that all parameters set during RT-HiL were correct.

The ramp-up was extraordinarily smooth, in other words a "plug-and-play" power supply. From the first heat to March '26, almost 3000 heats were performed with no AURA system trip, demonstrating an extremely high availability rate above 99.9%.

Moreover, it was possible to operate the EAF at full power - 56MW - using 5 power converters, demonstrating the robustness of the system with no trips nor thermal alarms occurring.

In few hours from arc-test, we were able to run the EAF at full power production.

The model-based design process is validated 100%, since AURA performances are also matching with simulation. Table 1 below lists a comparison of main performance figures simulated and measured at site.

Tab.1 - Power quality results.

POWER QUALITY		
	Simulated	Measured
Pst_{95%}	0.3	<0.3
THDi	1.8%	2%
Power Factor	0.96	≥0.96

Based on the same network data and short-circuit power, EAF including SVC, delivering the same power to furnace the AURA power supply flicker is compared with a DC- (table 2).

Tab.2 - Power quality comparison.

FLICKER COMPARISON		
	AURA	DC THY + SVC
Pst95%	<0.3	0.45

The higher control speed of AURA allowed for a faster electrode regulation compared to a traditional DC-EAF type, showing from the beginning in a much more stable power transfer to scrap. Thus, from process point of view,

the increase of power transferred to the furnace during RT-HiL, is confirmed during the observation period at site (table 3).

Tab.3 - Process performances.

PROCESS PERFORMANCES	
	Improvement rate
Average power input	+10%
Tap-to-Tap time	-10%

Future development

AURA technology paves the way for new control strategies which are also part of the development route. Improved control algorithms are under testing and will follow the same validation process, thanks to the developed RT digital twin. SMS is developing in further the AURA power converter design in the direction of increasing the power density and increasing the installation flexibility, to be more effective in green and brown field installations. In the next months, SMS is close to commissioning phase of n.2 DC-EAF 180 tons each in North Europe including

AURA system power supply. For this project, the connection grid-code foresees to provide validated EMT and RMS models: especially, validation is performed thanks to RTDS platform. Other than traditional power quality figures, LVRT and extended frequency temporary deviations are proven.

CONCLUSION

X-Pact® AURA technology demonstrates technical benefits in terms of power quality, flexibility and availability. The effectiveness of RT-HiL testing in EAF power supply

has been validated: it delivers highly accurate performance predictions and significantly shortens the commissioning period, creating substantial added value for both the Customer and SMS.

Furthermore, X-Pact® AURA system availability is confirmed to be above 99.9%. Fault-ride-through functionality is a remarkable asset for the final user, granting continuous production even with one or two power units not in operation.

Physical inspection of the equipment for regular maintenance is nil, all the parameters being remotely controlled by the AURA HMI in the control pulpit.

Compared to traditional thyristor power supplies, the superior performance of X-Pact® AURA system for both process and grid make it a true gamechanger in modern EAF technology.

REFERENCES

- [1] M.G.B. Lugnani, L. Bernardis, D. Beacco, M. Daita. "Latest SMS EAF technologies for safety and green steel production," ESTAD 2025, Verona, Italy, 2025

[TORNA ALL'INDICE >](#)