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	AREA: MARLIM LESTE E SUL								
	TITLE: <b>HULL MECHANICAL HANDLING PROCEDURES</b>				ESUP				
					INTERNAL				
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## SCOPE

a) This Technical Specification is focused on the design requirements for mechanical handling procedures and equipment for the Hull.

b) All mechanical handling procedures associated with the personnel transfer are excluded from the scope of this document.

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## PURPOSE

a) The purpose of this document is:

- To identify and describe the different types of logistic operations and associated handling tasks;
- To establish the main parameters and limiting conditions for each type of handling operation, so as to enable safe and efficient handling of all materials, components and equipment required for the FPSO hull/accommodation operations and maintenance;
- In addition, to define the minimum resources and devices to be provided in order to fulfill the cargo handling needs.

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## ABBREVIATIONS

A&EM Automation & Electrical Module

A&C Automation and Control

API American Petroleum Institute

CS Classification Society

FPSO Floating Production, Storage & Offloading

HSE Health, Safety and Environmental

HVAC Heating, Ventilation and Air Conditioning

HPU Hydraulic Power Unit

NR Normas Regulamentadoras (Brazilian Labor Ministry Regulations)

MCC Motor Control Center

VSD Variable Speed Drive

SDV Shutdown Valve

PCHE Printed Circuit Heat Exchanger

PS Portside

SB Starboard

SS Stainless Steel

SWL Safe Working Load

TG Turbogenerator

TBD To be defined

UPS Uninterruptible Power System

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## REFERENCES


All mechanical handling facilities and equipment shall comply with the requirements herein stated and with the following codes, standards, regulations and reference documents:

4.1

### APPLICABLE CODES AND STANDARDS

ASTM A391/A391M Standard Specification for grade 80 Alloy Steel Chain

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ASTM A391/A391M	Standard Specification for grade 80 Alloy Steel Chain
ASME B30.16	Overhead Hoists
ASME HST-1	Performance Standard for Electric Chain Hoists
ASME HST-2	Performance Standard for Hand Chain Manually Operated Chain Hoists
ASME HST-3	Performance Standard for Lever Hoists
ASME HST-4	Performance Standard for Overhead Electric Wire Rope Hoists
ASME HST-5	Performance Standard for Air Chain Hoists
ASME HST-6	Performance Standard for Air Wire Rope Hoists
BS 2853	Specification for the Testing of Steel Overhead Runway Beams for Hoist Blocks;
NR-1	<i>Disposições Gerais</i> (General Guidelines)
NR-10	<i>Segurança em Instalações e Serviços em Eletricidade</i> (Safety in Electrical Facilities and Services)
NR-11	<i>Transporte, Movimentação, Armazenagem e Manuseio de Materiais</i> (Materials Transportation, Handling and Storage)
NR-12	<i>Segurança no Trabalho em Máquinas e Equipamentos</i> (Safety in Machinery and Equipment work)
NR-17	<i>Ergonomia</i> (Ergonomics)
NR-26	<i>Sinalização de Segurança</i> (Safety Signaling)
NR-37	<i>Segurança e Saúde em Plataformas de Petróleo</i> (Safety and Helath in Oil Platforms)

Government codes, regulations, ordinances or rules applicable to the equipment in Brazil shall prevail over the requirements of this specification, including reference codes and standards, only if more stringent, otherwise they will be complied with by the other requirements.

#### 4.2 BASIC DESIGN REFERENCE DOCUMENTS

DR-ENGP-1.3-R.5	SAFETY ENGINEERING
DR-ENGP-1.4-R.2	REQUIREMENTS FOR SAFETY STUDIES
DR-ENGP-1.15	COLOR CODING
I-DE-3010.2Q-5266-630-P4X-001	GENERAL HANDLING PLAN
I-DE-3010.2Q-5266-630-P4X-021	ENGINE ROOM – HANDLING PLAN
I-DE-3010.2Q-1200-94A-P4X-001	AREA CLASSIFICATION – GENERAL
I-FD-3010.2Q-5266-631-P4X-001	GENERAL PURPOSE OFFSHORE CRANE (EN13852 – 1 ELECTRIC – DRIVEN CRANES)
I-ET-3010.2Q-1350-196-P4X-002	ERGONOMICS REQUIREMENTS FOR HULL
I-ET-3010.00-1200-956-P4X-002	GENERAL PAINTING
I-ET-3010.00-5140-700-P4X-002	SPECIFICATION FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS
I-ET-3000.00-1000-941-PPC-001	METOCEAN DATA (CAMPOS BASIN)
I-RL-3010.2Q-1350-960-P4X-002	MOTION ANALYSIS

