




**BLOCK PM304 CENDOR  
PHASE-2 DEVELOPMENT PROJECT**

**Project Title :** Front End Engineering Design for Cendor  
Phase-2 Development

**Document Title :** Riser Clamp Specification

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## 1 PROJECT BACKGROUND

### 1.1 Introduction

The Cendor Field, located approximately 140km off the east coast of peninsular Malaysia, commenced oil production in September 2006 using a Mobile Offshore Production Unit (MOPU) and an FSO (Floating Storage and Offloading vessel). The current "Phase 1" facilities have proven the reservoir has long term potential and it has been decided to proceed with Phase 2 development of the field.

Phase 2 requires 29 new wells drilled from 2 new wellhead platforms CDW-B and CDW-C, and connection of the existing wells at MOPU well bay (CDW-A) located adjacent to the MOPU which will then be removed. CDW-B and CDW-C will each have water injection, gas lift and oil production. CDW-C will be equipped with gas injection facilities for reservoir pressure maintenance. CDW-B is proposed to be cantilever linked to the CDW-A structure, whilst CDW-C is to be about 2 km to the west from the current MOPU site.

An FPSO will be the Cendor Producer (CDP-A) is to be located within the field and the existing FSO will be removed. CDP-A will process the crude oil received from the CDW- A/B/C, and stabilized oil will be offloaded to a shuttle tanker using a floating loading hose.

The Figure 1-1 shows a schematic of the Phase 2 facilities:

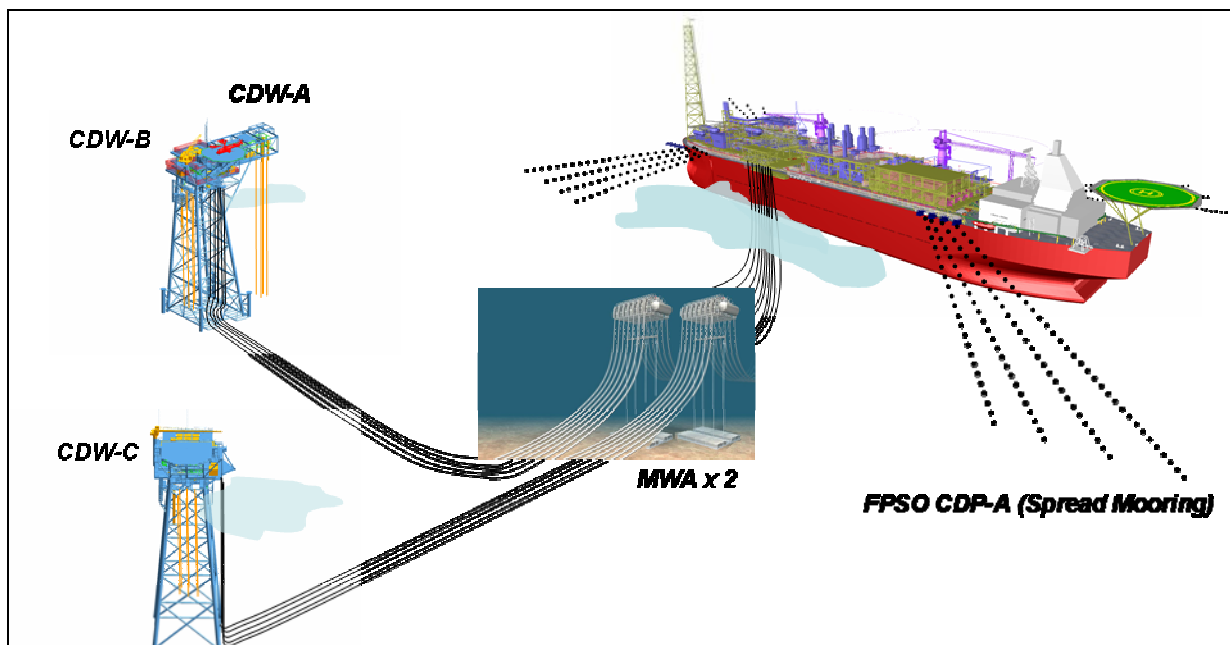


Figure 1-1 Cendor 2 Phase 2 facilities

## 2 GENERAL INFORMATION

This specification outlines the requirements for the Riser clamps to be used with the Mid Water Arches.

## 3 DEFINITIONS AND ABBREVIATIONS

The following definitions and abbreviations shall apply throughout the specifications.

### 3.1 Definitions

Company	Means Petrofac (Malaysia-PM304) Limited.
Company Group	Means COMPANY, its CO-VENTURERS (including PETRONAS), their respective directors, officers and employees of the aforesaid but shall not include any member of the Contractor Group
PML	Petrofac (Malaysia-PM304) Limited is the legal entity that operates the Cendor field and the entity that places project related contracts and insurances. It is also the entity that will eventually operate the development.
CP2	Cendor Phase 2 Development Project; also referred to as "the Project".
PMT	Project Management Team; specifically refers to that part of Petrofac which is directly responsible for management of the CP2 Project.
Sub-Supplier	Means "The company(ies) appointed by the Supplier and/or the Company to provide defined services.
Supplier	Means [ . ] and includes its sub-suppliers, their personnel, representatives, successors and such other persons to whom the Supplier has properly assigned the purchase order and/or service order issued by the Purchaser.
Shall	This word, or the terms "REQUIRED" or "MUST", indicates an absolute requirement.
Flexible dynamic riser system	Flexible dynamic risers, Mid-Water Arches, gravity bases, PLET and all equipment / accessories required to complete the link between PLETs and FPSO
Flexible static flowlines	Flexible static flowlines including all accessories / fittings to complete the static link between flexible dynamic riser connections and platforms
Verification and/or Certification Authority	Member of IACS(International Association of Classification Society) i.e. LR, DNV, BV, ABS

