ONSITE INNOVATION

Aaron Stryk and Cal Lipscomb, CB&I, USA, outline the innovative solutions that are keeping a complex project on schedule.

Construction is well underway on a new grassroots refinery being built by the Sohar Refinery Company for the Sultanate of Oman. This project, which is one of the most significant oil based projects to be set up in the Port of Sohar since the commissioning of Oman's first refinery 20 years ago, is scheduled for completion in the third quarter of 2006.

When completed, the refinery will receive a mixed feedstock of Omani crude oil and atmospheric residue. The crude oil feed will go to the new refinery's crude unit, which will have a capacity of 116 000 bpd, while the atmospheric residue will go to the refinery's cutting edge residue fluid catalyst cracker, which has a capacity of 75 260 bpd.

Until now, the atmospheric residue has been sold in the international marketplace. By building a new refinery that can process the residue, the Sohar Refinery Company not only adds value to this by product, but also creates new jobs, provides feed for such downstream industries as polypropylene, ethylene dichloride and aromatic products, and generates additional revenue for the country. The Sohar Refinery project is a large, complex project, made more challenging by the aggressive schedule required to bring the facility online by 2006. The tankage alone for this project includes 55 petroleum product storage tanks, 16 spheres and one elevated water storage tank. In total, there are 39 uniquely designed structures amassing 25 000 metric t of steel. Upon completion of the refinery, these structures will provide more than 1 million m^3 of bulk liquid storage and more than 40 000 m^3 of pressurised storage for propylene and liquefied petroleum gas. CB&I, the EPC contractor responsible for the engineering, material supply, fabrication, construction, testing and insulation of all tankage at the refinery, found innovative ways to address the challenges encountered by the size and scope of this complex project and still keep tank construction on schedule.

Figure 1. In addition to the 55 storage tanks built, 16 spheres were installed at the Sohar refinery, 10 of which were designed for storing propylene.

Some of the challenges encountered on this project involved meeting the requirements for local content, training the local crews, getting materials to the site on time and staying on schedule, even when materials were late. In finding solutions for these challenges, additional benefits were provided, including project cost savings and the presence of a trained workforce for future projects in Oman.

Meeting local labour requirements

Based on local content requirements, all contractors that worked on the Sohar Refinery project were required to use at least 30% local labour. This requirement was a good fit for contractors that direct hire local labour as a matter of practice. The goal of this practice is not only to hire the required number of local employees for a particular project, but also to train and retain them as long term, productive members of the contractor's workforce. This practice benefits the contractor, the local economy and the country as a whole, since it contributes to raising the number of skilled workers available for future projects in the country.

Since 1977, CB&I has had a presence in Oman and significant previous experience working with the Omani government. The company has been actively involved in the Omani tank business, primarily through the oil producing initiative 'Petroleum Development Oman' and several large scale tankage projects, including a 600 000 bbls storage facility in Muscat in 1999, as well as a 1 million bbls facility in Mina al Fahal in 1993, the largest tank in Oman. In 2003, after being awarded a new contract to construct

Figure 2. Work continues on the propylene spheres. According to project managers, this may be one of the largest sphere projects in several decades.

ENGINEERING CONTRACTORS OVERVIEW

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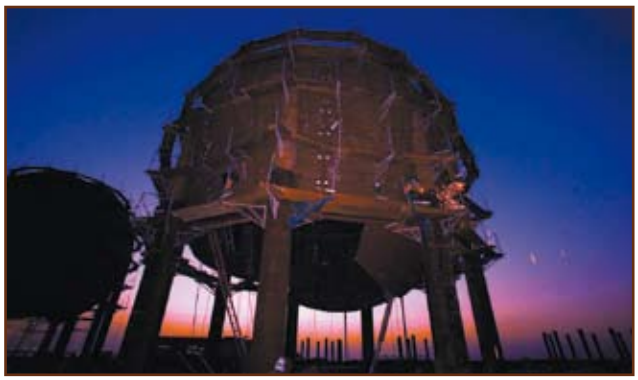

Figure 3. Each sphere is 16.74 m in diameter, 39.5 mm thick, and weighs 320 t empty and 1381 t while in operation.

two ammonia tanks, a permanent office was established in Oman, where the company is able to ship project cargo and equipment from regional warehouses around the globe, as well as manage project logistics and costs.

