

GENERAL SPECIFICATION

STRUCTURAL

GS EP STR 651

General principles for a F(P)SO design

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General Specification		GS EP STR 651
General principles for a F(P)SO design		
Rev.: 13	Effective date: 12/2016	Page: 2 of 43

Contents

1. Scope	4
2. Reference documents	4
3. Definitions	7
4. General considerations	10
4.1 Common design data	11
4.2 Safety and Environment	11
4.3 Classification	12
4.4 Flagging	13
4.5 Security	13
4.6 Interface definition	13
5. Design principles	13
5.1 General Architecture	13
5.2 Layout and hazardous area classification	18
5.3 Drains, Vents and Environment protection	21
5.4 Oil storage	28
5.5 Other liquid storages	30
5.6 Piping	30
5.7 Tandem offloading	31
5.8 Flare and vent systems	31
5.9 Living Quarter	32
5.10 Structural	32
5.11 Electrical	33
5.12 Materials	33
5.13 Control and Safety	33
6. Documentation requirements	34
6.1 Design documentation	34
6.2 Quality plan	36
6.3 Construction documentation	36
6.4 Required certificates at delivery	38

General Specification		GS EP STR 651
General principles for a F(P)SO design		
Rev.: 13	Effective date: 12/2016	Page: 3 of 43

7. Delivery	38
7.1 Preservation.....	38
7.2 Inspection, Test and Trial	38
7.3 Plans for approval	39
7.4 Contractor Other Items.....	39
7.5 Preparation for Towing.....	40
Bibliography.....	41
Appendix 1 Glossary.....	42
Appendix 2 Maximum operating design condition	43

General Specification		GS EP STR 651
General principles for a F(P)SO design		
Rev.: 13	Effective date: 12/2016	Page: 4 of 43

1. Scope

The purpose of this document is to highlight the specificities of floating production facilities as opposed to traditional onshore or offshore “fixed” installations that were the basis to derive the bulk of the codes and standards used in the oil and gas industry and also Company General Specifications.

Therefore, this document describes Company interpretation of General Specifications as applicable to F(P)SOs. It can be considered as a master Specification giving the rules for applying the other GS. It shall be read in conjunction with **GS EP SAF 380** which provides the requirements for safety engineering.

General requirements for the design of Offshore steel structures are given **GS EP STR 100** on the basis of **ISO 19900** Standard suite.

This document complements **ISO 19904-1** and **API RP 2FPS**.

Steel Hull design requirements are described in **GS EP STR 652**.

Hull fabrication requirements are in **GS EP STR 653**.

GS EP STR 102 gives requirements for the design of offshore topside structures as well as material selection and construction requirements for offshore structures.

GS EP STR 661 gives requirements for the design of the station keeping system in addition to **ISO 19901-7**.

A F(P)SO is a Floating (Production) Storage and Offloading unit. This definition covers a wide variety of floaters used for the production of oil and gas offshore.

This document was written for use on ship-shaped supports. Its use for other support designs (such as SPARs, Semi-submersibles, TLP) needs careful assessment. Even its use for barges such as the Nkossa NKP barge, or a LPG or LNG storage unit needs careful review, particularly with possible requirements of the classification society with regard to the containment system.

Specific aspects of the conversion of a tanker into a F(P)SO are treated in **GS EP STR 655**.

2. Reference documents

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

Choice of reference documents

National regulations are not listed in this document due to their high specificity and variability.

However, where national regulations exist, their provisions and those of the standards and codes to which they refer shall apply to the works done in the State, and supplementing or amending the provisions of this document.

The global design and final operation shall comply with the site Coastal State regulations applicable to F(P)SOs.

The following reference documents are applicable. As most of the documents are not strictly applicable to F(P)SOs, deviations shall be approved by Company.

General Specification		GS EP STR 651
General principles for a F(P)SO design		
Rev.: 13	Effective date: 12/2016	Page: 5 of 43

Recognition of reference documents

Unless otherwise indicated in this document, all the reference documents to be used, as well as their supplements shall be the latest editions.

