Journey of Offshore Wellhead Platform Reuse Project

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Abstract

Several Wellhead Platforms (WHPs) operated by Chevron Thailand Exploration and Production., Ltd. (CTEP) in the Gulf of Thailand are approaching the end of well depletion life. With effective asset integrity management program, most of WHPs are still in good condition. Therefore, an initiative of reused existing WHP topsides, jacket and partial pile sections instead of new procurement and fabrication the whole WHP becomes attractive opportunity as it can enable marginal economic projects, support energy conservation and minimize waster from decommissioning. The 1st pilot project on Topsides reuse was successfully performed in 2017 by relocating pre-cut Topsides from its jacket and placing on top of new jacket executed by a heavy lifting barge. In 2018, the 2nd campaign for 3 Topsides reuses was executed successfully.

After topside reuse project has been executed successfully. The total reuse concept was continued to explore the opportunity and expand the scope of Reuse project. With this initiative challenge, it would be the first ever conventional fixed WHP to be totally reused and relocated to continue its production at the new site which may create more alternatives and opportunities on reuse of existing assets in oil & gas industry. To overcome unforeseen challenges, a conceptual study following with FEED was performed starting in Q2'17 to test on operational constraints, engineering concept, constructability and high-level commercial evaluation. A fatigue analysis is another key study apart from other constructability analyses. Referring to FEED results in Q1'18 with project assurance process from internal Subject Matter Experts and external 3rd party engineering consultant, it can be concluded that total WHP reuse innovation is "technically feasible" and "commercially attractive" without any major project risk.

Keywords: Offshore, Wellhead Platform, Total Reuse, Topsides

1. Introduction

The preliminary conceptual configuration for the reuse of the existing WHP includes removing the Topsides, removing soil plug in existing piles, cutting the piles below mudline and subsequently lifting the Jacket clear of the seabed allowing it to be relocated, in its vertical position, to the new field location. Once reach at the new field location the Jacket will be lowered down on seabed, re-piled by utilizing the section of piles presenting inside the jacket legs as the first pile section. The Topsides are then reinstalled, hooked-up and commissioned.
With this CTEP's initiative challenge, it would be the first ever conventional fixed WHP to be totally reused and relocated to continue its production at the new location which may create more alternatives and opportunities on reuse of existing assets in oil & gas industry. To overcome unforeseen challenges, a conceptual study was commenced in Q2'17 by collecting data, screening all 250+ WHPs with remaining designed life and types of platforms, verifying latest inspection results from integrity management program and mapping various platform water depths. In addition, those available WHPs should be in the list of the Asset Retirement (AR) program which are claimed to be less economic value to invest further on well production and ready for decommissioning. The conceptual study was performed to test on operational constraints, engineering concept, constructability and high-level commercial evaluation. With expectation to utilize the reused WHPs at new location for another 15 years, one of the screening criteria for the selected WHPs (called as 'donors') is their service life should be less than 15 years. Therefore, a combined fatigue analysis considering damage and fatigue life of existing and new locations together with recalculation of anode depletion are the key studies to be considered apart from other constructability analyses in Front End Engineering Design (FEED).

2. Typical Chevron Wellhead Platform (WHP)

With water depth range of 55-75m, the typical Chevron wellhead platform in Gulf of Thailand (GOT) considered in this Total WHP reuse study consists of a 4-legged Jacket with through leg piles, a boatlanding and Topsides with platform crane and vent boom. The original platform installation involved lifting the Jacket off a cargo barge horizontally, placing it into the water for free flotation prior to flooding the jacket legs and upending to the vertical position with a heavy lift vessel (HLV) crane. The tubular piles with diameter of 36" or 42" are then inserted thru jacket legs and piled to target penetration approx. 100-120m below mudline. The piles are welded to connect with top of Jacket and the boatlanding is installed separately to suit the final water depth and platform levels. The Topsides is then lifted to install via the HLV on top of those four (4) piles.