Table 1

## 3.2 Abbreviations

Abbreviation	Description
3-LPE	Three-Layer Polyethylene
ABS	American Bureau of Shipping
AISC	American Institute of Steel Construction
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
AWS	American Welding society
bara	Bar absolute
barg	Bar gauge
BV	Bureau Veritas
Cd	Drag Coefficient
CD	Admiralty Chart Datum
CDP-A	Cendor FPSO
CDW-A	Cendor Wellhead Platform 1
CDW-B	Cendor Wellhead Platform 2
CDW-C	Cendor Wellhead Platform 3
Cl	Lift Coefficient
Cm	Inertia Coefficient
COC	Certificate Of Conformity
CP	Cathodic Protection
CPP	Central Processing Platform
CRA	Corrosion Resistant Alloy
CS	Carbon Steel
DBM	Design Basis Memorandum
DDE	Detail Design Engineering
DNV	Det Norske Veritas
EPC	Engineering, Procurement and Construction
ESD	Emergency Shutdown
FAT	Factory Acceptance Test
FEA	Finite Element Analysis
FEED	Front End Engineering Design
FPSO	Floating Production Storage Offloading unit
FSO	Floating Storage Offloading unit

Abbreviation	Description
FSS	International Fire Safety Systems Code
FWS	Full Well Stream
GOR	Gas Oil Ratio
HAT	Highest Astronomical Tide
Hs	Significant wave height (meter)
HSE	Health, Safety and Environment
IACS	International Association of Classification Society)
ID	Inside Diameter
IMO	International Maritime Organization; United Nations' specialized agency responsible for improving maritime safety and preventing pollution from ships.
IRC	Independent Review Certificate
ISO	International Organization for Standardization
LAT	Lowest Astronomical Tide
LR	Lloyds Register
LWS	Light Weight Structure
MOP	Maximum Operating Pressure
MOPU	Mobile Offshore Production Unit
MSDS	Material safety Data Sheets
MSL	Mean Sea Level
MWA	Mid-water Arch
NACE	National Association of Corrosion Engineers
NDT	Non-Destructive Testing
NFPA	National Fire Protection Association
OD	Outside Diameter
PLET	Pipeline End Termination
PML	Petrofac Malaysia Limited
PPM	Parts Per Million
PTFE	Polytetrafluoroethylene (Teflon)
PTS	PETRONAS Technical Standard
ROV	Remotely Operated Vehicle
RP	Recommended Practice
SAW	Submerged Arc Welded
SDRL	Supplier Data Requirement List

Abbreviation	Description
SG	Specific Gravity
SI	International System
SMYS	Specified Minimum Yield Stress
SOLAS	International Convention for the Safety Of Life At Sea
SPIR	Spare Parts Interchangeability Record
TAC	Type Approval Certificate
TBA	To be Advised
Tp	Wave peak period (seconds)
TRP	Technical Requisition Package
UTM	Universal Transverse Mercator
WCC	Weight Concrete Coating
WHP	Well Head Platform

Table 2



### 3.3 Design Life

The SUPPLIER shall ensure that no prototypes or components with inadequate service record are being offered under this scope of supply.

As a minimum, the design life of the FPSO Flexible dynamic riser system and ancillary equipment, in the site conditions specified hereinafter shall be at least equal to 20 years, in continuous operation and in accordance with verification and/or certification authority requirements.

### 3.4 Documentation

The full scope of document supply will be indicated in the TRP.

### 3.5 Units

Units given in drawings and documentation shall generally be metric (SI) units, except as listed below:

- Static pressure shall be in barg
- Tubing and fittings shall be seamless and shall be in imperial sizes
- Pipe sizes, flanges and valves shall be in imperial units

### 3.6 Weight Control

The SUPPLIER shall have a documented and implemented system for weight control. For all weights listed, the tolerance shall be given.

The weighing procedure shall give requirements for weighing equipment accuracy and calibration requirements.

For the units supplied, SUPPLIER shall calculate the weight and centre of gravity (CoG) with accuracy according to procedure acceptable to COMPANY.

The following weights shall be provided:

- Dry and operating weights and CoG, with the reference point.
- Weights of any auxiliaries, e.g. cooling water, lube oil, hydraulic oil, fuel.
- Test weight, i.e. filled with water.
- Weight of removable items for maintenance and repair.
- Transportation/installation weights.

All items over 1000 kg shall be weighed and documented with a weight certificate. For items above 5000 kg, the CoG shall be measured and included on the weight certificate. A list of non-weighed items shall be included in the weight certificate.

**3.7 Non-Conformity**

SUPPLIER shall notify COMPANY of any deviations to the regulations, codes and documents being part of the Purchase Order. All such deviations shall be notified on COMPANY Non-Conformity Request form and is subject to COMPANY approval.

#### 4 SPECIFIC REQUIREMENTS

The design, engineering, fabrication, testing, installation, commissioning requirements and Certification of the riser clamp shall be performed by or in collaboration with, and under the management and responsibility of the Flexible Riser SUPPLIER.

In addition the Power Control Cable SUPPLIER shall be contacted and all required information shall be exchanged between the flexible riser SUPPLIER and the Power Control Cable SUPPLIER.

As such interface information requirements shall be the responsibility of the SUPPLIER. (CP2-0000-00-PM-PRO-0003 Interface Management Guide for Procedural Development)

The SUPPLIER of the scope of supply shall be considered the focal point and responsible for all interface requirements

The riser clamp and the way it will interact with the MWA shall be designed and reviewed as an integrated approach with overall approval from the flexible dynamic riser SUPPLIER.

This is extremely important as the Flexible riser, flexible flowlines and power cable SUPPLIER, shall maintain full guarantee and warrantee for a duration as specified in the contractual documents agreed between parties and COMPANY.

