

GENERAL SPECIFICATION

STRUCTURAL

GS EP STR 653

F(P)SO - Hull fabrication requirements

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1. Scope

This specification aims at defining the minimum requirements, which are applicable to the fabrication of a new hull for an F(P)SO Floating (Production) Storage Offloading, or ship shaped FPU.

This specification addresses the minimum requirements for the quality insurance, the hull material, the fabrication methods, the welding, and the corresponding requirements for quality control, and documentation.

This specification does not address requirement for external topsides modules which are covered by the [GS EP STR 201](#) and [GS EP STR 301](#).

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

The present Specification shall be read and taken as a complement to Classification Society Rules, Regulations, Codes and Standards that are required as applicable or referenced by Contract, project specifications and General Company Specifications.

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 following reference documents are applicable as described in the following sections. When not explicitly referred in the following sections they may be used as guidance when relevant.

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.

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published at the effective date of this document.

Reference	Title
ABS	Guide for Building and Classing Floating Production Installations
API RP 2A-WSD	Planning, Designing, and Constructing Fixed Offshore Platforms-Working Stress Design
API SPEC 5L	Specification for line pipe
AWS A5.01	Procurement guidelines for consumables - Welding and Allied Processes - Flux and Gas Shielded Electrical Welding Processes
AWS D 1.1/D 1.1M	Structural welding code - Steel
BV NR216	Rules on Materials and Welding for the Classification of Marine Units
DNV-RP-C206	Fatigue Methodology for Offshore Ships

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Reference	Title
EN 10160	Ultrasonic testing of steel flat product of thickness equal or greater than 6 mm (reflexion method)
EN 10204	Metallic products - Types of inspection documents (Inspection certificate 3.2)
IACS	Shipbuilding and Repair Quality Standard (no. 47)
ISO 9712	Non-destructive testing - Qualification and certification of NDT personnel
Lloyd's Register of Shipping	Rules and Regulations for the Classification of a Floating Offshore Installation at a fixed location

Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published.

Reference	Title
GS EP STR 201	Materials for offshore steel structures
GS EP STR 202	Cast materials for steel structures
GS EP STR 203	Forged materials for steel structures
GS EP STR 301	Fabrication of offshore steel structures
GS EP STR 401	Loadout, seafastening, transportation and installation of offshore structures
GS EP STR 652	F(P)SO - Steel hull design requirements

3. Quality assurance

The Contractor or its designated SUB-Contractor in charge of the fabrication and assembly of the hull (hereafter called "the Builder") shall operate under a third party certified Quality Assurance system and shall maintain this Quality Assurance system during the whole construction period.

Within this quality assurance requirements, some requirements specific to shipbuilding activity are described within the present specification.

The Builder will demonstrate, prior to any Contract, that he is able to implement efficiently the quality and reliability enhancement procedures that are referred in the present specification.

Such specific procedures cover the following topics:

- Material quality control procedure, Identification, traceability, storage and handling
- Dimensional Control & performance follow-up of cutting, machining, positioning & welding equipment

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- Welding procedures
- Welders qualification & Follow-up Production
- Welding Traceability
- Quality control standards for dimensional tolerances
- Fabrication procedures with Erection and Assembly method Planning
- NDE procedures & performance & reporting
- Inspection personnel qualification
- Repair procedures
- Tank testing procedures
- Remedial actions/repair quality control and traceability system.

4. Materials

4.1 Structural steel

4.1.1 General

Following table summarizes the applicable rules and General specifications about structural steel in a F(P)SO:

Zone			Rules & regulations	Total GS
HULL	Rolled steel plates, sections, bars, tubular	Ship area	IACS standards Classification Society rules	GS EP STR 653 incl. Appendix 1 Part A, B
		Offshore area	IACS standards Classification Society rules	GS EP STR 653 incl. Appendix 1 Part A, B & C
	Cast & forged steel, Very High tensile steel - Quenched or tempered steel		IACS standards Classification Society rules	GS EP STR 201 GS EP STR 202 GS EP STR 203
Topside & other			N/A	GS EP STR 201 GS EP STR 202 GS EP STR 203

Specifications for purchasing materials shall be submitted for approval to Classification Society and Company.

All steels for the hull construction shall be fresh new steel produced by a steel Manufacturer holding valid quality system, tested and certified according to Class requirements, and approved by the Company.

Contractor shall provide on a weekly basis a status of purchasing, delivery and location of structural steel.

All materials shall have been approved at steel Manufacturer's plant by Classification Society.

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Any material may be inspected by the Classification Society or Company Representative before entering the fabrication process.

4.1.2 Requirements for Rolled Steel Plates, Sections, Bars and tubulars (structural steels)

The minimum requirements stated in Appendix 1 of the present specification shall apply for the FPSO hull ship and offshore areas in addition to the Classification Society requirements.

For some shortage or late modifications / repairs, Company may accept on a case by case basis material from stockists. In this case, in addition to Appendix 1, Contractor shall submit mill certificates to Company prior purchasing and Company reserves the right to require some complementary tests on product before acceptance of the material. In case of material substitution the new material shall be systematically taken from a higher grade than the substituted material.

