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HP Process Safety in the Sahara – Deployment of Blast Resistant Electrical Equipment Enclosure in Algeria

In our two previous articles, a strong case was made and the precedent explained for significant advancements in the protection of electrical equipment in the Hydrocarbon Processing (HP) industry.

This third article highlights a *proof-of-the-pudding* example and points to where the industry is headed. Specifically we'll detail the inclusion of a recently-completed project that includes a fully-operational, Type III blast resistant electrical equipment center (*enclosure*) at a North African natural gas processing facility.

The destination point of a team project by Lectrus, Rockwell Automation and a turbine OEM—a gas compression facility for a large consortium in northern Africa. The MCC that runs the turbine is enclosed within a pressurized, Type III blast resistant electrical equipment center (BREC) designed for this extreme desert environment.

Lectrus offers 3 types of blast resistant enclosure: two of interlocking panel design and the third of crimped steel plate with seamless welds. All were subjected to simulated and actual blast loads analyses and testing. Lectrus Blast Resistant Electrical Equipment Center (BREC) designs meet NEMA 3R and can meet NFPA 496 Pressurization Standards for explosive environments. Just one of Lectrus' unique differences is that they were the first BREC manufacturer to actually test and pass interlocking panel buildings for up to 4.0 psi side-on pressure rating. This rating represents a formidable blast load. As a result, a great many inquiries and orders continue to be generated for blast resistant electrical equipment enclosures and Lectrus is confident that a definable, optimal standard now exists for the accomplishment of every facility's safety goals in the area of protection for electrical operations.

The subject of this article is a key component of a recently-finalized, two-year-long joint project entailing the installation of a gas compression turbine and it's accompanying electrical and electronic controls at a gas field in Algeria

New Petro Kid on the (Global) Block

The Project involves the development of seven core natural dry gas fields in the southern central part of Algeria (Sahara Desert) and is a joint venture of two international petrochemical companies and a state-owned energy company. Beginning with financial arrangements between countries in the late 1990s, Phase One of the project was completed in 2004. The ultimate aim of this project, anticipated to last 15 years, is to supply 9 billion cubic meters per year of gas to the southern European market. Two supply pipelines currently link Algeria to Spain and Italy; a new gas compression station was constructed in conjunction with one of the lines. Phase One included the development of wells and well sites, a 310-

mile-long gathering system, and gas processing facilities. The latter, and a major component of the project, includes CO_2 removal, a compression station and metering systems. Simply stated, at this site, the natural gas contains a high level of carbon dioxide. In processing, about 1 million tons per year of CO_2 is compressed in two trains, dehydrated using triethylene glycol after three stages of compression, and undergoes final compression before it is sent out through the pipeline. A further, separate process involves the capture and storage of CO_2. As the processing removes CO_2 from the natural gas, the CO_2 is re-injected into an underground sandstone reservoir for permanent storage. It has been suggested that this exercise in CO_2 sequestration has been one of the largest yet undertaken, and the long-term environmental advantage of Carbon Capture and Storage (CCS) is that it keeps greenhouse gases out of the atmosphere.

The entire Saharan development will eventually involve all 7 gas fields, which lie about 745 miles south of Algiers. The first phase is associated with 3 northerly fields that lie closest to the existing Algerian export infrastructure, based on the main gas hub at Hassi R'Mel. The 4 more southerly fields will be developed so as to maintain overall production rates over the lifetime of the project. Additionally, there are 10 other projects known the world over to carry on similar operations with CCS. In every instance, no matter how far-flung the facilities are, they need process safety and protection for every worker. Part of worker protection and perpetuation of the facility's overall production and process viability must include sheltering and operational efficiency of the power controls that allow uninterrupted process operations, whether or not an explosive event occurs.