Warranty shall include all parts of the riser clamp.

## 5 APPLICABLE PROJECT DOCUMENTS, CODES & STANDARDS AND LOCAL & NATIONAL REGULATIONS

### 5.1 General

The SUPPLIER to ensure that all the Project Specifications, PTS's and International Codes & Standards used for this project shall be the latest revisions available at the date of award of EPC contract.

Additionally, the SUPPLIER shall ensure that the supplied equipment conform to the Local and National Regulations for e.g. DOSH (Department of Occupational Safety and Health) for inspection, installation and operation in offshore Malaysia.

### 5.2 Local and National Regulation

Design and manufacturing of riser clamp system shall comply with the requirements of the following Malaysian legislation and salutatory requirements:


- Factories and Machinery Act, 1967 (Act 139)
- Occupational Safety and Health Act and Regulations, 1994 (Act 514)
- Petroleum (Safety Measures) Act, 1984 (Act 302)
- Department of Occupational Safety and Health (DOSH)

### 5.3 Applicable Project Documents

The following references are applicable to this project:

PML-Document No	DPS-Document No	Document Title
<b>Project</b>		
CP2-0000-00-QA-QPL-0001	N/A	Project Quality Plan
CP2-0000-00-DC-PRO-0001	N/A	Vendor Data Management
CP2-0000-00-PM-PRO-0003	N/A	Interface Management Guide for Procedural Development
CP2-0000-00-MR-PHS-0001	N/A	FPSO Hull, Marine, Mooring and Riser Design Philosophy
<b>General Field Data</b>		
C50647/5842/R3	N/A	Metocean data document: CENDOR Phase 2 Metocean Criteria
KTN-PFC-10-404-SI	N/A	Factual Report for Geotechnical Investigation at Cendor II FPSO MWA
KTN-PFC-10-391-ADS	N/A	Cendor FPSO Geophysical Site Investigation Survey

PML-Document No	DPS-Document No	Document Title
KUL-12-09-0525-02	N/A	Geophysical and Geotechnical Integration Study
CP2-0000-00-ME-BOD-001-Rev.G1	N/A	Design Basis Memorandum rev. G1
<b>Flexible Risers, MWA-arch, Gravity Base, Power Cable and ancillary equipment</b>		
001-8100-00-MR-REP-0063	J09030-DPSC-81-J-RA-0063	Mooring Analysis
001-8100-00-MR-REP-0071	J09030-DPSC-81-J-RA-0071	Dynamic Riser Analysis
001-8100-00-MR-SPE-0077	J09030-DPSC-81-J-SF-0077	Flexible Riser Functional Specification
001-8100-00-MR-REP-0076	J09030-DPSC-81-J-RA-0076	Risers Master Equipment List
001-8100-00-MR-SPE-0072	J09030-DPSC-81-J-SF-0072	Risers Ancillary Equipment Specifications
001-8100-00-MR-SPE-0078	J09030-DPSC-81-J-SF-0078	Report on Riser Loads
001-3000-00-EL-SPE-001	J09030-DPSC-30-E-DS-001	Data Sheet for subsea composite Cable
001-3000-00-EL-SPE-0001	J09030-DPSC-30-E-SA-0001	Specification for Dynamic Subsea Composite Cable
001-8100-00-MR-SPE-0083	J09030-DPSC-81-J-SF-0083	Power Control Cable Ancillary Equipment
001-8100-00-MR-SPE-0073	J09030-DPSC-81-J-SF-073	MWA Functional Specification
001-8100-00-MR-SPE-0075	J09030-DPSC-81-J-SF-075	MWA Gravity Base Specifications
001-8100-00-MR-SPE-0084	J09030-DPSC-81-J-SF-0084	Flexible Flowline Specifications
<b>Drawings</b>		
001-5000-00-PL-LYT-0002	J09030-DPSC-50-Y-XE-0002	Overall Field Layout (In-Field) Drawing
001-5000-00-PL-LYT-0015	J09030-DPSC-50-Y-XE-0015	PLET Approach Drawings
001-5000-00-PL-PID-0001	J09030-DPSC-50-Y-XB-0001	Preliminary PLET P&ID
001-5000-00-PL-PID-0001	J09030-DPSC-50-Y-XB-0001	Flowlines P&ID
001-8100-00-MR-LYT-0079	J09030-DPSC-81-J-XE-0079	Riser General Arrangement Drawings
<b>Installation</b>		
001-5000-00-PL-SPE-0008	J09030-DPSC-59-Y-SA-0008	Specification for Power and Control Cable Installation
CP2-8000-00-NV-PLN-0001	OPS-DWG-2013-1089-01	Installation MWA and GBS Drawing
CP2-8000-00-NV-PLN-0002	OPS-DWG-2014-1089-01	FPSO Riser Installation Drawing

	<b>Riser Clamp Specification</b>	
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PML-Document No	DPS-Document No	Document Title
CP2-8000-00-NV-REP-0001	OPS-MST-1018-1089-01	MWA and GBS Installation Methodology
CP2-8000-00-NV-REP-0002	OPS-MST-1019-1089-02	Riser and Subsea Cable Installation Methodology
CP2-8000-00-NV-EQL-0001	OPS-SUM-1001-1089-02	Riser Installation Equipment List
CP2-8000-00-NV-EQL-0002	OPS-MST-1002-1089-01	MWA and GBS Installation Equipment list

Table 3

#### 5.4 International Codes and Standards

The standards to be used shall be governed by the Verification and/or Certification Authority requirements and by COMPANY requirements. As a minimum the following shall be used:

Det Norske Veritas (DNV)

