

Engineering Coffee Break.



it's coffee time & sharing.
Join us for a stimulating break!

**Dive into the world of
structure engineering
over a cup of coffee!**

What to Expect:

- Networking with fellow structure engineers
- Casual discussions on the latest industry trends
- Exciting tech talks and insights



Scan for Register!

Discussion :

EPC - Floating Production
Storage and Offloading (FPSO)

Speaker :

Mr. Abdul Rozaq Kurniawan
Marine Construction Supervisor



Sunday, 03rd December 2023
12.30 WIB - End

HTM ONLY

50K



Sahid Batam Center Hotel & Convention

- Free coffee / tea and snack
- Open to all structure engineering enthusiasts
- R.S.V.P by 01st December 2023
- Limited seat! (Only 30 Pax)

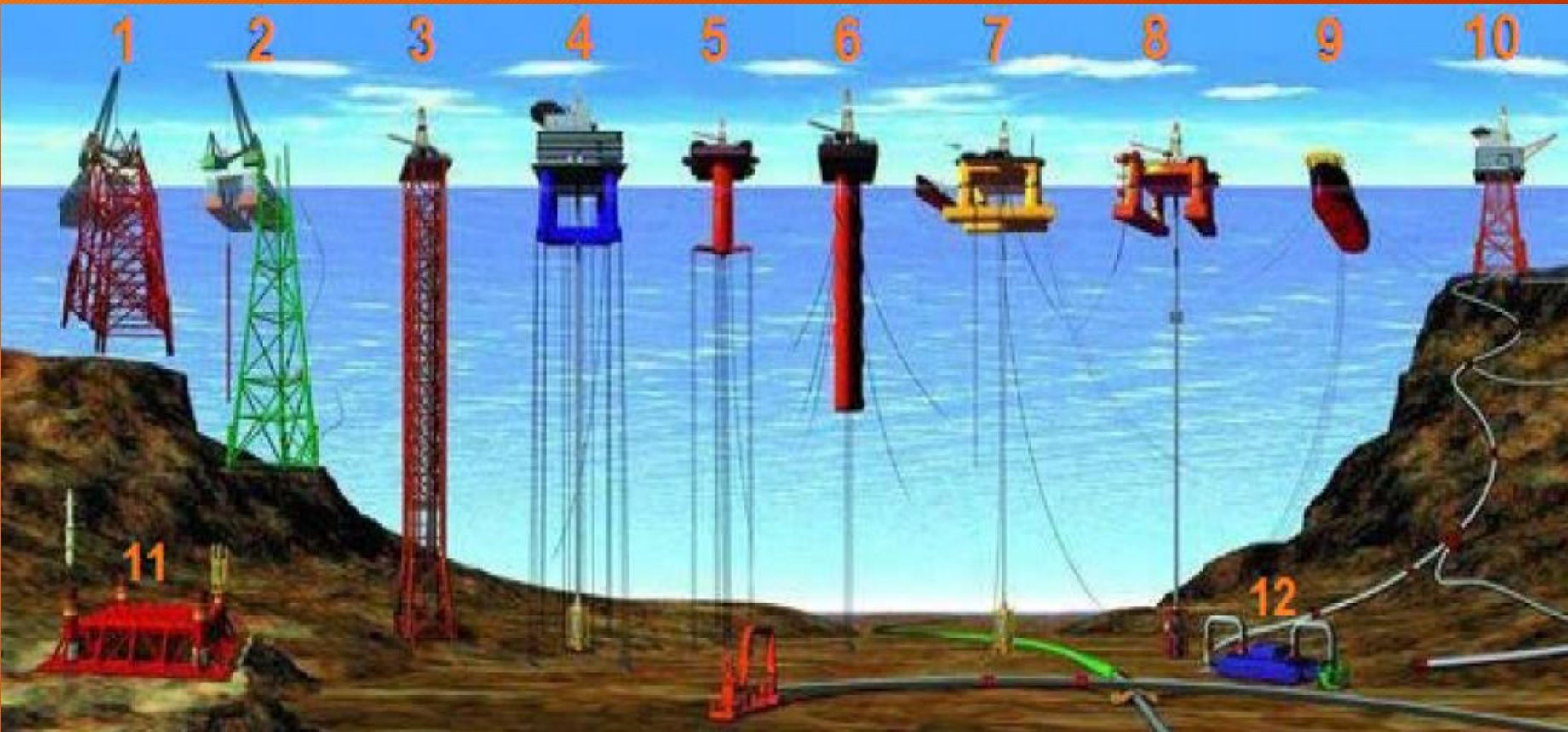
**MOSES Structure Engineering Community
Chapter Batam**