## 5 DESIGN REQUIREMENTS

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### 5.1 GENERAL

a) All lifting and handling means shall be designed to enable transfer of loads from their assigned incoming laydown area to target location and back.

b) During the Detailed Engineering Design, the cargo handling studies shall be carried out in three steps, corresponding to the three different stages of development of the project, namely:

- Preliminary Studies:
 

Preliminary studies are intended to check the main handling routes. Routes of the auxiliary and emergency generators must also have been studied. Preliminary allocation of the monorails are mandatory in this preliminary study.

They shall be performed at the beginning of the contract lifecycle, so that possible inadequacies pointed out in such studies can still be corrected before a major engineering advance.

At this preliminary stage the use of estimated data and typical models may be accepted. Also, intentional pessimistic allowances shall be introduced into equipment parameters, in order to compensate for the existing uncertainties over the available data.
- Intermediate Studies
 

Intermediate studies shall be performed in a later stage of the engineering development, when the design will have advanced in such a way that main information and technical data are made available. Simplified models will not be accepted in this phase. All handling volumes in the 3D model must be modelled. All 3D simulations requested in this document must be completed.
- Final Studies
 

Final studies shall be issued at the end of detailed engineering phase as a closing revision of the intermediate studies, when the cargo handling design is expected to be consolidated and all information and definitions will have already been confirmed.

c) Detailed Engineering Design shall issue at least: Technical Specification (ET), describing the philosophy to be adopted in the design. Drawing(s) (DE), Descriptive Memorandum (MD), Report (RL) and List of Handling Devices (LI) shall be issued at least for each module, describing all expected handling operations. The drawings shall contain at least plan and side views showing that the height of the module is sufficient to handling the largest item. Indication of handling routes and its capacities. All handling facilities to be used shall be identified by tag. It shall be shown in detail how the sling should be done on the items to be handled, or reference in the descriptive memorandum the drawings of the equipment suppliers where this detail is contained. The Report (RL) can be issued for all the modules and specifies the following types of information:

- Mechanical handling principles/philosophy;
- Removable weights and volumes;
- Access requirements and handling facilities required with respect to lay-out design;
- Runway beams and padeye locations, elevations and safe working loads (SWL);
- Lifting apparatus and their safe working load;
- Mechanical handling route layout;
- Transportation appliances and loading details;
- Pulling appliances and their working limits;
- Laydown and maintenance area requirements;
- A schedule to identify information required ahead of the project engineering progress.

## 5.2 OPERATION ENVIRONMENT

All cargo handling equipment and materials shall be designed and constructed for operation in offshore marine environment, according to the parameters (temperature, relative humidity, winds etc.) described in I-ET-3000.00-1000-941-PPC-001 METOCEAN DATA (CAMPOS BASIN).

*Note: For dry bulb air temperature of electrical equipment, use the most critical conditions, among those defined by CS and the specific equipment documentation.*

## 5.3 ACCELERATIONS AND MOTIONS

All cargo handling facilities shall be designed and manufactured to withstand the static and dynamic conditions described in I-RL-3010.2Q-1350-960-P4X-009 – MOTION ANALYSIS.

## 5.4 SERVICE LIFE

All cargo handling equipment and materials shall be designed and manufactured for 30 years service life without the need for major repairs or replacement of main components.

## 5.5 PRELIMINARY HANDLING STUDIES

As the equipment vendors – and, in some cases, equipment or package configuration – are not yet defined at the current stage of design development, the studies presented here shall be fully revised and completed during Detailed Engineering Design. Whenever required, any cargo handling needs arising from changes to equipment/ package dimensions, configuration, layout and/ or weight shall be met during Detailed Engineering Design.