- DNV-OS-C101 Design of Offshore Steel Structures, general LRFD Method
- DNV-OS-C401 Fabrication and Testing of Offshore Structures
- DNV CN-7 - Non-Destructive testing
- DNV CN-30.4 Classification Notes, Foundations, for the geotechnical design of the MWA Subsea Base (latest or equivalent Classification guidelines)
- DNV Rules for Planning & Executing Marine Operations - Pt.2 Ch.5 Lifting

American Petroleum Institute (API)

- API SPEC 17J for risers, MWA and ancillary equipment.
- API RP 17-B for risers, MWA and ancillary equipment.
- API-RP 2SK for the MWA Mooring system

American Society of Mechanical Engineers (ASME)

- ASME B16.5 : Pipe flanges, steel flanges and flanged fittings

#### 5.5 Petronas Technical Standard

70.10.70.11	The Preservation of Old and New Equipment and Piping Standing Idle
30.10.73.33	Installation and Commissioning of Cathodic Protection Systems
30.48.00.31	Painting and Coating of New Equipment
30.10.73.32	Design of Cathodic Protection Systems for Offshore Pipelines

Table 4

## 5.6 Order of Precedence

In the event of any conflict arising between this specification and other documents listed herein, refer comments to the COMPANY for clarification before design or fabrication commences. The order of precedence that applies is as follows:

- Malaysian Legislations and Regulations governing design, fabrication, installation and operation
- Purchase Order and Purchase Requisition
- Project Datasheets
- This Specification
- Other related equipment Specification
- Project Drawings
- Project Specifications
- International Codes and Standards
- Petronas Technical Standards (PTS)

Petronas Technical Standards (PTS) are for guidance. They will be used as a reference for the design and used where the COMPANY specifications and International Codes & Standards are silent on certain aspects.

## 5.7 Exceptions to Specifications

Any exceptions shall be communicated to COMPANY as stipulated in TRP.

## 5.8 Certification

The full scope of certification required will be indicated in the TRP

## 6 SUPPLIER RESPONSIBILITIES

SUPPLIER shall:

- Ensure all design and manufacturing shall obtain the following certificates from a recognised Verification and/or Certification Authority:
  - TAC: Type Approval Certificate for flexible dynamic riser and all ancillary components.
  - COC: Certificate of Conformity for all Manufacturing processes, materials, testing and packing and handling, until equipment is loaded FOB.
- Ensure design and fabrication integrity shall be certified through issuing of an Independent Review Certificate (IRC) by a 3rd party approved by COMPANY.
- Detail scope of supply in Master Equipment List (MEL);
- Obtain all necessary approvals and certifications
- Engage and supply verification reports from a third party design integrity verification organization.
- Be responsible for identifying and defining the interfaces with SUPPLIERS of other components that interface with the riser clamps.
- Ensure good project management and co-ordination, including control of its Sub-SUPPLIERS, to supply equipment in accordance with COMPANY quality requirements and schedule;
- Provide all management, engineering, procurement and quality control personnel, facilities, materials, equipment, and all other items, whether of a temporary or permanent nature, and shall perform all operations required for the execution of the work;
- Provide all vendor data collated in a dossier as approved by company in both hard and soft copies
- Document all design and engineering, analysis, and testing of the flexible dynamic risers and associated components as required by COMPANY in order to demonstrate that the supplied system is fit for purpose for the entire design life of its intended service;
- Provide all relevant documentation required in the referenced specifications for review of COMPANY;
- Incorporate all COMPANY and verification and/or certification authority comments and re-issue documentation for COMPANY and verification and/or certification authority final acceptance;
- If required by COMPANY, submit detailed design, analyses and relevant information to COMPANY for complete design review;
- Provide relevant support services and personnel during offshore installation, commissioning of the riser clamps.



- Submit in hard copy and PDF electronic format all reports requiring acceptance;
- At the completion of the scope of supply, provide to COMPANY in PDF format on compact disk(s) all reports, meeting minutes, transmittal record coversheets, and correspondence between SUPPLIER and COMPANY and SUPPLIER and SUB-SUPPLIER and between SUPPLIER and verification and/or certification authority (including emails and faxes);

**7 FIELD DESIGN DATA**

**7.1 Metocean Data**

The Flexible dynamic riser system shall be designed in accordance with the data and related parameters described in the metocean data documents issued by COMPANY.

C50647/5842/R3	Metocean data document: CENDOR Phase 2 Metocean Criteria
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**7.2 Soil Description**

The design of the Flexible riser and flowline system shall take due note of the soil information and at the FPSO installation site, as described in the document issued by COMPANY.

## 8 THE OVERALL FLEXIBLE DYNAMIC RISER SYSTEM

The flexible dynamic riser system form part of an overall subsea system.

Two MWA 's are used MWA-1 routing the flexible dynamic risers to CDW-B and MWA-2 routing the flexible dynamic risers to CDW-C.

To CDW-B: MWA-1

- 2 x Production lines from CDW-B to FPSO
- 1x Gas lift/injection line from FPSO to CDW-B
- 1x Water injection line from FPSO to CDW-B
- 1 x Integrated power and control signal cable to CDW-B

To CDW-C: MWA-2

- 2 x Production lines from CDW-C to FPSO
- 1x Gas lift/injection line from FPSO to CDW-C
- 1x Water injection line from FPSO to CDW-C
- 1 x Integrated power and control signal cable to CDW-C

The flexible dynamic risers connect as follows on the seabed:

Gas lift and water injection flexible dynamic risers connect to PLET

Production flexible dynamic risers connect directly to production flexible static flowlines.

The flexible dynamic risers from the seabed to the FPSO shall be arranged in a Lazy-S configuration being supported by a MWA tethered to a gravity base.