4.1.3 Additional requirements for Other Steels (structural steels):

Steels with SMYS greater than 430 MPa shall be fully compliant with [GS EP STR 201](#).

Steels delivered in Quenched and Tempered conditions shall be fully compliant with [GS EP STR 201](#).

Steel Castings shall be fully compliant with [GS EP STR 202](#).

Steel Forgings shall be fully compliant with [GS EP STR 203](#).

4.2 Other material

4.2.1 Materials for hull outfittings

Materials for hull outfittings (such as hand rails, manholes, hatches, pipe supports, cable ways, etc.) shall be either corrosion resistant (316L) with compatibility to hull steel and painting systems or black steel suitably protected either by paint or hot dip galvanized.

Galvanized and stainless steel parts should be mechanically protected during construction against grit & grinding debris.

4.2.2 Bolts & mechanical items

All bolts, nuts, and similar mechanical items used for hull fittings shall be as follow:

- For manholes and hatches: SUS 316 bolts & Brass nuts
- For rails, pipe supports, etc.:
 1. Fittings for weather exposed area & in water ballast tanks: JIS SUS 316 bolts & nuts+ washers
Bolting nuts and washers for items inside tanks and void spaces / cofferdams shall be JIS SUS 316.
 2. Fittings for machinery space and accommodation: Galvanized + painted bolts and nuts
Detail regarding the bolts standardization, reaming, extra bolt lengths etc shall follow the [GS EP STR 301](#).

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3. For bolting other than the hull fittings, **GS EP STR 201** and **GS EP STR 301** shall apply.

4.3 Steel identification & traceability

Contractor shall submit traceability system procedure for Company's review.

Mill certificates in conformance with class requirements shall be provided for every steel to be used in the hull construction in accordance with Appendix 1 of the present specification or **GS EP STR 201**, **GS EP STR 202**, **GS EP STR 203** when applicable. Copies of original certificates are acceptable provided they are certified by BV, **Lloyd's**, DNV, **ABS** or other body approved by the Company and the Classification Society. Confirmation tests and inspections shall be performed in accordance with the requirements of the Classification Society, and at Company request, when deemed necessary by Company.

The mill certificates shall show the results of testing required by the material specification. They shall include complete steel composition (showing any elements intentionally added, elements restricted by the material specification, elements in the carbon equivalent formula and other residual elements identified but not normally required to be reported) and mill inspections performed.

A record of all certificates of used steel shall be maintained during the construction and supplied to the Company on delivery, under paper and electronic formats.

Mill & Batch number code shall be marked on each steel product at delivery.

Marking system on parts shall not create crack sensitive points.

Each grade of steel shall be marked by coded marks to distinguish easily the various grades of parts. Steels parts for Ship and Offshore areas of the Hull shall be identified differently. Application of a different shop primer color is recommended for offshore areas.

During construction, Contractor will develop and apply a traceability system enabling to identify the item/batch number of steel plating in the finished hull and of section profiles up to the coating stage. Such system is to be submitted to the Company prior to steel ordering & fabrication. Consumables, applied welding procedures, welders, NDE results and reports shall be included in the traceability system. Company may perform with Contractor's inspection team some audit to check efficiency of the traceability system.

During the entire life of the hull, Company shall be able to trace any structural part of the hull, and get the origin (i.e. mill certificates, welding process, NDT performed, etc.). In order to achieve this, Contractor shall build a computerized system gathering and linking electronic format of the documentation. Sample of such system shall be submitted to Company for review prior to keel-laying.

4.4 Material storage and handling

Contractor shall submit Material Storage & handling procedure for Company's review.

All structural material shall be stored on flat surfaces, platforms or other Company approved supports in such a way to be free of significant deformations and free draining. Materials shall be free from dirt, grease, paint (other than primer), any aggressive chemicals and shall be protected from corrosion by a primary coating compatible with hull coating specification.

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Company may reject any fabricated part or subassembly that would be showing evidence or strong suspicion of inappropriate storage or handling.

Steel for the hull shall be stored in identified dedicated and agreed location. Various steel grades shall be stored separately and with clear identification.

Materials shall be handled and transported with appropriate means, preventing any significant deformation, not creating any surface damage.

Prior to steel cutting, Contractor shall organize inspection of the storage area with Company in order to audit the application of the storage and handling procedure.

5. Fabrication of parts & components

The minimum requirements of the **GS EP STR 301** for the hull fabrication are applicable with the relevant deviations as defined in the following sections for the specific application of a hull.

All fabrication including pipe penetration, cable penetration, outfitting, etc., shall strictly follow the construction drawings submitted to Company and Class. In case of discrepancy, Contractor shall issue a Non Conformance report and propose some remedial actions or repair to Company and Class approval before implementation.

In case some sub-assembly is performed outside shipyard, Sub-Contractor shall be approved by Company, and Contractor shall organize one quality audit with Company.

Based on engineering, **GS EP STR 301** and Class requirements, Contractor shall prepare dedicated fabrication standards for the F(P)SO hull fabrication and submit them to Company and Class approval at least 3 months before steel cutting.

