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Ursa Expansion and Surveillance Projects

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The Ursa Tension Leg Platform (TLP) is located in Mississippi Canyon, Gulf of Mexico at a water depth of 3800 feet and approximately 90 miles offshore of the Louisiana coast. Shell is the primary owner and operator of this oil and gas production facility initially installed in 1998. Similar to its role in the original design, NELSON has been one of the principal members of the integrated design team responsible for the design for various platform additions and maintenance activities at Ursa. Although this includes multiple engineering disciplines, the focus of this article will be on structural engineering activities.

Some of these expansion and surveillance projects include subsea tie-backs, waterflood and gas lift installations, VIV (vortex induced vibration) and ROV (remotely operated vehicle) equipment installations, compressor additions, POB (personnel on board) expansion, low pressure system conversions, and turbine generator swap out. These brownfield jobs have unique design and installation considerations, and require additional work processes beyond the normal number crunching for typical “in-place” analysis. Close planning with and support for the various construction and operations teams is a must. For the Structural Design Team, some of the primary design and installation challenges include platform weight management, material handling, and safety.

Weight Management

A TLP is a floating vessel, like a ship, and therefore project weights are closely tracked and managed throughout all phases of a project in order to maximize remaining payload, which is a commonly used term to describe the load carrying capacity of the TLP. Weight management is critically important for planning future development scenarios.

For large projects like subsea tie-backs and waterflood installations, NELSON’S experience with global weight studies allows us to locate and configure large equipment packages so that the most advantageous layout is achieved with respect to payload. Basic stability principles indicate that the TLP must remain level, with its horizontal center of gravity at its center point, and at a constant draft, in order to maintain uniform, pre-set tension in the tendons that secure it to the seafloor. Also, the location of the vertical center of gravity of the TLP is critical to its stability. Ballast water is pumped into and out of ballast tanks as TLP loads are removed or added in order to maintain the TLP center of gravity and tendon tension within acceptable limits. Understanding the implications of where weight is added, in addition to how much weight is added, is of critical importance when designing expansion projects.

Weight evaluation and equipment configuration are also important early on in a project when platform crane capacities, module lifts, and barge transport are studied. Where package weights exceed platform crane capacities, heavy lift vessels must be used to lift

UPWF Project - Platform Crane Lift View from DB 50

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UPWF Project - Platform Crane Lift View from TLP

the packages onto the platform. Contracts with marine installation contractors for heavy lifts must be secured many months in advance of when the actual work is performed due to derrick barge high workload and limited availability. NELSON'S experience with and input to lift studies and lift barge evaluations have been important contributions to the selection process, allowing timely project schedules to be achieved.

Project weights and configuration have a direct impact on cost, especially when equipment and structures are being installed on an existing offshore platform. Particular attention is given to the work associated with offshore construction, and great efforts are taken to modularize equipment packages and minimize offshore "stick building" and welding. Modularization is effective for both weight reduction and simplified constructability.

Since its inception, Ursa expansion projects have consumed nearly 6,500 tons of available payload. Estimated operating weights for various projects, including riser and umbilical loads, are as follows:

- Crosby Subsea Tie-back (1,005 tons)
- Princess Subsea Tie-back (848 tons)
- Crosby Gas Compressor Installation (713 tons)
- Ursa Princess Waterflood (2,971 tons)
- Ursa Gas Lift Installation (321 tons)

Material Handling

It is common on expansion projects to work very closely with the offshore installation contractor and offshore hookup contractor on material handling issues including lift planning and design for demolition items, equipment relocation, temporary equipment setting and permanent equipment additions.

For the Ursa Princess Waterflood project, UPWF, the upper deck of the Power Module was cleared to make room for 3 large facilities packages and various interconnecting structures. This required the demolition of 8 existing deck beam packages (220 tons), the largest being 53'x 65' and weighing 60 tons. This pancake deck was field cut into 3 pieces, with lifting eyes added for rigging and removal, in order to safely handle the sections.

UPWF Project - Hydraulic Trailers used for Module Weighing and Loadout

Lifts for relocated items were also required during the UPWF project. The Power Module waste heat and turbine exhaust stacks, exhausting at nearly 1,000 degrees F during operation, were extended approximately 40' to an elevation above the newly added equipment. The exhaust tip ducting sections for all 6 turbines and waste heat box were removed and relocated to the higher elevation.

Another series of lifts and extensive planning was required for the relocated Power Module crane and 220' boom. The boom was removed in 3 sections using temporary boom rest stands, and the crane cab was removed in 9 sections. A temporary bullfrog crane weighing 160 tons, with a 65 ton API static rated capacity, was installed on the Wellbay Module upper deck to perform these lifts and various other lifting activities while the Power Module crane was out of service. The crane components were sent to shore and refurbished. The reassembled crane, which weighed 123 tons, was later set by McDermott's DB 50 derrick barge onto a new pedestal and kingpost at the upper deck of the Sulfate Reduction Module (see photos).

