

# UNDERWATER OPERATIONS IN OFFSHORE OIL ENGINEERING

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**Abstract:** Aiming at the characteristics in the diving project management, this paper analyzes and evaluates the difficulties and risks of underwater work, puts forward the corresponding safety managements. These measures ensure the underwater operations safely and smoothly. The engineering lasts 195 days, uses 160 diving equipments, and dives 282 person-times. The total diving time is 17900 minutes, and the maximum diving depth is 70 meters.

## I. INTRODUCTION

The Offshore oil exploit is engineering with high devotion and high risk. Working environment is bad, and safe requirements are strict. Diving support for offshore oil engineering is an important assurance. Underwater engineering need supported by diver.

## II. MAIN BODY

Following diving environment data directly affect the safety of diving operations: wind, swell wave, sea current, visibility, seabed sediment and tide. Need to control a circumstance and adopt corresponding measure.

### [1] METEOROLOGICAL

In winter it is mainly influenced by the northeast monsoon in the engineering area, the wind force is 6-7 classes, biggest 8 classes, strong breeze frequency 32%. In summer it is mainly influenced by the southwest monsoon, the typhoon reaches to 12 classes; the strong breeze frequency is 30%. Annual temperature is in 6.7-34.1°C, average temperature is 24.7 °C. Annual rainfall is 87mm - 992.2 mm.

### [2] HYDROLOGY AND GEOLOGY

The construction water is a full-day tide. The highest tide is 3.3- 3.7 m, and the lowest tide is 0.23-0.58 m. The rising tide toward the northeast, the average flow velocity is 1.5 knot, the maximum flow velocity reaches to 3 kn. In winter and spring, the surface current is 0.4 knot, and 0.15 knot in 10m underwater, 0.25kn in bottom. The wind currents depend on sea wind force variety. Sea water temperature annual average is 26°C, the winter spring is subjected to the sea water vertical direction convection function, the different depth water temperature presents uniform appearance, the average water temperature is 20.2 °C in January, the lowest is 13.7 °C . The visibility in water is 5 classes. The sea bottom is a sediment bottom.

Before the project implementation, a set of detailed safety management files were compiled, targeted safe education and professional diving training were organized. According to diving contents, character and project schedule, we decomposed total project target into the specific tasks of various stages. As an example of oil drilling platform vertical pipe installation, the project implementation process is introduced.

#### (1) OPERATING SHIP ANCHORED IN PLACE.

The operating ship anchored scheme is drawn up through the analysis of meteorological data in the sea areas. Back of the operating ship is closed to the drilling platform, make divers working water area is in the downstream of wind.

(2) LAYOUT DIVING OPERATING SITE.

Including operating site of surface and underwater. One diver dives with a descend line into the site of the lowest vertical pipe clamp along the dipsey lead, and tie up descend line to the clamp, with convenient to diver arrived at the underwater operating site and transfer tools.

(3) OPEN THE PIPE CLAMP FIXED BY BOLT.

Arriving at the operating site diver cleans out adherent sea creatures and removes the bolts. It is difficult to open the bolt by the tool of ratchet spanner and hydraulic impact wench because of erosion, some of those can be opened, the work efficiency is lower. The problem is solved by underwater cut technical.

(4) VERTICAL PIPE INSTALLED.

Surface crane lifting vertical pipe onto the pipe clamp accurately through the ROV monitoring and diver guiding. Diver untie the fixed cable, close the clamp and carry on initial underwater fix with long bolt. Then replacing the standard bolt fixed.

(5) CHECK AND ACCEPTANCE.

Divers upload the underwater image of vertical pipe installation and fixing timely to the surface through underwater photography and video. The experts check and accept.

When accept task, a project team is established to carry on organizing and management to the project. Members of the project team, experts and divers analysis the engineering, think that following difficulty and risk is exist.

(1) BAD ENVIRONMENT OF DIVING OPERATION.