At the FPSO the flexible dynamic risers are connected to the riser balcony with a flange connection (ASME type swivel flange). The flexible dynamic risers are supported at their connection by bend stiffeners suitable to operate in 100yr storm conditions.

## 9 RISER CLAMP ARRANGEMENT

The clamps shall be arranged on the MWA to retain the flexible dynamic riser to the MWA.

Riser clamps shall be located at the top of the MWA and be sized to suit the respective flexible dynamic riser.

The MWA shall have a foundation / housing in which the clamps can be located and mechanically locked.

All requirements will be dictated by Verification and/or Certification Authority, Riser suppliers and COMPANY, however as a minimum the clamp design shall be performed by Flexible Risers and Cable Suppliers respectively, who should perform as well the risers dynamic analysis.

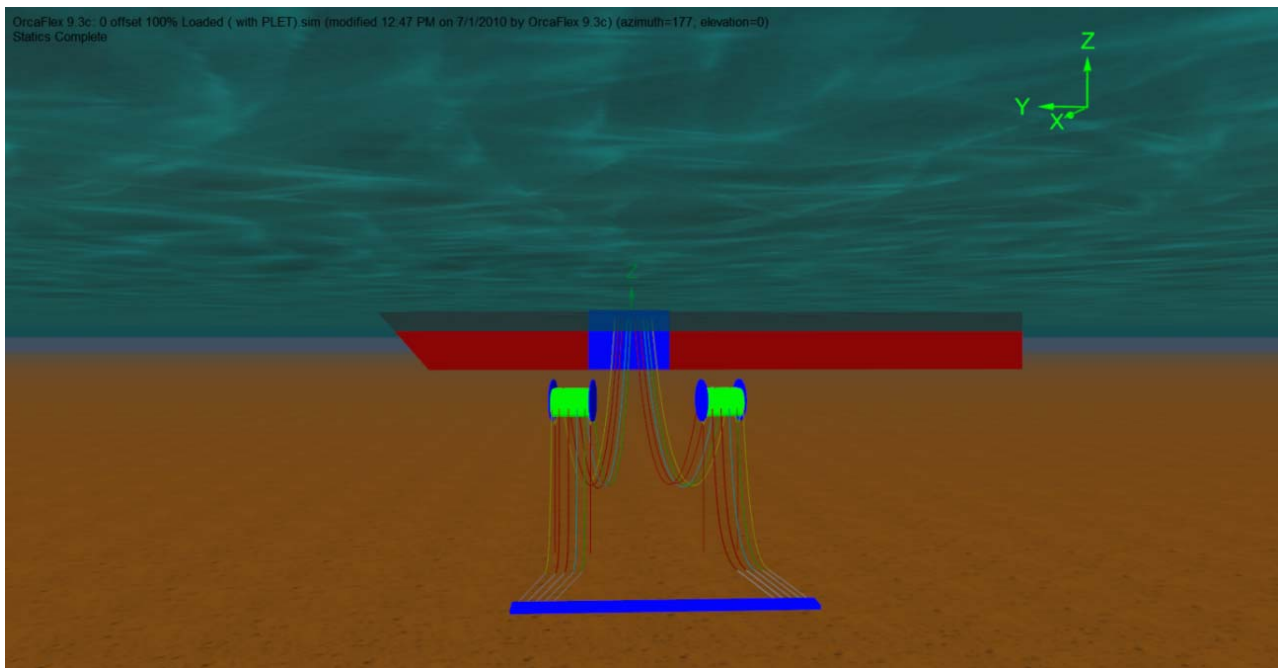


Figure 2 MWA arches and FPSO (subsea view)

## 9.1 Riser clamp

The riser clamps shall comprise of four steel quarter-shells bolted together between flanges at the clamp's axial split line.

Each clamp quarter-shell shall consist of a quarter-cylindrical clamping shoe supported by a series of circumferential stiffeners.

The shoe and the stiffeners shall terminate in an axially oriented bolting flange at either end.

An intermediate axial flange provides a location for the clamp's sacrificial anodes.

The resulting structure shall be of cylindrical profile which can be secured in the clamp housing irrespective of the riser's circumferential orientation to the arch.

The type of riser clamps to be used shall be friction clamps that slide over the riser and are held in place by friction between the clamp and the riser outer sheet.

## 10 DESIGN REQUIREMENTS

### 10.1 Riser clamp design cases

In the design of the clamp as a minimum the following shall be engineered and designed:

- Functional Design
- Structural Design
- Cathodic Protection

### 10.2 Riser clamp design details

The MWA and riser clamp shall be suitable to be brought to a depth of 10 m from the seabed and kept there securely for temporary abandonment after installation.

The MWA system, including riser clamps shall be designed for all operational and installation load cases both extreme and fatigue loads. Structural analyses shall be performed for all loads and load combinations relevant for the transportation, installation and operation phase, including loading effect of slugging.

All components of the MWA system, including riser clamps and any components supplied by sub-suppliers shall have a design life of 20 years.

All warranties for the riser clamps shall include all components and sub-supplier components, if any.

The MWA riser clamp design shall take into account replacement of risers during the field life

The riser clamp design shall take into account inspection programs including ROV's/divers. Any part of the MWA shall not hinder the inspection program

Marine growth shall be taken into account for the MWA system buoyancy and any effect this may have on the riser clamp design.