## 5.6 HANDLING MATRIX


For zones located outside the pedestal crane reach, cargo handling will be needed using mobile equipment, permanent or temporary structures. Thus, one matrix defines the requirements for this type of movement without the pedestal crane:

Weight Range	MATRIX	
	Frequency	
	Daily / Weekly	Yearly / Periodic / Occasional
W > 10 t	monorail and trolley	
1t < W ≤ 10 t	Monorail and trolley	
300 kg < W ≤ 1 t	Lifting lug or two or four wheels hand truck	
20 kg < W ≤ 300 kg	Lifting lug or two wheels hand truck	
W ≤ 20 kg	Two wheels hand truck	Manual

In addition to the load weight, other conditions affect the handling method to be chosen for each operation, such as:

- the distance that the load must be displaced;
- load picking position with respect to the floor level;
- physical and chemical characteristics (hazardous materials);
- load size and shape;
- handling route geometry and involved elevations;
- access facilities available;
- wind speed etc.

In any given case, the safest possible handling method and procedure for the specific situation shall be applied, so as to avoid accidents when lifting and displacing the load.

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## 5.7 CARGO HANDLING ROUTES

Cargo handling routes shall be free from obstacles that might block or impair the displacement of trolleys and similar handling devices. The handling studies shall thoroughly assess and identify the dimensions of all items to be transferred, ensuring that adequately proportioned handling routes are provided for their removal and transportation. It is mandatory that the doors along the handling routes are wide enough to accommodate the largest piece of equipment that needs to be moved.

During the transportation of equipment and materials between laydown areas, predefined handling routes must be strictly followed, utilizing the available handling equipment facilities.

To maintain safety, the handling route shall be physically separated from the primary escape route whenever practically possible, guaranteeing an unobstructed path for emergency situations.

The handling routes shall be designed to be as flat, straight, unobstructed, and level as possible, with non-slip surfaces to prevent accidents. Ramps shall have a maximum slope based on the slope limitations imposed by the cart / trolley / roller and ergonomic criteria.


When selecting handling trolleys, careful consideration should be given to their footprint, wheel type, wheel load, and turning radius, ensuring they are compatible with the designated handling routes.

## 5.8 SAFETY

- All handling operations shall be performed strictly within the specified operational limits and following the instructions established by each equipment manufacturer.
- All cranes and handling devices shall be operated in compliance with the FPSO Safety Management System, in order to prevent accidents and material damages.
- Safety shall be ensured throughout all handling operations by training the involved personnel, certifying handling procedures for cranes and other lifting devices, using personal protection equipment and warning signs, checking stability of tooling and structures, and providing protection against dropped objects as far as practical and in full compliance with current HSE regulations and rules.
- Operating procedures shall include instructions to minimize travel of objects being lifted above equipment, piping manifolds and pipe racks.
- Handling and safety instructions and device certificates shall be provided as required by the applicable rules and regulations.
- Handling equipment intended for installation within classified areas shall be suitable for that purpose – for instance, non-sparking materials and surface finish; certified electrical equipment and components, as applicable. The relevant area classification certificates shall be provided.
- Loose tools, accessories and equipment shall be properly stored and stowed.
- Above 0.4 g horizontal acceleration, movable devices shall be secured to fixed structures.
- All handling devices shall be fitted with 316 SS nameplates or permanent labels stating SWL, tag number and technical data. If the SWL is for dynamic conditions, this shall be included in the marking. If not explicitly marked as dynamic, SWL shall be reduced for all devices as required to account for actual conditions at the moment of use. Actual conditions include induced loads from environmental factors and any imposed loads, such as pulling force from a side lead, during the operation.

## 5.9 MAINTENANCE

- Hull/accommodation Layout shall be designed to enable safe and easy access and material flow, by means of transportation routes, disassembly and maintenance areas, and overhead spaces.
- All parts/ components involved in maintenance shall be able to be transferred between their normal locations and the supply vessel or FPSO workshops/ laydown areas.
- Whenever required, equipment shall be fitted with temporary guides and supports, hoisting points, A-frames and dedicated davits or lifting appliances.

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d) Control valves and their actuators, and large sized valves in general, shall be removable for maintenance purposes.

e) All parts requiring *regular onshore maintenance* shall be removable for overhaul using dedicated means.

f) All parts which may require *non-scheduled onshore maintenance* shall be removable for overhaul using specific means to be fitted as and when required.

**5.10 PAINTING**

a) Painting requirements shall be according to I-ET-3010.00-1200-956-P4X-002 – GENERAL PAINTING. Color code shall be according to DR-ENGP-1.15 – COLOR CODING.

