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Flowline and subsea production equipment installation with specific assistance methods under adverse meteorological conditions in the Golf of Venezuela

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ABSTRACT

PDVSA Offshore Production Division develops the Gran Mariscal Sucre Project with the gas exploitation of the Dragon, Patao, Mejillones and Río Caribe fields located at about 40 km north of the Paria Peninsula, Sucre State, Venezuela. Phase I of the project consists of the exploitation of the Dragon field which was planned in two production stages: First, an Accelerated Production System (APS), and second, the total production of the Dragon and Patao fields. All of this production will be operated from the Dragon platform.

The gas produced in the Dragon field wells during the (APS) will be collected by an API 5L X-65 16 inch diameter and 19 kilometer length pipeline, and then, transported to land through a 36 inch diameter and 105 km length pipeline for its distribution to the internal market.

This work describes the activities developed during the 16 inch diameter flowline installation in the Dragon field, which was developed in conjunction with the Pipeline End Terminations and In Line Sleds Installation (PLETs, ILS') as well as their valves by using a pipelay crane vessel. The installation of these supporting structures was a challenge for a vessel of this kind, given that these had an estimated weight of 14 tons, and the meteorological conditions at the moment were crucial, with more than 4 mts height waves, 23 knot winds, and around 4 m/sec flow speeds in the sea bottom. Such scenario required some adjustments in the vessel stinger and the usage of some of equipments or Remote Operated Vehicle (ROVs). The strategy used in order to avoid the pipeline fatigue during the support structures installation was the usage of a compensation buoy that allowed minimizing the weight of the structures by using the 1200 ton capacity crane and maneuvers in the vessel propellers (pipelay crane vessel has Dynamic Positioning DP-2), thus ensuring the continuity of the pipelay operations.

The installation of these subsea production equipments will allow the delivery in the APS up to 300 MMCFD, hence becoming the first offshore activity in Venezuela. Offshore gas production will allow accomplishing the social commitment of gasifying the northeastern region of the country allowing the substitution of liquid fuels of high export value by feeding electrical power generating plants.

Keywords: off shore, Accelerated Production System, Plets, ILS', Dragon field.

ABREVIATIONS

PLET: Pipeline End Termination
ILS: In Line Sled
APS: Accelerated Production System
MMSCFD: Million Standard Cubic Feet per Day
Ton: Tons
Kips: Kilo pounds
Mts: Meters

INTRODUCTION

The purpose of this paper is to describe the 16" diameter subsea pipeline lay procedure in Dragon field which was performed jointly with the valve support structure (PLETs, ILS) and their respective valves with the use of an S lay vessel. These equipment conform the infrastructure of the offshore gas production as part of the Mariscal Sucre Project Phase I.

The subsea production equipment installation in the Dragon field wells will allow the delivery to the internal market of 300 MMSCFD of gas.

SCOPE OF THE PROJECT

PDVSA Offshore Division develops The Mariscal Sucre Project with the exploitation of the gas fields Dragon, Patao, Mejillones and Rio Caribe located 40 kilometers north of the Paria Peninsula, in Sucre State, Venezuela. The Phase I of the Project consists in the Dragon field exploitation. Initially a 300 MMSCFD of gas production under an Accelerated Production System (APS) and subsequently a total production of 600 MMSCFD of the Dragon field together with the Patao field. All of this gas will be manage throughout the Dragon-Patao platform for its delivery to shore in accordance with the gasification social commitment of the country.

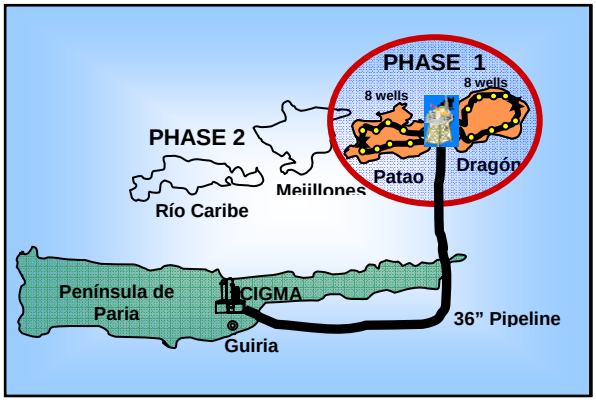

Figure 1. Mariscal Sucre Project location

SUBSEA PRODUCTION EQUIPMENT INSTALLED

a. **Gathering pipeline:** 16" pipeline for gas transportation.