	<b>Riser Clamp Specification</b>	
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### 10.3 Riser clamp design input from flexible dynamic riser supplier

The following information shall be provided as a minimum during the design of the clamps by the flexible dynamic riser supplier

Information Required	Value	Units
Safety Factor against Slippage		
Riser Coefficient of Friction		
Axial Loading		
Clamp Bore		
Clamp Length		
Pressure Limit		
Max. Riser Diametric Contraction		
Max. Riser Diametric Expansion		
No. Of Bolts/Flange		
No. Of Clamp Sections		
Gap Width		
Length of Bolt Between Flanges		
Bolt Size		
Cross-sectional Area		
Young's Modulus		
Yield Strength		
Material Factor		
Riser Sheath Thickness (assumed)		
Riser Stiffness (E) (assumed)		
Clamp Circumferential Stiffness (T/DC)		
Clamp Radial Stiffness (R/Dr)		
Riser Radial Stiffness (R/Dr)		
Overall Radial Stiffness (R/Dr)		
Radial Force due to Contraction		
Radial Force due to Expansion		
Radial Force to achieve capacity		
Max. Radial Force		

Table 5

**10.4 Riser clamp design input from flexible dynamic riser analysis**

The clamp loads will be obtained from the flexible dynamic riser and power cable analysis and especially the detailed riser clamp Analysis on the MWA 's

The following information shall be provided as a minimum required.

Clamp	Maximum Load
12" Production	
8" GI	
8" Wi	
Power Cable	

Table 6

**10.5 Riser clamp design parameters**

As a minim the following parameters need to be incorporated into the clamp design

Safety Factor on Slippage = 1.5

Riser Coefficient of Friction = 0.07 - 0.09 To be confirmed by Riser supplier

Dynamic power control cable= 0.15 To be confirmed by Riser supplier

The riser clamp shall interface with the MWA through the riser clamp housing for locking the riser clamps to the MWA. The riser clamp housing shall be designed in cooperation with MWA supplier so suit the MWA structure.

The clamp shall have sufficient elasticity to allow for the maximum expansions and contractions of the risers.

The allowable clamping pressure which may be applied to the risers shall be documented by the riser and power cable supplier.



### 10.6 Riser clamp structural design information

The following information shall be provided as a minimum during the design of the riser clamps by the SUPPLIERS.

Information Required	Value	Units
Max. Radial Force		
Max. Circumferential Force		
Force per Bolt		
Stress per Bolt		
Allowable Bolt Stress		
Bolt Utilisation		
Installation Tension/bolt (excl. Load Factors)		
Installation Torque		
Max. Radial Force (excl. Load Factors)		
Clamping Pressure		
Installation Radial Force (excl. Load Factors)		
Pressure Area		
Installation Clamping Pressure		
Utilisation		

Table 7

### 10.7 Riser clamp stress analysis

The Riser Clamps are to be designed and stress checked according to AISC WSD or DNV-OS-C101, or on similar Rules issued by the Verification and/or Certification Authority for the following:

- Lifting of clamp and support of the riser / power cable
- Contact analysis between riser / power cable and clamp
- Pressure / slippage analysis
- Two point clamp pressure analysis

### 10.8 Riser clamp FEA

A full FEA analysis shall be performed for the riser clamp with the loads from the flexible dynamic risers. This will be done for operational cases, 100-yr storm cases and installation cases including the abandonment 10 m from the seabed.

### 11 MATERIALS AND MANUFACTURING

#### 11.1 General

The riser clamp supplier shall provide an inspection program based on proven experience for COMPANY approval.

The riser clamp supplier inspection programme shall meet as a minimum regulatory and code requirements as mentioned in this document.

The riser clamp shall be subjected to thorough inspection and testing and all test data shall be available and verified prior to hand over to operation.

#### 11.2 Materials

The selection or exclusion of any materials for the riser clamp components will be defined after consideration of Verification/certification authority and COMPANY requirements and the design environment.

As a minimum they will comply with the following:

Component	Material
Riser clamp	Carbon Steel to BS EN 10025 Grade S355 J2G3 or equivalent

Table 8

#### 11.3 Material supply

The fabrication SUPPLIER is responsible for the supply of all materials for this work. Material requirements are as follows:-

- All structural steel materials are required to be supplied with 3.1.b material certificates.
- The gravity base is to be fabricated from steel materials which comply with the requirements of BS EN 10025 Grade S275.
- All padeye plates and supporting structures are to be supplied in accordance with BS EN 10025 Grade S355 72 G3 or equivalent.
- Tubulars, if used, are to be supplied as seamless pipe. Fabricated constructions are not acceptable.
- All padeye plates are to be supplied with certified through thickness properties.

As an alternative to this, these materials may be ultrasonically inspected in accordance with BS EN 10160:1999 Grade S3E4.

#### 11.4 Material traceability

SUPPLIER shall be responsible for establishing complete material traceability. This will be achieved as follows:-

- All material received will be clearly marked or stamped.
- Any part cut from a plate or section will have the identical marking transferred.
- The plates/sections used in the construction of an assembly are to be clearly documented.
- The format of a document generated by SUPPLIER shall be in accordance with COMPANY requirements and applications of such information.

SUPPLIER shall be responsible for ensuring that their Sub-Suppliers provide all documentation and services in accordance with their and COMPANY requirements to meet the performance requirements of the equipment and services

#### 11.5 Welding

With regard to the subject of welding the following shall be noted:-

- Welding shall be conducted in accordance with the requirements of EEMUA publication No 158
- SUPPLIER shall propose the welding process to be used.
- SUPPLIER is required to submit weld procedure qualification records (WPQR) for review and acceptance. Welding may not commence until WPQR's have been accepted.
- SUPPLIER is required to generate weld procedure specifications (WPS) for production welding. All WPS's must be submitted for review and acceptance.
- Welding may only be conducted by suitably qualified personnel. Welder qualification records (WQR) are to be submitted for review and acceptance.
- SUPPLIER is at liberty to propose standards for weld documentation although the proposed standards must be internationally accepted.
- Third party approval of SUPPLIER documentation is to have been conducted by a Verification and/or Certification Authority acceptable to COMPANY.
- All welding qualifications shall be current and valid and in accordance with applicable codes

SUPPLIER is responsible for completing weld logs. These logs shall indicate the following as a minimum:-

- Weld Number
- Weld Procedure Specification
- Welders Name

- Date Completed
- Format of weld logs are to be agreed with COMPANY.

