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VESSEL-LESS UNDERWATER INSPECTION AT FIXED OFFSHORE STRUCTURE BY UTILIZING MINI REMOTELY OPERATED VEHICLE (MINI-ROV)

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ABSTRACT

Mini Remotely Operated Vehicle (mini-ROV) technology has been utilized to perform underwater inspection with optimized Risk-based Underwater Inspection (RBUI) scope for offshore platforms which conventionally utilize divers and ROV supported by Dynamic Positioning Diving Support Vessel (DPDSV). This technology was introduced by launching mini-ROV from platform deck to perform General Visual Inspection (GVI), Cathodic Potential (CP) Survey, Flooded Member Detection (FMD) & Ultrasonic Thickness (UT) measurement with customized mini-ROV integration with other tooling. The small size ROV is light and easy to handle by technician onboard platform deck. It is also capable to enter congested areas as it is easily maneuvered, which help to capture close visual of the findings. During emergency, the mini-ROV can be mobilized instantly at site to support any GVI related scope. PETRONAS has successfully deployed this technology at four platforms in one of the operating regions from 2017 to 2021 with cost saving of 30%-50% compared to conventional method. The successful implementation in PETRONAS can become benchmark and reference for other Oil & Gas operators as an alternative to conduct optimized RBUI scope which can contribute to lower Operating Expenditure (OPEX).

Keywords: mini-ROV; vessel-less underwater inspection; RBUI

ABBREVIATION

CP	Cathodic Potential
DPDSV	Dynamic Positioning Diving Support Vessel
FMD	Flooded Member Detection
GVI	General Visual Inspection
IDAMS	Inspection Data Analysis and Management System
OPEX	Operating Expenditure
PLTA	Proprietary, License & Technology Assessment
PDG	Portable Diesel Generator
RBUI	Risk-based Underwater Inspection
SIM	Structural Integrity Management
SICS	Structural Integrity Compliance System
U-IMAGe	Upstream Inspection & Maintenance Assurance Guideline
UT	Ultrasonic Thickness

1. INTRODUCTION

Many offshore platforms have been installed in Malaysian waters since 1968. PETRONAS is currently operating a fleet of more than 200 fixed offshore structures. More than 50% of the platforms are aging structures which has been in service for more than 30 years. As a prudent operator, PETRONAS has established a guideline for Upstream operations on the requirements for inspection and maintenance of offshore facilities, which includes substructure underwater inspection. The guideline for structural inspection and maintenance is in line with local regulation and API RP 2SIM.

Underwater inspection is required for the purpose of gathering performance data of the platform to ensure safety and integrity of the assets for continuous operation. The inspection data comprises of major input to Structural Integrity Management (SIM) program and addresses the key areas of Data, Evaluation, Strategy, and Program to manage risk levels in Risk Based Underwater Inspection (SICS RBUI © 2015

PETRONAS) [3] program. The data plays a crucial role in ensuring the right methodology is deployed in support of digitalization and data driven decision making.

Over the years, the underwater inspection in PETRONAS facilities has been carried out by using divers and/or ROV onboard DP DSV covering both inspection and maintenance scopes. Millions of dollars have been spent to complete the inspection scope conventionally. With depletion of reserve which led to high unit maintenance cost, it is essential to find new ways to reduce the cost of underwater inspection. In line with the strategic thrust of being efficient, bringing value to operations and allowing technology as differentiator, vessel-less underwater inspection by using Mini-ROV technology has been exploited and successfully implemented at few platforms in one of the operating regions throughout the year from 2017 until 2021.

2. METHODOLOGY

The proposed idea is to conduct underwater inspection without utilizing any marine vessels during site execution. Prior to engagement of service provider, platform suitability evaluation is recommended to be conducted including availability of deck space and material handling capacity. Logistic arrangement for equipment and manpower (bedding) should also be planned to ensure efficient site execution.

2.1 Technology Evaluation

Mini-ROV is an off-the-shelf technology and many models are available in the market. Each model has its own strengths and weaknesses which are built for different application and functions. In order to shift from conventional inspection method, the project team invited several service providers to share their technology together with subject matter experts. The models which are capable to perform the required scope of work are identified and site demonstration of the functions were conducted.

2.2 Planning and Preparation

Site survey or desk study was conducted by PETRONAS engineer together with service provider to:

a. Availability of deck space
b. Identify safe area for control cabin / work area
c. Identify power source for the equipment
d. Identify material handling arrangement

The proposed location for equipment placement and work area are to be agreed by all parties especially offshore installation manager to avoid operation disruption.

