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DATE	JUN/28/17	JUL/30/20	APR/22/21	FEB/10/23	APR/29/24	
EXECUTION	MARLON	MARLON	CXO5	CXO5	CXO5	
CHECK	JORDANI	LUIZFELIPE	NTX1	NTX1	NTX1	
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1 INTRODUCTION

The Purpose of this document is to detail how the activity “Weight Control" is supposed to be performed during the basic design and FEED (Front End Engineering Design) and to give to the CONTRACTOR the global directives, in order to proceed with the weight control during the detailed design and construction phases.

This document contains a generic description showing how several different systems are to be considered in the Weight Control.

The CONTRACTOR shall present his procedures based on the directives given herein and in the Annex I. This annex presents an example of a “CONTRACTOR's weight control procedure” to be issued for PETROBRAS approval.

The objective of the activity "Weight Control" is to control the weight evolution along design phases and subsequent phases, by grouping items with their weights and centers of gravity, totaling these data, identifying trends and determining corrections, in order to assure that the unit will achieve estimated stability and motions performance. It shall also be used as an input for structural calculations.

2 GENERAL REQUIREMENTS

Each item must have its origin specified according to the following weight class parameters:

Weight Class	Definition
A	Lifting weight Weight extracted from 3-D model (structure, piping, outfitting, HVAC duct, Cable duct, etc. whatever is modeled) Equipment weight (weights coming from official vendor documents issued after contract signing)
B	Weight estimating from AFC drawing Equipment weight (vendor confirm and provided weight but contract not signed yet)
C	Weight estimated from preliminary drawing Equipment weight (vendor provided weight in their preliminary quotation) Weight taken from previous reference document Weight taken just on assumption FEED data

The transverse center of gravity (TCG) in relation to the center line shall be target is less than 2% of the unit's width, and must not exceed 4% of this value, in order to avoid future fixed ballast compensation. Thus, the TCG is not supposed to divert to one side, or as usual, to the risers balcony. If the TCG surpasses the referred maximum, the RD (responsible for discipline) of the weight control shall inform the RD of the arrangement and/or the Design Coordinator to correct this impact in the design.

It is mandatory to define in the WCR what is considered as a part of Hull and Topside.

Hull: It is considered the floating structure, all equipment and systems located inside the hull and in the Main Deck, the upper and lower risers balcony, hull utilities module, stools or multipoint supports, helideck and Living quarters.

Topside: Everything fixed on the stools or multipoint supports and the Flare System. It is important to say that during the lifting campaign some equipment placed on the upper part of a module can be removed due to the limited lifting capacity of the shipyard and thus their weights need to be subtracted for the weight calculations. Posteriorly they must be incorporated to the referred module after it is integrated to the unit.

2.1 LIFTING

Every equipment to be lifted with the module must belong to the referred module.

When a module is to be lifted, it is expected that all equipment that belong to that module will be lifted together with it.

The Weight Control Representative shall check, in the Design Bases, if there will be any weight restriction for the modules lifting. This should be foreseen due to the lifting of shipyards capacity.

Lifting weight control estimates must be in accordance with the expected lifting plan for the construction phase.

2.2 RESPONSIBILITIES

A person responsible for weight control must be designated for the entire unit. As the design comprehends all design disciplines (structure, safety, mechanical, naval architecture, electrical, piping, instrumentation & automation, architecture, telecommunication, marine systems, HVAC, etc.), each discipline must have a person designated as responsible for the weight control of items related to that discipline. This person is nominated Responsible for the discipline (RD).

2.3 SUBDIVISION / CODING

The Weight Control subdivision structure is divided in four levels as follows:

1º level: PARTS – Identified by Topside (composed by all equipment that are in modules, pipe rack, riser pipe rack and flare system); Hull (all equipment that are in its limits); Living Quarter (composed by all equipment that are in its limits), and Areas (all equipments that are in its limits); It is necessary to define the Parts limits (Xmin, Xmax; Ymin, Ymax; Zmin, Zmax).

2º level: MODULES, Pipe rack, riser balcony – Just like in the first level (Parts), it is necessary to define the Modules limits (Xmin, Xmax; Ymin, Ymax; Zmin, Zmax) and inform their names.