The Challenge

Rockwell Automation, world renowned for their Allen Bradley® division of automation control products and software solutions, approached Lectrus in 2007 with a challenge. The natural gas facility in the Algerian desert needed a new turbine for their gas compression operations. The turbine manufacturer had contacted Rockwell Automation to design the control of the unit and Rockwell Automation in turn, asked Lectrus to integrate generator and motor control centers into a robust, blast resistant, walk-in metal enclosure. The project objective was to maintain gas production levels, using gas turbines to drive the gas compressors. Rockwell Automation came at this project from the need for a deliverable able to withstand a 2.5 psi blast load for 60 ms duration. The structure would also have to endure an environment that ostensibly included sandstorms and temperatures ranging to 131°F. Going through calculations on their own, Rockwell Automation staff depended on Lectrus' expertise to advise them specifically what to do with equipment placement, etc., within the structure. Ken Litwicki, Senior Application Engineer at Rockwell Automation and their point man on this project, elaborates, "From our standpoint, we wanted to partner with someone who would over-design, a shelter the customer would never have to worry about on site in Algeria. We came into the project knowing approximately what we were expecting as far as blast resistance is concerned, because Rockwell Automation has had similar experience in the petrochemical field. But we partnered with Lectrus to help with the final design meeting the specifications for this site. In our research of the best companies out there, when we heard that Lectrus and Baker Risk had done all their preliminary computer and physical testing, and had decades of experience building shelters, we knew we could be confident in their abilities to tailor an enclosure to our specs. So we really listened to them."

“A good way to explain this type of structure technically," says Dave Cole, Vice President of Engineering at Lectrus, "is that it's a blast resistant, IEC-rated (International Electrotechnical Commisssion) electrical equipment enclosure. It's IEC-rated because this unit is going into the Saharan region. And although they're walk-in, they're not classified as occupied structures.

Whereas designing and building such an enclosure was by no means a hard task for Lectrus, in the ensuing months the challenge would prove to be dealing with a myriad of changes to the original plans. In one respect, there would be a lack of answers from the owner and clearly interpretable baseline information provided. And at other times, reams of documentation would invariably appear that, in the end, had little or no practical application, once studied. An unforeseen part of the project at the beginning, that challenging aspect rode with Lectrus throughout its duration.

The Enclosure

Rockwell Automation and Lectrus attended a formal kickoff meeting at the turbine manufacturer’s headquarters in November 2008, and the project began taking substantive form. The first in a series of drawings was generated based on a spec of 14 ft. x 35 ft. (Figure 1)

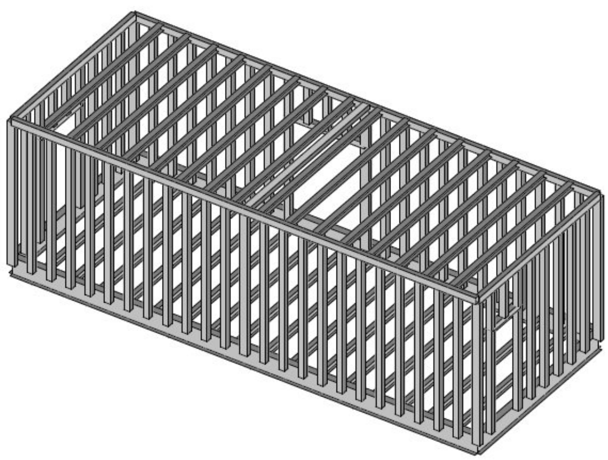

Figure 1 – Basic structural diagram of the blast resistant enclosure for the turbine

Matt Rich, Lectrus’ Project Manager went into further detail to explain another aspect of this particular enclosure. “A common requirement for this industry is that the enclosures need to be pressurized. One reason is that you do not want things like coal dust, volatile chemical vapors, blowing sand or most other foreign elements entering and permeating these enclosures. The positive pressure inside the enclosure ensures that virtually all foreign objects and volatile gases remain outside.

“Our design included pressurization,” he added. “Every entrance into the enclosure, whether it was the entry air for air conditioning, or otherwise, incorporates it. In the event of a blast, there are blast dampers that have been designed into the structure to immediately shut automatically and prohibit contamination from that event. There's a battery room as well, that houses a DC power system. The batteries vent off very small amounts of hydrogen gas that must be exhausted; and that room also have its own, separate system of blast dampers built in, similar to those for the HVAC system that vents and cools the entire enclosure."