To assist in the recruitment of local employees, the Omani Ministry of Manpower provides a list of candidates for training for positions that require skilled labour, as well as for other trade specific positions such as drivers, watchmen and office clerks. The Ministry of Manpower also provides government funded education programs and on the job training for local labour. For the Sohar refinery tanks, training was needed for 60 workers in three different areas: welding, fitting and rigging. The government financed this training, which took place over a span of seven months, followed by one month of on the job training onsite.

For the 60 Omani who took part in the training program, the first phase of the training focused on communication skills to enhance their ability to communicate with supervisors and fellow colleagues from multinational backgrounds. The second phase of the program focused on safety, and the final phase of the program focused on skill development in specific trades. Although not all 60 original workers 'graduated' the program, the government assisted in replacing any participant who did not work out or chose not to continue.

In addition to the candidates provided by the Omani government, some of the workers selected for this project were Omanis who had been previously recruited and trained for the ammonia tank project in 2003. These employees, already familiar with company policies and procedures, were willing to share their knowledge with their fellow countrymen. As they shared a similar cultural background with the new employees, they were able to quickly communicate information about the company, its requirements and the specific tasks that needed to be undertaken on the project.

During the onsite phase of the training program, experienced travelling crew members helped integrate new employees. These employees were first given a safety orientation and then, under the supervision of experienced employees, they were integrated into the crews to learn basic construction practices. On the job training initially began with a chance to observe the construction activity and then followed with the opportunity to participate. Arabic speaking superintendents, foremen and site construction managers were on hand to communicate with the new additions and ensure that they were compliant with all regulations and safety standards. The site manager also had opportunities to mentor and motivate the crew, gaining their trust and cooperation as the project progressed. In this environment, local employees developed a sense of ownership and pride, as well as an understanding that the skills they took away from this job would prove helpful for obtaining future work.

Meeting the schedule

In addition to the labour issues, other challenges were presented by the need to meet the 19 month construction schedule. As various situations were encountered during the normal course of the project, innovative solutions were found to resolve each situation. For example, significant non uniform settlement occurred due to soft subsurface soil layers under erection and hydrotesting loading. This issue was discovered early on by the project team that monitored and recorded the movement of the foundations while under loading. The team came up with innovative ways to counteract this settlement by using air bags and jacks to lift the structures and reinforce the foundation where needed.

Another way this project was kept on schedule was by implementing the philosophy of standardised components and drawings. This practice reduced the number of drawings that required submittal, checking and approval. For example, nozzles, man ways, sumps, as well as many other tank and sphere components were detailed on one or two drawings for all structures instead of individual drawings for each structure. In addition to reducing the number of drawings by 20%, this standardisation allowed for fabrication to be completed in an assembly line manner rather than requiring individual drawings to be completed before work could commence on a particular structure.

Also, in the ordering of the bulk steel plate, the number of plate sizes was reduced. For instance, if one design needed 6 mm plates for the bottom but the majority of the tanks required 8 mm plates, which were used for all designs. Although this practice may perhaps be more costly in raw material purchase price, it helped improve the efficiency of the mill, reduced administrative checking and paperwork, minimised the chances for error due to the plate interchangeability between designs and decreased the segregation and temporary storage effects. This same philosophy was also used for ordering piping, pipe supports and structural steel.

Cost savings

Several cost saving practices were implemented on the tank project. One such practice was the advanced purchasing of all bulk materials in addition to the main steel plate, which allowed consolidation of purchase orders for such items as pipe, pipe fittings, flanges and structural steel. In addition to the cost benefits, early in advance purchasing helped to manage the schedule by facilitating the arrival of materials at the required location well ahead of the dates the materials were needed for the construction activities.

One of the other ways in which costs were reduced was through the elimination of chemicals to treat sea and brackish hydrostatic test water. Through proper testing and analysis of the brackish well water used for hydrostatic testing on this project, CB&I was able to verify that chemical additives were not required. Without the need for chemical additives, the brackish well water used for testing could be directly discharged to the sea without harm to the environment. This resulted in significant savings and made it much easier for Sohar Refining to obtain an environmental permit.

Moving forward

The completion certificates for the first tanks were issued in June 2005. Although these tanks became operational in July, the majority of the storage units will not be used until the overall refinery has been commissioned in 2006.

However, once this refinery is completed, the Sultanate of Oman will have more than just additional refining capacity. With the help of the Ministry of Manpower and international contractors, Oman will have a trained workforce with the skills necessary to work on future petroleum projects, as well as the problem solving skills needed to handle scheduling and construction challenges encountered. ■