3º level: ITEMS – It is necessary to insert the data of each item according to the Responsible.

4º level: ITEM CLASSIFICATION – Subdivision of the item. Example: Pump B-5115001 – Item Classification: EQP - Equipment.

3 DATA FOR PARTS, MODULES AND ITEMS

3.1 PARTS

· Description of the Part according to chapter 1 (Introduction).

3.2 MODULES

· Description of the Module according to chapter 1 (Introduction).

3.3 ITEM

. Part – identification of the Part that the item is inserted. Ex.: Topside, Hull, Living Quarter, etc.

. Module – identification of the Module that the item is inserted.

. Discipline – discipline responsible for the item.

· Name – weight item description.

· Weight - eight of the complete item (see Annex I for item components considerations) for dry, operating and test condition.

·Center of gravity (X, Y, Z) - which defines the position of the item center of gravity.

· Contingency factor - percentage of uncertainty referring the weight of the item.

· Fluids Contingency factor - percentage of uncertainty referring the weight of fluids inside of item.

.Dimensions of the items – and their dimensions (Xmin, Xmax, Ymin, Ymax, Zmin, Zmax), with reference to the coordinate system indicated.

· Responsible - indicates the discipline responsible person according to the abbreviation glossary.

· Revision

· Tag/Remark - identification number according to PETROBRAS Internal Rules N-1521/N-1522.

. Date of Change - it indicates the date when an item is inserted or modified.

. Weight Class – the discipline responsible person must indicate the origin of the weight item according to chapter.1 Introduction.

· Item Classification – Subdivision of the item according to the discipline indication.

4 CONTINGENCY FACTOR

The contingency factor determines the margin (always positive) considered, due to the uncertainties in the weight estimate. This factor is to be updated (reduced) during the project phases as the uncertainties are being reduced.

This margin is set up for each item as a percentage of the given weight.

In the beginning of a Basic Design, the sum of the weight of an item with its contingency factor shall be the maximum value that this item should be weighed with its contingency factor at the end of the Detailed Design. It means that the possible increase of the weight of an item during all phases of the Design shall be accompanied with the decrease of the contingency factor.

In Table 5.1 below it is shown the contingency level that normally is suggested in all design phases.

Table 5.1 - Contingency level of the weight considering all design phases

STEP / Discipline	Conceptual Design	Basic Design	Detail Design	AFC	As-Built	Weighted
Primary Structure	20%	15%	10%	7%	5%	3% ~ 1%
Secondary Structure	25%	20%	12%	7%	5%	3% ~ 1%
Hull Structure	20%	15%	10%	5%	4%	3% ~ 1%
Mechanical	25%	20%	12%	7%	5%	3% ~ 1%
Piping	25%	20%	12%	7%	5%	3% ~ 1%
Electrical	25%	20%	15%	10%	5%	3% ~ 1%
Instrumentation	25%	20%	15%	10%	5%	3% ~ 1%
Architectural	25%	20%	15%	10%	5%	3% ~ 1%
HVAC	25%	20%	15%	10%	5%	3% ~ 1%
Safety	25%	20%	15%	10%	5%	3% ~ 1%
Global (approx.)			12%	6.5%	4.5%	3% ~ 1%

5 COORDINATE SYSTEMS

The center of gravity of the Unit is given with reference to the global coordinate system, which shall follow right hand rule. The global coordinate system shall be clearly described in the Weight Control report.

6 REPORTS AND REVISIONS

For each Part and for the complete Unit, weights (with and without contingency factor) and the COG shall be presented at each report.

Revisions, at Basic Design, are supposed to be issued in conjunction with General Arrangement revisions or whenever major changes are detected. Revision of the weight control is designated by letters in sequence (A, B, C,...), starting with 0 (zero) for the original or PR for the preliminary report.

7 CONSIDERATIONS ON WEIGHT CONTROL PROCEDURES

Basic design takes major decision on weight and weight control. Detailed design is the main responsible for weight control over steel works and material choice.

Early stage weight forecast cannot be limited to listed items. A great number of items not listed shall be attached to the unit during conversion or construction. Small items in great number shall add significant weight. These items shall be included as “miscellaneous”.