MOSES ENGINEERING COFFEE BREAK Introduction to FPSO

By Abdul Rozaq Kurniawan



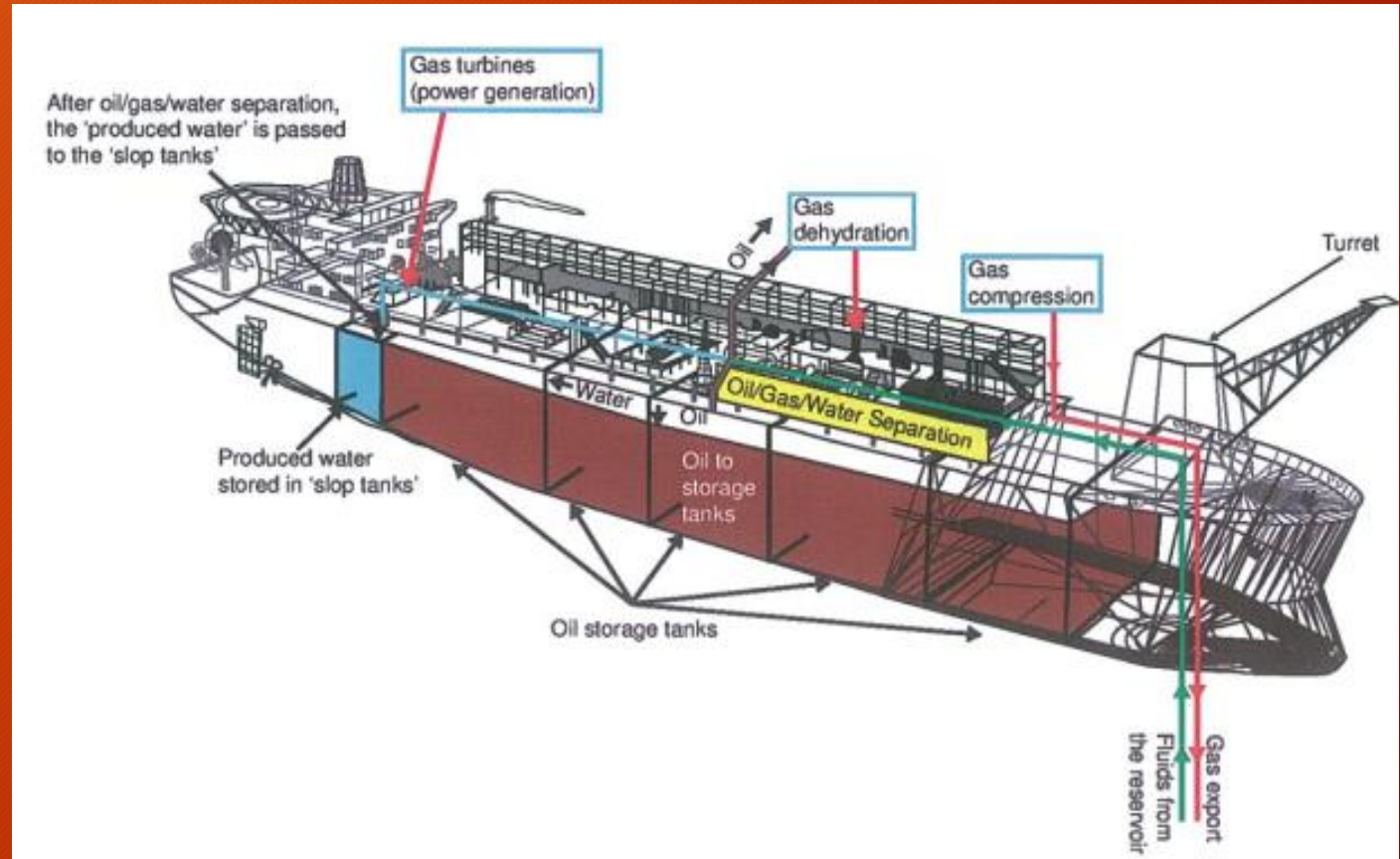
Type of Offshore Platform



1. Fixed Platform
2. Fixed Platform
3. Compliant Tower
4. TLP
5. TLP
6. SPAR
7. Semisub
8. Semisub
9. FPSO
10. Jacket Platform
11. Subsea Tieback
12. Subsea Manifold

Definition of FPSO

FPSO is large permanently moored oil tanker that has an oil and gas processing facility mounted onto its deck



What is FPSO Role

- Provide a safe environment for production operations;
- Provide facilities to deliver a high level of production uptime;
- Provide facilities with the reliability & integrity for life of field operations;
- Provide crude oil storage, offloading capability;
- Provide facilities to process, export or dispose of with associated fluids and contaminants;
- Provide suitable utilities and accommodation to support production operations;

It's about the safe production of hydrocarbon resources

World Fleet FPSO

Offshore Magazine (Data as off 1st September 2022)

- 163 units - Operating FPSO
 - 51 units - New Build
 - 112 units - Conversion
- 16 units - Available FPSO
 - 5 units - New Build
 - 11 units - Conversion
- 30 units - Under Construction
 - 21 units - New Build
 - 9 units - Conversion

GRAPH 1: OPERATOR vs. CONTRACTOR FPSOs

(Anticipated 12/31/2022)

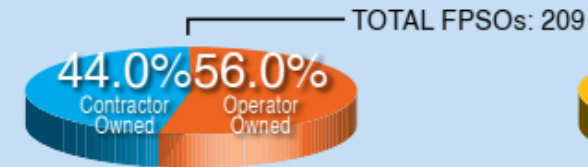


Table 1: (Operating + Available + On Order)

	OPER	AVAIL	ON ORDER	TOTAL	%
Operator	96	4	17	117	56.0%
Contractor	67	12	13	92	44.0%
Grand Total	163	16	30	209	100.0%

GRAPH 2: NEW BUILD vs. CONVERSION FPSO

(As of July 1, 2022)

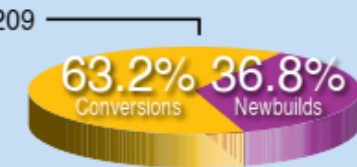
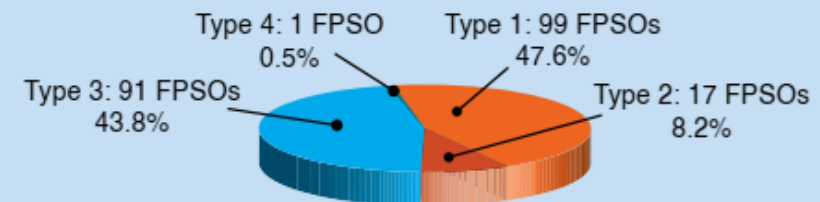


Table 2: (Operating + Available + On Order)

	OPER	AVAIL	ON ORDER	TOTAL	%
Conversion	112	11	9	132	63.2%
Newbuild	51	5	21	77	36.8%
Grand Total	163	16	30	209	100%

GRAPH 3: FPSO OWNERSHIP/FPSO MANAGEMENT TYPES



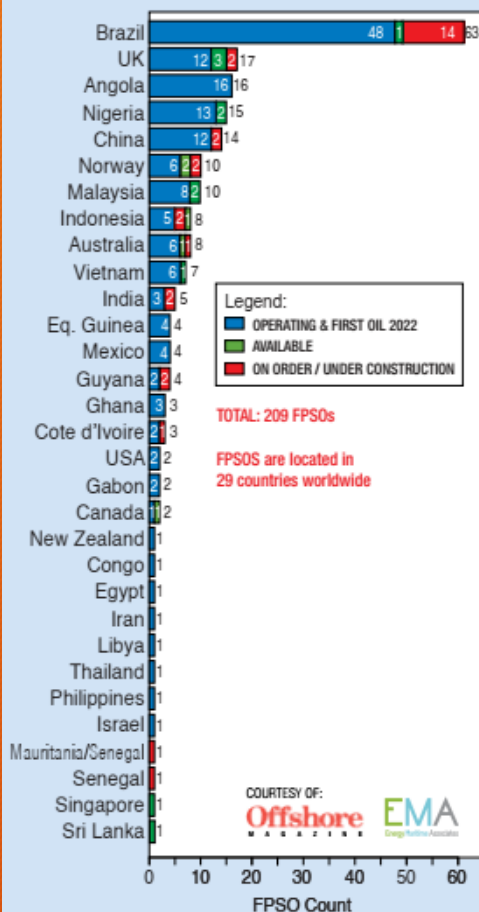
- 1 = F00 & FOM – Field Operator Owned FPSO & Field Operator Managed FPSO
- 2 = F00 & CM – Field Operator Owned & Contractor Managed FPSO
- 3 = CO & CM – Contractor Owned FPSO & Contractor Managed FPSO
- 4 = CO & FOM – Contractor Owned FPSO & Field Operator Managed FPSO