**5.11 PACKAGE AND SKID MOUNTED EQUIPMENT**

a) Suppliers shall provide each package and/ or skid mounted equipment with dedicated means for disassembly and removal of components subject to repair or maintenance, so as to bring them to the skid or package boundaries for further handling using the resources available on the Unit. Sub-assemblies, electric motors, auxiliary equipment etc. shall be provided with padeyes or equivalent lifting means.

b) Package and skid mounted equipment shall be designed and constructed considering the cargo handling needs arising from lifting and transportation, installation on site, normal operation and maintenance.

**5.12 3D SIMULATION**

Contractor shall perform 3D simulations related to the activities of cargo handling for maintenance, in order to prove and facilitate the understanding of the written procedures for these activities:

a) The simulations shall result in Video describing the execution of the cargo handling simulation

b) The provisional elements used in the Simulation videos cannot be part of the official project database. It shall be segregated into a specific item in the project hierarchy.

c) In the video, it shall be necessary to show the 3D model of the elements, as well as their TAGs, involved in the maintenance cargo handling of the equipment like hoists, cables, spread bars, etc.

d) Establish the trajectory for moving the equipment considering the tolerances, clearances and movements (“balance”) of the cargo handling devices, including the sling configuration and angles for all lifts, with the actual position of the lifting lugs for the equipment;


e) The simulations shall start with the equipment in its operating location, show the entire process of moving the load until the equipment arrives on some main handling route, such as the central pipe rack route or in some region where the crane has access to lift directly.

f) The simulations shall identify all necessary items to be dismantled for the handling operation (panels, handrails, removable coamings, piping spools etc.)

g) The simulation shall be done for the following equipment:

- Auxiliary Generators
- Emergency Generator
- Small-sized medium voltage motors
- Switchgears columns
- Medium voltage transformers coils removal
- Transformer Coils –
- Pull-In/Pull-Out – Handling of main and auxiliary cables, assembly of riggings, positioning of auxiliary sheaves.



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## 6 OPERATION

### 6.1 TYPES OF LOGISTIC OPERATIONS

6.1.1 Each operation described in the following sections is classified as one of the types listed below and assigned the limiting conditions for safe operation of the relevant equipment.

6.1.2 As regards mechanical handling, four categories of logistic operations are defined:

<b>SRCL</b>	Standard Regular Consumable Logistics
<b>SICL</b>	Standard Infrequent Consumable Logistics
<b>SML</b>	Standard Maintenance Logistics
<b>NSML</b>	Non-Standard Maintenance Logistics

6.1.3 Non-Standard Maintenance

- "NSML" is defined as a maintenance event which is highly unlikely to occur throughout the FPSO expected service life. On-board lifting and handling facilities will not be provided nor designed for this type of operation, however the FPSO Hull/accommodation layout design shall be developed so as to create no major obstacles to the possible disassembly, removal and transportation of equipment, if required;
- "NSML"-type logistic operations require external assistance as well as special procedures to be prepared by CONTRACTOR;
- NSML classified equipment list shall be done during Detail Design to include all items deemed relevant, which shall be agreed upon with Petrobras.

### 6.2 OPERATING SCHEDULE

6.2.1 In normal conditions, transportation of general supplies to the FPSO will be performed by supply/ service vessels once every two weeks.

## 7 CARGO HANDLING RESOURCES AND EQUIPMENT


### 7.1 HULL/ACCOMMODATION SCOPE OF SUPPLY

The following types of lifting and handling devices shall be provided, as a minimum (refer to Section 9 for additional details and reference sketches):

- Monorails/ runway beams
- Manual, chain driven, pneumatic driven or electric motor driven hoists
- Manual, chain driven or electric motor driven beam trolleys
- Removable hatches
- Removable panels
- Hydraulic stackers
- Hand pallet trucks
- Tilting floor drum stands
- Lift tables
- Shift skates
- Manual cable pullers
- Wire rope winches
- Portable hoists
- Beam clamps
- Cylinder transport cabinets
- General purpose lifting devices: tackles, slings, chains, ropes etc.

### 7.2 MONORAILS, PADEYES, TROLLEYS AND HOISTS

- Hoists with trolleys running along lifting beams shall be fitted as necessary, to ensure flawless load transfer from the original locations to one of the available laydown areas or to another device for further handling using the cranes.
- Motor-driven hoists shall be pneumatic. Only hoists that work on a long monorail such as those on the central piperack monorail and on the SDV's region shall be electric motor-driven hoist.

