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	UNIT: ATAPU 2 AND SÉPIA 2									
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UNIT:

ATAPU 2 AND SÉPIA 2

SHEET

2 of 28

TITLE:

**TOPSIDE'S MECHANICAL HANDLING  
PROCEDURES**

NP-1

ESUP

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## 1 SCOPE

- a) This Technical Specification is focused on the design requirements for mechanical handling procedures and equipment for the Topsides
- b) All mechanical handling procedures exclusively associated with the FPSO Hull and its systems (for example, personnel transfer, handling of provisions, garbage disposal and handling of supplies for the accommodation and other areas out of the Topsides scope of supply) are excluded from the scope of this document.

## 2 PURPOSE

- a) The purpose of this document is:
  - To identify and describe the different types of Topsides-related 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, supplies, components and equipment required for the FPSO Topside operations and maintenance;
  - In addition, to define the minimum resources and devices to be provided in order to fulfill the cargo handling needs.
- b) During Detailed Engineering Design of the FPSO Topsides, this document shall be used as a guideline for the following purposes:
  - To verify and confirm the sizes, locations, quantities and design data of laydown areas, handling routes, trolleys, hoists, lifting beams, removable hatches and panels and other handling resources foreseen in the Basic Design;
  - To define type and lifting capacity of monorails, trolleys, hoists, A-frames, auxiliary laydown areas and other cargo handling devices not explicitly mentioned in this document but required to fulfill the requirements herein specified; and
  - To define all required interfaces, which enable safe, efficient and trouble-free transfer of loads between the Topsides and Hull systems.

## 3 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
NR	Normas Regulamentadoras (Brazilian Labor Ministry Regulations)
PS	Portside
SB	Starboard
SS	Stainless Steel
SWL	Safe Work Load
TG	Turbogenerator
TBD	To be defined
UPS	Uninterruptible Power System

## 4 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
ASME B30.16	Overhead 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-17	<i>Ergonomia</i> (Ergonomics)
NR-18	<i>Segurança e Saúde no Trabalho na Indústria da Construção</i> (Safety and Health at Work in the Construction Industry)
NR-26	<i>Sinalização de Segurança</i> (Safety Signaling)
NR-30 – Anexo II	<i>Plataformas e Instalações de Apoio</i> (Platforms and Support Facilities)
NR-37	<i>Segurança e Saúde em Plataformas de Petróleo</i> (Safety and Health on 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.

### 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-3010.2D-1200-94A-P4X-001	AREA CLASSIFICATION – GENERAL
I-DE-3010.2D-5266-630-P4X-001	GENERAL HANDLING PLAN
I-DE-3010.2D-5266-630-P4X-002	M-01 – FLARE SYSTEM – HANDLING PLAN
I-DE-3010.2D-5266-630-P4X-003	M-02 – CO2 COMPRESSION – HANDLING PLAN
I-DE-3010.2D-5266-630-P4X-004	M-04 – CO2 REMOVAL – HANDLING PLAN
I-DE-3010.2D-5266-630-P4X-005	M-05 – MAIN GAS COMPRESSION – HANDLING PLAN
I-DE-3010.2D-5266-630-P4X-007	M-05B – VRU SYSTEM – HANDLING PLAN
I-DE-3010.2D-5266-630-P4X-008	M-06 – GAS DEHYDRATION, FUEL GAS AND HCDP – HANDLING PLAN
I-DE-3010.2D-5266-630-P4X-009	M-07A – INJECTION AND EXPORT COMPRESSION – HANDLING PLAN
I-DE-3010.2D-5266-630-P4X-010	M-07B – INJECTION AND EXPORT COMPRESSION – HANDLING PLAN