COURTESY OF:  EMA
Energy Markets Association

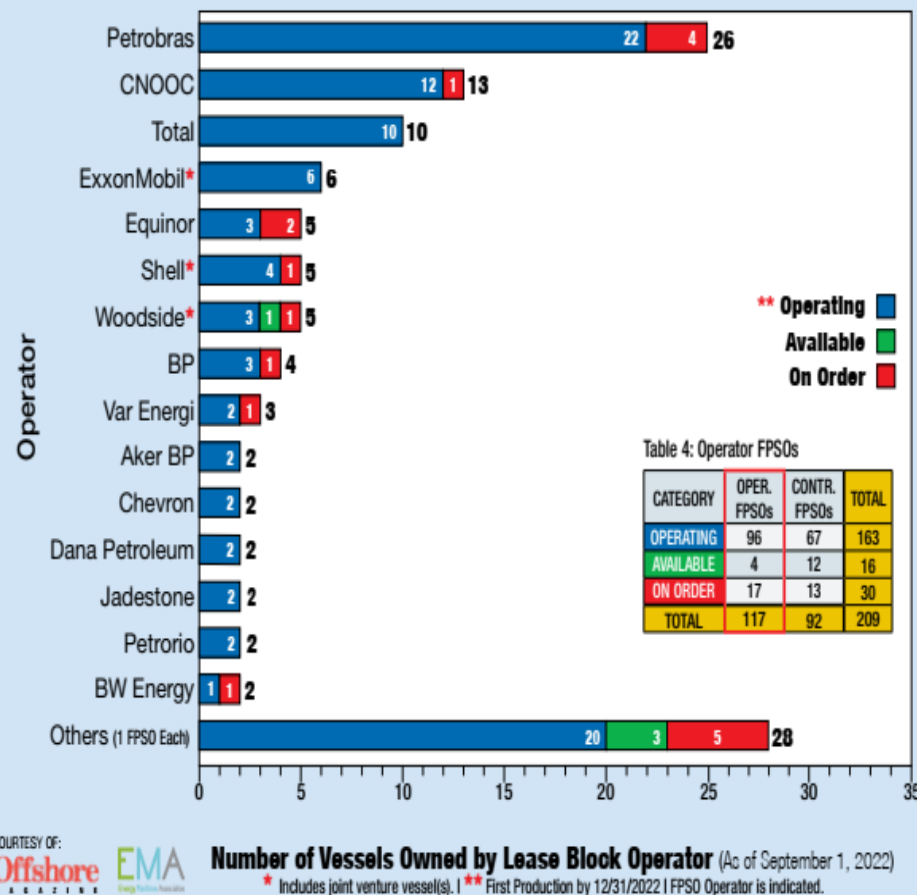
Worldwide FPSO Distribution

GRAPH 7: FPSOs BY COUNTRY LOCATION

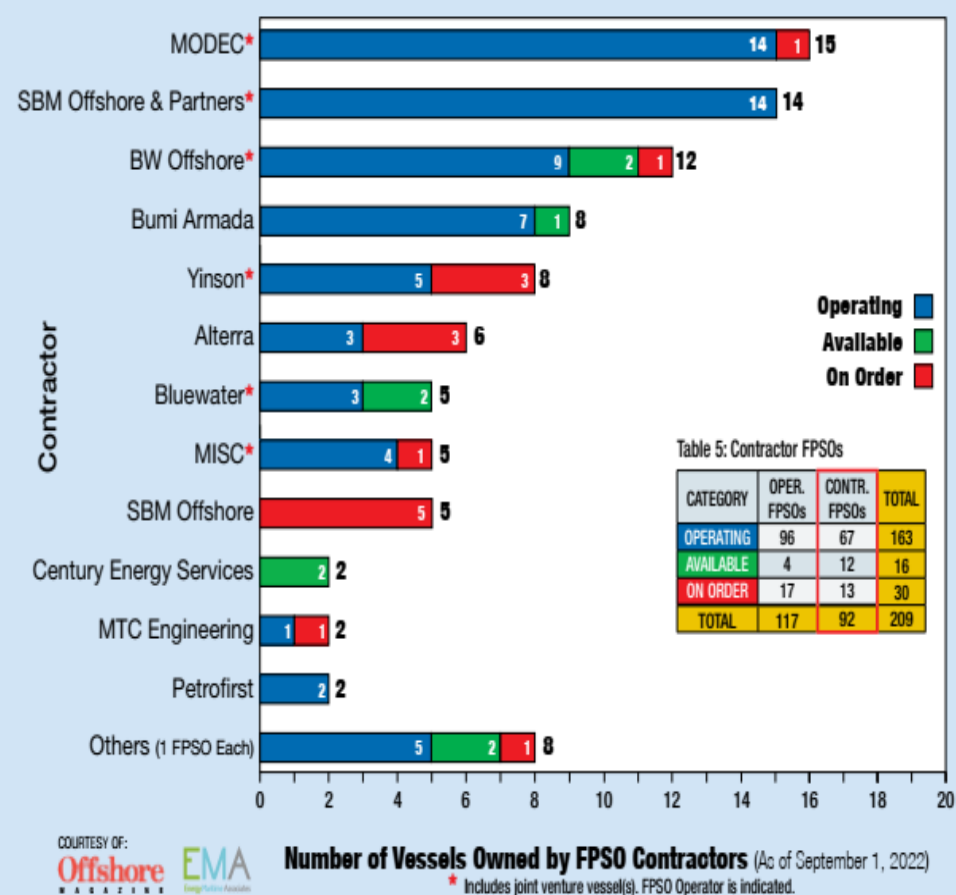
(As of September 1, 2022)