Figure 2 shows the final iteration of the structure, after a series of changes introduced into the original design necessitated a separate, blast resistant, enclosed portion housing the cooling unit.

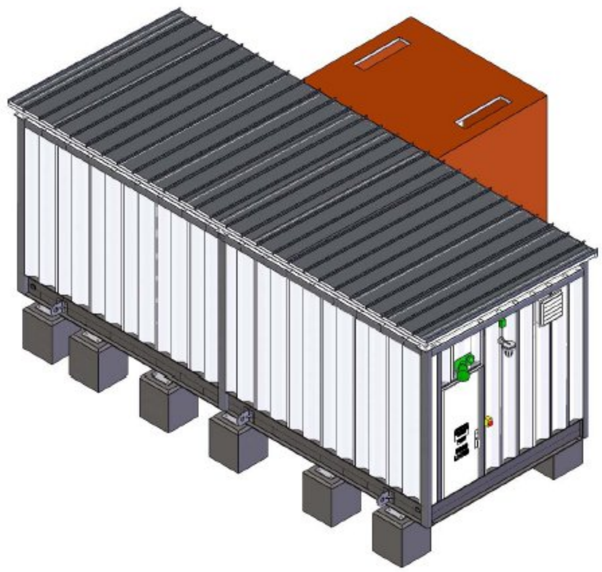

Figure 2 – Drawing of the turbine control center enclosure in its final iteration, with blast protection enclosing a specially-designed cooling unit

The completed, 75,000-pound blast resistant enclosure is of Type III construction composed of a quarter-inch crimped steel plate, seam-welded outer wall, backed by a structural steel frame. The wall is 8 inches thick with a smooth interior wall, 5-psi blast-rated doors, two air-lock entry rooms and blast dampers for HVAC. The ultimate load rating for this structure has not yet been precisely determined, but it is determined that the enclosure could withstand blast loads at least as high as 4.25 psi. Future analysis of the same type as used in initially validating the design will determine the exact ultimate loads.

Matt Rich comments on an unusual aspect of this enclosure, "Actually, in our design, the air conditioning system is 100 percent redundant. We had two full-blown air conditioners built into one housing...pure, one-of-a-kind, custom design.

"We had a blast shield designed and built around the air conditioner, which is a very unusual design (to incorporate into an otherwise standard, single-unit module). Usually, even in a blast building, what you want to do in the event of a major catastrophe is to protect the contents, as we are here. And the air conditioner's not normally considered a critical component...the end user just wants major protection, not infinite protection. But in this instance, we designed and built this blast shield around the units to keep the system redundant—and because the design criterion for the air conditioner was 131°F on the upper end. As mentioned, the customer is located in the Sahara desert, so the 3 major reasons for redundancy in the HVAC system predicated our running with this one-off design and configuration." (Figure 3)