I-DE-3010.2D-5266-630-P4X-011	M-09 – PIG LAUNCHERS/RECEIVERS AND PRODUCTION & INJECTION MANIFOLDS – HANDLING PLAN
I-DE-3010.2D-5266-630-P4X-012	M-10A – OIL PROCESSING AND WELL SERVICE – HANDLING PLAN
I-DE-3010.2D-5266-630-P4X-013	M-10B – PRODUCED WATER TREATMENT – HANDLING PLAN
I-DE-3010.2D-5266-630-P4X-014	M-10C – OIL PROCESSING – HANDLING PLAN
I-DE-3010.2D-5266-630-P4X-015	M-11 – WATER INJECTION AND SULPHATE REMOVAL – HANDLING PLAN
I-DE-3010.2D-5266-630-P4X-016	M-12 – POWER GENERATION – HANDLING PLAN
I-DE-3010.2D-5266-630-P4X-018	M-13 – POWER GENERATION – HANDLING PLAN
I-DE-3010.2D-5266-630-P4X-019	M-13B – POWER GENERATION – HANDLING PLAN
I-DE-3010.2D-5266-630-P4X-020	M-14 – CHEMICAL UNITS AND PRODUCTS STORAGE AND UTILITIES – HANDLING PLAN
I-DE-3010.2D-5266-630-P4X-021	M-15 – UTILITIES – HANDLING PLAN
I-DE-3010.2D-5266-630-P4X-022	M-15B – UTILITIES AND HULL GENERATION – HANDLING PLAN
I-DE-3010.2D-5266-630-P4X-023	M-16 – LAY-DOWN AREA – HANDLING PLAN
I-DE-3010.2D-5266-630-P4X-024	M-17 - AUTOMATION AND ELECTRICAL – HANDLING PLAN
I-DE-3010.00-1400-140-P4X-004	GENERAL NOTES FOR TOPSIDES STRUCTURES
I-FD-3010.2D-5266-631-P4X-001	GENERAL PURPOSE OFF SHORE CRANE (EN13852 – 1 ELECTRIC – DRIVEN CRANES)
I-ET-3010.2D-1350-196-P4X-001	ERGONOMIC REQUIREMENTS FOR TOPSIDES
I-ET-3010.00-1200-956-P4X-002	GENERAL PAINTING
I-ET-3000.00-1200-940-P4X-001	TAGGING PROCEDURE FOR PRODUCTION UNITS DESIGN
I-ET-3010.00-5140-700-P4X-002	SPECIFICATION FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS
I-ET-3010.2E-5268-968-P4X-001	RISER PULL-IN AND PULL-OUT SYSTEM
I-ET-3A36.00-1000-941-PPC-001	METOCEAN DATA (SANTOS BASIN CENTRAL CLUSTER REGION)
I-ET-3A26.00-1000-941-PPC-001	METOCEAN DATA
I-RL-3010.2D-1350-960-P4X-002	MOTION ANALYSIS

## 5 DESIGN REQUIREMENTS

### 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 and if dimensions of deck trolleys are compatible with these routes. Preliminary allocation of the monorails is 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, 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. Drawings (DE), descriptive memorial (MD) and list of handling devices (LI) shall be issued at least for each module, describing all expected handling operations. The drawing shall contain at least a plan and side view showing that the right foot 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 handling, or reference in the descriptive memorial the drawings of the equipment suppliers where this detail is contained.

## 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-3A36.00-1000-941-PPC-001 – METOCEAN DATA (SANTOS BASIN CENTRAL CLUSTER REGION) and I-ET-3A26.00-1000-941-PPC-001 - METOCEAN DATA.

*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-3010.2D-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 AND TRANSFER MATRIX

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

Transfer Matrix: This Matrix refers to that uses mobile transfer equipment.

Handling Matrix: This Matrix refers to the cargo handling that need permanent or temporary installed handling equipment.

Mobile, permanently or temporary installed handling devices shall be foreseen according to the table below:

Weight Range	MATRIX			
	Frequency			
	Daily / Weekly	Yearly / Periodic / Occasional	Daily / Weekly	Yearly / Periodic / Occasional
W > 40t	no transfer		external barge crane facilities	
1t < W < 40t	no transfer	four wheels hand or self-propelled truck	permanent handling structure and permanent powered handling equipment	permanent handling structure and permanent powered handling equipment
300Kg < W < 1t		Four wheels hand truck		permanent/temporary handling structure and powered/manual handling equipment
20Kg < W < 300kg	two wheel hand truck		permanent/temporary handling structure and removable manual handling equipment	
W < 20Kg	two wheel hand truck	manual transfer	manual handling	
	<b>Transfer Matrix</b>		<b>Handling Matrix</b>	

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.

Cargo handling routes shall be free from obstacles that might block or impair the displacement of trolleys and similar handling devices.

## 5.7 SAFETY

- a) All handling operations shall be performed strictly within the specified operational limits and following the instructions established by each equipment manufacturer.
- b) All cranes and handling devices shall be operated in compliance with the FPSO Safety Management System, in order to prevent accidents and material damages.
- c) 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.

- d) Operating procedures shall include instructions to minimize travel of objects being lifted above equipment, piping manifolds and pipe racks.
- e) Handling and safety instructions and device certificates shall be provided as required by the applicable rules and regulations. Operating manual shall be delivered in Brazilian Portuguese Language.
- f) 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.
- g) Loose tools, accessories and equipment shall be properly stored and stowed.
- h) Above 0.4 g horizontal acceleration, movable devices shall be secured to fixed structures.
- i) All handling devices shall be fitted with 316 SS nameplates or permanent labels stating SWL, tag number and technical data.