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
American Bureau of Shipping FPI	Rules for Building and Classing Floating Production Installations
API RP 2FPS	Recommended Practice for Planning, Design, and Constructing Floating Production Systems
BS 4727-3 GROUP 08	Glossary of electrotechnical, power, telecommunication, electronics, lighting and colour terms. Terms particular to telecommunications and electronics. Acoustics and electroacoustics
BS 61260	Electroacoustics - Octave-Band and Fractional-Octave-Band Filters
BS 6841	Guide to measurement and evaluation of human exposure to whole-body mechanical vibration and repeated shock
BV NR445	Rules for the Classification of Offshore Units
DNVGL-RU-OU-0102	Floating production, storage and loading units
HSE Offshore Technology Report 2001/068	Noise and vibration
IALA	Recommendations for Marking of Offshore Structures
IEC 60034-9	Rotating electrical machines - Part 9: Noise limits
IEC 60092-502	Electrical Installations in ships - Part 502: Tankers - Special features
IMO COLREG	International Regulations for Preventing Collisions at Sea
IMO ICLL	International Convention on Load Lines
IMO IS 2008	International Code on Intact Stability 2008
IMO ISPS Code	International Ship and Port Facility Security code
IMO LSA Code	International Life saving Appliances Code
IMO MARPOL 73/78	International Convention for the Prevention of Pollution from ships

General Specification		GS EP STR 651
General principles for a F(P)SO design		
Rev.: 13	Effective date: 12/2016	Page: 6 of 43

Reference	Title
IMO MODU	Code for the Construction and Equipment of Mobile Offshore Drilling Units
IMO resolution A468 (XII)	Code on Noise Levels on Board Ships
IMO resolution MEPC 139(53)	Guidelines for Application of MARPOL Annex I requirements to FPSOs and FSUs
IMO SOLAS	International Convention for the Safety of Life at Sea
ISO 19900	Petroleum and natural gas industries - General Requirements for Offshore Structures
ISO 19901 (Parts 5; 7)	Petroleum and natural gas industries - Specific requirements for offshore structures - Parts 5; 7
ISO 19904-1	Petroleum and natural gas industries - Floating offshore structures - Part 1: Monohulls, semisubmersibles and spars
ISO 6954	Mechanical Vibration - Guidelines for the Measurement, Reporting and Evaluation of Vibration with Regard to Habitability on Passenger and Merchant Ships
Lloyd's Register of Shipping FOIFL	Floating Offshore Installations at a Fixed Location
OCIMF	Guidance Manual for the inspection and condition assessment of Tanker Structures

Note that references to Class Society Ship Rules are implicit through the listed documents and not called independently to clearly keep priority to Offshore Rules.

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 ELE 021	Electrical design criteria for floating units
GS EP ENV 001	Environmental Requirements for Projects Design and E&P activities
GS EP EXP 311	Plant integrity - Minimum inspection requirements
GS EP GEO 505	Monitoring of Metocean Conditions for Offshore Units
GS EP LSO 110	Environmental effects considerations for helidecks
GS EP LSO 115	Helideck Specifications for Operations
GS EP LSO 201	Towing of Watercraft
GS EP LSO 202	Personnel transfer between watercrafts and between watercrafts and offshore structures

Reference	Title
GS EP SAF 221	Safety rules for buildings
GS EP SAF 228	Liquid drainage
GS EP SAF 262	Pressure protection relief and hydrocarbon disposal systems
GS EP SAF 380	Safety engineering requirements for an F(P)SO
GS EP STR 001	Weight monitoring and weighing offshore and onshore units
GS EP STR 003	Crane for floating offshore installations
GS EP STR 004	Riser / Umbilical Pulling Rig, Pulling and Mooring Winches
GS EP STR 005	Lifting Appliances other than cranes and winches
GS EP STR 006	Requirements for the design, fabrication and testing of Overhead Travelling Cranes
GS EP STR 100	Offshore steel structures - General
GS EP STR 102	Design of offshore topside structure
GS EP STR 401	Loadout, seafastening, transportation and installation of offshore structures
GS EP STR 601	Floating Unit Integrity Management System Requirements
GS EP STR 602	F(P)SO - Requirements for the Certification of Compliance with International Maritime Conventions
GS EP STR 603	Hull and Mooring monitoring
GS EP STR 631	Deepwater CALM Buoy Terminals
GS EP STR 652	F(P)SO - Steel hull design requirements
GS EP STR 653	F(P)SO - Hull fabrication requirements
GS EP STR 655	Requirements for conversion of a tanker into a F(P)SO
GS EP STR 661	FPSO - Design requirements for mooring and anchoring systems
GS EP STR 901	Design rules and construction standards for ancillary structures of offshore and onshore installations