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c) For electric motor-driven hoists that will stay permanently in lifting beams, electrical cable shall be mount in cable carriers, also known as drag chain, energy chain or cable chain.

d) Hoist chain shall follow ASTM A391M and shall have a corrosion resistant treated for better protection and longer life.

e) For handling procedures using monorails, trolley and hoists, or pad-eyes and hoists, the design shall consider headroom available, considering the space necessary for trolley, hoist, sling angle, equipment to be removed, etc.

f) Lifting beams are fitted with their respective trolleys or hoists.

g) A significant number of chain hoists foreseen within the scope of this Technical Specification are intended for infrequent use, remaining mostly out of operation. These devices, when installed outdoors in an offshore environment, require periodical inspection, maintenance, lubrication and cleaning, in order to keep them in good operating condition and to avoid damage to critical components such as gears, racks, pinions, bearings etc. Therefore, in order to minimize CAPEX and maintenance, the following premises have been established for the Basic Design:

- The total quantity of hoists is to be kept as low as possible;
- When not in use, the chain hoists are to be preferably stored inside a closed toolbox or cabinet, to be defined during Detailed Engineering Design;
- Whenever required for a specific handling task, the hoist is brought from its storage place and temporarily installed on the beam trolley. Heavy hoists which cannot be manually transported and installed are displaced with manual cars and lifted to their operating locations using auxiliary devices such as smaller hoists, or shieves attached to beam clamps or padeyes.
- Monorails of identical Safe Working Load (SWL) shall be of the same beam type and size to ensure consistency in the Facility. This will ensure minimum redundancy in trolley hoists selection.

h) Whenever the local arrangement restrictions do not allow the installation of running trolleys, welded padeyes (to be defined during Detailed Engineering Design) shall be installed as required, with sufficient loading capacity to lift the relevant loads on each area. Portable hoists or other lifting devices may be temporarily installed on those padeyes. Loads shall be placed on hand trucks, pallet trucks or similar devices for further transfer to their final location.

i) Beams for lifting service shall be designed to withstand the main loads which require handling for maintenance or repair, located within their respective areas, and the materials/ consumables normally used on the area.

j) Monorails shall be equipped with bolted end stops in order to remove and install trolley/hoist. Space shall be provided for access and dismantling of the trolley / hoist.

k) Trolleys running on beams transversely installed with respect to the FPSO main axis shall be fitted with locking devices or positive traction (rack and pinion or sprocket wheel and geared rack), to ensure safe handling conditions under the maximum expected FPSO lateral motions and accelerations.

l) Electric motor driven devices shall be provided with fail-safe automatic brakes, released when the motor is energized.


  

**7.3 REMOVABLE HATCHES**

a) Whenever mechanical handling is restricted for layout reasons, removable hatches shall be installed to enable vertical access between decks and transfer of loads between different levels using the cranes and other devices.


b) Hatches shall be installed flush with respect to the deck level, to enable unimpaired transit of personnel and material.

c) Welded padeyes and/ or handles shall be fitted onto the hatches for handling and hoisting using the cranes.

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#### 7.4 REMOVABLE PANELS

- a) Whenever no other handling solution is feasible, removable panels shall be provided to enable withdrawal of electrical panels and large-sized equipment from rooms.
- b) Locking devices and lifting eyes shall be installed on the removable panels.
- c) Removable panels shall have the same surface finish and fireproofing class as the adjacent fixed walls or bulkheads.
- d) Removable panels, which may be either plain type or fitted with hinged doors, shall be bolted to the respective walls or bulkheads.
- e) Whenever technically and economically feasible, removable panels may be specified as sliding type instead of bolted; this alternative is easier to use and helps optimize the cargo handling operations.

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## 8 HANDLING DUTIES

### 8.1 INCOMING AND OUTGOING LOADS RELATED WITH THE HULL/ACCOMODATION OPERATION

The following table shows the main types of incoming and outgoing loads, their respective logistics operation class, and the source and target locations.