As a pilot project in the company, it is essential for project team to give assurance on HSE and reliability of the equipment and underwater operation in offshore. Inspection and functional testing of the equipment were conducted prior to mobilization.

FIGURE 1: ROV FUNCTIONALITY TEST AT WHARF.

Work pack joint review was conducted between all stakeholders prior to execution work. The site execution procedures were discussed and agreed by all parties. JHA prepared by site execution team was thoroughly challenged and finalized based on actual site condition. Mitigation plan of the identified hazard were put in place.

2.3 Equipment and Manpower Mobilization

The equipment consists of mini-ROV, its tooling, and control cabin. Subject to the identified scope of work, the tools inclusive of CP probe, cleaning tools, UT probe and high-resolution camera. Where required, portable diesel generator (PDG) and portable crane might need to be mobilized to provide power supply and assist material handling. All equipment to be mobilized to offshore location will have to go to standard inspection and testing as per company's requirements.

FIGURE 2: MINI-ROV AND TOOLINGS

As this inspection method is deployed from the installation, typical inspection crew required are:

a. Subsea inspection engineer
b. ROV supervisor
c. ROV pilot
d. ROV technician
e. Data controller / recorder
f. Company site representative

Subject to availability of the candidate, some of the position can be multiskilled. It is observed that the manpower is very much reduced compared to conventional underwater inspection method.

FIGURE 3: PDG FUNCTIONAL TESTING.

FIGURE 4: INSPECTION OF CONTROL CABIN.

Among the challenges faced by the project team throughout the first 4 deployments including no available safe zone for placement of non-EX-rated equipment (PDG), no material handling capability, congested deck area for deployment of mini-ROV and logistic constraint. Early identification of these challenges provides the project team early preparation to mitigate the issues. With the absence of DP DSV, the site execution crew would need to commute via fast crew boat to site and also would require bedding at living quarter or workboat during the underwater inspection campaign. As for the equipment, the project team required to secure deck space inside the supply boat to transport the equipment to offshore platform.

2.4 Site Execution

Once all the equipment arrived at the designated platform, they will need to be lifted from supply vessel to the designated deck by using platform crane. In the case of pilot implementation at Platform-A, due to limitation of existing jib crane, portable crane is required to be installed on the platform to lift all equipment onto the designated deck. The portable crane parts were assembled, load tested and then verified by company surveyor.

FIGURE 5: PORTABLE CRANE INSTALLATION.

After portable crane load test completed and verified, all equipment were lifted to main deck and/or cellar deck. Electrical cables were connected between PDG and control cabin. PDG undergone functional test by company electrician before obtaining green tag as assurance on the functionality of PDG. After the control cabin powered up by the PDG, functionality test was conducted by certified ROV technician. In some other cases where power supply is readily available at the platform, the control cabin will be directly connected to the platform power source. Once functionality of mini-ROV was tested, then ROV operation was ready to proceed. The mini-ROV is deployed from platform deck to conduct underwater inspection.

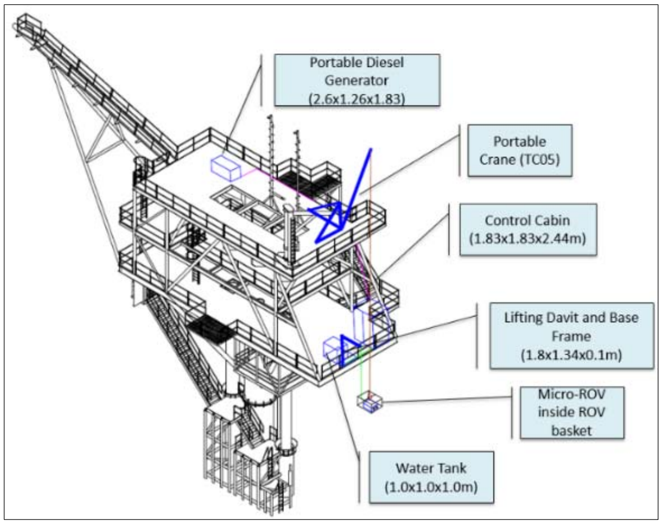

FIGURE 6: OVERALL EQUIPMENT LAYOUT ARRANGEMENT AT MAIN DECK AND CELLAR DECK.

FIGURE 7: ROV OPERATION IS READY TO PROCEED FOR UNDERWATER INSPECTION.

FIGURE 8: LAUNCHING OF ROV FROM PLATFORM DECK TO UNDERWATER USING DAVIT.

