

MOORING LINE PRE-LAY AND INSTALLATION PROCEDURE

PROSEDUR PRA-LAY DAN PEMASANGAN MOORING LINE

INFORMASI ARTIKEL

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Abstract

Abstract. Mooring Line Pre -Lay and Installation Procedure is using AHTS with the power engine 30.000 BHP and has capacity of bollard pull 300 ton is used for mooring line installation for FPSO Marlin Natuna. The Mooring Installation often fail due to the anchor drag during testing. In this site activity the anchor drag is used. The type of anchor drage is strevpris MK6 with the weight 15 ton and after installation it should be test loaded 243 ton, it is 80% from his capacity 304 ton. The Acceptance criteria for the mooring installation is the anchor can not allow drage out of the target box, with allowable drage 13-16 m, during tension test with 30 minute the holding time. The result from the site activity of the mooring line installation as follow ; the tension mooring line number 1,2,3,4,5,6,7,8 are pass with the tension test 250 ton, and the final position of all anchor within in the target box eith the maximum drag 2m.

Keywords: Mooring Line, Tension test, target box.

Abstrak

Abstract. Prosedur Pemasangan Mooring Line dengan AHTS yang memiliki kekuatan mesin 30.000 BHP dan memiliki kekuatan tegangan Tarik bolar 300 ton digunakan untuk pekerjaan pemasangan mooring line untuk FPSO Marlin Natuna. Pemasangan Mooring Line sering mengalami kegagalan pada saat dilakukan pengetesan tegangan Tarik, karena jangkar akan bergerak keluar dari target box. Tipe jangkar yang digunakan pada pekerjaan ini adalah tipr Strevpris MK6 yang memiliki berat 15 ton. Jangkar ini harus di tes Tarik setelah selesai dipasang dengan kuat Tarik 243 ton 80% dari kekuatan yang dimiliki 304 ton. Kriteria lolos tes adalah jangkar mampu bertahan selama masa tes 30 menit dengan kekuatan tegangan 243 ton dan jangkar tidak keluar dari target box dengan besar pergerakan 13-16 m. Hasil dari tes di lapangan ternyata jangkar nomer 1,2,3,4,5,6,7,8 semuanya lolos dengan tegangan tes 250 ton, dan jangkar hanya bergerak maksimum 2 m dari batas 13-16 m, sehingga jangkar masih di dalam target box .

Kata kunci: Tali tambat, tegangan tes, Crane, kemampuan tanah, ruang batas.

I. INTRODUCTION

The content of this document forms the Mooring System Installation Plan for the 8 point spread mooring system of the FPSO Marlin Natuna (hereinafter referred to as FPSO) for the Forel field located in Block B of the Natuna Sea, 24 km of Northwest Belanak and has 91m water depth in average.

The selected FPSO is owned by the consortium (hereinafter wholly referred to as 'OWNER') of PT .ABC. The FPSO shall be chartered by PT.X E&P Natuna Limited (hereinafter referred to as 'MEPN / CHARTERER')

OWNER has awarded a contract to PT. Y for the Offshore Transportation and Installation Works for the FPSO Project, which comprises the following Work Scope.

1. Mooring System Installation (Phase 1)
2. FPSO Towage and Mooring System Hookup to FPSO (Phase 2) .

The FPSO mooring arrangement consists of eight (8) mooring lines (2 lines per corner) moored using 92mm diameter Grade R4 studless mooring chains. The Field Layout Drawing is included under Appendix 2

The FPSO vessel heading is to 045° (i.e. North-East) with symmetrical anchor pattern. The mooring anchors are positioned from 640 m – 950 m horizontal distance from fairlead and a 5 degrees spacing between each line. The General

Arrangement Drawing of the FPSO is included under Appendix 1

This procedure is based on no ROV operations during the mooring system installation (Phase 1).

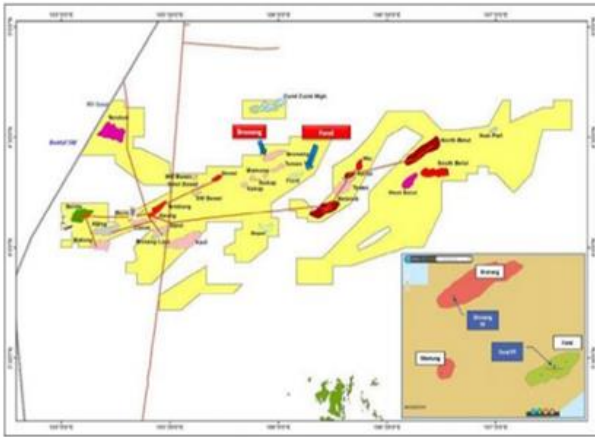


Figure 1. Natuna Block B PSC Location Map

II. METHODE OF RESEARCH

This document is to provide a plan for the installation of the FPSO spread Mooring System all chain system with mooring drag anchors.