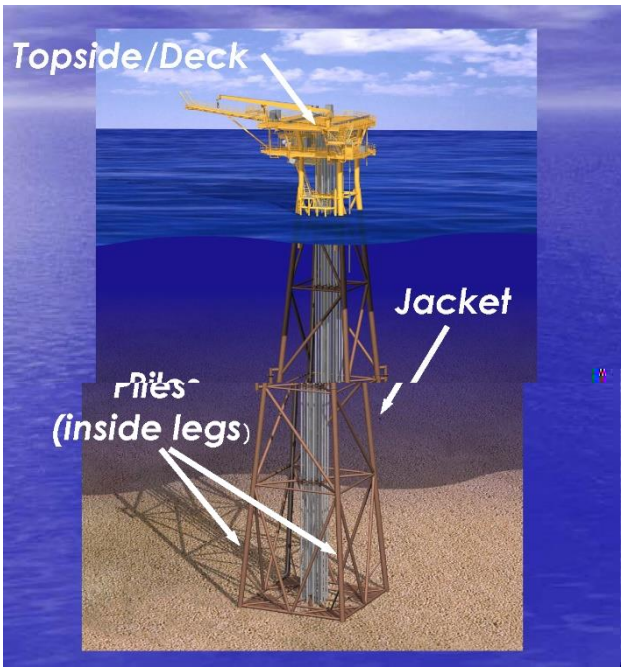

Figure 1: Typical WHP Arrangement

3. Journey of offshore Wellhead Platform Reuse

In 2018, this project was one of CTEP's Business Objective supporting "Step Change Campaign". The FEED study was performed in Q1'18 to ensure that the total WHP reuse is feasible in all technical aspects and constructability by capturing all potential risks, water depth limitation, work schedule and other concerns including commercial attractiveness compared with budgetary of new WHP installation and Topsides reuse. With more than 8 months of engineering study, various of structural analyses were performed such as Topsides removal, jacket with partial pile sections removal, lifting, transportation and installation (T&I), on-bottom stability, in-place, fatigue, weight control report (WCR), material take-off (MTO), etc.

To deal with different water depth issue between existing and new locations, miscellaneous calculations of additional subsea template, Topsides pup pieces and/or boat landing adjustment were evaluated for flexibility of WHP mapping criteria.