### 11.6 Non-Destructive Testing

As a minimum the NDT testing shall incorporate the following number of scans.

#### Straight Butt Welds

- From both sides of the weld on one side of the plate using 45<sup>0</sup>, 60<sup>0</sup> and 70<sup>0</sup> probes, plus
- A lamination search using 0 probe.

#### T-butt and Corner Welds

- From both sides of the weld on one side of the plate using 45<sup>0</sup>, 60<sup>0</sup> and 70<sup>0</sup> probes plus,
- A weld scan using 0 probe from the plate which is parallel to the throat of the weld, plus
- A lamination scan using a 0 probe.

Note: In addition, a scan for transverse weld cracking shall be carried out from the weld crown on submerged arc weld joints thicker than 25mm.

Automated methods of UT (eg. Sonomatic Zipscan) can be submitted for COMPANY approval.

#### Ultrasonic Acceptance Criteria

Ultrasonic acceptance criteria shall be as per the requirements of DNV-OS-C401

#### NDT Operator Requirements

- All NDT operators shall be qualified to an internationally recognized qualification equivalent to or exceeding:
- CSWIP
- AINDT (Level 2)
- ASNT (Level 2)

Japanese Institute for NDT (Level 2) acceptable to COMPANY and Verification and/or Certification Authority.

### Minimum required NDT Examinations

- Mid Depth Buoyancy Tanks

Weld Type	Type of Examination	Proportion of all Welds Tested	Proportion of Each Weld Tested
Full Penetration Butt Welds	UT or RT	100%	100%
	MT	100%	100%
Partial Penetration Welds	MT	100%	100%
	UT	20%	100%
Fillet Welds	MT	100%	100%

Table 9

- Mid Depth Buoy Tubulars and Arches

Weld Type	Type of Examination	Proportion of all Welds Tested	Proportion of Each Weld Tested
Full Penetration Butt Welds	UT or RT	25%	100%
	MT	25%	100%
Partial Penetration Welds	MT	20%	100%
	UT	20%	100%
Fillet Welds	MT	10%	100%

Table 10

- Clump Weight

Weld Type	Type of Examination	Proportion of all Welds Tested	Proportion of Each Weld Tested
Full Penetration Butt Welds	UT or RT	10%	100%
	MT	10%	100%
Partial Penetration Welds	MT	20%	100%
	UT	20%	100%
Fillet Welds	MT	10%	100%

Table 11

Notes to above tables:

- All welds to be 100% visually inspected.
- NDT shall take place no sooner than 48 hours after welding.
- All welds shall be visually examined and passed prior to NDT.
- Where RT is selected for all welds of a particular type, some UT may be prescribed by COMPANY to confirm that all possible defects are being detected. Similarly, UT procedures may be checked by some RT where nominated by

COMPANY. In the event that the preferred method is found to be deficient, the procedure shall be revised and re-submitted for approval. Welds already examined shall be re-examined with the revised procedure.

- Butt welds include T butt welds and corner welds.

### 11.7 Air Leak Testing

All water-tight compartments shall be pneumatically leak tested as follows:

- All joints and welds except those previously tested shall not be painted or covered in any way, to allow for examination during the test.
- The compartment shall be pressurised to 3 psi for half an hour. During the period that the compartment is under pressure it shall be isolated from all personnel by roped enclosure and warning signs. All nearby operations shall be suspended, including those in adjacent compartments.
- Pressure shall then be reduced to 2 psi for the bubble or foam liquid test. Only test personnel shall be present. Ambient temperature shall be recorded during the test. All welds to the compartment and all hatch closures shall be leak tested. With due allowance for temperature effects the pressure should not fall in the sealed compartment over the test period.
- No pressure testing shall be performed when the ambient temperature is -5 C or lower.
- Air pressure shall be measured by a manometer or calibration gauge of appropriate range. A relief valve set and tested for 3-1/2 psi shall be included in the pressurising circuit between the compartment and the isolating valve.
- Where possible the pressuring circuit shall be connected to a flange on pipework connecting the compartment.
- A commercial bubble solution formulated for leak testing shall be used.
- The operation shall be under full time supervision by an officer empowered to exclude all except authorised personnel from the exclusion zone. Adjacent compartments shall be vacated and then sealed off prior to the test.

### 11.8 Hydrostatic Testing

Hydrostatic testing is required for each buoyancy tank as specified below:

- Upon completion of buoyancy tank fabrication and prior to commencement of blasting and coating, Supplier shall carry out hydrostatic testing in accordance with the procedure outlined below. Buoyancy tank fabrication is considered complete only after all appurtenances have been welded to buoyancy tank wall and semi-ellipsoidal heads. Each hydrostatic test of buoyancy tank or drain/vent plugs shall take place for a period of 6 hours at a pressure of 655 kPa.
- The buoyancy tank shall be weighed prior to hydrotesting.

- Weighing procedures shall be carried out to a procedure approved by COMPANY.
- Each tank compartment shall be hydrotested with fresh water or inhibited sea water and upon successful compartment hydrostatic testing, the buoyancy tank shall be weighed following the same procedures as those used prior to hydrotesting to ensure that all water has been successfully drained.

Another hydrostatic test to 655 kPa shall be carried out against the external seal of each nipple plug. Multiple testing of plugs and caps is allowed. The following procedure shall be carried out:

- Inspect threads of nipple plugs to check there is no damage and install permanent plugs.
- Install caps and test equipment.
- Carry out hydrostatic test.
- Remove test equipment and check threads to ensure there is no damage.
- Install permanent cap plug and carry out hydrostatic test.