Wind force in the working sea area usually reach 7 classes, the biggest gust wind measured in 10 years reach to 42.5 m/s. The sea condition are worse, the biggest wave is up to 9.9 m measured in 1 year. The current is faster, affected by tide, windy flow, ocean currents and ocean surges, the maximum flow speed can reach 4 kn. The duration of flat tide is short. All above influence underwater work safety and work efficiency.

(2) HELIUM OXYGEN DIVING OPERATION.

The maximum diving depth is up to 70m in operation of seabed pipeline paved and vertical pipe installed. Helium oxygen diving technique need to be adopted when the depth of underwater is more than 60 meters. By now, helium oxygen mixture dive in the domestic main used for diving training, lack of practical engineering experience.

(3) THE RANGE OF UNDERWATER OPERATING DEPTH IS BROAD (0-70M).

Different diving way should be adopted according to underwater operating depth. Air diving way should be adopted if diving depth is less than 60 meters. SCUBA diving apparatus, surface supported diving apparatus can be chosen. Helium oxygen mixture diving way should be adopted if diving depth is more than 60 meters. Helium-oxygen diving equipment can be chosen.

(4) WORK AND REST DOES NOT RULE, PROJECT LASTS LONG.

The divers operate underwater with good condition, such as weather, sea conditions and the tides. When the condition allows, they usually work day and night, maybe induce the diver's fatigue, and affect the safety. According to the engineering plan, divers live in ship for five months. It is a big challenge to physical and psychological of divers.

(5) UNDERWATER OPERATING TECHNOLOGY IS COMPLEX.

Following technology should be adopted: underwater search, underwater cleaning, underwater detection,

underwater welding and cutting and so on. Following underwater operating tools and equipment need to be used: hydraulic tools, welding-cutting equipment, underwater television system and underwater camera.

#### (6) UNDERWATER OPERATING DIFFICULTIES

If pipe suddenly ruptures, firstly divers need to search and find the residual end of broken tube in the seabed, then a lifting hole need cut on the broken pipe, and then cable connected in by diver. The underwater work of this circumstance belongs to emergency repairing work. Diving depth is same as the water depth. In addition the thickness of coating cement covering pipe reaches 120mm, it is difficulty to clean up the coating cement to cut the lifting hole underwater.

The underwater project security management

**(1) Construction scheme:** According to the different specific tasks and diving depth, air diving scheme of detection of pipe and pipe cradle, pipe abandoned, broken pipe salvage were written; helium oxygen mixed gas diving scheme of detection of bottom pipe, pipe abandoned, broken pipe salvage, open and close the clamp of Standpipe also were written.

**Establish security program:** According to the working underwater environment characteristics, diving depth and underwater task difficulty and other factors, elaborate air diving medical support plan, helium oxygen diving medical support scheme and gas security scheme. Established corresponding emergency plans.

**(2) Safety education.** Education of safety regulations and knowledge, diver's security awareness was trained. Professional education: Diving technology and equipment, underwater detection, underwater welding and cutting, diving medicine.

#### **(3) Professional training**

The adaptability training: According to the diving depth, the diver had completed the pressurized exercise equivalent water depth of 30 meters, 50 meters, 70 meters of, and oxygen sensitive tests in the compression chamber gradually.

**The simulation training:** The air and helium oxygen diving training had been done in the diving training pool.

**The emergency exercise:** According to the security plan, training of emergency rising out of water, trauma and diving diseases treatment had been done.

### III. CONCLUSION

The original working duration of offshore engineering of paving undersea oil-gas pipeline in the investigated area is 130 days, but actually is 195 days. Helium oxygen mixture diving technique was used; the maximum diving depth is 70 meters. The following diving work has been done safely and successfully: underwater detection of pipe cradle, detection of submarine pipeline and detection of A/R cable; underwater operation of broken pipe emergence repaired; underwater operation of vertical pipe installed. Accumulated experience for offshore engineering diving support and helium oxygen mixture diving engineering practice.

### REFERENCES

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