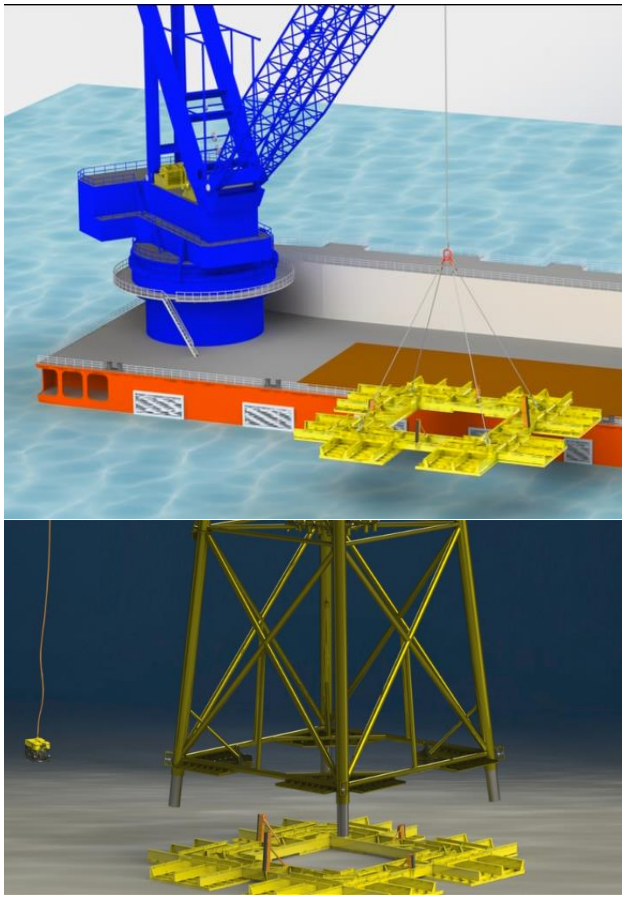

Figure 2 & 3: Additional Subsea Template installation

In engineering study, the Topsides will be cut and lifted on to the barge similar as reverse engineering for new topsides installation. After disconnecting pipelines from WHP risers, the soil plug in existing piles will be removed to achieve at least 5m below mudline, then Jacket and partial pile sections will be removed by cutting piles approx. 5m below mudline. Both jacket and attached remaining piles will be lifted from seabed and wet towed a substructure vertically 20m above seabed to new location to ensure enough clearance for crossing over any live pipeline.

Referring to FEED results together with project assurance process on engineering reviews from internal structural Subject Matter Experts (SMEs) and 3rd party engineering consultant from classification societies [1-11], it can be concluded that this total WHP reuse innovation is "technically feasible" and "commercially attractive" without any major project risk or concern.

4. Major Sequences of Wellhead Platform Reuse

4.1 Topsides removal

Prior to removing Topsides, the preparation shall be done to ensure that no hydrocarbon and/or chemical liquid remain onboard which may lead to any potential spillage during T&I including, all movable parts are secured in place and all Topsides piping, well, and stairs are disconnected separately from jacket part. Topsides and jacket lifting padeyes inspection and strengthening shall be performed in advance to minimize spending time of HLV.

4.1.1 Remove and lift Topsides from Jacket Piles

Topsides will be rigged up with lifting slings connected to HLV crane hook. After that, Topsides' legs with diameter of 36" or 42" tubular will be cut off from top of four (4) piles. The Topsides with approx. lift weight in range of 500-1000MTon will be lifted vertically to clear jacket structure approx. 8m above MSL.

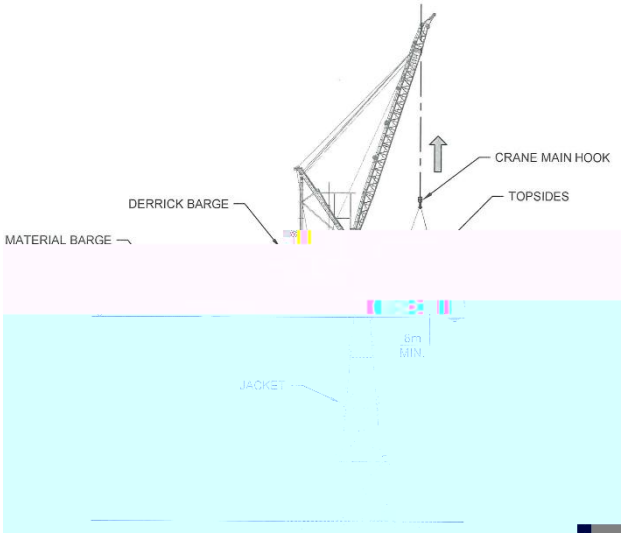

Figure 4: Lift Topsides from Jacket Piles

4.1.2 Set down Topsides on material barge

The grillage, pre-fabricated seafastening members and load transfer beams shall be engineered and prepared on the material barge. The material barge will be towed to alongside with HLV. The HLV crane will revolve to lift Topsides above material barge and lower its down to rest on the load transfer beams. Welders will install the seafastening as tie down members to secure Topsides against barge motions during transportation.