#### 11.9 Weighing of Mid Depth Buoy

Weight control is critical during fabrication due to the narrow range of buoyancy which is required for operation of the mid depth buoy system.

Dimensional tolerances shall be maintained as specified herein or in referenced in associated specifications to ensure accurate predicted final weight.

Before fabrication starts, the Supplier shall compute the fabricated weights of each arch/buoyancy tank and complete mid depth buoy based on the final design and shall include any material substitutions. COMPANY will confirm the buoyancy tank lengths based on the calculated weights provided by the supplier.

The computed weights shall be agreed with COMPANY before fabrication starts.

The Supplier shall provide the mid depth buoy to within 1% of the agreed predicted weight.

The Supplier shall perform weight tests outlined below using a crane holding the test load and a calibrated and certified lifting gauge. The fabricated weights shall be incorporated in the as-built drawings.

The mid-depth buoy components shall be weighed on three occasions (3 readings at each occasion) as follows:

- Upon completion of fabrication of buoyancy tanks and arch tubulars and prior to hydrostatic pressure testing and commencement of blasting and coating.
- Immediately subsequent to hydrostatic pressure testing in order to verify drainage of all the water
- Upon completion of all work on the mid depth buoy. If the mid depth buoy is transported in components then final weighing of individual components is

required prior to leaving the fabrication site. Due allowance should be made for any additional material or weld metal added to the fully assembled mid depth buoy

- A complete weighing procedure shall be submitted to COMPANY within four weeks of purchase order award. All weighings shall be witnessed by COMPANY's representative and there shall be no variance to procedures and equipment used (including instrumentation) for any weight test

#### 11.10 Weighing of Clump Weight

The Supplier is to weigh the completed grillage before the placement of the cast in-situ lead fill.

Supplier is then to weigh the grillage complete with cast in-situ lead fill using calibrated lead cells. The suggested method is to sling from the main tether padeyes to a crane with a calibrated and certified lifting gauge. The two additional cast in-situ lead (or substituted scrap steel) tablets are also to be weighed after final assembly.

The Supplier is to supply calculations demonstrating that the final required submerged weight of the scrap steel tablets (if used) is sufficient to ensure that the total submerged weight of the clump assembly is achieved.

The final computed weights for the two tablets will be agreed with COMPANY before fabrication ends and before COMPANY accept them as being completed.

The grillage shall be within  $\pm 5\%$  of the required weight. The total assembly shall be within  $-0 + 3\%$  of final weight required.

#### 11.11 Trial Assembly

Prior to shipment of either completely assembled mid depth buoy or mid depth buoy components, the following trial assembly shall take place:

- Clamp a dummy pipe piece on both flowline hose clamps
- Trial fit anchor shackles in arch padeyes
- Trial fit anchor shackles in buoyancy tank padeyes
- Trial fit anchor shackles in clump weight padeyes

#### 11.12 Riser clamp manufacturing documentation

SUPPLIER is responsible for the supply of the final documentation packages for the riser clamp. This is to include the following as a minimum:-

- Material certificates
- Material traceability records Weld logs
- NDT reports



- Painting records
- Load test reports
- Weighing records

## 12 SPARES

### 12.1 Spares

The SUPPLIER's scope of supply shall include the following categories of spare parts:

- Two (2) Years operating spares
- Include anodes for riser clamps for the 20 year design life

The SUPPLIER shall provide with his quotation separate priced, itemized, lists for each of the above categories of spares.

Un-priced lists shall be included, in the technical portion of his offer, for review during the bid evaluation phase.

After placement of the purchase order, the SUPPLIER shall re-submit the lists of spare parts using the Spare Parts Interchangeability Record (SPIR) forms attached to the procurement documentation.

### 12.2 Special Tools

The SUPPLIER's scope of supply shall include all necessary Special Tools required for the installation, maintenance and operation of the equipment.

## 13 PRESERVATION, PACKING AND PREPARATION FOR SHIPMENT

### 13.1 General

All items shall be properly prepared and protected from damage for sea freight and road / rail transportation.

The SUPPLIER shall notify the COMPANY prior to shipment and shall only ship upon authorisation from the COMPANY.

### 13.2 Load-out

The responsibility for load out of the completed structure onto the transportation vessel is for the SUPPLIER.

### 13.3 Protection

All supplied items shall be thoroughly cleaned and made free of any loose mill scale, weld spatter, rust, etc. prior to shipment.

All components shall be pre-assembled to maximum extent possible.

Any internal / external parts which might be subjected to damage or displacement during shipment shall be protected with appropriate supports, bracing, framing, etc. or shipped loose if appropriate with proper tagging, packing, etc.

Screwed connections left open for shipment shall be protected with plastic plugs.

### 13.4 Lifting

The riser clamps are to be lifted in accordance with requirements specified on the lifting drawings.

The riser clamps are to be lifted using the equipment specified by the SUPPLIER and accepted by COMPANY or its representative.

### 13.5 Sea fastening

SUPPLIER shall provide sea-fastenings and structural support for the riser clamps on the transportation vessel This shall be discussed and agreed during the fabrication phase in more detail.

### 13.6 Lifting Accessories

The SUPPLIER shall supply all lifting devices/attachments required for transport and installation of riser clamps.

The lifting devices / attachments shall be designed to allow single lift and ROV installation without causing deflections, which would result in permanent deformation

All lifting devices including spreader, lifting slings, lifting lugs and lifting shackles (one set) shall be designed, fitted up and tested as a minimum for a total load of 2.0 times the lifted weight, as per reference DNV guidelines for marine operations - Pt.2 Ch.5 lifting.

All lifting procedures and the design of lifting/installation features, lifting lug calculations and certificates shall be reviewed by the COMPANY or its representative.