Material Flow	Item	Operation Type (see 6.1.2)	Location		Handling Device
			From	To	
Incoming	Chemicals	SRCL	Supply boat	Laydown area	Crane
	Lubricating oils & greases	SML			
	Maintenance materials and spare parts				
	Routine parts / equipment	SML	Laydown area		
	Heavy equipment for onshore repair	NSML	TBD	TBD	External

### 8.2 HULL/ACCOMMODATION

#### 8.2.1 Fixed Equipment

The following Hull/Accommodation loads require handling:

Equipment	Loads to be handled
Pressure vessels	Internals
Heat exchangers	Complete exchangers, tube bundles, plates
Rotating equipment	Pump and compressor rotors, casing or complete equipment; driving machinery rotors, stators or complete machine
Special packages	Filter media, packing, gas cylinders
Piping and valves	Pipe spools, complete manual valves, valve internals
Instrumentation	Control valves, actuators, internals; panels, instruments; HPU parts (motors, pumps), skids
HVAC equipment	Compressors, pumps, fans and motors, air handling units, chillers, heaters, air filters
Electrical	Complete transformers, transformer coils, batteries, switchgears cabinets, circuit-breakers, UPSs, battery-chargers, grounding resistors, current-limiting reactors, motors stators, motors rotors, motors heat-exchangers, complete motors, low-voltage generators stators, low-voltage generators rotors, medium-voltage generators heat-exchanger, medium-voltage generators rotors, variable speed drivers, soft-starters, lighting fixtures, floodlights, circuit-breakers removable rail cars, Lighting panels, junction boxes, portable isolation mats.
Fire & Safety equipment	Bottle racks, fire extinguishers, personal protection equipment

#### 8.2.2 Temporary Equipment and Materials

The following temporary equipment and materials require handling:


Equipment/ Material	Loads to be handled
Maintenance materials	Insulation, paints, scaffolding


#### 8.2.3 Handling Duties

a) Pressure vessels:

- Manhole covers and flanged heads weighing over 50 kg shall be fitted with davits. Internals can be removed from the vessels through the manholes.
- All other related parts shall be handled with chain blocks and trolleys.

b) Heat exchangers:

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<ul style="list-style-type: none"><li>▪ Handling means are to be provided on all modules where fixed tubesheet exchangers are installed, such as monorails and trolleys with hoists. These exchangers are subsequently lifted with the offshore crane, for direct transfer to the supply boat.</li><li>▪ For shell and tube heat exchangers with removable bundles, monorails shall be provided for bundle handling and removal from exchanger shell. Space in front of channel cover shall be reserved for withdrawal of heat exchanger bundle. Pull posts shall be installed as material handling aid for bundle extraction, whenever required.</li><li>▪ For shell and tube heat exchangers with removable bundles, its complete removal shall be considered NSML, that is, it is not necessary to provide definitive devices to handle it as a whole, but there must be routes without major obstacles to enable its removal if necessary.</li><li>▪ For plate and frame heat exchangers, manual handling of plates and tie-bolts are considered and performed locally.</li><li>▪ For heat exchangers with removable tubesheet, bundle extractors shall be provided whenever required.</li></ul> <p>c) Rotating equipment:</p> <ul style="list-style-type: none"><li>▪ Loads weighing up to 5 t are transferred to the deck trolley using the skid and/ or module built-in resources, and parts heavier than 5 t are transferred to the deck trolley, aided by slings attached to padeyes or beam clamps on structural beams, temporary I-beams and/ or A-frames combined with chain blocks, or equivalent means;</li><li>▪ Consideration may be given to removing the motor cooler to increase clearance between the electric motor and hoist, if necessary. Other handling options can be proposed for evaluation of Buyer, such as handling from the side of the skid, however, additional disassembly of equipment for this handling should be avoided.</li></ul> <p>d) Instrumentation:</p> <ul style="list-style-type: none"><li>▪ Heavy parts such as control valves and actuators are handled using chain hoists attached to beam trolleys or padeyes.</li><li>▪ On areas where no fixed structure is available above the valves, portable tripods or portable gantry cranes are used to hoist the parts and place them on carts or trolleys for transfer to the target location (ex.: maintenance area, workshop or laydown area).</li><li>▪ For the removal of heavy and/ or large sized valves, the adjacent pipe spools and actuator shall be previously disconnected from the valve body.</li></ul> <p>e) Pipe Spools:</p> <ul style="list-style-type: none"><li>▪ Removable spools shall be as short and light as possible, with 2 m maximum length and 0.5 t maximum weight.</li><li>▪ Scaffolding arrangements, portable gantry cranes or tripods can be used to support spool pieces. Alternative facilities such as davits, lifting lugs, pad eyes etc. can be provided above pipe spools, located on the nearby steel structure, in order to enable spool handling by means of hoists.</li></ul> <p>f) Valves:</p> <ul style="list-style-type: none"><li>▪ Where heavy valves are not accessible by crane, the use of portable lifting appliance such as A-frame should first be considered. Where the use of portable lifting appliance is not considered feasible, fixed lifting points shall be provided either by a monorail or padeyes. Beam clamps should only be used on beams specially designated as lifting points.</li></ul> <p>g) Electrical Equipment:</p> <ul style="list-style-type: none"><li>▪ Electrical generators, panels, transformers, Ups and Battery-chargers have a low probability of requiring handling throughout the FPSO service life, in case this occurs, the following shall be considered:</li><li>▪ Generators rooms shall be fitted with monorails and suitable doors or removable panels to allow handling.</li></ul>				