Early stages of the design cannot transfer responsibilities for missing items, or under evaluated weight and centers of gravity to later stages. Optimistic assumptions must be considered together with adequate amounts.

Structure and steel works must be carried out very carefully since early stages of the project, setting the best forecast for each listed item and margins for minor not listed items. Detailed design must be performed within defined weights. Very usual mistake is to relax weight control on dimensioning of auxiliary structures during detailing phase.

General arrangement must care for area and walkways. Area expansion during assembling or detailing phase which is not accounted means enormous non predicted weight increase. Steel material specification during assembly is very important and must be in accordance to the predicted weight.

Excess weight on a single item is not a problem, because it can generally be compensated on other items, however such excess is to be treated like an exception and not accepted as a matter of rule.

At the completion of platform construction, CONTRACTOR shall perform an inclining test as required by Classification Society (CS) and International Maritime Organization Code (IMO-Code).

7.1 Weight Reduction

Steel is the major item of weight on a vessel, so every steel detail specification must be rigorously controlled.

Steel may be divided in major items:

· **Hull structural steel:** It is a consequence of the decisions taken in basic design, and control on scantlings is mandatory.

· **Steel works and supports:** Although this item represents a weight smaller than hull steel, it plays the major importance on deck load. Steel works include modules structures, stools, structural supports for modules, handrails, ladders, working platforms, supports, pipe racks, riser hangers, hatches, pipe supports in general, helideck, crane pedestals, rails and reinforcements to the structure. Great efforts are generally dedicated to the optimization of hull structure, however little efforts are dedicated to the dimensioning of steel works, although they constitute a high center of gravity load.

· **Pipes**: Pipes are generally made of steel and represent a small stake on the overall cost of the Unit, but a significant stake on deck load. Major decision on amount of pipe takes place during design phase, when systems and arrangements are defined. However, a precise evaluation of pipe amount during basic design phase is very difficult. Initially large margins are generally allocated for piping.

· **Equipment:** Heavy equipment, like turbo compressors, pumping units, turbo generators, represent a major stake on deck load and its equipment skid. Lighter weight solutions, however, may have a significant impact on costs. Notwithstanding the previous sentence, it is to be kept in mind that skid bases and steel works on package units must have the same consideration as steel works, because they are very heavy, while representing little cost.

7.2 Discipline Divisions

7.2.1 Structure

The calculation of net steel weight may be based on nominal thickness of plate, profiles and include tolerance of plate fabrication welds and painting (approximately 3% of steel weight).

Miscellaneous weight item may be considered with the purpose of including small reinforcement plates not considered in the weight control calculation and other modifications generated in the detailed engineering.

The item “foundation for equipment” considers only local reinforcements in the equipment supporting region, to be included in the detailed engineering design. The weight of equipment skids is not to be included in the structural items, but in the equipment discipline. Equipment skirts and saddles and

skids structures under vendor's responsibility are part of equipment discipline scope (static and dynamic). In case of a different approach is followed, it shall be properly explained.

It may be considered that the weight reductions due to openings, holes, doors, etc. will be compensated by the corresponding local reinforcements.

Structure weight considers only main ladders, handrails, platforms and railings of the hull. Therefore, similar items that belong to the equipment are included in the equipment weight calculation. Monorails braces and hangers shall be treated as a secondary structure including the Monorail itself. Other handling devices shall be kept as a equipment discipline item for weight control purposes.

Only main pipe-racks in the general arrangement drawings are to be considered in the proper structural item.

Structural estimated weights shall be shown in details along the detail phase. Temporary structure considered only for installation phase purpose (braces, padeyes and others) shall be presented separately.

Item Classification:

PRIM: Primary structures

SEC: Secondary structures ,Bulkheads, etc.

TERTIARY: Outfitting structures, Handrails, stairs, etc.

FRAMES: Frames

LONGBH: Longitudinal Bulkhead

MCS: Multi Column Support

SHELL: Shell Hull structures

STRGS: Stringers

MNRLS: Monorails

Weld and Painting: Weld and Painting

Note 1 – Supports in structure discipline regards to the structure above the deckplate or grating which supports the piping supports, equipment saddles, skirts or skids and which are not under the vendor's scope.