### 5.8 MAINTENANCE

- a) Topsides 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.
- b) 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.
- c) Whenever required, equipment shall be fitted with temporary guides and supports, hoisting points, A-frames and dedicated davits or lifting appliances.
- 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.

### 5.9 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.


### 5.10 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.

### 5.11 MODULE DESIGN

- a) The SELLER is responsible for designing and providing built-in lifting facilities to deliver the operation and maintenance loads up to the module limits, and for preparing the applicable operating procedures to fulfill these needs.



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- b) If required to bring the loads to any location out of the reach of the deck crane, then monorails, trolleys, deck trolley pathways or equivalent devices shall be provided for this purpose, in order to enable flawless material handling.

## 5.12 3D SIMULATION

SELLER 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 be 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 must 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 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.
- 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 simulation shall be done for the following equipment:
  - Loads pertaining to the compression units: turbine, electric motor, gearbox, compressors and vorecon;
  - Loads pertaining to the main generator: gearbox, turbine, electrical rotor and stator of the electric generator and air cooler;
  - Medium voltage transformers coils removal;
  - Small-sized medium voltage motors;
  - Large-sizes medium voltage motors rotor removal;
  - MCCs columns;
  - Switchgears columns;
  - Medium voltage VSDs;
  - Heat exchangers that are fixed tubesheet type;
  - Simulation of how the largest load in each module will be handled to lowest levels;
  - Flare Tip;
  - Main Seawater lift Pumps.

## 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:

- a) "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 Topsides layout design shall be developed so as to create no major obstacles to the possible disassembly, removal and transportation of equipment, if required;
- b) "NSML"-type logistic operations require external assistance as well as special procedures to be prepared by SELLER;
- c) NSML classified equipment list shall be done during Detail Design to include all items deemed relevant, which shall be agreed upon with Buyer.

## 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 TOPSIDES 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, pneumatic driven or electric motor driven beam trolleys;
- Self-propelled diesel-hydraulic deck trolley;
- Self-propelled electrical deck trolley;
- Power Pusher;
- Overhead crane(s);
- Portable davits and respective pedestals;
- Portable gantry cranes;
- Removable hatches;
- Removable panels;
- Hydraulic stackers;
- Hand pallet trucks;
- Floor cranes;
- Hand trolleys and 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 TAG MARKING

- a) For tag marking, shall be follow I-ET-3000.00-1200-940-P4X-001 – TAGGING PROCEDURE FOR PRODUCTION UNITS DESIGN;

- b) Use the prefix "TN" for handling equipment that does not have a specific prefix for its tag in the Tagging Procedure. For example, load skates, elevating cart, power pusher, decktrolleys, "A" frame, beam clamp, hydraulic jack, tripod mobile cart, beam trolley, besides all combined trolley hoists and chain hoists, all of this miscellaneous equipment shall receive the prefix tag "TN";
- c) Structures used for cargo handling such as monorails, padeyes, pulling post, etc shall be physically tagged with their specific tag and SWL.

### 7.3 OFFSHORE CRANES

Main characteristics and some relevant operating data of the offshore cranes to be installed on the Unit are given below: I-FD-3010.2D-5266-631-P4X-001 - GENERAL PURPOSE OFF SHORE CRANE (EN13852 – 1 ELECTRIC – DRIVEN CRANES)

- a) As far as practical, lifting and handling of incoming/ outgoing cargo and also on-board load handling within the FPSO shall be performed using the pedestal cranes. Additional facilities are to be provided for all areas out of the cranes' reach.
- b) The aft crane, installed, is designed for daily operation, mostly handling chemicals, supplies and spare parts.
- c) The fore crane is intended for maintenance support
- d) In case of maintenance on one of the cranes, the other one shall work as a back-up, and means shall be provided to enable unimpaired material handling during the repair period, until both cranes are available again.
- e) For estimated lifting frequencies associated with Topsides maintenance and operation, refer to the following table. All figures shall be confirmed during Detailed Engineering Design.