Depending on the model and weight of the mini-ROV, launch and recovery of the system can be handled manually, using available platform crane, simple Launch and Recovery System (LARS) or manually release of mini-ROV from boat landing stage. During underwater inspection at Platform-A, the project team had launched the mini-ROV using crane. Meanwhile, the mini-ROV was launched via manual handling at the boat landing stage area during underwater inspection at Platform-B, C and D.

During the underwater inspection, subsea inspection engineer (SIE) and ROV pilot will communicate to ensure the correct component will be inspected based on scope of work (SOW) and IDAMS. SIE will give direction to ROV pilot which component to proceed and double confirm by data recorder. At boat landing area, the ROV technician will maneuver the umbilical to prevent it from making any contact with marine growth at main component underwater (i.e. termination clamp, caisson, guyed-wire, boat landing, etc.) which could cause umbilical to be parted.

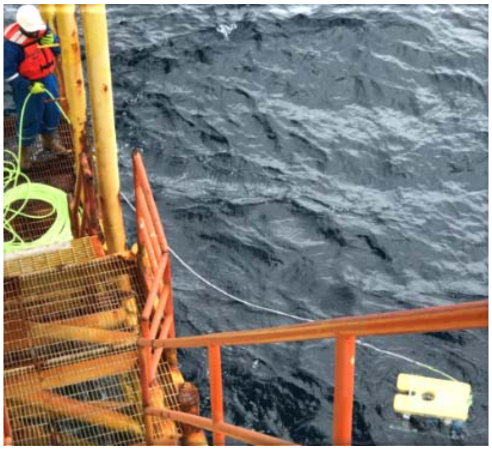

FIGURE 9: ROV TECHNICIAN MANEUVER THE UMBILICAL

3. RESULTS AND DISCUSSION

Implementation of technology requires careful evaluation of technology readiness, suitability of candidate and value creation for the business. Mini-ROV technology was successfully piloted at a guyed wire monopod Platform-A in September 2017, which is a simple structure with minimal components. With successful pilot implementation, second deployment was executed at another similar Platform-B in March 2018. In collaboration efforts with service provider, an improved visual and video were captured from the inspection. The inspection scope for both platforms comprises of general visual inspection, splash zone inspection, seabed survey and cathodic potential survey. Minor marine growth removal was possible, however it was too time consuming and inefficient. Subsequently, third deployment was conducted at a braced monopod Platform-C with different substructure configuration in August 2020. Venturing into a more complex jacket structure, the latest deployment was at a four-legged fixed steel jacket Platform-D, which was completed in November 2021.

Thorough evaluation on suitability of the platform were conducted prior to deployment including jacket configuration, availability of deck space and material handling capacity. Project Risk Assessment was also conducted prior to execution with recommended safeguard in place. As mini-ROV operations require power supply, identification of power source was to be determined during planning stage. There might be situation where portable generator set need to be mobilized.

In ensuring the efficiency and minimize downtime during execution, site simulation and functionality test was conducted at wharf prior mobilizing equipment to offshore. Logistic arrangement for equipment and manpower were utilizing available offshore support vessels i.e. fast crew boat and supply vessel. For location where living quarter is not available, existing accommodation work boat or daily commuting from shore would have to be considered.

Mini-ROV were customized and integrated with other toolings i.e. CP probe, FMD probe, UT probe and brush tooling to complete the identified scope i.e. General Visual Inspection (GVI), Cathodic Potential Survey (CP), Flooded Member Detection (FMD) and Ultrasonic Thickness measurement (UT). Adopting agile concept, continuous improvement on mini-ROV was performed based on the lesson learnt from the previous deployment to improve site performance. After the pilot deployment of mini-ROV at Platform-A & B, the project team work closely with underwater inspection subject matter expert and service provider have taken another step to enhance the capability of the technology. The improvements include:

- Addition of flooded member detection integration tool, allowing the FMD (ultrasound) to be mounted on the mini-ROV.
- Crash bar was installed to stabilize the mini-ROV during spot cleaning activity.
- Plug and play socket for tooling change out which improved the efficiency by 60%.

The company build confidence with mini-ROV technology for underwater inspection of substructure through multiple successful deployments. Continuous replication at other location with different structural configuration and complexity is ongoing to gauge the limit of the technology, taking into consideration the efficiency and business needs.

4. CONCLUSION

The successful implementation in PETRONAS can become benchmark and reference for other Oil & Gas operators as an alternative to conduct optimized RBUI scope which can contribute to lower Operating Expenditure (OPEX).

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