



Exploration & Production

GENERAL SPECIFICATION

STRUCTURAL

GS STR 001

Weight monitoring and weighing offshore units
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1. Scope

The objective is to know the weight and centre of gravity of assemblies and subassemblies at any time during a project with a quantified contingency margin and to keep the weight and the centre of gravity under control throughout the whole duration of the project.

In particular, the weight monitoring shall enable CONTRACTOR to continuously follow the trends in weights and position of centres of gravity compared to the specified requirements. It is CONTRACTOR's responsibility to mobilise the required resources and means in order to fulfil these objectives.

This general specification defines:

- The minimum "weight monitoring" requirements to be observed when estimating, recording, reporting and verifying the weight and centre of gravity for all assemblies and/or subassemblies in petroleum structures
- Weight monitoring in every phase from engineering to the end of construction
- The minimum "Weighing" requirements to be observed for measuring weights and centres of gravity.

Unless otherwise indicated in the job specification, this general specification does not cover the concrete hulls of floating supports. Special arrangements for each project are covered in job (or particular) specifications which supplement or amend this general specification.

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

Where national regulations exist, their provisions and those of the standards and codes to which they refer shall apply, supplementing or amending the provisions of this document.

If there are no national regulations covering all or part of the subject of this document, the reference documents shall be strictly applied, as supplemented by the provisions of this document.

Only the main reference documents are mentioned; the CONTRACTOR shall be responsible for complying with all secondary reference documents dealing with the subject of this document.

Standards

Reference	Title
ISO 19901-5	Offshore Structures-part 5: weight control
ISO 19900	Offshore structures
API RP-2A WSD	Recommended Practice for Planning and Construction of Fixed Offshore Platforms - Working Stress Design
API RP-2A LRFD (ISO 13819-2)	Recommended Practice for Planning and Constructing of Fixed Offshore Platforms - Load and Resistance Factor Design
ISO 1000	International system of units

**Professional Documents**

Reference	Title
Not applicable	

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	

Total General Specifications

The provisions of this document shall be applied in the light of the supplementary documents supplied by the OWNER, including:

- Country specificity appendices
- Job specification
- Data sheets
- Articles and conditions; list of tasks
- Quality assurance provisions.

Reference	Title
Not applicable	

3. Terminology

The following terms shall apply to the weights and centres of gravity.

3.1 Weight control

Organization by which weights can at any time be compared with the prescribed weights so that any deviation can be corrected to achieve the prescribed weights and the prescribed tolerances.

3.2 Weight monitoring

Obtaining, verifying, recording and processing information on the weight of each item of an assembly so that the total weight and position of the centre of gravity of that assembly is known at all times.

3.3 Target weight

The weight of an item or assembly including the associated "tolerances" and "contingencies". This weight is determined at the beginning of the engineering phase and is checked throughout the project against the maximum allowable weight.

3.4 Estimated weight

"Bid drawing" stage according to [API RP-2A](#).

The weight based on the estimated equipment weights, on drawings or design drawings with approximate calculations, on information available at particular times or on experience giving an indication of the weight for an item or assembly.

3.5 Calculated weight

"Design drawing", "fabrication drawing" and "installation drawing" stages according to [API RP-2A](#).

The weight determined by calculation, bill of quantities, MTO, etc.

3.6 Weighed weight

The weight of an item or assembly as measured in the presence of a third party witness and of necessity accompanied by a certificate and accuracy of weight. The certificate shall specify the status at the time of weighing (dry or other, etc.).

3.7 Dry weight

The weight of an item or assembly installed with no fluids, consumables or tools, etc.

3.8 Operating weight

The weight of an item or assembly installed and in operation including consumables, operating fluids, without floor live loads.

3.9 Lift weight

The total weight of an item ready for lifting, including all lifting devices (shackles, slings, spreaders, etc.) including packaged items.