3. Definitions

- **FPSO** is a Floating Production, Storage and Offloading Unit.
- **FPU** is a Floating Production Unit. (No Storage facilities).
- **FSO** is a Floating Storage and Offloading Unit. (No Production facilities).

For simplicity, we use the abbreviation FPSO throughout this document to refer to a unit that has oil storage capacity and production facilities.

General Specification		GS EP STR 651
General principles for a F(P)SO design		
Rev.: 13	Effective date: 12/2016	Page: 8 of 43

- The letter O refers mainly to the oil export and covers a variety of possibilities: tandem offloading, export to a remote loading buoy or export through a pipeline.

The use of brackets in F(P)SO means that requirements is valid for any type of vessel.

- **LPG:** Liquefied Petroleum Gas
- **LNG** Liquefied Natural Gas
- **Hull:** includes hull structure, marine systems, living quarters and any other equipment located inside the hull.
- **Topsides:** corresponds to the facilities located above hull used for process, utilities and other related functions. FSOs do not have topsides.
- **Turret:** corresponds to the structural, mooring and riser support parts of a turret.
- **Appurtenances:** F(P)SO specific elements including their foundations which are protruding from the hull not normally existing on ships (such as risers supporting structures, boat-landings, mooring support structures, topsides stools, protectors, flare foundations...).
- **Fore** or **bow** refers to the end of hull where flare and possibly turret are located. The F(P)SO is generally towed by this end. Note that for interpretation of ship rules during towing, the end from where the F(P)SO is towed shall be treated as a bow. Moreover, for interpretation of ship rules on site, the end facing the prevailing waves shall be treated as a bow as well.
- **Bow Area** covers the hull deck area where usually towing equipment as well as tandem offloading equipment is installed.
- **Aft** or **stern** refers to the bow opposite end, where living quarter is generally located.
- **Hull deck:** refers to the uppermost continuous deck of the hull. The term of main deck, sometimes used for process deck shall not be used.
- **Process deck** is the Topside lower deck.
- **Process tank:** refers to hull compartment dedicated to process function such as wash tanks, settling tanks.
- **LQ: Living Quarter** includes the Hotel / Catering functions, the helideck and usually the Central Control Room. LQ level are numbered from the level corresponding to the process deck level (A deck) upwards to roof level below the helideck.
- **Lay-down Area:** The Lay-down Area is an area situated in front of the LQ dedicated for the temporary storage of goods/spares/consumables which are transferred onboard the F(P)SO by one of the pedestal cranes.
- **Surfer Landing:** the light craft landing structure described in **GS EP STR 901** used to transfer personnel from vessel to vessel.
- **Cargo Area** is the section of the Hull where oil is stored. It may include Cargo Oil Tanks (COT), Sea Water Ballast tanks (WB), Slop tanks, Process tanks...
- **Machinery space** is the section of the hull located under the LQ. Machinery space levels shall be numbered downwards from hull deck (No 0) to keel (No n).