This document will clarify the various phases and steps of the installation. It should be demonstrated that installation in accordance with procedure will not impart overload or cause damage to the permanent mooring and anchoring components.

This document will provide confirmation that the installation will be a controlled operation leading to an as installed mooring system comparable to the approved design and that sufficient means of inspection, measurement and recording are deployed to confirm the actual installed configuration.

This Document is to be read in conjunction with the following Project Documents.

1. FPSO Mooring Analysis Report (Document No: P2104-F-MO-ANA-5001 dated 4/10/22)
2. 13723 Hanochem Forel FPSO Anchor Technical Evaluation
3. OFFSHORE GEOTECHNICAL SURVEY AT FOREL FPSO MOORINGS LOCATION
4. Project Execution Plan-
5. Offshore Positioning and Survey Procedures – Doc. No. FOI-PRO-0001
6. HAZID Report- Doc. No-FOI-HSE-0003

This document contains-

- a. Description of FPSO Mooring System (Refer to Attachment 3)
- b. Procedures for the deployment of the drag embedment anchors and the pre-laying the moorings
- c. Procedures for test loading of the anchors
- d. Procedures for lay down of the mooring chains in a dog leg fashion with subsea recovery rigging
- e. Details of the main installation vessel

2.1 Prototype and Instrumentation

The FPSO heading will be considered equal with 045 deg. clockwise to Global North direction with symmetrical anchor pattern.

The FPSO will be moored with 8 spread mooring lines connected to drag anchor. The mooring system can be divided into 4 clusters. Each cluster consists of 2 mooring lines spaces 45-50 deg from its centre line. Excursion limiter is introduced in cluster 2 to deal with existing pipeline safe restriction zone. Main mooring lines data are shown in Fig. 2,3,4,5 and Table 1,2,3.

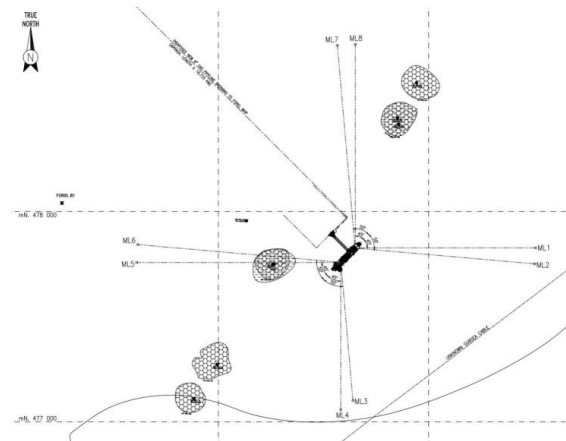


Figure 2. Mooring System Lay Out

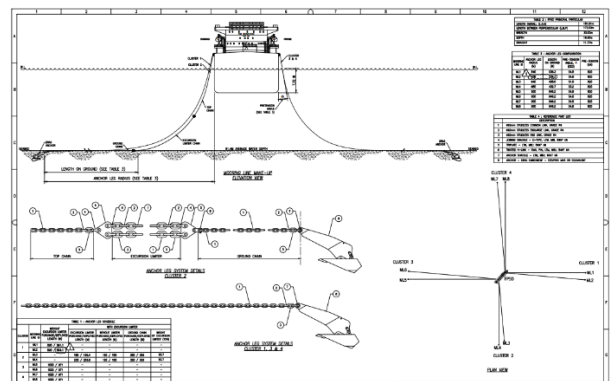


Figure 3. Mooring Line Make Up



Figure 4. AHTS



Figure 5. FPSO

Table 1. Mooring System Component

Mooring Chain	
Number of Mooring Chain	8
Chain Type	Studles Common Link
Chain Diameter	92 mm
Material Grade	R4
Length Mooring Line 1,2	800 m
Mooring Line 3	695 m
Mooring Line 4	735 m
Mooring Line 5,8	1000 m
MBL	8497 kN
Excursion Limiter	Mooring Line 3,4
Drag Anchor	
Number of Anchore	8
Anchore Type	Strevpris MK6
Weight	15 MT
Soil	
Soil Type	Very Soft to soft Clay
Undrain Shear strengt	1.4-14.2 kPa

Table 2. Mooring Chain Properies

Parameter	Value
Size	92 mm
Type	Studless
Grade	R3
Nominal Length	Varies
Weight in Air	0.189 MT/m
Weight in Water	0.165 MT/m
MBL-Uncorroded	8497kN or 866 MT

Table 3. Drag Embedment Anchor Properties

Parameter	Description
Type	Vryhof Strevpris MK6
Size	15 MT
Ultimate Holding Capacity, osft Soil	565 MT
Fluke/Shank setting Angle	50 deg. Mud open Angle
Drag Distance Estimate	13-16 m
Penetration Depth Estimate	6.7-7.5 m

2.2 Mooring Anchor Position

Proposed coordinate of FPSO mooring anchors are as follows (refer to Appendix 1-Mooring Field Layout Drawing.