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- On main power transformers, the coils are the parts subject to repair or replacement. In Hull Transformers Room 1, coils shall be lifted using monorails (fitted along the structural beams) and temporary hoisting handling arrangements, for displacement to a location close to a removable side panel. In Hull Transformers Room 2, there shall be removable hatches above mains power transformers, and the coils shall be lifted to the upper level using temporary hoisting and handling arrangements.
- Equipment in Hull Normal Panels Room shall be handled using manual trucks up to the removable hatch that allows handling to the upper level. At this point they shall be lifted using temporary hoisting and handling arrangements.
- Equipment in Essential Panels Room shall be handled using manual truck up to Hull Transformers Room 1, through a removable door or panel.
- Other electrical items having lower weight but a higher probability of being serviced or replaced such as circuit-breakers, UPS components, etc. shall be manually disassembled and moved using manual trucks, which pass through the normal maintenance routes and access doors.

h) HVAC Equipment:

- Fans, electric motors, heaters, dampers, filter bags and other parts can be handled manually or using the mechanical devices provided by each packager, then transferred to carts and brought to the reach of the crane using the appropriate means, according to their original location.

i) Fire Fighting and Safety Equipment:

- CO<sub>2</sub> or INERGEN cylinders are manually handled and placed into transportation cabinets (see item 9). Cylinders located in areas outside of the crane's reach are displaced using hand trucks or trolleys, to an area within the crane reach.
- Fire extinguishers, portable safety devices and personal protection equipment can be manually handled and transported using hand trolleys.

j) General items:

- Insulation materials, paints, tools, scaffolding materials and similar goods are manually handled and/ or transported using hand trolleys.

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HANDLING AND LIFTING DEVICES


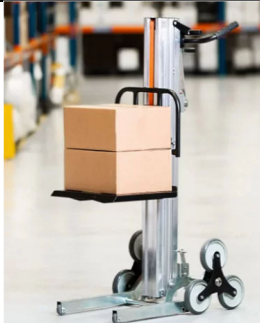


The table below provides an initial list of necessary handling and lifting devices to be provided by SELLER, which is not exhaustive:

Item	Device	Reference Sketch	SWL	Qty.	Purpose
01	Beam Trolley		TBD	TBD	Maintenance
02	Manual Chain Hoist		TBD	TBD	Maintenance
03	Chain Operated Beam Trolley		TBD	TBD	Maintenance
04	Pneumatic Chain Hoist		TBD	TBD	Maintenance
05	Heavy Duty Manual Chain Hoist		TBD	TBD	Maintenance



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Item	Device	Reference Sketch	SWL	Qty.	Purpose
06	Trolley Mount Electric Driven Chain Hoist		5 t	1	Transfer of heavy maintenance loads SDV region
07	Trolley Mount Low Headroom Pneumatic Driven Chain Hoist		Up to 40t	TBD	Maintenance
08	Trolley Mount Ultra Low Headroom Pneumatic Driven Chain Hoist		Up to 40 t	TBD	Maintenance
09	Beam Clamp		5 t	2	General use
10	Shifting Skate		1 t	06	General use



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Item	Device	Reference Sketch	SWL	Qty.	Purpose
11	Transporter Carts		TBT	TBT	Carts shall be provided to move the items that were stored in the warehouses with the capacity to accommodate them on the shelves
12	Pantograph Carts		TBT	TBT	Carts to improve the ergonomics of workers in lifting movements shall be foreseen.
13	Loose Items	Wire and fiber ropes, sheaves, blocks, hooks, shackles, cargo net slings, slings with various lengths, swivels, clamps and related hardware as required to assist operations using the handling devices herein specified.	TBD	TBD	General use
14	Davit		TBD	TBD	Portable utility davit, with or without wheel base