GRAPH 4: RANKING OF OPERATORS BY OWNED FPSOs



GRAPH 5: RANKING OF CONTRACTORS BY FLEET SIZE



FPSO Family

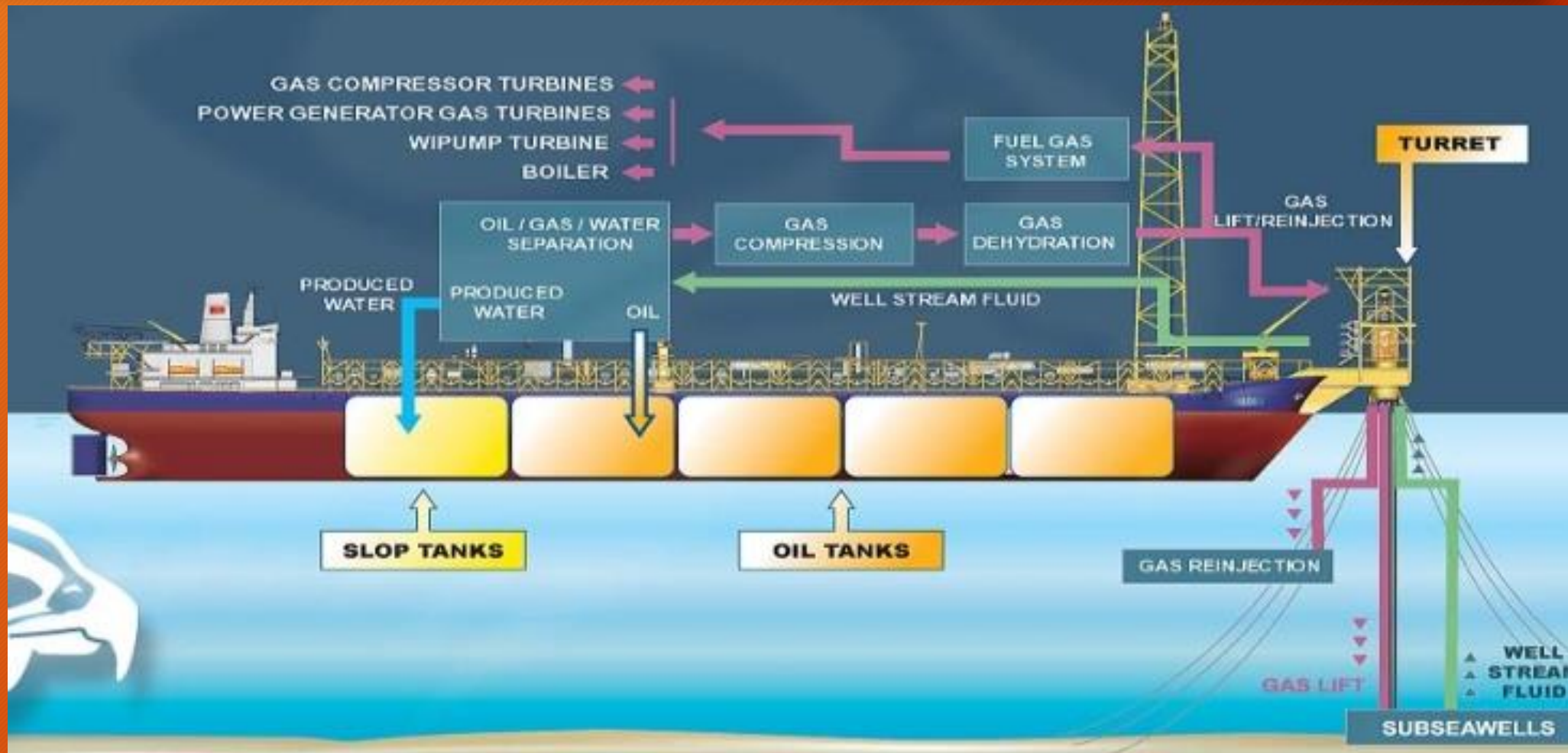
- Regular Tankers
- SPM Terminals
- FPU (Floating Production Unit)
- FSO (Floating Storage & Offloading unit)
- FPSO (Floating Production Storage & Offloading)
- FSRU (Floating Storage Regasification Unit)
- FLNG (Floating Liquefied Natural Gas)

Why FPSO ?

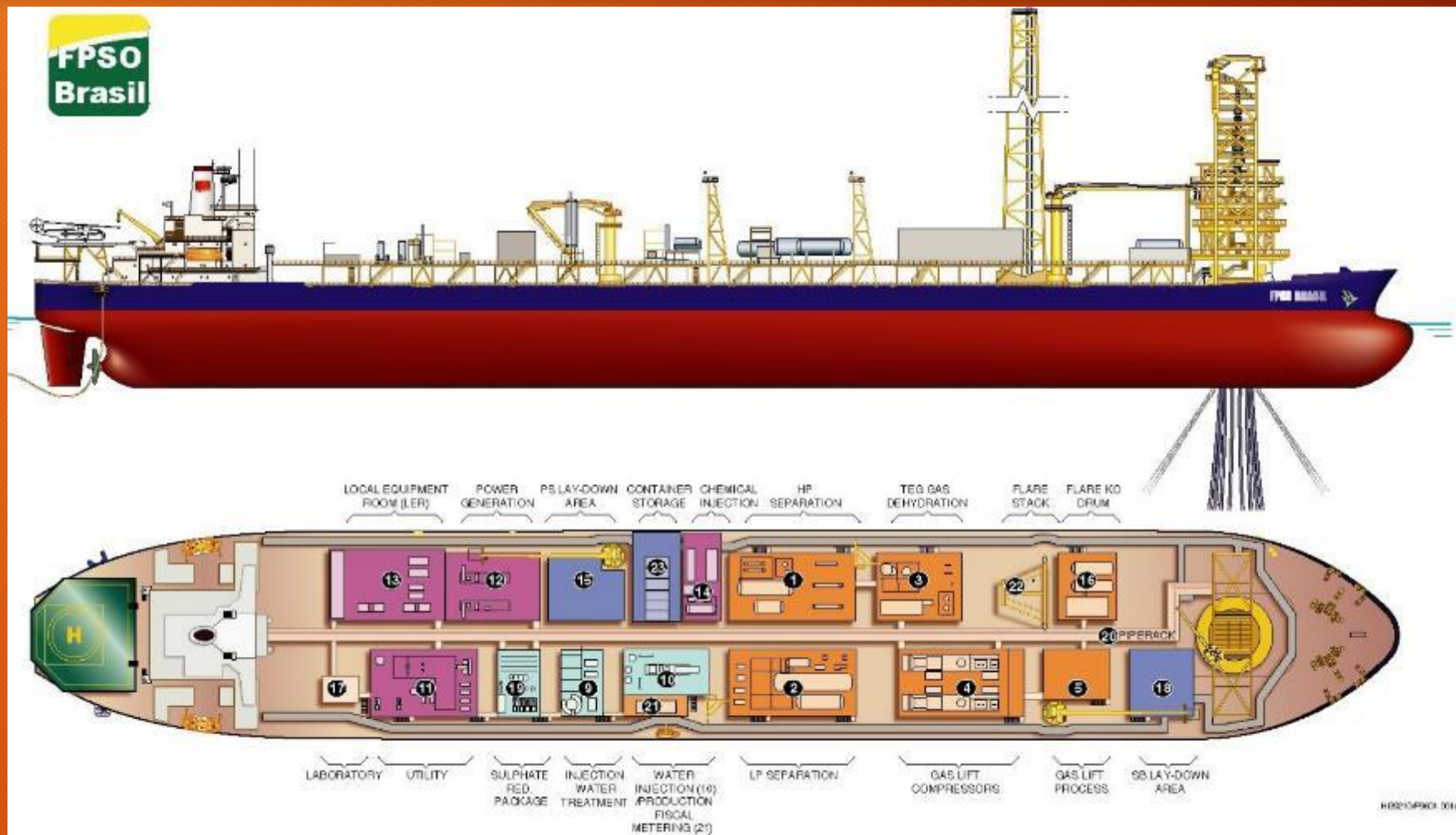
- Recoverable asset
- Marginal fields (North Sea)
- Political stability (Nigeria)
- Re-use is feasible
- Lack of infrastructure (storage)
- Deep water
- Improve First Oil Date
- Parallel engineering
- Drill while you build