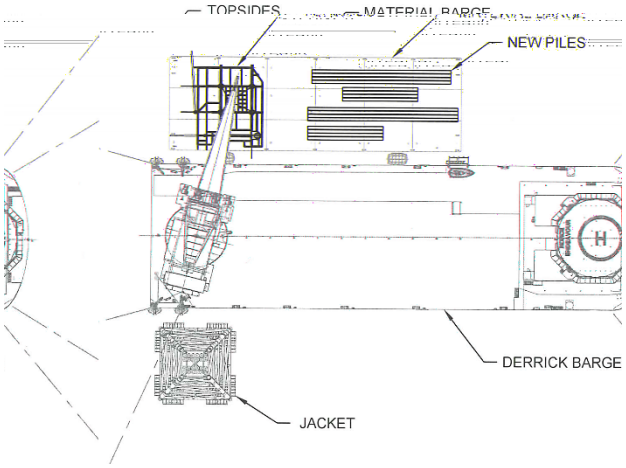

Figure 5: Revolve Topsides to material barge

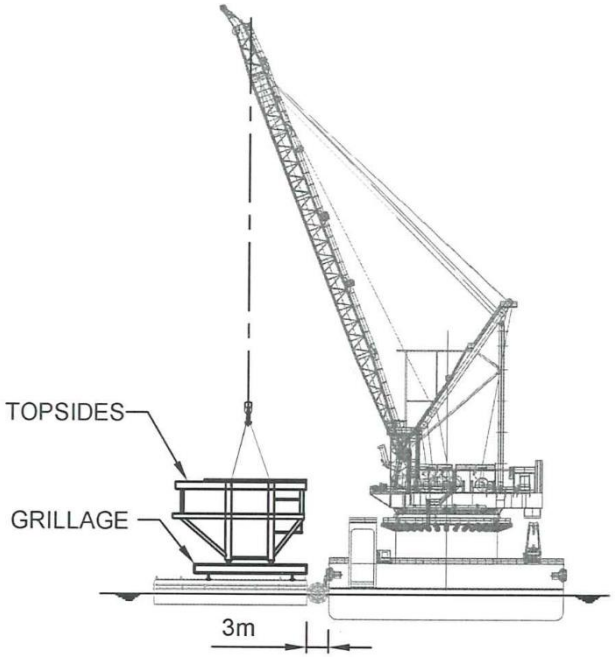

Figure 6: Secure Topsides on material barge

4.2 Jacket removal

Prior to removing Jacket, the preparation shall be done also such as disconnect subsea riser from pipeline spool which need to be performed by diver to disconnect and install the riser/spool blind flanges, temporarily secure boatlanding and not stable part, inspect and/or strengthen existing padeyes in case of reuse requirement, grind smooth pile top to make elevation and build up profile for future pile stabbing or installation of lifting trunnion, etc.

4.2.1 Cut piles and Lift Jacket free of seabed

The soil plug in existing piles shall be removed to achieve at least 5m. below mudline (if any) by special tool sitting top of pile. The piles will be cut at 5m. below mudline by inserting high water jetting equipment thru the piles in Jacket. The prefabricated lifting trunnion could be installed on top of pile in case existing Jacket padeyes can't support lifting off weight.

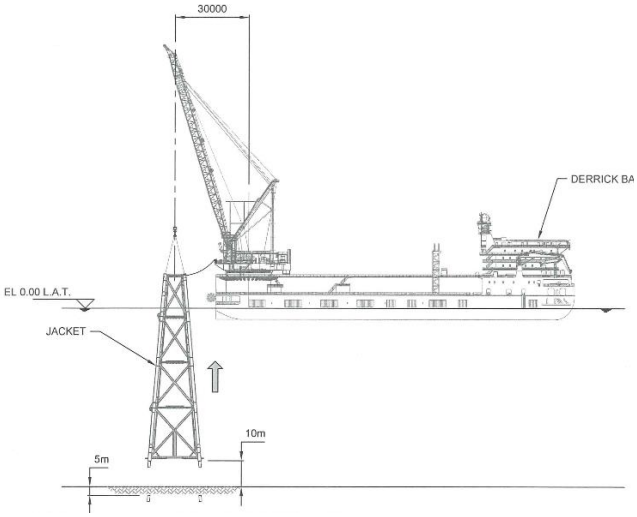

Figure 7: Cut piles and lift jacket free of seabed

4.2.2 Jacket retrieval to vessel stern

The lifting gear will be installed to jacket and connect to main hook of HLV crane. The initial lift off weight (stage 1) of the Jacket together with partial of piles inside could be in range of 1000-1300MTon depending on the water depth, marine growth weight, remaining pile skin friction, mudmat suction pressure, and Jacket appurtenances weight. The Jacket will be lifted vertically up 20m off seabed (stage 2) and pull to secure at HLV stern. These two (2) lifting stages will be derived to get the critical hook load and sling loads to cover in rigging design and selection.