Loads to be lifted	Mean Interval (days)
Equipment supplies	~1.75
Chemicals (tote tanks), lubricating oils and greases	~3.5
Equipment maintenance parts and components	~36

### 7.4 MONORAILS, PAD-EYES, TROLLEYS AND HOISTS

- a) 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.
- b) All hoists shall be chain type
- c) Motor-driven hoists shall be pneumatic. Only hoists that work on a long monorail such as those on the central pipe rack monorail and on the SDV's region shall be electric motor-driven hoist.
- d) 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.
- e) Hoists shall be of chain and shall follow ASTM A391M and shall have a corrosion resistant treated for better protection and longer life.
- f) 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.
- 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 shall be established in the Detailed Engineering Design:
  - The total quantity of hoists is to be kept as low as possible;
  - On modules which require several hoists with the same capacity, it is recommended to purchase 01 (one) hoist for each SWL – or 02 (two) whenever simultaneously required for critical load transfer from one lifting beam to another;

- When not in use, the chain hoists are to be preferably stored inside a closed toolbox or cabinet within the module area, to be defined during Detailed Engineering Design, or using one of the available stores on the Main Deck;
  - 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.
- 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) 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.
- k) Electric motor driven devices shall be provided with fail-safe automatic brakes, released when the motor is energized.
- l) After the necessary tests, the hoists shall be hibernated according to Exhibit 8 – Directives for Commissioning Process

## 7.5 DECK TROLLEY

SELLER shall design the above referred internal paths for deck trolleys displacement within the modules to be obstacle-free (considering equipment, piping, valves, structure, cabling etc.), in order to enable unimpaired transit of the loaded trolley until arriving to the pipe rack handling route. Free width and height shall be sufficient along the whole handling path within the modules.

During Detailed Engineering Design, structural verification shall be performed on the Main Deck areas intended for transit of the Deck Trolley, such as the main maintenance routes.

It is SELLER`s scope to provide decktrolleys operation training in Brazilian Portuguese language.

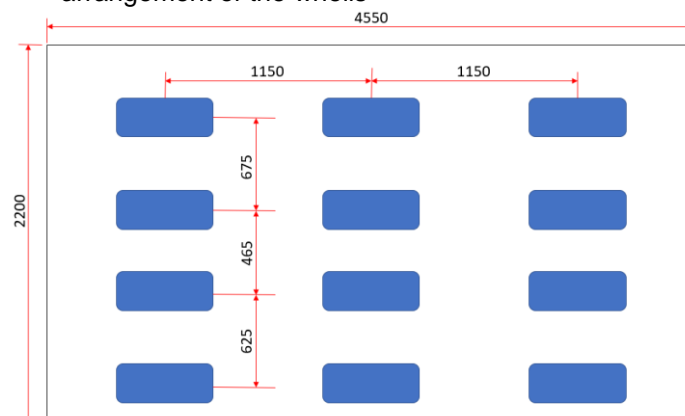
### 7.5.1 Electric deck trolleys self-propelled:

- a) Five (05) electric self-propelled trolleys omnidirection shall be provided, one (1) with 40 t loading capacity (SWL), one (1) with 10 t loading capacity (SWL) intended for the transfer of maintenance loads exceeding 5 t on the Process Plant Deck and three (3) with 10 t loading capacity (SWL) specifically to take the food container from the laydown area to its parking spot near the accommodations. Of these three deck trolleys that will be used to transport the food container, one of them will be a spare. See Section 9, item 02 for reference sketch.
- b) The layout of the food container parking in the M15B, shall be in a way that allows the emptying of the container without the need to remove the container from the top os the decktrolleys. However, features such as padeyes or monorails shall be provided to enable the removal of the food conteinar from decktrolleys in the parking area, if necessary.
- c) It shall be of suitable material to work offshore, shall be ATEX and shall be controlled by a wireless control.
- d) A place with charging station shall be reserved for the deck trolleys and it shall have a cover to protect it from the weather when it are not in use. For the specific deck trolleys to transport the food container, two (2) electric charging points shall be allocated in the container parking lot near

the accommodation to enable the charging the battery of the deck trolleys while the container is unloading.