FPSO Layout



FPSO Layout



Design Drivers

- Reservoir characteristics
- Field life/service life
- Site conditions
- Subsea development lay-out
- Regulatory standards & operator requirements
- Well intervention needs

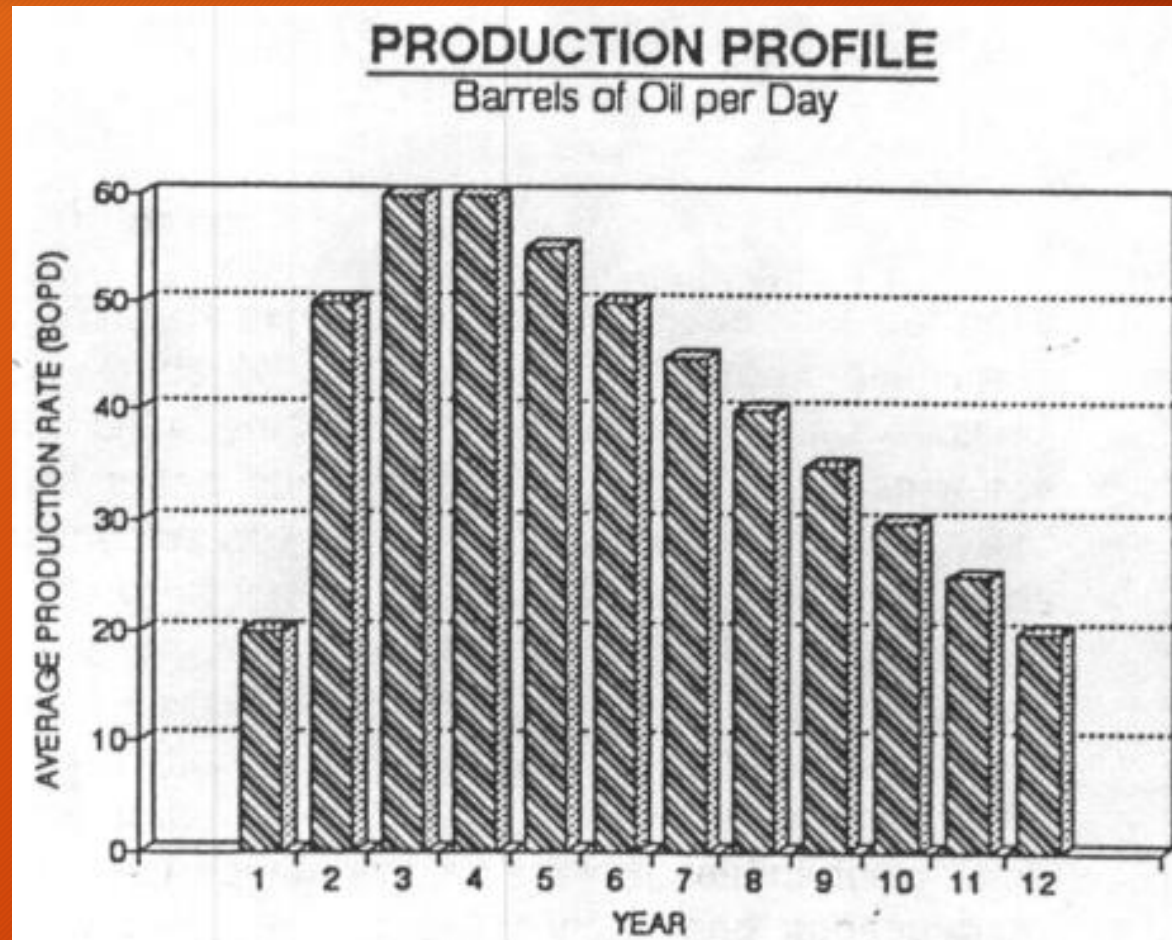
Reservoir Characteristic

- Plateau production capability
- Pressure, temperature, viscosity
- Wax, asphaltenes
- CO₂ and H₂S content → materials, coatings
- Water cut → bpd throughput > bopd
- Gas Oil Ratio (GOR) → compression, gas swivel
- Water or gas injection
- Gas lift