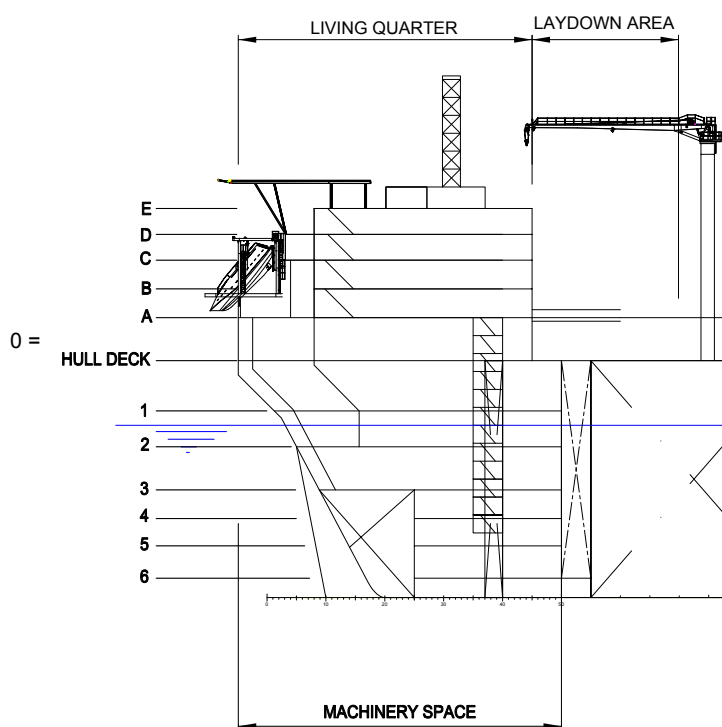
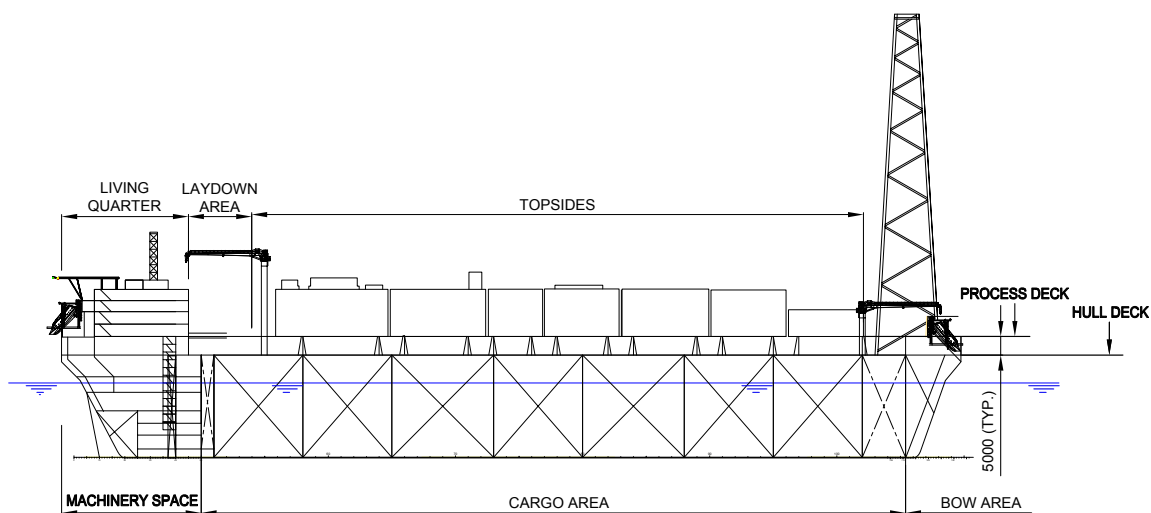
General principles for a F(P)SO design