3.10 Maximum allowable weight

Maximum stipulated weight for one or more stages in the implementation of a project (for example: lift, operating, etc.).

3.11 Hydrotesting weight

Weight of an item in test conditions; including equipment temporarily required for the test.

3.12 Contingency

A quantity that can be added to the weight of an item or assembly to reflect the level of design and/or implementation of the item concerned.

3.13 Tolerances

Positive or negative values linked to the construction tolerances of each item being used.

3.14 Subassembly

Part of a structure consisting of items that are indivisible for weight control purposes and lifted all at once. Known equipment to be added in future must be included in the subassembly and marked "Future".

Weighing of prefabricated blocks is acceptable. In Particular Specification, the weighing of subassemblies above 50T shall be requested.

3.15 System

A system is defined as the combination of equipment and bulk supporting the same petroleum function. The definition and limits of the systems are defined in standard specifications.

3.16 Equipment and packages

The equipment and packages (the combination of equipment and related bulks) comprise the specific equipment responsible for or involved in a specific oil field function, such as separator, turbo-compressor, crane, etc. They are identified on drawings and documents by standardized identifiers; this identifier can be used to distinguish between bare equipment and packages. Disciplines concerned: boilermaking, mechanical, electrical, instrumentation, HVAC, safety.

3.17 Bulk

Bulk, or standardized equipment is defined as non-specific equipment such as piping, valves, electrical cables, etc.

3.18 Future weight

The weight of an identified item or assembly that is to be installed in the future and in operation including consumables, operating fluids, without floor live loads.

3.19 COMPANY reserve

The provision weight for unidentified item to cover possible project development or change to be defined in the Particular Project Specification.

4. Weight monitoring

4.1 Definition of equipment and bulks by discipline

4.1.1 Structures

This discipline mainly covers bulks; the following are distinguished:

- Main structures: Load-bearing beams, trusses and helping to provide the strength, lifting lugs, etc.
- Secondary structures: Gratings, staircases, ladders, railings, access platforms, cladding panels, other joists and deckplates, miscellaneous supports, etc.

4.1.2 Architecture

This discipline mainly comprises bulks.

- Rooms: bulkheads, floor coverings, raised floors and suspended ceilings, thermal insulation and soundproofing, doors, etc. The rooms concerned are the plant rooms (substation, instrumentation room), the control room, workshop, stores, laboratory
- Fire-break walls
- Fireproofing.

4.1.3 Boilermaking/Mechanical

These disciplines mainly cover the equipment.

- Boilermaking: vessels, heat exchangers, strainers, pig traps, etc.
- Mechanical: pumps, compressors, turbines, speed reducing gears, handling gear, etc.

4.1.4 Piping

This discipline mainly covers bulks.

- Piping (flowlines, manifolds, including the fire system)
- Valves
- Fittings, couplings, in other words flanges, bends, joints, tees, etc.
- Piping supports.

4.1.5 Electrical

This discipline covers:

- Equipment
 - Inside cubicles: cabinets, distribution panels, battery chargers, inverters, batteries, variable speed controllers, etc.
 - Outside cubicles: main and backup electricity generators, transformers.

Note: The electric motors associated with the machines they drive are counted with the equipment in the "mechanical" discipline.

- Bulks: cables, trays, runs and supports, junction boxes, lighting, etc.

4.1.6 Instrumentation/Telecommunications

This discipline covers:

- Equipment
 - Inside cubicles: cabinets, logic controllers, computers, consoles, PCs, printers, microwave link stations, etc.
 - Outside cubicles: wellhead control panels, machine control panels.
- Bults: links (cables, junction boxes), in-line instrumentation (pressure stats, flowmeters, senders) and supports.

4.1.7 Air conditioning (HVAC = Heating - Ventilation - Air Conditioning)

This discipline covers:

- Equipment: refrigerating plant, air coolers, heat exchangers
- Bults: recycling cabinets, fan convectors, ducting, extraction chambers, supports, etc.