Vertical load of Jacket and heave motion will be taken care by HLV hook and horizontal loads which Jacket may experience from seastate and vessel motion during transportation will be transferred to vessel stern fenders (horizontal and transverse). The attached slings from deck tuggers to two (2) nearside jacket legs will also assist to reduce Jacket movement and prevent top of jacket to hit HLV crane boom during transportation.

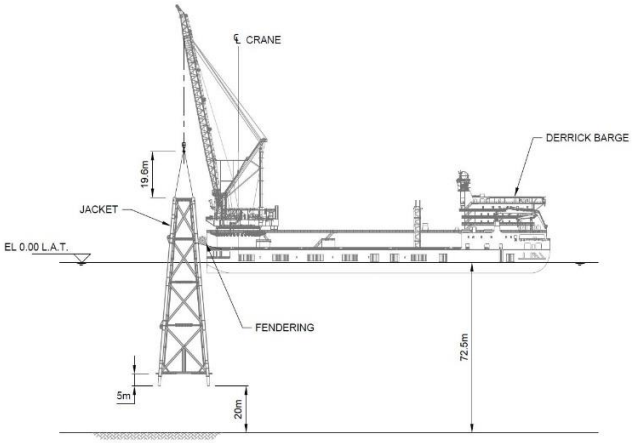

Figure 8: Lift Jacket up and secure to vessel stern

4.2.3 Recover vessel anchors and wet tow to new site

Once jacket is secured to vessel stern, it needs to be transported to the new site location by still having the jacket hanged vertically by HLV main hook and restrained horizontally by HLV stern fenders. As mentioned in 4.2.2, the structure of stern fenders will be prefabricated to HLV vessel attached to main deck and stern hull prior to mobilizing to work offshore.

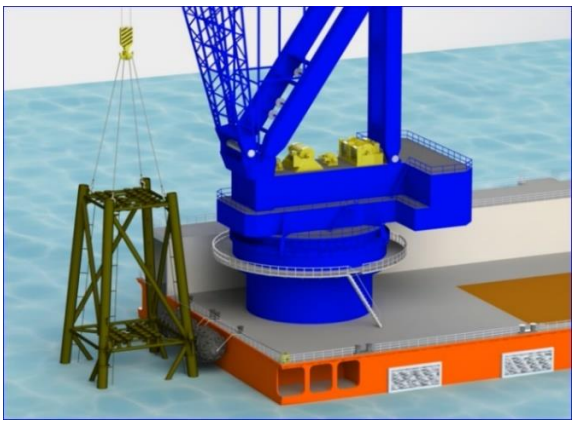

Figure 9: Jacket positioning during wet tow

All anchors of HLV will be recovered and the AHT tug will moor to tow HLV to new position. The Jacket will be wet tow to new position with speed range of 3-4 knot. In transportation, the interface loads transferring to main hook and stern fenders including deflected shape of jacket caused by barge motion and towing seastate will be analysed to assist on rigging design and selection, stern fenders design, seastate limitation for wet towing, towing speed selection, etc. MOSES simulation software was used to analyze on vessel motion responding with wet towing seastate and hydrodynamic part. The hydrostatic forces on jacket, HLV crane and stern fenders and other relevant objects will be extracted and applied in jacket model in SACS structural analysis program. In the SACS model, Jacket and suspended slings will be determined on their integrities during wet towing transportation while considering the maximum Hook loading from the MOSES simulations.