Table 1. 16" gathering pipeline specifications

Property	PIPELINE	
	Inch	mm
Pipe Outside Diameter	16	406,4
Pipe Wall Thickness	0,875	22,23
Pipe Grade	API 5L X-65	
Pipe Manufacturing Process	Seamless	
Pipe Coating Material	3LPP	

Figure 2. 16" gathering pipeline

b. **PLET (Pipeline End Termination):** steel structures that contain isolation valves installed al the beginning and al the end of the 16" gathering pipeline.

Table 2. PLET specifications

Property		PLET	
		Feet	Meters
Dimensions	Length	17,7	5,395
	Width	6,9	2,1
	Height	14,3	4,35
Weigh	In Air (Ton)	12,8	

Figure 3. PLET

c. **ILS (In Line Sleds):** steel structures that contain 9" block valves and allow isolation of the wells production from the gathering pipeline.

d. **ILS pigging (In Line Sled):** steel structure that contains a 16" pigging valve which permits to sectioned the production gathering system in two.

Table 3. Equipment specifications

Property		PRODUCTION ILS		PIGGING ILS	
		Feet	Meters	Feet	Meters
Dimensions	Length	15,7	4,785	16,5	5,03
	Width	7,08	2,159	6,9	2,1
	Height	12,07	3,679	14,3	4,35
Weigh	In Air (Ton)	13,9		12,3	

Figure 4. ILS Pigging

Figure 5. Production ILS

PIPELINE "S" LAY VESSEL

The vessel used for the pipeline lay and the structure installation is a Dynamic Positioning (DP) vessel that use the installation method most commonly known as "S" lay. This vessel had only been used for pipeline laying. For the execution of the structure's installation (PLETS, ILS, Valves) in the Dragon field some modifications were necessary in the stinger and in the tensioners of the vessel and it was also necessary the use of buoys with the purpose of maintain the pipeline integrity and the equipment correct position by the time of the laying.

Figure 6. "S" lay vessel

Table 4. "S" lay vessel specifications

Lay vessel data	
Type of vessel	Dynamic possitioning (PD2)
Total lenght	162,3 mts
	37,8 mts
Draft	Min. 5,8 mts max. 6,6 mts
Manufacture year	2010
Flag	Vanuatu
Tensors	3 with Te 500, Temax 650 wth 4

COMPENSATION BUOY REQUIRED FOR THE STRUCTURE INSTALLATION TO MAINTAIN THE POSITION AND INTEGRITY OF THE PIPELINE

To maintain the position of the structures as well as its mechanical integrity during its installation it was necessary the use of a compensation buoy with a work capacity of 70 Tons. The required tension to maintain the mechanic integrity of the pipeline with the equipment during the installation was T= 47 Kips and a catenary's radio of r=800 mts.