4.1.8 Safety (firefighting, lifesaving)

This discipline covers:

- Equipment: lifeboats and associated booms, inflatable rafts
- Bults: fire hydrants, hose reels and nozzles, extinguishers, fire and gas detection systems, supports, etc.

4.1.9 Internal sea-fastening/Lifting gear

Internal sea-fastening, mooring guides, temporary structural reinforcements for lifting, packaging/protection for transportation, lifting beams, spreader bars, temporary stands for these, slings, shackles, etc. (these items are all removed after hook-up).

4.2 Weight estimates

Weight estimates shall itemize, for each discipline, the following various weights:

4.2.1 Structure

- Weight of main structure
- Weight of secondary structure
- Weight of living quarters structure
- Weight of helideck
- Weight of main supports.

4.2.2 Architecture

- Weight of architecture of each room (electricity plant room, instrumentation room, control room, laboratory, workshop, stores, etc.)
- Weight of architecture of living quarters

- Weight of fire-break walls
- Weight of fireproofing.

Note: For integrated electrical and instrumentation cubicles, the architecture and structural weight shall be differentiated from the weight of electrical and instrumentation equipment.

4.2.3 Boilermaking/mechanical

- Weight of each item of equipment, for each system in turn
- Weight of turbine intake and exhaust ducting.

4.2.4 Piping

- Weight of bulk piping, for each system in turn
- Weight of bulk piping associated with each pig trap, comprising: by-pass, line from/to ESDV, accessories (drainage, vent, etc.)
- Weight of bulk piping associated with lines passing through a structure (platform) to another structure
- Weight of valves
- Weight of secondary supports.

4.2.5 Electricity

- Weight of high voltage cables, including their cable trays, supports and junction boxes
- Weight of low voltage cables, including their cable trays, supports and junction boxes
- Weight of lighting in the sense of light spots only
- Weight of small panels and transformers such as: lighting and low voltage panels and transformers.

4.2.6 Instrumentation/Telecommunications

- Weight of instrumentation cables, including their trays, supports, junction boxes
- Weight of telecommunication cables, including their trays, supports and junction boxes
- Weight of in-line instrumentation: sensors, senders, etc.

4.2.7 Air conditioning (HVAC)

- Weight of fans, miscellaneous cabinets
- Weight of ducting and support structures.

4.2.8 Safety

- Weight of equipment: lifeboats and associated booms, inflatable rafts, etc.
- Weight of bulks: fire hydrants, hose reels and nozzles, extinguishers, fire and gas detection systems, etc.

4.2.9 Sea-fastening and lifting

- Weight of packaging/protection items, desiccant product, etc.
- Weight of sea-fastening
- Lifting gear.

4.3 Weight control procedure

The weight monitoring procedure must define in particular:

- The weight control organisation with names, responsibilities and flow of information
- The contents of the disciplines (as comprehensive as possible)
- The start point from which the coordinates of the centre of gravity positions are measured
- The weight monitoring forms and all associated codes
- The tolerances and contingencies for each discipline, as defined in Appendix 1
- The content of the weight monitoring reports (full report and monthly report for inclusion in the overall progress report)
- The software and hardware used
- The method of obtaining information on weights and centres of gravity from suppliers at the various procurement stages (bid, order confirmation, assembly drawings and handling sketches, final weighing)
- The information that is to appear on plans, by discipline
- The detailed weight monitoring forms and check lists, for each discipline
- The weighing procedures and check lists required from SUPPLIERS and MANUFACTURERS
- The report forms and weighing certificates
- The information recycling frequency by discipline and the method of collecting this information
- The method by which the weight control team is supervised by the weight control manager
- The method of ensuring monitoring continuity from the engineering stage to the end of construction
- A prediction of intermediate weighings with verification of the results obtained and explanations of discrepancies found
- Updating of the calculated weights.