7.2.2 **Static Equipment**

For weight distribution purposes, the following philosophy shall be adopted:

- Tanks, towers, filters, separators and heat transfer equipment comprises hull, internals, skid and eventually the access stairs and platforms. Instrumentation on the lines is not comprised.
- Water heating comprises base, furnace, fans, panel and everything mounted on the skid.
- Test burner comprises burner, boom pipes and cables.
- Flare comprises only the burner. Boom, pipes and cables are not comprised.

Item Classification:

EQP: Equipment

7.2.3 **Rotative Equipment**

For weight distribution purposes, the following philosophy shall be adopted:

- Pumps and compressors (driven by electric motors) comprises the pumps, compressors, motor, skids, instrumentation and accessories. The instrumentation mounted on the suction and discharge lines is not comprised.
- Fire pumps (driven by diesel engine) comprises pumps, gear and diesel engine (with accessories and instrumentation mounted on the same skid). Diesel tank, start-up air bottles and pipes are not comprised.
- Crane - The crane pedestals and boom rest supports are not comprised.
- Package units (air compression units, helicopter refueling, desulfurization unit, etc...) comprise instrumentation, piping, cables and equipment mounted on the skid.
- Gas compression unit comprises turbocompressor skid, process skid, local control room and pipes connecting the equipment to the process skid. The weight of the waste recovery heat exchange is to be divided between the two turbocompressors.
- Turbogenerator comprises the turbogenerator itself and the skid with the local accessories.

Item Classification:

EQP: Equipment

7.2.4 **Marine Equipment**

For weight distribution purposes, the following philosophy shall be adopted:

- Mooring, offloading (driven by electric motors) comprises the pumps, compressors, motor, skids, instrumentation and accessories. The instrumentation mounted on the suction and discharge lines is not comprised.

Item Classification:

EQP: Equipment

7.2.5 **Instrumentation**

Instrumentation (including instrumentation cables) comprises cables and fittings necessary to their installation. The instrumentation weight is considered within the weight of the item (equipment or pipe) where it is installed.

Item Classification:

EQP: Equipment (Panels, Metering Skids, HPU, HMI, Chromatographs…..)

TRAY: Cabletrays.

Cables: Cables

INST: Instruments.

Supports: Instruments Supports.

7.2.6 **Electrical**

Electrical comprises cables, Cabletrays, fittings, lighting and panels necessary to their installation.

Item Classification:

EQP: Equipment

TRAY: Cabletrays.

Cables: Cables

LGTFX: Lightings

Supports: Supports and Lighting supports.

7.2.7 **Telecom**

Telecommunication items comprises Equipment, cables, antennas and fittings necessary to their installation.

Item Classification:

EQP: Equipment

TRAY: Cabletrays.

Cables: Cables

7.2.8 **HVAC**

"Fans" comprises motor and base.

"Ducts" comprises dampers, diffusers, air filters, insulation and fittings.

Condensing units comprise the unit itself, air coolers, electric motor, piping and base.

Item Classification:

EQP: Equipment

DUCT: Duct.

7.2.9 **Piping**

Piping comprises pipes, support fittings and insulation.

Item Classification:

PPRUN: Pipe run by Sistem (including flange weights)

Valv: Valves

Support: Support

7.3 Weight Control Report

Weight Control Report shall be periodically (monthly) issued and shall indicate all design conditions.

Weight Control Representative shall prepare a trend analysis plotting all totals from previous reports in a graphic showing evolution as a function of time. All variations (increases and decreases) shall be indicated for each part and for the totals. It's important to have such analysis for future scenarios, before reaching a point of non-return (i.e., managers are to be informed of consequences of planned actions before fabrication or purchase is turned into a fact).

Each weight evaluation sets a new forecasting of the final weight and new margins are established. As the construction and assembly trends to the end the forecast shall be closer to the final weight, independently if such final weight is acceptable or not.

8 Attachments

Attached in the Annex I is a model for submitting weight data in an Excel table.

This is an example spreadsheet to fill out and include in the Weight Control Report.

Annex I_Model Item Delivery.xlsx

The Annex II is the itemization of discipline that is a minimum guide list of items to be considered in Weight control report.

Annex II Discipline Items.XLSX

The Annex III is the example of a procedure tb be issued by contractor.

Annex III_Procedure Example.docx