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King Ranch Gas Plant - RADU Recovery Project

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In mid-November 2013, a pump failure at ExxonMobil's King Ranch Gas Plant (KRGP) started a fire that damaged approximately one hundred feet of piperack in the Refrigeration and Demethanization Unit (RADU). The fire also caused damage to adjacent pumps, pipe racks, piping, and appurtenances on nearby process vessels. The fire was quickly contained and allowed to burn out; fortunately there were no injuries, which was a direct result of the prompt actions taken during its incipient stage.

ExxonMobil personnel quickly responded to the incident, and after performing a comprehensive damage assessment, realized that they would need help in determining the extent of rebuild required, designing replacement components, initiating procurement, and implementing reconstruction. ExxonMobil called on NELSON in mid-December and we responded quickly, mobilizing a multi-discipline team to the facility within a week to start defining the scope and continuing the excellent work that was begun by ExxonMobil personnel.

Although the newest unit at KRGP, the RADU dates back to 1960. As we soon discovered, the design of the original plant was robust, but somewhat unique compared to current designs. With the plant down, reconstruction was put on a fast-tracked schedule, which presented some significant hurdles to overcome.

Overview of Damaged Piperack - Looking North

NELSON's first order of business was to determine the full extent of demolition and reconstruction that would be required so that we could define the scope of the project, marshal the needed resources, and move forward quickly with the re-design and rebuild. NELSON worked quickly to define demolition limits for foundations, pipe racks, piping, electrical, and instrumentation, and then provided those details to the site so that demolition work could progress.

Concurrently, NELSON moved forward to determine the best means of re-constructing the pipe racks, as the structural scope would need to be executed as soon as demolition was complete. The original RADU piperack was a space frame constructed from pre-cast components that were interconnected by field-welding the main reinforcing steel at the joints and then installing high strength grout to complete the connection and moment frames. The piperack columns were supported from drilled piers with a continuous moment connection constructed by the same means. It was actually quite impressive that the necessarily close tolerances were maintained in the concrete construction of the original facility.

Although the original design was indeed robust and very corrosion-

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resistant, it did not lend itself well to reconstruction on a fast-tracked schedule. After a quick study, it was determined that the most expedient rebuild approach would be to cut off the concrete piperack columns at the top of the drilled piers and then reconstruct the structure as a bolted steel moment frame with base plates bolted to the existing piers. Following erection, the new steel piperack would be fireproofed per current ExxonMobil specifications.

The geometry of the replacement rack was set to match the existing rack. The depth and width of the members were selected to fall within the envelope dimensions of the existing structure to avoid interference issues with piping and other components of the re-build.

A major consideration for the piperack redesign was the ability to erect the structure in sections and support levels of piping before the rack was fully erected. Special attention was paid to the bolted moment connections to facilitate quick erection with adequate tolerances. Sliding connections were provided at the interconnection to the existing piperacks to allow for horizontal movements while transferring vertical gravity loads. The existing concrete piperack is a stiffer structure than the new steel frames and the sliding connections were employed to avoid having the re-built piperack effectively laterally supported from the existing structure. Such an arrangement could lead to overloading of the existing frames and/or foundations.

NELSON was able to complete the basic structural design within a few weeks and generate a material requisition and "Approved for Bid" drawings by the end of January, 2014. Bay, Ltd. of Corpus Christi, Texas was selected to fabricate both the structural steel and the piping. Fabrication was started in mid-February and onsite erection started in late March. An excellent effort was made in the field to ensure that new column anchorages were accurately located and aligned. This effort paid off as the field erection of the structural steel went smoothly and without any significant fit-up issues.

Concurrently with the structural design work, NELSON set out to verify the damaged piping versus the P&ID's and piping plan and elevation drawings from the original design. This verification work was slow-going due to the ongoing clean-up and make-safe operations in the field. However, a cooperative effort between ExxonMobil Operations, Construction and NELSON allowed us to complete the initial verifications in a shorter than expected time frame such that demolition could proceed and we could get started with the replication of the piping system.

At NELSON's recommendation, it was decided to generate a 3-D model of the affected piperack and piping systems to produce piping isometric drawings in order to avoid interferences and verify that all piping was accounted for. This 3-D model quickly became a useful tool for planning the construction effort and later on, executing the project. It was the project's philosophy that RADU be rebuilt to match the original design as much as possible. However, it was also necessary to make sure that the reconstruction was in accordance with current codes, standards and practices. An intensive effort was spent up front to verify the current process data and existing piping materials were in accordance with current standards. The facility included refrigerated lines, steam lines, hydrocarbon lines, firewater and other utility systems. As one could imagine, there have been some modifications made to the ASME code in the last 50+ years that led to some study and work to verify materials that would meet the current standards.

Close-up View of Original Concrete Piperack Bent

NELSON worked with ExxonMobil Construction to determine the limits of piping demolition and set tie-points for the new construction early on. As work in the field progressed, it was determined that a number of aspects of the design would need to be enhanced during the construction phase. All of the major piping that was routed on the original design was included in the 3-D model, from which isometric drawings were generated, shop-fabricated, and installed in the field. There

South End of Reconstructed Pipe Rack - Looking Northwest

were many additional small lines that were field-routed in the original construction from standard details. For replacement of these lines, NELSON personnel spent many hours onsite, hand-sketching isometrics for the construction crews to expedite and facilitate the reconstruction.

The original RADU construction utilized conduit supported in the piperack for the power distribution system with underground laterals to outlying equipment. A major challenge for the design and reconstruction team was the determination of the extent of hidden heat damage and then developing a recommendation for the most economical and expedient means of reconstruction. As in other areas, the National Electric Code has evolved significantly since the early 1960's, and there were some challenges in selecting components that met the present code and were compatible with the existing system and equipment.

Replicating the Control System for the RADU unit was also quite a challenge. As you would expect, much of the Control Systems had been upgraded since the original installation – but not all. There was a mixture of more recent and older instrumentation that required replacement. Access to the site for detailed inspection during the initial stages of the design was limited due to hazardous materials abatement, clean-up, and demolition activities. Fortunately, the ExxonMobil Control Systems Engineer had developed a plan of action and compiled numerous documents relating to the DCS and PLC systems, available wiring diagrams, etc. that was used to get a fast start on the replacement design and procurement activities.

Identifying the instruments that required refurbishment, replacement and procurement was on the critical path to completing the project. As a parallel effort to the field work, NELSON worked feverishly to develop new instrument data sheets, identify potential vendors, evaluate products, obtain quotes and then send out the packages for purchase.

After the initial site demolition was completed, NELSON designers were able to access the affected areas to document what was still there and then created as-built wiring diagrams of surviving panels and cabinets in the fire zone and those suspected of having a connection to other parts of it. ExxonMobil I&E construction supervisors were instrumental in assisting our needs while we were both onsite and back in Houston compiling documents. Throughout the development of the reconstruction design package, the I&E contractor, Custom Automated Controls (CAC), was invaluable in their efforts to help solve "mysteries" in real time while working with NELSON to determine the optimal replacement schemes.

As the design of the replacement Control System was completed and field I&E activities began to ramp up, NELSON provided full-time Engineering and Designer support in the field for installation and testing activities.

The RADU was successfully restarted in November of 2014 – approximately 12 months after the initial incident. The successful rebuild project was a collaborative team effort of many parties including client project management, Operations and Engineering, Construction, and NELSON. NELSON is proud to have been part of that team, from early damage assessment through the construction and pre-commissioning phases.

Upper Elevation of Reconstructed Piperack - Looking Southwest

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