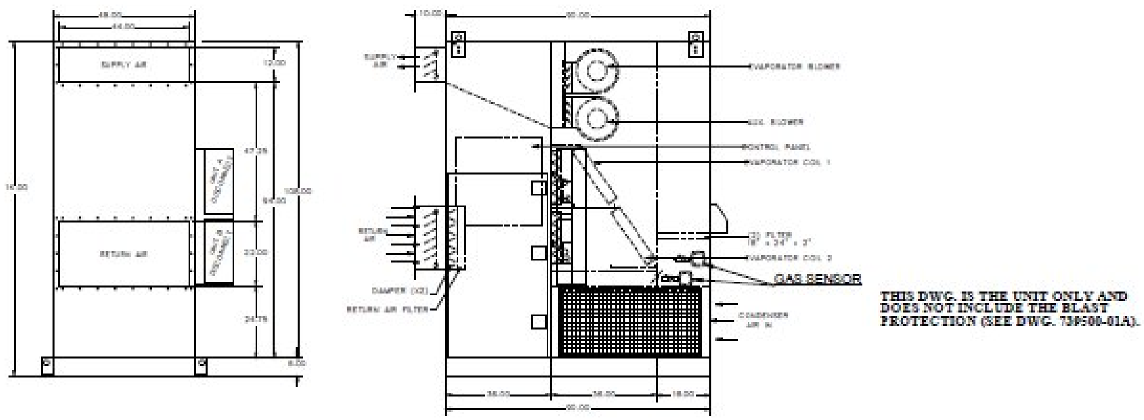

Figure 3 – The fully-redundant air conditioner unit designed and incorporated into the blast resistant enclosure

As the project evolved and facts were made known that necessitated changes, one aspect significantly altered the design. Originally, the design was placed within the site map such that it would meet the blast resistance criteria for that particular area of the plant. At that point, spec called for major protection for just one side of the enclosure—
the area facing the primary area of anticipated blast pressure. However, over time it was discovered that the entire structure needed to be protected. The enclosure was then redesigned to include the same level of blast protection from every conceivable direction.

"One big thing to remember is that when customers say, 'Must meet a blast spec of point-one-seven bar or 2.46 psi at 60 milliseconds…there are many things involved from an overall design standpoint to adhere to that benchmark," Litwicki said. "It's not just a flat figure that begins a design profile—that number is arrived at from a list of different parameters and variables in a blast scenario. For instance, the HVAC, the inner wall vs. the outer wall, and blast direction all figure into the design. There's a station factor that's proportional to the pressure it's designed for. In our case, we're talking about a distance of 8 to 12 inches between the inner wall and the outer wall. And from a blast-resistance standpoint, the structure is completely sealed and includes remote sensors to detect gas leaks before they reach the enclosure."

"Typically, we are known as an automation company. Many of our partners, our customers, come to us from an efficiency standpoint, looking to do upgrades based on existing situations in the field. In this particular case our customer had asked us to help them with an upgrade using our technology for Motor Control Centers (MCCs) (IntelliCENTER® MCCs), as it applies to the equipment used in their process. We tied into a partnership with the turbine control manufacturer to apply our intelligent MCCs with their ControlLogix® UCP (Unit control panels), to package an integrated turbine control system. That specific environment called for blast protection as well as many other things that play into this. You have heat dissipation inside the building, created by the equipment, so the enclosure needed to be specifically designed to accommodate a heater and/or air conditioner—and that had to be blast protected also. We were contacted by the company that wanted to do the upgrade, which required a new turbine, new process equipment and new controls. So with our customer it was one complete package and a natural solution. The key was to provide the best, most efficient design and fit for our equipment as a contractor, and that's why we chose Lectrus to design and build the right blast resistant equipment center for Algeria."

Dave Cole adds, "The customer had certain design features that they wanted included in their electrical equipment center. At the same time, they wanted us to be sure that some aspects were excluded from our design. They had come to us specifically for a more robust structure, and that is what we provided them with."

The quoting and design engineering went on for a couple of years. But when Lectrus and Rockwell Automation arrived at the actual construction phase of the project, they received official customer notice very late in the game. The expected and need-by dates had changed from the owners' perspective and from the three contractors involved with the unit. In addition, the turbine manufacturer had gone into overdrive on their end. Lectrus originally had 20 weeks to complete the enclosure but in real time, they completed it in 8 weeks.

Because of the timing aspects involved, Lectrus worked as closely as possible with Rockwell Automation in the coordination of electrical equipment and controls installation. Additionally, both Rockwell Automation and the turbine OEM have continued to evolve the design since the enclosure was placed on site at the turbine manufacturer. Original completion and shipment of the enclosure was August 2009. At that time, and with the timeline that existed for completion as requested by the customer, Lectrus had deliverables yet to be incorporated within the unit. Because of this, the unit remained a work in progress, even though the original enclosure was completed in August. The take-away for customers is that Lectrus' support and involvement extends to every one of its projects until completion of the job, which may often occur long after the original BREC has been completed and shipped. In other words, Lectrus and Rockwell Automation involvement with a project doesn't end when the BREC is finished; it ends when the team finishes the game, and not beforehand.