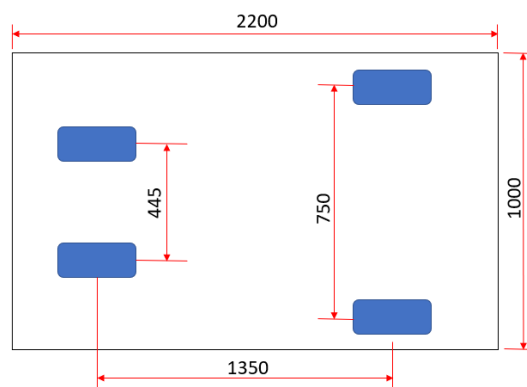
- e) It shall run on dedicated area along the centerline of the main handling route underneath the Pipe Rack, which connects the fore and aft regions of the Process Plant Deck;
- f) The full length of the main handling route shall be structurally reinforced to withstand the displacement of the loaded trolley, and also considering the applicable dynamic factor arising from the lowering of loads onto the self-propelled trolley cargo deck.
- g) For design of the floor structure where the deck trolleys will transit, the heaviest load to be moved in each handling rout shall be considered.
- h) For the 40t capacity decktrolley, design of the floor structure should be limited to loads up to 25t. As loads above 25t will have a low handling frequency, temporary steel plates must be provided if the pressures imposed by the decktrolley are greater than those supported by the floor.
- i) For the floor structural design and arrangement of the Basic Design, the following characteristics of decktrolleys described below were considered. These characteristics can be changed in the Detailed Engineering Design. If the decktrolley's size is changed, it must continue to be able to access areas of interest and transport the loads. The wheel arrangement can also be changed as long as the floor is design for the new arrangement

- 40 t Deck trolley: 4550mm Lenght x 2200mm Width.  
Max wheel footprint: 10500mm<sup>2</sup> (175mm x 60mm). Figure 1 shows the arrangement of the whells



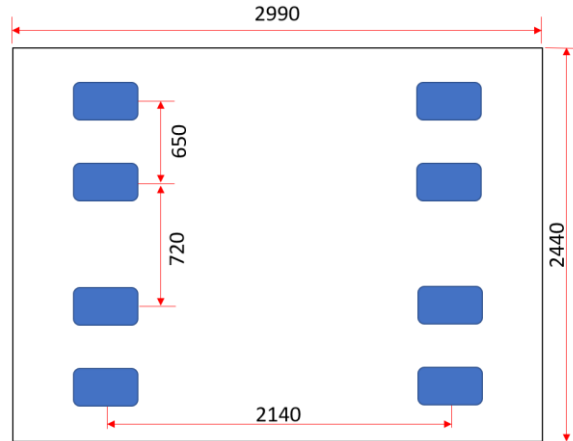
**Figure 1 - 40t decktrolley wheel arrangement**

- 10 t Deck trolley: 2200mm Lenght x 1000mm Width  
Max wheel footprint: 8700 m<sup>2</sup> (200mm x 43,5mm). Figure 2 shows the arrangement of the whells



**Figure 2 - 10t decktrolley wheel arrangement**

- 10 t Deck trolley for food container: 2990mm Length x 2440mm Width  
Max wheel footprint: 6700 mm<sup>2</sup> (200mm x 33,5mm). Figure 3 shows the arrangement of the wheels



**Figure 3 - Wheel arrangement 10t decktrolley for food container**

- j) All electric deck trolleys must provide for the release of the wheels to make it possible to tow the deck trolley with load in case of failure or battery run out. A cart capable of towing the deck-trolley with load must be provided in this case, the Diesel-hydraulic self-propelled trolley can be used or another device to be provided by the SELLER.

#### 7.5.2 Diesel-hydraulic self-propelled trolley – 5 t:

- One (01) diesel-hydraulic self-propelled trolley shall be provided, with 5 t loading capacity, intended for general cargo handling on the Process Plant Deck and, if required, on the Main Deck. See Section 9, item 01 for reference sketch.
- This vehicle may be transferred between both previously mentioned deck levels as required, using the deck cranes, by means of the built-in lifting lugs provided on the trolley.
- It shall be able to run along the Pipe Rack main handling route, and also on the process plant modules, through specific handling and maintenance routes.
- On the modules specifically intended for deck trolley operation, the handling routes and maintenance areas shall be structurally reinforced to withstand loads corresponding to the trolley's own weight plus the heaviest part to be handled on each area (approx. 8 t static load), and also considering the applicable dynamic factor arising from the lowering of loads onto the trolley cargo deck. During Detailed Engineering Design, this condition shall be demonstrated by means of the relevant calculations.
- Modules intended for deck trolley operation shall be interconnected and also connected to the pipe rack handling route by means of access paths reinforced to withstand the expected loads as stated on item (d).
- During Detailed Engineering Design, it shall be ensured that all corners of escape routes intended for deck trolley transit be provided with an internal "chamfer" measuring at least 0.25 x 0.25 m, so as to enable the trolley maneuver around the corner. In case this requirement should not be possible to comply with, alternative handling procedures and devices shall be developed to perform all necessary cargo lifting and displacement within the affected areas.
- In order to prevent unsafe operation of the deck trolley by running along routes which would collapse under the excess load, each route designed for this purpose shall be properly marked, including indication of the maximum local loading.