In addition, crane utilization was assessed against allowable hook load for a regional vessel at the required lift radius, as well as allowable side lead angle due to relative motion between Jacket and crane vessel. The analysis results verified that the Jacket has adequate global structural integrity to sustain all design seastate conditions up to the 10-year return period operating storm within Chevron field.

4.2.4 Lower down Jacket - subsea template option

Upon arriving the new site, vessel to set up approx. 30m. from the lowering position. Reposition vessel for the final lowering position. Slack and disconnect all mooring lines that secure the jacket at stern. Only control tugger lines remain on the jacket for jacket lowering. Slew crane to position jacket on starboard side of the vessel

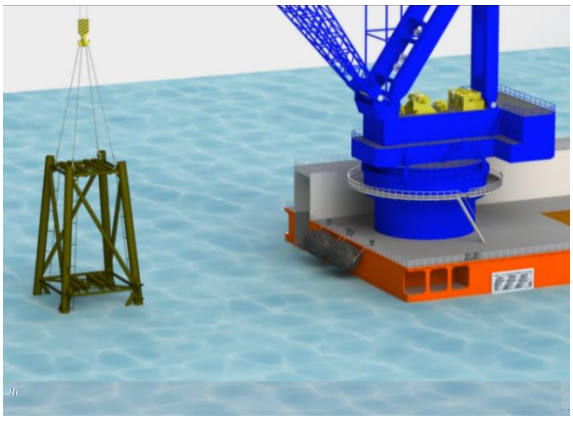

Figure 10: Disconnect all mooring lines from Jacket at stern

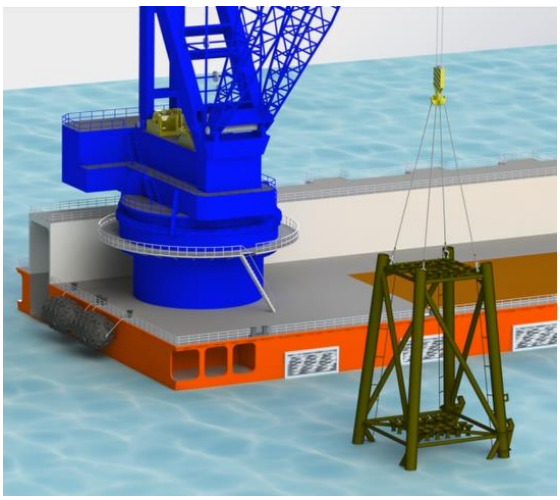

Figure 11: Revolve crane to starboard to lower jacket

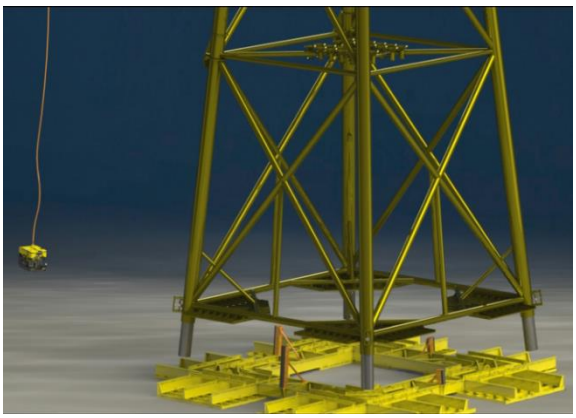

Figure 12: Lower jacket onto template

4.2.5 Jacket Installation - subsea template option

The Jacket will be installed by using the partial sections of the piles in the jacket legs. The material barge with new fabricated piles will be alongside vessel port side. The preparation of the top of pile end to be completed prior to Stabbing the new pile section on top of existing pile and weld out. The existing crown shim will be removed to allow pile to

self-penetrate and/or drive the piles. Pile sequence subject to stack up and on bottom stability assessment. The Jacket will be levelled and welded out on new crown shims to connect between Jacket and piles.