Production Profile

Usually
peaking up
front

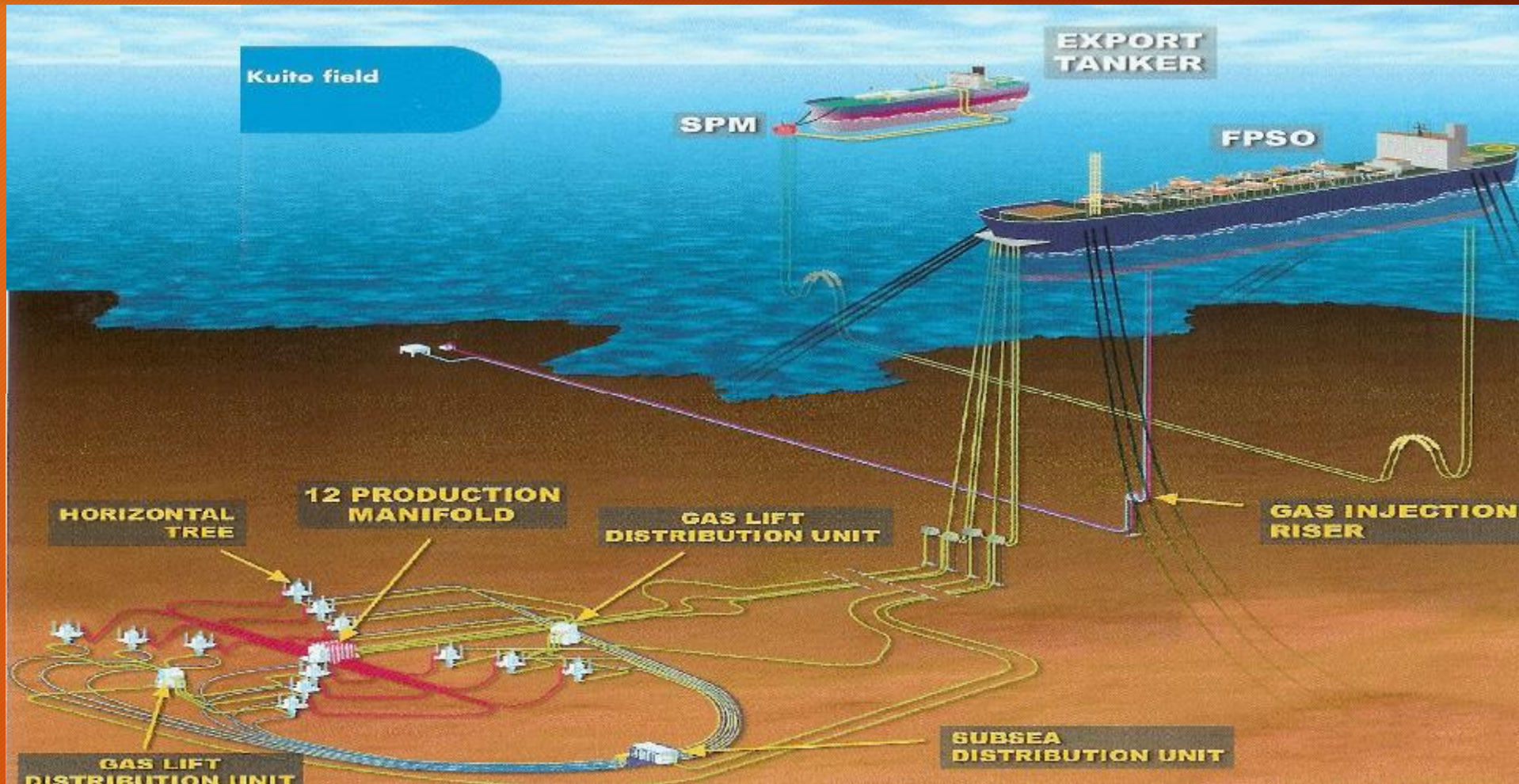
Water cut
influence



Site Conditions

- Sea surface (wind, waves and current) → spread mooring or weather-vaning
- Waves → motions, accelerations → workability; extreme motions, stresses; fatigue
- Current profile for riser design → Vortex shedding
- Water depth → riser design and mooring system selection
- Sea bed soil condition for Anchor selection
- Air temperature → possibility of icing on GTG

Subsea lay-out



Standard and Codes

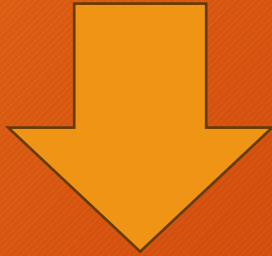
- Classification Society (Lloyds, ABS, DNV, etc.)
- Flag State
- International Conventions : IMO, SOLAS, MARPOL
- Detailed standards : API, ASME, ISO, ILO, etc
- Owner requirement

Vessel Sizing

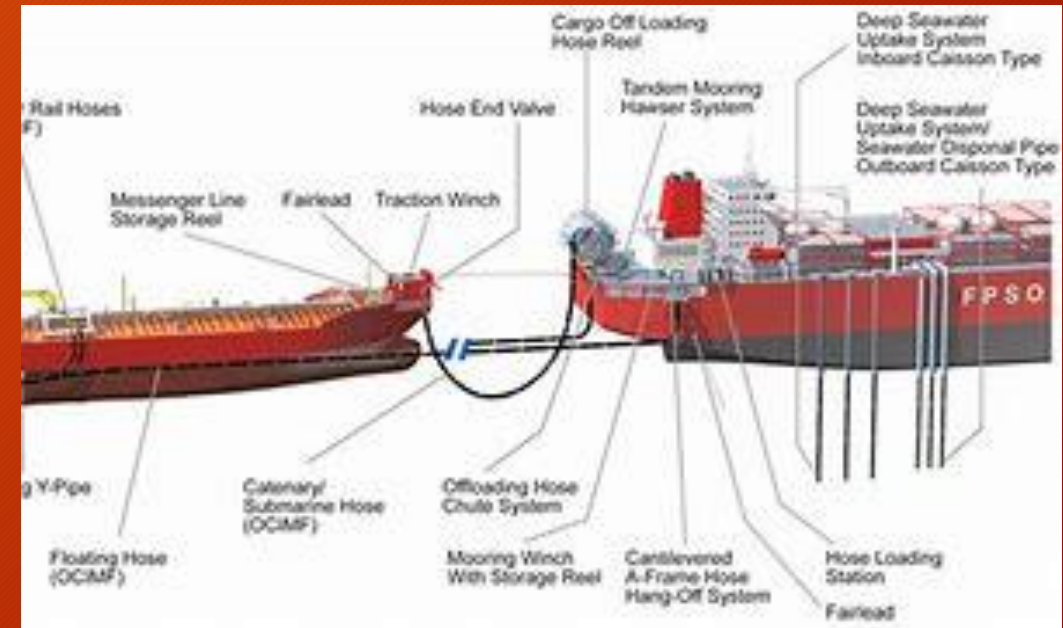
- Field production rate (bopd)
- Oil specific gravity (ton/m³, degrees API)
- Shuttle tanker schedule, days between offloading
- Sea state persistence data
- Complexity, size & weight of process plant
- Gas disposal : use, export, re-inject
- Availability of ships (for conversion)