## 7.6 LAYDOWN AREAS

7.6.1 Additional laydown areas on the Main Deck shall be included in the Hull Detailed Engineering Design. The operating interfaces and procedures which relate the Topsides laydown area and the Hull laydown areas shall be defined during Detailed Engineering Design. Other laydown areas within the Process Plant, if required to enable flawless handling, shall be defined during Detailed Engineering Design.

7.6.2 The Laydown Area is intended for the following duties related with the Topsides operation and maintenance:

- a) Storage and handling of chemicals.
- b) Temporary storage and handling of lubricating oils and greases.
- c) Temporary storage and handling of materials and spare parts for the utilities and power generation modules, seawater lift pumps, A&EM (Automation and Electrical Module) and other Process Plant systems.

The Laydown Area is also used as the main interface for the whole FPSO's incoming and outgoing material.

## 7.7 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 unimpaird transit of personnel and material.
- c) Welded padeyes and/ or handles shall be fitted onto the hatches for handling and hoisting using the cranes.

## 7.8 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.

## 7.9 DAVITS

- a) Reinforced areas with suitably sized and spaced bores for fastening removable davit pedestal bases shall be provided on the process modules' upper level floors, near the edge, as a provision for mounting removable davits, in order to help load transfer to the modules' lowermost level. See Section 9, items 23/24 for reference sketches.

## 7.10 MISCELLANEOUS ITEMS

- a) Portable gantry cranes: See Section 9, item 22 for reference sketch.



- b) I-beams, permanently or temporarily attached to existing structures.
- c) Lifting lugs with 2~5 t capacity, to be provided at suitable locations throughout all modules, according to the nearby loads, enabling installation of temporary lifting devices such as chain hoists to assist the routine maintenance operations.
- d) Refer to Section 9 for a list of the minimum required handling devices.
- e) For handling equipment heavy duty skates and rollers can be used. Structural engineering shall be consulted to ensure that the loads imposed to the accessway are properly distributed and within structural design limits.

## 8 HANDLING DUTIES

### 8.1 INCOMING AND OUTGOING LOADS RELATED WITH THE TOPSIDES 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				
Outgoing	Routine parts/ equipment	SML	Laydown area	Supply boat	External
	Heavy equipment for onshore repair	NSML	TBD	TBD	

### 8.2 TOPSIDES

#### 8.2.1 Fixed Equipment

The following topside 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
Fuel gas treatment	Filters, electric heater cartridges
Piping and valves	Pipe spools, complete manual valves, valve internals
Instrumentation	Control valves, actuators, skids, internals; panels, instruments, HPU parts (motors, pumps)
HVAC equipment	Compressors, pumps, fans and motors, air handling units, chillers, heaters, air filters
Electrical	Complete transformers, transformer coils, batteries, switchgear 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 removal rail car, Lighting panels, junction boxes, portable isolation mats.
Fire & Safety equipment	Bottle racks, extinguishers, personal protection equipment
Flare	Flare tip, igniter components

#### 8.2.2 Temporary Equipment and Materials

The following temporary equipment and materials require handling:

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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 will be handled with chain blocks and trolleys;
- Means shall be provided to enable withdrawal, handling and reinstallation of the oil dehydrators' transformers, located on top of the vessels, and also for maintenance of the vessels' electrodes.

#### b) Heat exchangers:

- For fixed tubesheet type tubular heat exchangers, only chemical cleaning and routine checking or small repairs can be performed in place. Any other maintenance duties require removal of the complete equipment for transfer to a shore-based workshop;
- Handling means are 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;
- 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;
- 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 handling it entire, but there must be routes without major obstacles to enable its removal if necessary.
- For printed circuit type heat exchangers (PCHE), maintenance can be considered locally. In an event of equipment removal during breakdown maintenance, direct crane lifting of PCHE from module upper deck shall be primarily considered;
- For plate and frame heat exchangers, manual handling of plates and tie-bolts is considered and performed locally;
- For heat exchangers with removable tubesheet, bundle extractors shall be provided whenever required.

#### c) Rotating equipment:

- As far as possible, heavyweight parts or components of rotating equipment that require handling have been arranged within the reach of the deck crane;
- On modules where it was not feasible to satisfy this condition, 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;
- The HVSD (Hydraulic Variable Speed Drive) shall be handled without removing the electric motor. 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.