For weight monitoring during on-site construction, the items should be identified with:

- An initial "not installed" or "installed" code letter. The code must be reviewed with the issue of every monthly report

- A second code letter indicating whether the item is permanently installed on the defined assembly as follows:
 - A = permanent installed on fabrication yard
 - B = temporary installed on fabrication yard (removed between hook-up and operation)
 - C = permanent installed at sea after hook-up
 - D = permanent installed at sea after subassembly hook-up (lifting operation)
 - E = temporary installed at sea after subassembly hook-up and removed before operation (lifting operation)
 - F = permanent but stored in a temporary location on the subassembly during lifting (must become C or D before operation)
 - G = permanent future (for an extension when the platform is in operation)

4.4 Weight monitoring report

This report gives information on at least three levels.

- Overall with assembly and subassemblies
- By subassembly and discipline
- By discipline and SUPPLIER.

After obtaining all the data by discipline, the results must be combined in summary tables for dry weight, load-out weight, transportation weight, installation / lifting weight, operating weight, test weight, future weights, COMPANY reserve, non-factored blanket live loads ,etc, with indication of discipline weights and contingencies used.

These tables must be combined in the monthly weight monitoring and control report.

For the monthly report, it is advisable to give overall weights only (dry weight, load-out weight, transportation weight, installation / lifting weight, operating weight, test weight, future weights, COMPANY reserve, non-factored blanket live loads ,etc)by subassembly and to concentrate the analysis using graphics to make the weight aspect easier to grasp; for example, for each subassembly and the entire assembly:

- Graphs showing the weight trend over time
- Pie charts showing the percentages by discipline.
- Sketches showing the CoG location and displacements trends in the 3 directions and the pattern of maximum excursions considered in the design

If divergences appear, reasons for weight changes must be included in the report.

If the weight is greater than the maximum allowable or the centre of gravity is outside the preset area, a corrective solution must be proposed.

5. Weighing

5.1 Weighing programme

The weighing programme shall be submitted to COMPANY for approval. It shall specify the number of weighing operations and their timing within the construction sequence, determined in relation with the criticality of the unit transportation and installation operations. It shall also take into account the impact on construction activities, both due to the weighing operations themselves and to the possible need for corrective actions.

As a minimum, the weighing programme shall consider :

- a first intermediate weighing at the end of the main bearing structure assembly with about 50-60 % of the expected weight :
- a second intermediate weighing two months prior to the load-out,
- a final weighing two weeks prior to the load-out.

For launched jacket an intermediate weighing (panel or subassemblies) and when possible a final weighing shall be done. For Lifted jacket an intermediate and final weighing shall be done.

5.2 Weighing resources

5.2.1 Weighing equipment

The performance and reliability of the weighing system must provide an overall accuracy of ± 0.5 % on the total weight weighed and the associated centre of gravity for items of more than 200,000 daN and an accuracy of ± 1 % for items of less than 200,000 daN.

To design structural parts (in some cases, structural reinforcements for an item to be weighed) and supports needed for the weighing operation, all systems and equipment shall be submitted, with their performance and reliability, operating temperature range and other information, for approval prior to construction. The effects of the environment (wind) must be taken into account. If the supports for the weighing equipment are different from the production or installation supports, the behaviour of the item being weighed must be verified.

Weighing by jacking and reading the pressure is not accepted. Load cells shall be used.

The load capacity of the weighing apparatus must be at least 1.5 times the heaviest calculated load being weighed.

Low tonnage packages or bulk packaged products that do not require a centre of gravity measurement can be weighed with the lorry on a weighbridge or by spring balance on a crane.

5.2.2 Calibration

A calibration certificate must be issued by an approved independent organisation recommended by the MANUFACTURER. It must be produced according to the standard and code for the measurement systems used.

If, due to a handling error during the operation, the load is greater than the capacity of the apparatus, the apparatus must be changed or recalibrated.