Shuttle Tanker Schedule

- Regular or irregular
- Effect of weather while offloading and require disconnecting
- Mechanical breakdowns



FPSO Storage capacity = BOPD x Shuttle Interval + 10 ~ 15% reserve

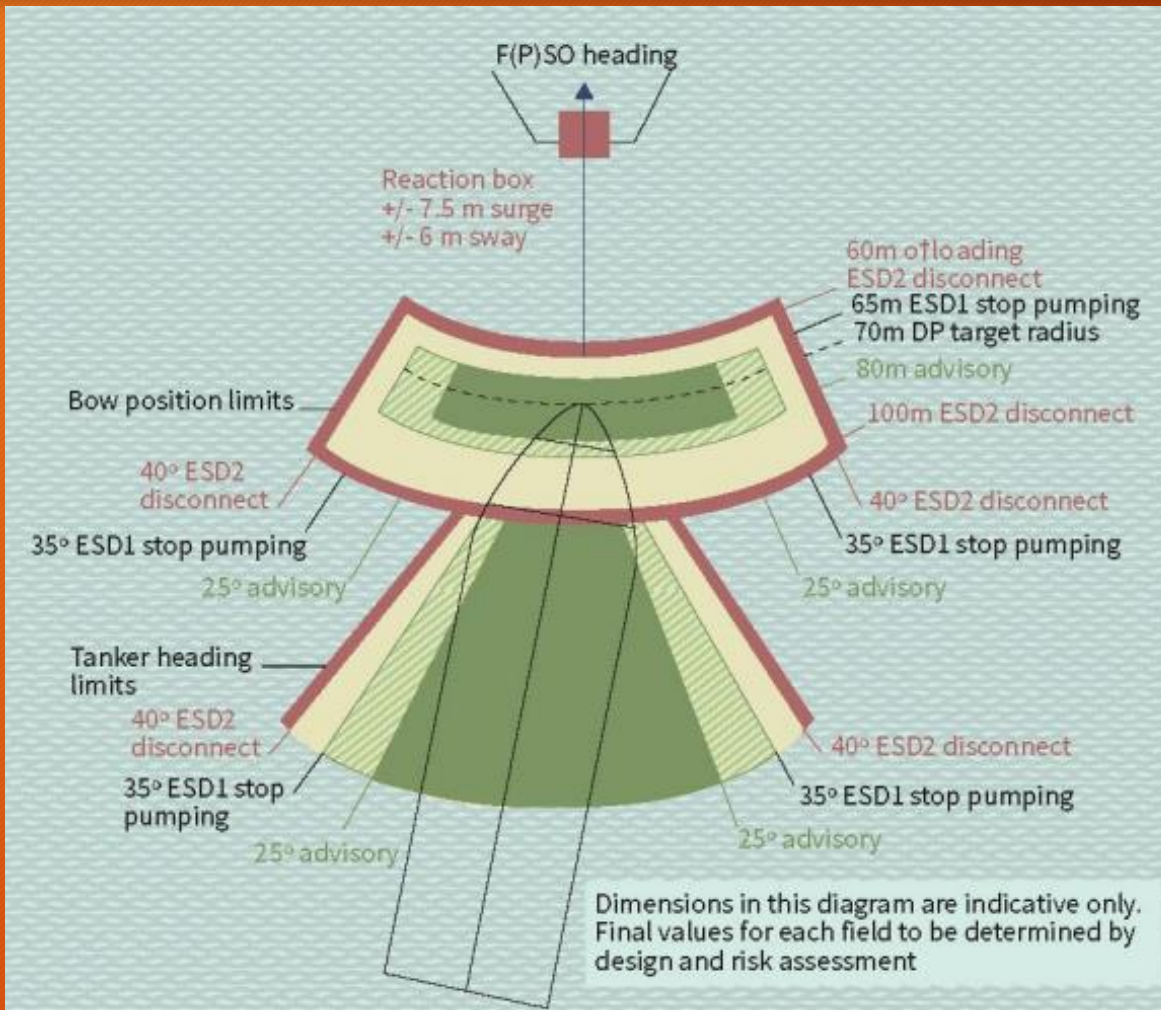


Criteria for Tandem Offloading

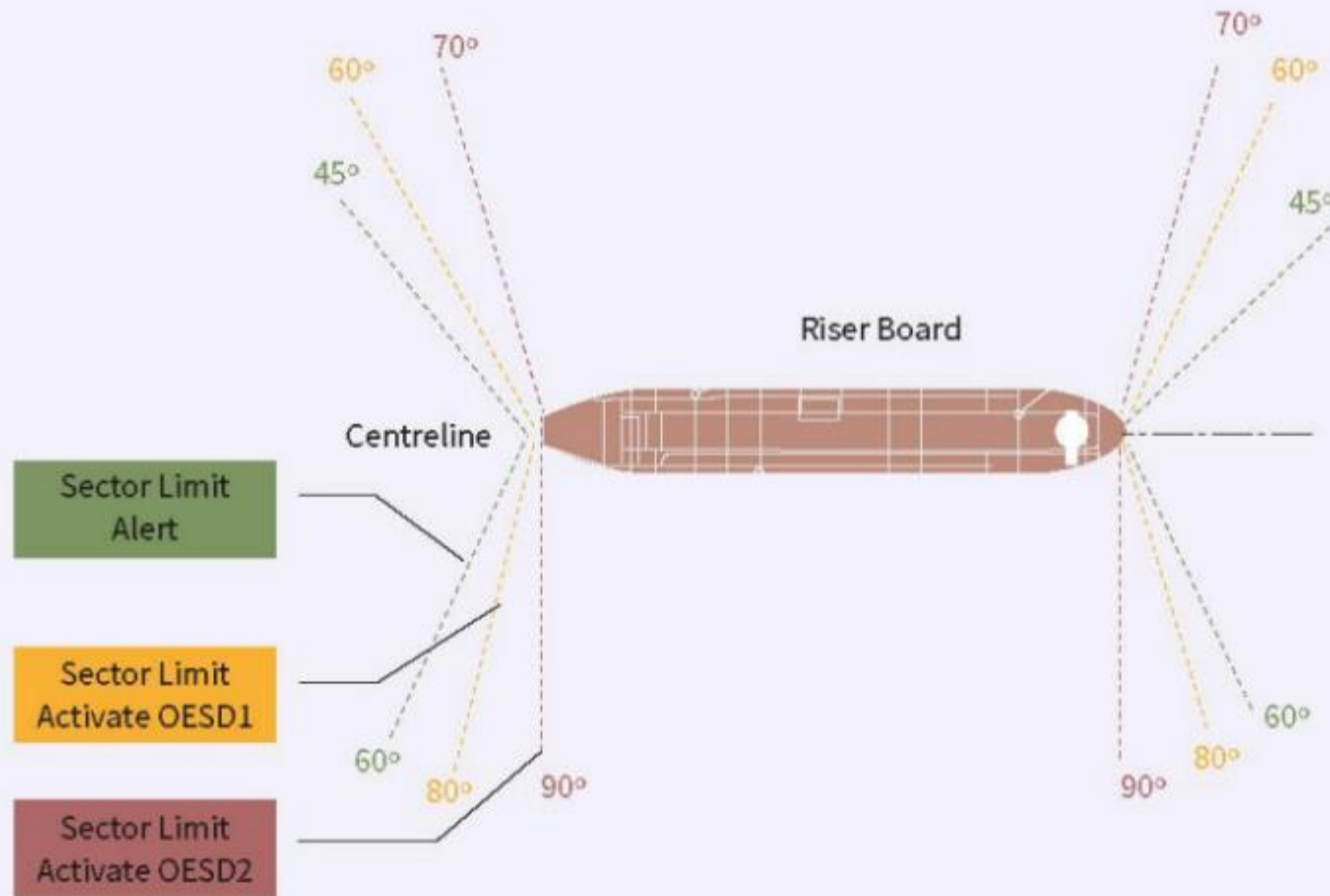
Source UKOOA

	Connect	Disconnect
Sign wave height	4.5 m	5.5-6.0 m
Max wave height	8 m	9.5 m
Max wave period	15 sec	15 sec
Wind speed	35-40 knots	35-40 knots