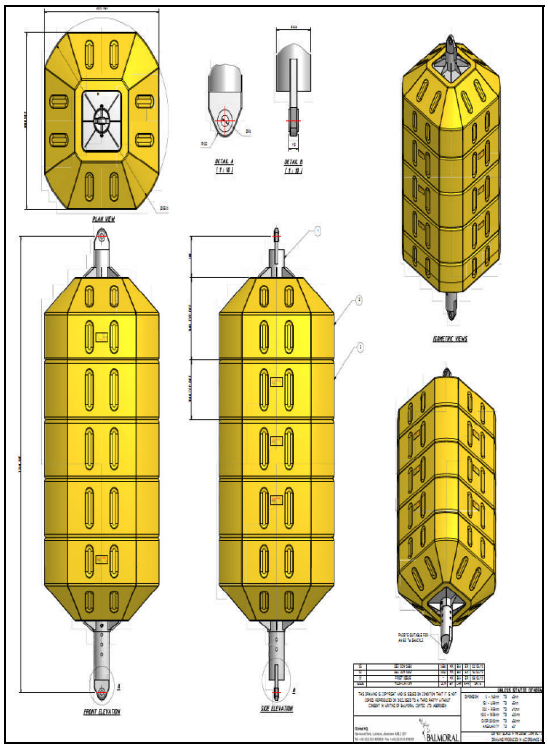

Figura 7. Boya de compensación para instalación de equipos

VESSEL CONDITIONING PREVIOUS TO THE PIPELINE LAYING AND ELEMENTS INSTALLATION

The vessel came from Ghana (where it was performing a subsea rigid pipeline installation 1500 mts deep). The vessel moved to Trinidad for the execution of the next works:

- Removal of the third section of the stinger's tail with the purpose of adapt it to water depth between 130-150 meters.
- Adjustment of the bearing housing of the vessel to adapt them to the 16" pipeline profile (tension 47 Kips, 800 mts radio) as well as the elements dimensions to install (tension 52 Kips, 800 mts radio).
- Change of the support chairs in the tensioners for handling of the 16" pipeline and elements (PLETs, ILS).

Figure 8. Removal and adjustment of the stinger and tensioners

REGISTERED WEATHER CONDITIONS DURING THE INSTALLATION OF THE DRAGON FIELD'S 16" GATHERING PIPELINE

During the pipeline installation campaign of the Dragon field's gathering pipeline executed in 35 days some adverse weather conditions were present which in several opportunities merited stop operations and make additional calculations to maintain the established route conserving the correct angle and radio during the laying of the pipeline throughout the stinger**.**

Table 5. Registered weather conditions during the installation

Registered weather conditions during the installation		
Variables	Lower	Higher
Wind (Knots)	14	23
Waves (mts)	1.2	4
Marine current (Knots)	2.5	3 a 5
Lay efficiency (Km/day)	0.6	0.25

SUBSEA PRODUCTION EQUIPMENT INSTALLATION PROCEDURE

The main activities performed for the subsea production equipment installation jointly with the gathering pipeline are described as follow:

Pre-installation activities:

1. Offshore previous preparation for the beginning of the 16" pipeline and structure installation (deployment of the lay vessel and support vessels to Dragon field)

Installation activities:

2. Starting of the 16" pipeline and suction pile installation and installation of the PLET 1 and pigging trap.
3. 16" pipeline lay.
4. Installation of the joint coating in field.
5. Production ILS installation
6. Pigging ILS installation
7. Baffles installation.
8. 16" pipeline lay and installation of the PLET 2 and pigging trap.

Post-installation activities:

9. Post-installation activities of the 16" pipeline (visual inspection, documents generation and as built drawings).

RESULTS Y ANALISYS

The activity started with the suction pile installation which was a temporary anchoring system to startup with the laying operations of the subsea pipeline. Its aim is to fix the PLET 1 and the pigging trap and also to counteract the impact of the drag forces of the pipeline during its laying process.

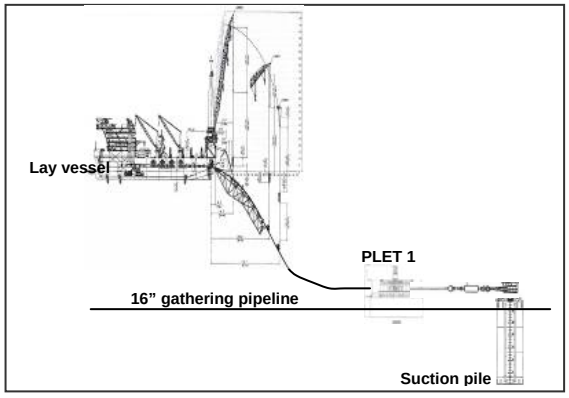

Figure 9. Starting scheme of the lay and installation of the PLET 1


Figure 10. Lowering of the suction pile

Figure 11. PLET 1 installation welded to the first joint

Afterwards the 16" pipeline welding and laying continued until the established coordinates were reached for the first production ILS installation. This activity was repeated until the completion of all the ILSs including the pigging ILS and the gathering pipeline. Finally the PLET 2 was installed with the pigging trap to complete the installation of the Dragon field's gathering system.