Often times, a significant portion of a surveillance project involves handling temporary equipment. In developing the equipment general arrangements, structural analysis is required to ensure that the equipment is placed at deck locations suitable for the imposed reactions. The equipment and skids must be designed for dynamic lift as they are removed from supply boats and set onto the platform. Tie-down details must be developed for the "in-place" analysis. It is

UPWF Project - 635 Ton Sulfate Reduction Module Lift

important to understand where uplift forces may occur due to equipment operation or the occurrence of an unforeseen winter storm. Some examples of temporary equipment installed at Ursa are:

➢ VIV equipment- used to install suppression strakes on tendons and risers to mitigate vortex induced vibration from loop current loading.

➢ ROV equipment- includes remotely operated vehicle, A-frame, winch, cage, transformer, hydraulic and auxiliary power units, docking head, cursor, and control and work vans

➢ subsea riser installation equipment- includes chainjack, chain basket, chain handling skid, hydraulic power units (HPU), winch skid, diving equipment, and HPU control cabin

➢ waterflood riser installation equipment-includes chainjack, chain basket, HPU's, pull-in winches, assist tuggers, and diving equipment

➢ umbilical installation equipment

➢ office buildings and living quarters

➢ bullfrog and jib cranes

➢ temporary work platforms in lieu of scaffolding

Ideally, equipment setting locations are accessible using the TLP module cranes; however, this is not always the case and moving items to their final locations requires other methods. Material handling for all types of items: demolition, relocated, temporary, and permanent, sometimes involves the use of carts, pipe rollers, skates, airfloats, winches, padeyes, and assist lines. The rule of thumb is that "where there's a will, there's a way". This approach has lead to many innovative solutions over the course of these projects. Furthermore, these projects require the design of many lifting aid structures, including:

➢ bridge crane runways and monorails

➢ spreader bars and sling arrangements

➢ fender/rub rail structures for crane hoist line to avoid side load on crane boom

➢ bumpers and setting guides

➢ low headroom equipment removal devices

➢ transport and lift skids for support of equipment not meeting dynamic lift requirements

➢ static stands for equipment support during maintenance operations.

UPWF Project - Water Filtration Module and Sulfate Reduction Module Barge Transport

Health, Safety, and Environment (HSE)

As always, safety is at the forefront for expansion projects. HAZIDS, HAZOPS, Operability Reviews, Layout Assessments, and Human Factors Engineering (HFE) Workshops commonly take place during both the Define and Execute phases, with structural engineers participating as active and necessary contributors in the process.

Crosby Gas Compressor Installation Project - Chemical Tank Skid Setting

HFE studies help to identify specific project aspects of equipment, systems, and areas that require more detailed thought to meet project specific performance requirements. HFE design has a critical impact on equipment usability and user safety or health. Operability Reviews help identify and assess potential operability, maintainability, and reliability issues associated with development, installation, and operation of the proposed topsides facilities.

For the UPWF project, these studies were valuable for the design/layout of the following:

➢ equipment arrangement of 3 large modules (Water Injection Module, Sulfate Reduction Module, and Water Filtration Module)

➢ revised crane boom orientation for the relocated Power Module crane necessary to maintain an obstacle free sector for conducting safe flight operations to the Ursa helideck.

Crosby Subsea Tie-back Project - Methanol Tank Skid Installation

Crosby Gas Compressor Installation Project - Chemical Pump SKid Setting

➢ location of source water intake caissons and overboard water disposal casings

➢ heavy lift planning for module and crane setting (675 ton Water Injection Module, 635 ton Sulfate Reduction Module, 427 ton Water Flood Module)

➢ control room building acoustical design for noise attenuation due to its proximity to turbine/injection pump units

➢ material handling operations

➢ personnel access/egress

Hazard management and reducing risk exposure are important challenges for expansion and surveillance projects due to very high activity levels with simultaneous construction, commissioning, maintenance and well servicing activities all taking place while performing ongoing production operations and striving to maximize platform up-time.

Conclusion

Weight management, material handling and HSE awareness are daily activities occurring on the Ursa TLP even after project completion. During all of the aforementioned projects, many unique design and installation challenges were identified and resolved by NELSON staff on the Structural Design Teams in their support of construction and operations.

The success of Ursa expansion and surveillance projects is a result of the joint efforts of, and cooperation among, many teams. NELSON is proud to have had the opportunity to participate in such world class projects, and looks forward to continued challenges arising from further Ursa development work.