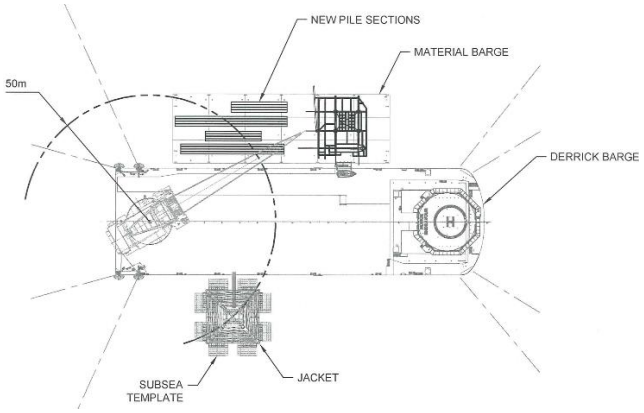

Figure 13: Alongside Material barge with new piles

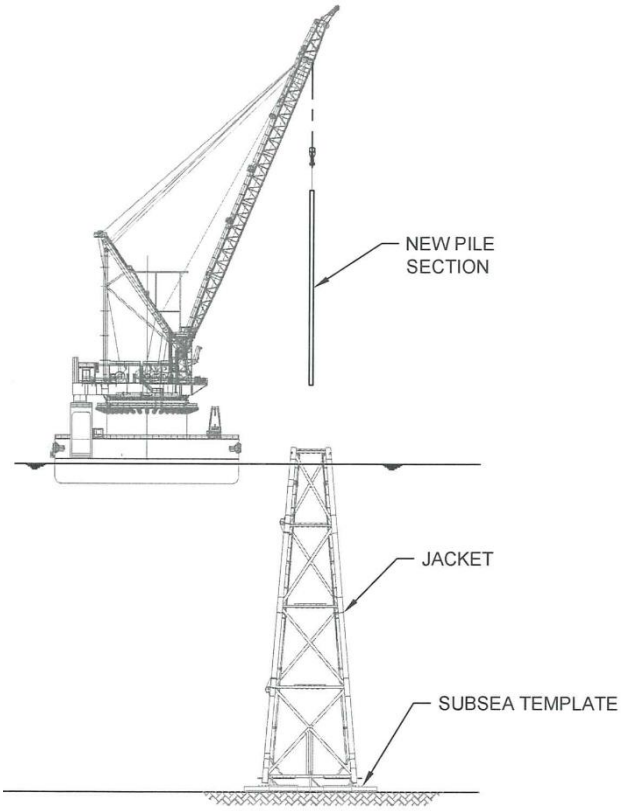

Figure 14: Stabbing the new pile section on the existing pile

4.2.6 Topside Installation

After completion of Jacket installation, the topside will be installed by using the conventional methodology.