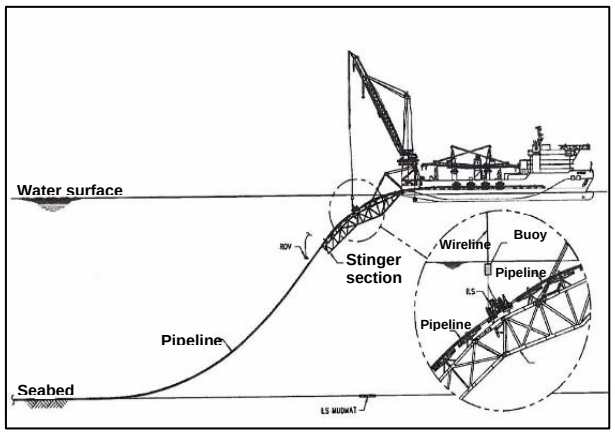

Figure 12. Scheme installation of the ILS


Figure 13. ILS structure positioning

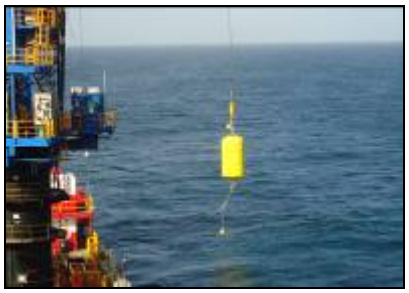
Figure 14. Use of the compensation bouy

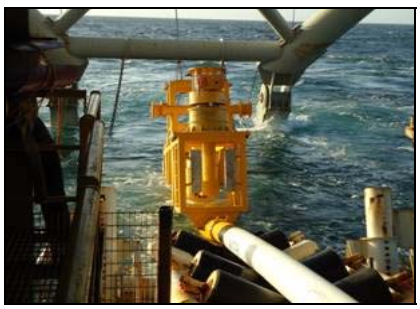
Figure 15. Exit of the ILS throughout the stinger

CONCLUSIONS

1. The time of the pipeline and equipment installation in the Dragon field was affected by this aspects:

• Adverse weather conditions which directly influenced the daily efficiency of the lay. In normal conditions a 0.6 Km/day efficiency was accomplished while with adverse weather conditions the efficiency was 0.25 Km/day.

• Because the vessel had been used only for pipeline laying (2.0 Km/day efficiency aprox.) some of its elements were adapted to install equipment of large dimensions (PLETs, ILSs, valves) with a total execution time of the works of 35 days instead of 9 days (if it only were laid pipe) which represented an additional 75% time of execution.

2. For the equipment installation it was required the use of a compensation buoy (70 Tons capacity) with the purpose of assure the mechanical integrity of the pipeline and maintain the correct position of the equipment (PLETs, ILSs) during its descent to the support (mudmat) installed on the seabed.

3. With the "S" lay vessel was successfully accomplished the installation of the next equipment and pipeline that conform the subsea production system of the Dragon field:

   - 02 PLETs with its 16" valves and pigging traps.
   - 07 production ILS with a 9" valve each.
   - 01 pigging ILS with a 16" valve.
   - 18.2 Km of pipeline of 16" diameter.

4. The use of the compensation buoy was able to sustain the required tension (T= 47 Kips) for the pipeline laying along with additional equipment and the required catenary's radio (r=800 mts) maintaining its mechanical integrity.

5. The subsea production equipment installation in the Dragon field Hill allow the delivery to the internal market of the country of 300 MMSCFD of gas being this the first offshore gas production to develop in Venezuela.

REFERENCES

[1] Technip. G1200 – 16 inch Flowline Installation Procedure, document N°. TF027337-000-CP-3861-802, 2012.