UPWF Project - 675 Ton Water Injection Module Setting

Temporary ROV Equipment Installation

JOHN D. FERNANDEZ, JR. P.E.
1927 - 2010

John D. Fernandez, Jr., former Vice President of Waldemar S. Nelson & Company, passed away at the age of 82 on February 5, 2010, following an illness. He joined our predecessor firm, Bedell & Nelson, in 1952 and served in our Mechanical Department until his retirement in 2003, a remarkable career of over 50 years that was marked by many groundbreaking projects. He was nicknamed "Rocket" for his favorite car, a Rocket 88 Oldsmobile.

In the words of Tom Ehrlicher, a fellow mechanical engineer, "Rocket had a great ability to immediately know the fundamental engineering "rightness" of things. When he made one of those amazingly descriptive Rocket sketches of something, you could be sure it was going to work and that it would look practically identical when finished in detail. And if he looked at something for a few minutes and said it couldn't be made to work, you'd be wasting your time trying to prove him wrong. As recently as last December, when we had to come up with the conceptual design of a lift arrangement for a floodgate, I found myself wondering what Rocket was up to, even at age 82. He would have been perfect for the job."

Other friends remembered him with fond comments:

"*John and I had a special friendship because of his close ties to the Tulane Baseball program over the years; he had great insight into that particular sport. And it has to be mentioned that he was a fantastic bridge player. He really enjoyed playing."*--- Steve Pumilia

"*Who could forget the sketches with the man in a hard hat and wrench in his hand?"*--- Wayne Talley

"*I will miss him, I think about him often, and feel fortunate to have known him."*--- Steve Johns

"*Rocket will be missed. He was a great engineer and a great guy who was an important part of building the company in its early years*.--- Ken Nelson.

Rocket will be fondly remembered and sadly missed. We extend our condolences to all his family.

Houston Office Announces Retirements

Bob Steele, Bill Seward and Harry Marker

On March 31, 2010, a Mechanical/Process Department luncheon was held in honor of three of our Houston Office personnel who have reached major milestones in their personal lives by officially beginning their retirements. Two of the retirees, Bill Seward and Harry Marker, had nearly ten years of service with the company, joining the firm during the first year of operations in Houston. Bob Steele worked with NELSON for three years, and was also a significant contributor during his tenure.

Harry Marker retired March 31, 2010, after forty-six years working as a mechanical engineer. He graduated from University of Iowa in 1963 with a B.S. in Mechanical Engineering and obtained his Professional Engineering license in 1986. His work experience includes the food processing, manufacturing of basic chemicals, coatings and resins, and mechanical design for the petro chemical, refining, and oil & gas industries. Harry joined the NELSON Houston office on September 18, 2000. His technical strength was particularly evident through the strong reputation he had with our clients. Harry was an excellent mentor to our less experienced engineers. His retirement will provide the opportunity to enjoy his wife's companionship as well as his seven grandchildren.

Bill Seward also retired on March 31, 2010, after nearly forty years in the upstream oil and gas and synthetic fuels industries. Bill received a B. S. in Chemical Engineering from Rice University in 1965 and a M.S. in Ch.E. from the University of Minnesota in 1967. Bill received his Professional Engineering license in 1970. He has worked for contracting, consulting and operating companies during his career. Bill joined the NELSON Houston staff on August 16, 2000, as a Senior Process Engineer. He was promoted to a Staff Engineer in 2005. Bill's knowledge, organization and technical skills have been recognized by Nelson's management as well as our clients. Bill was effective in delegating work to our junior engineers and has been an effective mentor to them. Bill will be enjoying his retirement with his wife, children and grandchildren; he will also be traveling, composing music, and working on his 1939 Buick.

Bob Steele retired on March 31, 2010, after twenty-five years in the upstream oil and gas industry. Bob received a BA in 1971, and a MChE, in 1972, from Rice University. He then served for five years in the U.S. Army Corps of Engineers in Virginia, Colorado, and Germany as a combat engineer, ending his military career after two years as a company commander. He joined Exxon in 1977 and retired in 2000. Having graduated from South Texas College of Law in 1995, he became a solo attorney doing "mom and pop law" as his friends described it, until 2007 when he joined Nelson. Bob will spend more time with his family – he and his wife, Mary, are planning many trips, landscaping, and enjoying their new home in Alpine, Texas.

Harry, Bill and Bob will be missed by the Nelson staff and the clients who had the opportunity to work with them on their project teams. We wish the very best for these three fine professionals in their retirement years.

Houston Office Tenth Anniversary Celebration

We gathered on February 2, 2010 to salute the staff for ten years of successful operation in Houston.

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