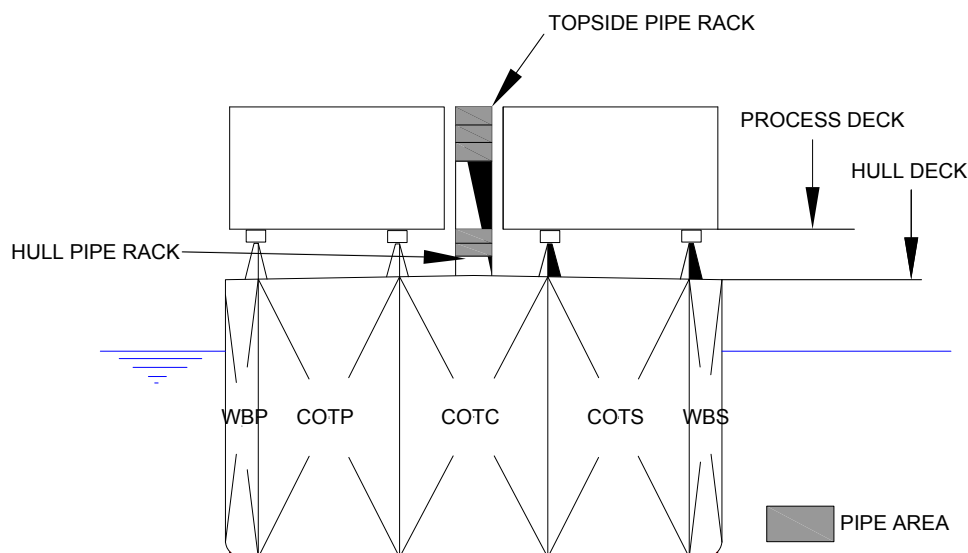
Rev.: 13

Effective date: 12/2016

Page: 9 of 43

The following sketches show a typical FPSO arrangement to illustrate the above definitions and numbering conventions.





4. General considerations

A F(P)SO shall be treated as a single facility with different functions. An integrated approach is required for its design, in particular for the evaluation of operational and safety aspects.

All systems such as:

- Instrument, Control and Safety System
- Safety and escape
- Fire protection and fire-fighting
- Piping
- Electrical
- Mechanical handling
- Marine operations
- Etc.

must be considered globally for the whole facility.

Similarly identification of hazards, assessment of accident consequences such as explosions shall be conducted for the overall facility. Particular attention shall be paid to risers, loading system (bunkering, methanol) and offloading systems.

Consideration shall also be given as far as required to facilities which may interfere with the FPSO operation and safety such as the sub-sea layout, the export tanker and any other vessel in the near vicinity (wellhead platforms or drilling rigs for example).

The F(P)SO design shall be studied for all phases that may be contemplated by the unit, from construction to decommissioning. At early phase of the project, utility balance and design

General Specification		GS EP STR 651
General principles for a F(P)SO design		
Rev.: 13	Effective date: 12/2016	Page: 11 of 43

principles shall be defined to determine when and how critical utility systems (water, air...) are available. Such principles shall be part of the project particular specifications.

4.1 Common design data

Part of the FPSO such as the hull or a process-package may be designed and constructed under a separate contract.

However the design shall satisfy at least Common design data specific to the site and the application.

The Common design data shall include detailed information on:

- Environmental data
- Fluid information (viscosity, temperature, etc.)
- Layout of the field-facilities (including subsea)
- Health, safety and environment protection plan
- Operating philosophy
- Typical requirements for export (nominal cargo (or parcel) size, tanker size (displacement) and frequency, etc.)
- Connections to other installations (risers, mooring-lines, etc.) with their detailed characteristics (size, loads, fluids, etc.)
- Means of Access (including type and size of supply-boat, helicopter, crew-boats)
- Emergency evacuation
- Contractual and technical interfaces (scope and battery limits)
- Main global analysis results such as motions values, level of accelerations, hull deflections
- Module or pancake deck supporting arrangement (layout and loads)
- Temporary phases in particular type of work performed and manning during tow from yard to site and start-up phases on site
- Inspection, maintenance and repair strategy
- Plan for future extension or works including decommissioning and dismantlement.

It will be based on the design principles developed in section 5.

4.2 Safety and Environment

A unique Health and Safety management system shall be established and provided.

It shall be based on an integrated description of the facilities dealing with all functions and resources as well as on an integrated risk approach as required in **GS EP SAF 380**.

General Specification		GS EP STR 651
General principles for a F(P)SO design		
Rev.: 13	Effective date: 12/2016	Page: 12 of 43

4.3 Classification

The F(P)SOs, their station-keeping systems (mooring system, yokes, turrets, ...), the product transfer systems (side by side or tandem offloading) and the SPM (CALM buoys, etc.) shall be classed by a recognized Class Society.