Integration of Electrical Equipment and Process Controls

"I believe one of the situations that really helped Rockwell Automation, as well as our customer, is that we used the Integrated Architecture™ approach," asserts Litwicki. "Our embedded success, if you will, was integrated architecture. What that means is, our PLCs (Programmable Logic Controllers) are right inside the UCPs (Unit Control Panels). They were connected and wired specifically through a network into the motor control center—so there's intelligence there. And some of that intelligence aids in the gathering of the data provided by the turbine. So from the operations standpoint, there are many things that work together to make this a state-of-the-art facility, both inside and outside the equipment shelter. For instance, in the past, when a motor control was simply hardwired into the pump, motor, valve, turbine, etc., the unit could fail from overheating and you wouldn't know it until the failure of the unit. Then you'd have to troubleshoot it to get the unit back online—jumping through hoops sometimes—whatever it took to fix the broken device. This would most likely present a difficult task.

“The beautiful thing about our Integrated Architecture MCC/PLC system is its embedded intelligence. Let's say the temperature has risen in relation to a specific component; the system can send out an alarm that in essence is saying, 'Did you realize the temperature has risen 10 degrees within the last 10 hours?' There MAY BE a problem….! These solutions are *thinking* solutions, so you have a very proactive software environment that's working on behalf of operations. From a manufacturing standpoint, that's why our customers go with us; there's a huge differential at work in the base structure of our solutions that thinks for the systems in place, such as with the turbine operation.

Operating within the safe environment of the BREC, the Rockwell Automation Integrated Architecture system provides a series of complete solutions via an information tier of software applications and services for performance management of the turbine. Their ControlLogix® PLCs, in conjunction with Allen-Bradley® MCC equipment, is being used to provide intelligent, high-speed, high-performance, multidiscipline control (sequential, process, drive, and motion) for this operation. In addition, the architecture is fully redundant, ensuring a safe, 24/7 operation and further protected by Lectrus' uniquely-configured enclosure in the extreme environment. All the MCCs and UCPs are Rockwell Automation equipment.

Figure 4 illustrates the layout of the equipment and controls within the enclosure.

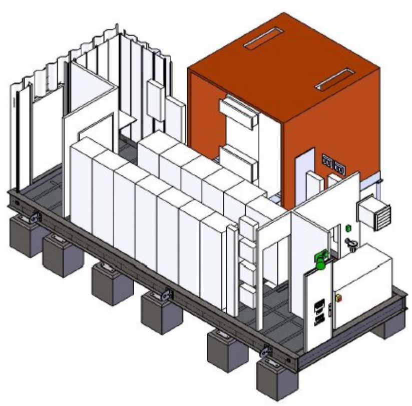

Figure 4 – Cutaway View of the gas turbine control enclosure showing electrical equipment and protected air conditioning system

In monitoring the process, typically the Power Distribution Centers (PDCs) are remote—but for this project they put a desk with a control screen in the BREC, with a station for personnel to monitor the operation.

“Another benefit is that there's a lot of room for operational add-ons and changes in the future,” Litwicki explains, “The operation today is the result of many man-hours and suggestions fitted to a single solution. What Rockwell Automation did with our partners is incorporate equipment and solutions that allow for amendments when future decisions call for newer and different operational components. We made it so that new things could be plugged in, so to speak, and new devices could be added into our embedded architecture. Withal, while maintaining the Integrated Architecture methodology, the core pieces are there; it's really a step into the future taken in the present. For example, let's say that sometime in the future, somebody is thinking about a newer solution using alarms in the system and says, 'You know, maybe we should set up trigger point alarms for every time the temperature increases two degrees.' Using our system, they could quickly check and see if something's wrong in lieu of a remote, hardwired situation that would allow pressures and temps to build and cause an explosion. That's another part of the beauty of what's there now: Proactive maintenance.”