Table 4. Proposed Position of Drag Anchor

Mooring Anchor		UTM Coordinate		Heading
ID	Cluster	Easting (m)	Northing (m)	
Line 1	1	621.509.37mE	477.826.86mN	090 deg
Line 2	1	621.502.19mE	477.751.13mN	095 deg
Line 3	2	620.640.18mE	477.101.08mN	175 deg
Line 4	2	620.582.18mE	477.056.63mN	180 deg
Line 5	3	619.611.32mE	477.757.47mN	270 deg
Line 6	3	619.616.95mE	477.842.50mN	275 deg
Line 7	4	620.566.04mE	478.789.34mN	355 deg
Line 8	4	620.655.55mE	478.794.69mN	000 deg

The Proposed FPSO mooring design centre is as follow Table 5 ;

Table 5. FPSO Mooring Design Centre (MDC)

Description	UTM Coordinate		Heading	Water Depth
	Easting (m)	Northing (m)		
FPSO MDC	620.609.8 mE	477.785.1 mN	045 deg from North	91.4 m (MSL)

2.3 Final Anchor Position

The final position of the anchor will be determined using catenary calculation. To complete catenary calculation, the following information will be recorded:-

- 1) Final load reading from field holding test
- 2) Pay-out length of mooring chain with reference to main installation vessel’s stern roller
- 3) Survey fix on main installation vessel’s stern roller
- 4) Water depth reading from vessel’s echo sounder
- 5) Vessel aft draft reading.

The result Position Anchor Installed, can be seen in Table 6.

Table 6 Final Position Anchor Installed

Mooring Anchor		UTM Coordinate		Heading
ID	Cluster	Easting (m)	Northing (m)	
Line 1	1	621.507.37mE	477.825.86mN	090 deg
Line 2	1	621.501.19mE	477.750.13mN	095 deg
Line 3	2	620.639.18mE	477.102.08mN	175 deg
Line 4	2	620.580.18mE	477.057.63mN	180 deg
Line 5	3	619.610.32mE	477.758.47mN	270 deg
Line 6	3	619.614.95mE	477.844.50mN	275 deg
Line 7	4	620.565.04mE	478.791.34mN	355 deg
Line 8	4	620.654.55mE	478.796.69mN	000 deg

As Table 6. The result all Anchor Installed in side of allowable distance of the drag allowable. The Anchor was drag max 2 m still under the allowable from the target box max 7m drag out of the box. All Anchors had been pulling tested until 243 MT as design.

III. RESULT AND DISCUSSION

3.1 Analysis of Tension vs Actual Test on site

After Installation, the mooring should be test loaded to ensure adequate holding capacity of the anchoring system [1] . For Permanent moorings with drag anchors, the mooring lines should be test loaded at least 80% of the maximum strom load [2] determine by a dynamic analysis for the intact condition,

the holdime time for tension test is 15 minutes [1]. The tension design vs test on site can be found in table 7.

Table 7. Tension Design and Test

Line	Design Tension Ton	80% Design Tension Ton	Test Tension
1	304	243	250
2	304	243	250
3	304	243	250
4	304	243	250
5	304	243	250
6	304	243	250
7	304	243	250
8	304	243	250

Test monitoring, can be seen on portable load cell equipment, the other equipment to monitor tension can be seen on tnsion monitor at vessel, load cell and tension monitor at vessel can be seen in figure 6 and picture 7



Figure 6. Portable Load Cell



Figure 7. Load Monitor on Vessel

3.2 Anchor Position

The Acceptance criteria for the position of anchors is 13-16 m see in figure 8.

The final position can be seen on Table 6. From this table all anchors was drage as variously 1-2 m, still below the acceptance criteria 13-16 m.

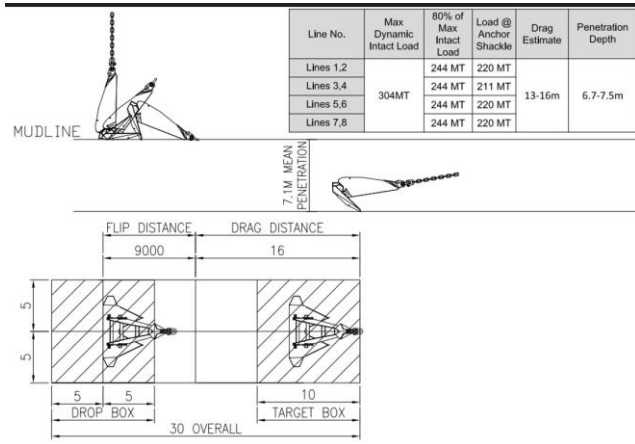


Figure 8. Drag Acceptance Criteria

IV. CONCLUSIONS

1. In carrying out the design for Mooring Line FPSO , it should be considered the drag estimate and tension test.
2. The biggest the drag anchor is 2 m within in inside target box.

3. For maximum tension test 250 ton, the anchor stabil within in the target box for 30 minute holding time, as Class requirement.

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