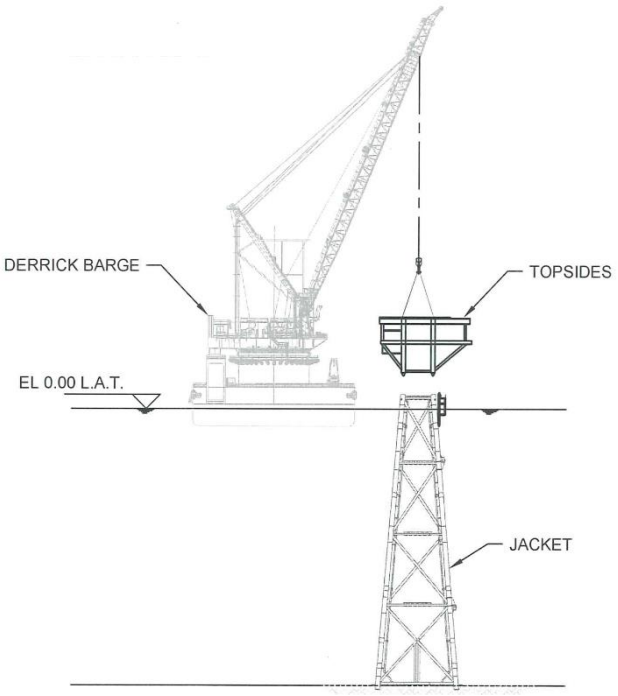

Figure 15: Topside Installation

5. Impact on Thailand

This total WHP reuse challenge will be a starting point of big step change in Thailand offshore Oil & Gas industry. The benefit is not only for Chevron Thailand which aims to safely develop and deliver the affordable, reliable and cleaner energy that is necessary for social and economic progress, but it will also advantage to kingdom of Thailand and enabler opportunity for other stakeholders in:

- **Enhance country reputation for promoting green policy:** With reuse of WHP topsides, jacket and partial of pile segments, it could reduce waste generation of approximate 1,600MT of structural steel per platform. All reusable pressure vessels, valves and some major equipment as remote compressor and platform crane will also lead an environmental benefit to decrease the contaminated waste to shore.
- **Support energy conservation:** As less steel production from the mill, it will reduce Carbon dioxide (CO_2) emission from furnace to environment in range of 1,800-2,000 kg CO_2/Ton Steel [12]. In this case it could saving CO2 emission of 2,880 Ton of CO_2 per reuse platform.
- **Be environmentally friendly:** With saving of tonnage of steel to be casted, it will also good for environment including reduce number of decontamination process at

onshore. This reuse also aligns with UN Sustain Development Goal No. 12 on responsible to consumption and production.

- **Minimize waster from decommissioning:** The total WHP reuse will minimize decommissioning waste which need to be decontaminated and brought back to steel furnace for recycling.
- **Enable opportunities to other Oil & Gas operators:** As this total reuse of conventional WHP has never been done before in the this industry, it will enable this reuse opportunity to other Oil & Gas operators.
- **Bring in innovation and add more alternative to Thailand Oil & Gas industry:** As mentioned above, Thailand could be a leader on the reuse innovation and in line with the principles of circulation economy. This will open more alternatives and opportunities not only to Thailand Oil & Gas, but also to other industries.
- **Reduce import materials for new WHP and its facilities:** Various of special steel grades, equipment and consumables which need to be imported form outer country can be reduced and save spending within Thailand.

6. Conclusion

Based on effective asset integrity management program on offshore facilities, the opportunity to reuse existing WHP at new location instead of new procurement and fabrication the whole WHP becomes more attractive as it can enable marginal economic projects, support energy conservation and minimize waster from decommissioning. And this total WHP reuse can also add values to fully utilize the whole design life cycle of WHP and its facilities.

With confirmation on “technically feasible” and “commercially attractive” from internal Chevron peer teams, engineering consultant and 3rd parties on the FEED results, this great innovative can lead a reduction of whole EPCI duration (engineering design, procurement, fabrication, transportation and installation) on repetitive conventional way from 20-24 months for new WHP cycle and 18-20 months for Topsides reuse cycle to 12-14 months for Total WHP reuse cycle. The estimated cost saving of this total WHP reuse could be around 35% compared with a new WHP cost.

In overall, project benefit from this engineering study could lead high impact to economic and flexibility not only for CTEP on minimizing waster from decommissioning, reducing CAPEX investment and decreasing import material and facilities for new WHP construction, but also Thailand Oil & Gas industry on enhancing country reputation on promoting green policy, enabling opportunities to other Oil & Gas operators, bringing in innovative to Thailand Oil & Gas industry, etc.

Acknowledgement

Authors really appreciate Chevron management on supporting opportunity and funding this step change study. In addition to the final results and quality assurance, all internal chevron working teams, peer review from Chevron global teams, external engineering consultant, offshore installation contractor, and 3rd party as classification societies certified this study are highly recognized as key functions to drive this quality FEED study to be ready for future implementation.

Special thank you to government sector as Department of Mineral Fuels (DMF) on providing guidance and supporting this total WHP reuse project initiative.

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