Approximately 4 people served on the Rockwell Automation team in bringing their portion of this project to fruition: Project Manager, Lead Application Engineer Ken Litwicki, and Sales.

Where We’ve Been and Where We’re Headed

Ken Litwicki comments on the big picture, "This opportunity has provided our client with an operation that is truly advanced. Parts of refineries all over the world still use 1900s technology. Of course it's upgraded and made to provide more advanced information than it once did. But the wonderful combination of Lectrus and Rockwell Automation's expertise and technologies has allowed our two companies to offer a smart solution—both in physical protection and in supplying proactive process control in our client's operation.”

There is growing demand for oil and gas globally, which translates directly to increasing production. It has been posited that strong parallels exist between the Exploration & Production sector of the oil and gas industry of today and the US semiconductor industry of the 1980s. The need for process efficiency and safety is as strong now as it has ever been in the history of HP. Other challenges also exist, such as greater emphasis on green technologies, but safety and efficiency remain at the forefront. Here we have presented an actual project that was accomplished despite significant challenges, to perform flawlessly in an austere desert environment. But change some key features, the location and the refinery, and you have a typical scenario for not only filling the customer's needs, but moving beyond that point with extra protection, redundancy and future add-on adaptability.

Jeff Gallups has high marks for the quality of their products and his role in designing them, "I feel really good about the structures and what we build here. As far as moving into the Petro industry like we are, that's where we're seeing the highest load ratings you can deal with. And I go to work knowing that because we can handle that, we can handle anything any industry hands us. Our modules are a perfect fit for what the HP industry needs and is looking for."

Matt Rich sums up this project and the two companies' proficiencies by sharing, "We have proven our capabilities concerning every single aspect of working with a customer on critical timelines, adaptable to design challenges and changes as a continually-occuring part of the project. The result is exactly what we promise: True, custom engineered value-added solutions. There's nothing the customer can present as a need in this industry that we can't do."

"We have proven our capabilities concerning every single aspect of working with a customer on critical timelines, adaptable to design challenges and changes as a continually-occurring part of the project. The result is exactly what we promise…" - Matt Rich, Lectrus Project Manager

Lectrus Corporation of Chattanooga, TN, has over 40 years in the custom design and fabrication of electrical equipment enclosures, maintains 50 acres of facilities in two plants (Chattanooga, TN and Houston, TX) and serves a wide variety of industrial segments as well as the Military. From project planning, innovative design solutions, electrical equipment integration, site assistance and full customer support, no electrical enclosure project is beyond the scope of Lectrus' proficiencies—including blast resistant equipment centers, operator centers, custom enclosures and skids.

Rockwell Automation, Inc. (NYSE:ROK), the world's largest company dedicated to industrial automation and information, makes its customers more productive and the world more sustainable. Headquartered in Milwaukee, WI, Rockwell Automation employs about 19,000 people serving customers in more than 80 countries.

Literature Cited:

1. Cole, D., Bennett, R.H., and Austin, D., White Paper: Performance Limits of Blast Resistant Electrical Equipment Centers for Hydrocarbon Processing Facilities – Part I (2009).

2. Cole, D., Bennett, R.H., and Austin, D., White Paper: Performance Limits of Blast Resistant Electrical Equipment Centers for Hydrocarbon Processing Facilities – Part II (2009).

3. Cole, D., Bennett, R.H., and Austin, D., "Protecting Essential Refining Operations Using Blast-Resistant Electrical Equipment Shelters," IEEE-PCIC-AN-22 (2008).

4. IEA Greenhouse Gas R&D Programme, Iain W. Wright, British Petroleum.

5. Oilvoice, Nov. 28, 2007

6. In Salah Gas Consortium, “Carbon Capture and Storage at In Salah Gas” (2009).

7. Society of Petroleum Engineers, *Talent & Technology*, "A Changing Dynamic: The Need for Collaboration on Talent Development and Climate Change in the E&P Industry" (2007).

8. KBR Technical Paper, “Processing Considerations for Carbon Capture & Storage” (2009).