#### d) Electrical equipment:

Heavyweight electrical items, especially those installed inside the A&EM (M-17), have a low probability of requiring handling throughout the FPSO service life; in case this occurs, the following shall be considered:

- A&EM is outfitted with removable side panels to enable removal of large sized loads and facilities to enable the handling through this panels shall be provided.

- A&EM (M13 – Room) shall have facilities such as davit or monorail to enable cargo handling between the balcony of M13-Room and the top of central pipe rack.
  - On main power transformers, the coils are the parts subject to repair or replacement. Coils are lifted using monorails (fitted along the structural beams) and temporary hoisting and handling arrangements, for displacement to a location close to a removable side panel. Power transformers shall be suitable to replacement of the core, in case of damage. For the disassembly, it is acceptable to remove parts of the transformer enclosure. To allow core disassembly and assembly, the core shall be designed in sections;
  - VSDs are to be split into their main components, i.e. transformer panels and rectifier cell panels, before removal using the available monorails with trolleys and hoists;
  - Other electrical items having lower weight but a higher probability of being serviced or replaced – such as circuit-breakers, UPS components, etc. – are manually disassembled and removed from the A&EM using manual trucks, which pass through the normal maintenance routes and access doors. Electrical panel columns are handled through the doors in the electric rooms;
  - Use of monorails shall be considered for handling of electrostatic transformers (M-10A and M-10C) during maintenance activities;
  - Additionally, necessary means shall be provided for the draining, temporary storage and disposal of used oil from the electrostatic transformer transformers (M-10A and M-10C). For accessing drain nozzles on the transformers and bushing housing, adequate space shall be provided around the transformer;
  - Electrical motors weighing up to 40t shall be removed complete, with the air cooler, rotor and stator. If the motor does not have direct access from the crane, its handling to the laydown area must be prioritized through the electric deck trolleys. If the height of the electrical deck trolley plus the electrical motor with the air cooler is not enough to pass through pipe rack main handling route, removal of the air cooler may be considered.
- e) Instrumentation:
- A&C panels are removed from the A&EM uppermost level through the removable panel of the adjacent HVAC Room;
  - Heavy parts such as control valves and actuators are handled using chain hoists attached to beam trolleys or padeyes;
  - 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);
  - For the removal of heavy and/ or large sized valves, the adjacent pipe spools and actuator shall be previously disconnected from the valve body.
  - For all metering skids, cargo handling facilities (such as monorails or others) shall be foreseen for flow meters, calibration stream and valves maneuver and maintenance. These facilities may either be supplied together on the skid or integrated on the module.
- f) Pipe Spools:
- Removable spools shall be as short and light as possible, with 2 m maximum length and 0.5 t maximum weight;
  - 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.
- g) 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.
- h) Fire Fighting and Safety Equipment:

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- CO<sub>2</sub> 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.

## i) Flare Tip:

- For handling of Flare Tips it will be necessary an special portable structure to be installed on top of flare tower in order to allow their maintenance. SELLER shall issue a detailed procedure for this operation considering solutions available in the market and shall be installed lashing points and pad eyes described in the procedure. The total load capacity and stresses expected on the top of Flare Tower for this maintenance shall be foreseen and present in a structural calculation report.

## j) General items:

- Insulation materials, paints, tools, scaffolding materials and similar goods are manually handled and/ or transported using hand trolleys or the diesel-hydraulic deck trolley alongside the pipe rack main handling route.

## k) Lubricating Oil Handling and Storage:

Oil for the TG and compressor packages will be delivered to the FPSO in portable tanks and may be temporarily stored on the laydown area.

- For the TG, oil tanks can be directly placed on the modules storage area using the handling devices;
- In module M-14 there is a region foreseen, on the 1<sup>st</sup> deck, to storage lubricating oil drums. In this region, indicated in the drawing I-DE-3010.1Y-5266-630-P4X-015 – M-14 – CHEMICAL UNITS AND PRODUCTS STORAGE – HANDLING PLAN, an overhead crane capable of covering the entire area necessary to store the drums shall be installed;
- For the gas compression packages, tanks arriving from the supply boat are picked with the fore crane and placed on the respective modules or temporarily stored on the one of the laydown areas provided by the HULL Seller.

## l) Mole Sieve Absorbent Media (M-06B):

- Use of deck cranes for the transport of absorbent media during loading activities of mole sieve vessels shall be considered during the design;
- Laydown area above pipe rack may be considered as a temporary holding area for loading/unloading equipment and absorbent media.