For the F(P)SO, the scope of Classification shall include the following components:

- The hull and living quarters
- The utilities systems of the hull
- The safety and life saving systems
- The cargo handling systems and in particular the offloading system (hawsers, hoses and ancillary equipment)
- The methanol loading and storage system
- The Lifting appliances (Cranes and other devices)
- The hull integrated supports of topsides
- The structure integrating the station-keeping system (turret, chain stoppers, etc.)
- The station-keeping system
- Hull onboard towing equipment.

The hull shall be built under the survey of the Classification Society such that the following class notations according to [BV NR445](#) ([American Bureau of Shipping FPI](#), [DNVGL-RU-OU-0102](#), [Lloyd's Register of Shipping FOIFL](#) or equivalent if Classification Society is not Bureau Veritas) are assigned when the FPSO is completed:

I ✕ HULL ✕ MACH

Offshore Service Barge – Production - Oil Storage –

Unrestricted navigation "SITE Notation"

✕ POSA ALM LSA OHS HEL IG COW AUTO STI COMF HEALTH-NOISE1 HEALTH-VIB1

VeriSTAR HULL INWATERSURVEY ERS-H ERS-M ERS-S

The "Unrestricted Navigation" notation is required for voyage.

The detail of STI (specific thickness increment) notation shall be based on [GS EP STR 652](#) requirements for corrosion allowances.

For benign environment, tropical or sheltered area notation may be considered upon Company and CLASS approval.

The FPSO shall be designed and built to comply with the latest editions of the Regulations and Guidance (at effective date of Contract) unless otherwise required by Company.

Minimum requirements for compliance with International Maritime Conventions ([IMO COLREG](#), [IMO ICLL](#), [IMO MARPOL 73/78](#), [IMO SOLAS](#), [IMO LSA Code](#), [IMO IS 2008](#), [IMO ISPS Code](#), [IMO MODU...](#)) are defined in [GS EP STR 602](#). The certification for the transit voyages should be limited to the minimum required by flag state. However it shall be assumed that the tow voyages will be performed with personnel on board.

General Specification		GS EP STR 651
General principles for a F(P)SO design		
Rev.: 13	Effective date: 12/2016	Page: 13 of 43

The transfer systems (SPM or other types and their moorings) shall be classed separately from the F(P)SO, but if possible by the same Classification Society.

The process systems (topsides), the export lines and the flowlines and risers do not require classification in general unless required by Company. Riser and mooring installation equipment shall comply with OHS Notation and **GS EP STR 004**.

4.4 Flagging

Depending on Countries, Project Particular Specification may require a flagging policy on site.

In case of wet tow, FPSO shall be flagged as required in **GS EP LSO 201**.

4.5 Security

F(P)SOs, and the associated SPM (CALM buoys, etc.) if any, shall be considered as Port Facilities in application of the **IMO ISPS Code**.

4.6 Interface definition

The design and the follow-up of construction of a FPSO shall include:

- Identification of interfaces (nature, type, performance and verification of this one) between different areas or functions
- Physical description (location, nature, loads, displacements, deflections)
- Split of responsibilities in the management and documentation of these.

5. Design principles

5.1 General Architecture

5.1.1 Impact of response to environment

F(P)SOs move under the actions of the environment. This results in accelerations and inertia loading which influence the structural design and modify the behaviour of equipment.

Similarly, the floater is submitted to static inclinations (trim and heel) due mainly to ballasting/cargo configurations but also to the mean action of environment (wind in particular). These effects are different and may affect the accuracy of certain measurements (in particular liquid/gas levels in tanks and vessels), the operability of certain equipment (suction heads of pumps, including firewater pumps). Permanent trim is recommended to ensure adequate sloping of venting, depressurization and drainage systems (in particular the flare header).

Extreme inclination by flooding of compartments is to be assessed in the stability analysis (refer to **GS EP STR 652**) and in the topsides design.