These fabrication Standards may address differences with Yard Quality Manual, specific to the project. In such case, Quality manual shall be made available to Company.

The approved fabrication standards shall be compiled in a pocket A5 size booklet delivered to Company and Class. The standards shall be written in both English and local language at fabrication yard.

The fabrication standards shall cover the whole range of the hull production, including structural steel, piping and outfitting, bevel detail, acceptable fit up conditions, welding WPS, NDE, welding consumable, dimension control tolerance, acceptable methods for correction of the distortion, forming, etc.

The fabrication standards shall address both recurrent and particular details.

5.1 Workmanship

Two weeks before steel cutting, Contractor shall organize some training of his QA and line QC foremen. Company Supervisors and Class Supervisors shall be invited. Main differences between VLCC construction and F(P)SO standard shall be highlighted. List of "Offshore" interfaces and details shall be stressed. Main key points of QA procedures and schedule shall be reminded.

At all levels, Contractor shall make sure that all workers shall be well informed that they are not working on a "normal hull" but on an "offshore type vessel" with particular specifications and standards to be applied.

5.2 Straightening

All rolled plates, bars and sections shall be flattened, straightened and free from twist before entering the fabrication process.

Such flattening and straightening shall be obtained in accordance with the requirement of Classification Society without excessive heat or local mechanical damage. Hot flattening and straightening procedures shall be qualified. Mechanical tests shall demonstrate that steel characteristics are not affected.

5.3 Cutting & machining

Cutting of parts shall be made essentially on Computer Assisted cutting machines and using qualified procedures and cutting parameters ensuring an adequate dimensional control of parts and a good edge smoothness and profile. All edges shall be free of flaws.

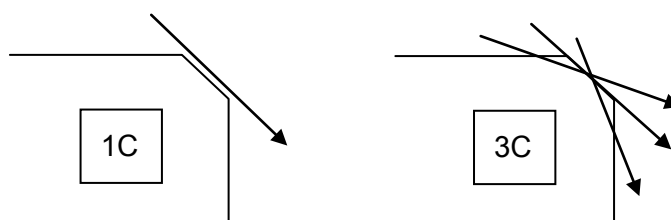
Contractor has to perform regular dimensional control of parts and edges inspection and report to Company.

Hand cutting shall be limited to the practical minimum and performed under controlled parameters and by qualified personnel. In all cases, hand cutting shall be done prior to block stage.

Machining procedure, when performed, shall ensure that edges are free from crack initiators or metallurgical degradation detrimental to subsequent welding.

5.4 Edges preparation

Edges not intended to be further welded shall be clean, smooth and free from notches and flaws. They shall receive 3C grinding in coated areas and 1C grinding in non coated areas as show below.



Edge preparation shall be in accordance with WPS, which is to be approved by Company, and in accordance with the requirement of Classification Society.

Edges in fatigue highly and sensitive areas shall be free from notches and ground smooth (minimum 3C).

5.5 Forming

Forming of steel plates and shapes, when needed, may be done either by hot or cold forming.

Cold forming shall be limited to strain ratio of 5% or a curvature radius to plate thickness ratio of 10.

Cold forming with higher strain ratio above 5% of PS defined in section 6.4 of **GS EP STR 301** shall be followed by strain ageing tests or appropriate heat treatment of the material.

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Hot forming shall be performed according to qualified procedures proven through qualification metallurgical tests of same extent as welding procedure tests (tensile, hardness and bend tests, Charpy tests for grades for which minimal impact toughness values are required).

6. Welding

The minimum requirements of the **GS EP STR 301** for the hull material are applicable with the relevant deviations as defined in the following sections for the specific application of a hull.

6.1 General

The hull structure shall be of welded construction throughout. All butt welds shall be full penetration welds. Welding processes using a temporary ceramic backing are allowed. Welds with permanent backing are not allowed for any category.

Manual shielded metal arc welding (SMAW), single or double wire automatic submerged arc welding (SAW), gas tungsten arc welding (GTAW), Flux core wire (FCAW-GS) processes are acceptable.

Electrode gas (EGW) may be accepted by Company. Contractor shall submit a report with typical parameters and mechanical tests results to Company.

Automatic processes shall be preferred as far as possible.

Continuous welding shall be used throughout the hull.

Welding equipment shall be of adequate capacity and well maintained (including electrical wires) in order to get and maintain the required weld quality throughout the construction of the hull. Contractor to perform regular checking of welding equipment (functioning and safety) and report to Company.

Most of the welding work shall be performed in workshops or under shelter and with good access and favourable position.

No welding shall be performed under rain or excessive wet conditions, neither when steel temperature is below -10°C .

Preheat and Post-heat shall be performed according to approved procedures and with adequate temperature checking and recording equipment.

In fatigue and high fatigue sensitive areas, welds shall be ground smooth with minimum 15 mm radius, depending on weld throat size.

Ceramic backing for butt welds are authorized only if followed by gouging and back weld due to risk of hot cracking.

6.2 Procedures

Prior to start of fabrication, Contractor shall submit Welding Procedures Specifications, including the following information:

- Welding procedure designation
- Planned range and conditions of use
- Description of the welding process