For heavy tonnage packages, the weighing apparatus must be calibrated during the month prior to weighing and in the same environmental conditions (where necessary, corrections can be made between the temperature on site and in the weighing shop). Preferably, it should be done with the complete weighing system intended for the weighing operation.

Weighing accuracy: The contingency for calibrating the weighing apparatus shall be such that total accuracy of the weighing operation will be ± 0.50 %.

The calibration accuracy shall be maintained across a minimum range of ± 25 % of the expected loads.

5.3 Weighing procedure

The procedure for weighing assemblies and subassemblies must be consistent with how critical the weight is for lifting and the range of weights to be taken. It shall clearly define the anticipated time for weighing according to the construction schedule and related constraints.

The quality of the supports and the accuracy of estimation or measurement of the construction equipment temporarily installed on the subassembly to be weighed must be taken into account.

Three weighings followed by reset shall be carried out in order to obtain a meaningful sample of values.

For big packages, the weight differences recorded between three weighings must be less than 1 % between maximum and minimum for the overall weight and 2 % for each weighing point.

During each weighing, wind speed and direction shall be measured and, if necessary, corrections shall be made.

The weight shall be taken in the most level conditions possible before and during the weighing. The levels of each weighing point must be correlated with the different weighing measurements. The accuracy of the weights taken at each point shall be linked with the delta of the level difference recorded before and during weighing (influence of the rigidity of the item).

The procedure shall apply to each item weighed and shall comprise:

- The procedure for calibrating the weighing system
- The studies to be made
- A description of the weighing systems and resources used
- A detailed description of all sequences of the weighing operation with drawings and diagrams
- The provisional adjustments made on the ground and the structure
- An organization chart of the staff concerned and their functions
- The weight and centre of gravity obtained from weight monitoring
- The principle of measurement of weighing point level, of air temperature and wind speed and direction
- Analysis of the results.

5.4 Weighing report

The report shall contain the following information:

- Readings of all measurements of the weighing operation parameters
- The position of the centre of gravity in the horizontal plane and vertical plane .
- A list of the temporary items with their weights and the positions of their centres of gravity

- A list of the items to be added with their weights and positions of their centres of gravity
- Calculation of the centre of gravity for the different possible configurations:
 - Load-out
 - Transport
 - Installation (lifting, launching , float-over etc.)
 - In -place
- The calibration certificates for the weighing apparatus
- The weighing certificate signed by an authorized third party
- Weight monitoring data with the expected weight prior to weighing.

6. Quality procedures

6.1 Quality plan

Before the service begins, a Quality Plan shall be prepared listing all the actions of design, study, procurement, production and inspection. These actions must be the subject of detailed procedures.

The Quality Plan shall cover all the weight monitoring and weighing actions for which the CONTRACTOR and its SUBCONTRACTORS or SUPPLIERS are responsible. It must be consistent with the schedule for the design and implementation of the work.

6.2 Inspection plan

After considering the Quality Plan, the OWNER shall supplement the CONTRACTOR'S Quality Plan with the actions it will take (document reviews or inspection (witness) points and hold points). At least the following points shall be considered:

Non-exhaustive list

- **Weight monitoring**
 - Procedures: hold point
 - Report: review
- **Weighing**
 - Procedures: hold point
 - Calibration: hold point
 - Weighing:
 - . Equipment: witness
 - . Subassemblies: witness
 - . Assembly: witness
 - Report: review

Appendix 1 Percentages of contingency + tolerances

Phases	Basic engineering	Detailed engineering		Construction	
Disciplines	IFD	IFD	AFC	As-built	Weighed weight
Structural	20	12	7	5	3
Mechanical	20	12	7	5	3
Piping	20	12	7	5	3
Electrical	25	15	10	5	3
Instrumentation	25	15	10	5	3
Architecturals	25	15	10	5	3
HVAC	25	15	10	5	3
Safety	25	15	10	5	3
Hull	15	10	5	4	3

IFD = Issue For Design

AFC = Approved For Construction