**8.3 MAIN DECK**

8.3.1 Handling duties: equipment underneath the topsides deck shall be handled using chain blocks, either temporary ones fixed to padeyes or running on beam trolleys. Whenever feasible, loads shall be

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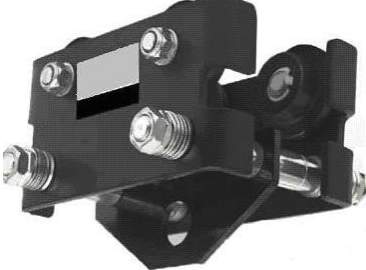




transferred to a location within the reach of deck cranes, or else displaced along the maintenance routes using pallet trucks, hydraulic stacker, hand trolleys or the deck trolley.

- 8.3.2 It shall be verified during Detailed Engineering Design, that the areas on the Main Deck intended for loads displacement are structurally capable to withstand the involved loads.





## 9 HANDLING AND LIFTING DEVICES


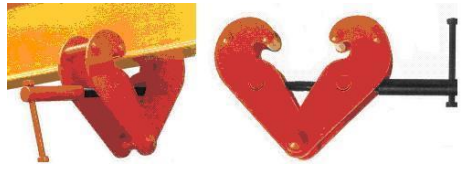



The following table shows a preliminary list of the required handling and lifting devices:

Item	Device	Reference Sketch	SWL	Qty.	Purpose
01	Diesel Self-Propelled Deck Trolley		5 t	01	Load handling at the process plant deck and main deck levels
02	Electric Self-Propelled Deck Trolley		10 t	03	Food Container handling
			10 t	01	Load handling at the Process Plant Deck and Main Deck levels
			40 t	01	
03	Davit		TBT	TBD	Transfer of loads at the between Process Plant levels and Main Deck levels







Item	Device	Reference Sketch	SWL	Qty.	Purpose
04	Beam Trolley		TBD	TBD	Maintenance
05	Manual Chain Hoist		TBD	TBD	Maintenance
06	Chain Operated Beam Trolley		TBD	TBD	Maintenance
07	Hook Mount Pneumatic Chain Hoist		TBD	TBD	Maintenance
08	Heavy Duty Manual Chain Hoist		TBD	TBD	Maintenance




Item	Device	Reference Sketch	SWL	Qty.	Purpose
09	Trolley Mount Pneumatic Driven Chain Hoist		Up to 40t	TBD	Maintenance
10	Trolley Mount Low Headroom Pneumatic Driven Chain Hoist		Up to 40t	TBD	Maintenance
11	Trolley Mount Ultra Low Headroom Pneumatic Driven Chain Hoist		Up to 40t	TBD	Maintenance
12	Trolley Mount Electric Driven Chain Hoist		25 t	1	Transfer of heavy maintenance loads in central pipe rack

Item	Device	Reference Sketch	SWL	Qty.	Purpose
13	Cylinder Transport Cabinet		1 t	01	Cylinder handling using the cranes
14	Beam Clamp		5 t	04	General use
15	Heavy Duty rollers		10t	06	General use
16	Shifting Skate		1 t	06	General use
17	Lift table		0.5 t	01	General use, maintenance tasks

Item	Device	Reference Sketch	SWL	Qty.	Purpose
18	DIN Hand Pallet Truck		2 t	04	General use – mainly for palletized cargo
19	Hydraulic Stacker		2 t	01	General use, maintenance tasks
20	Hand Trolley		0.3 t	03	General use (light duty)
21	Hand Truck		0.5 t	03	General use, gas cylinder

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Item	Device	Reference Sketch	SWL	Qty.	Purpose
22	Gas Cylinder Trolley (Stair Climber)		0.2 t	02	Gas cylinder for transport on stairs
23	Portable Gantry Crane (2 m span)		5 t	02	Maintenance tasks
24	Pedestal for Portable Davit		1 t	04	Top Level of Process Modules
			2 t	03	
25	Portable Davit		0.5 t	01	Top Level of Process Modules
			1 t	01	
			2 t	01	
26	Portable Tripod		1 t	02	General use; dismantling of valves and pipe spools on decks with no structure above the loads

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Item	Device	Reference Sketch	SWL	Qty.	Purpose
27	Manual Cable Puller		1.6 t	04	General use
28	Tilting Floor Drum Stand		01 Standard Drum	02	General use
29	Wire Rope Winch		1.5 t	01	General use
30	Hydraulic load test for hoist capacity to 12 t		12t	01	General use
31	Wireless Loadshackle		12t	01	General use
32	Wireless Loadshackle		25t	01	General use
33	Wireless Loadshackle		55t	01	General use

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Item	Device	Reference Sketch	SWL	Qty.	Purpose
34	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