Visibility	500-800 m	

Tandem Offloading Limits Turret Moored FPSO



Tandem Offloading Limits Spread Moored FPSO



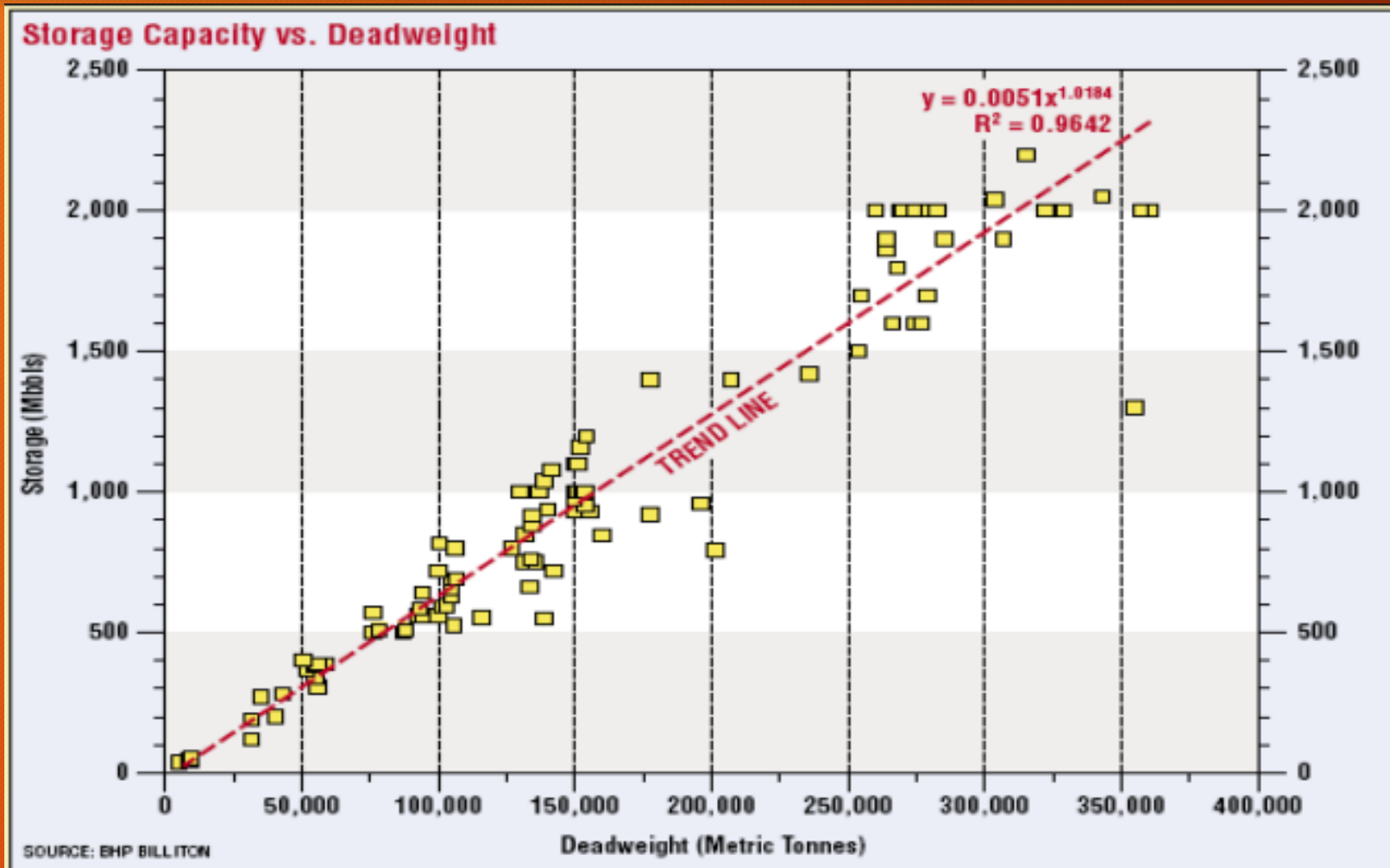
Design Steps

- Determine total storage tank capacity
- Max. filling of tanks typically 98%
- Determine dwt capacity requirement
- Add estimated weight of the process plant
- From comparable ships, estimate main dimensions and lightweight or steel weight
- Allow for project specifics (e.g. turret)

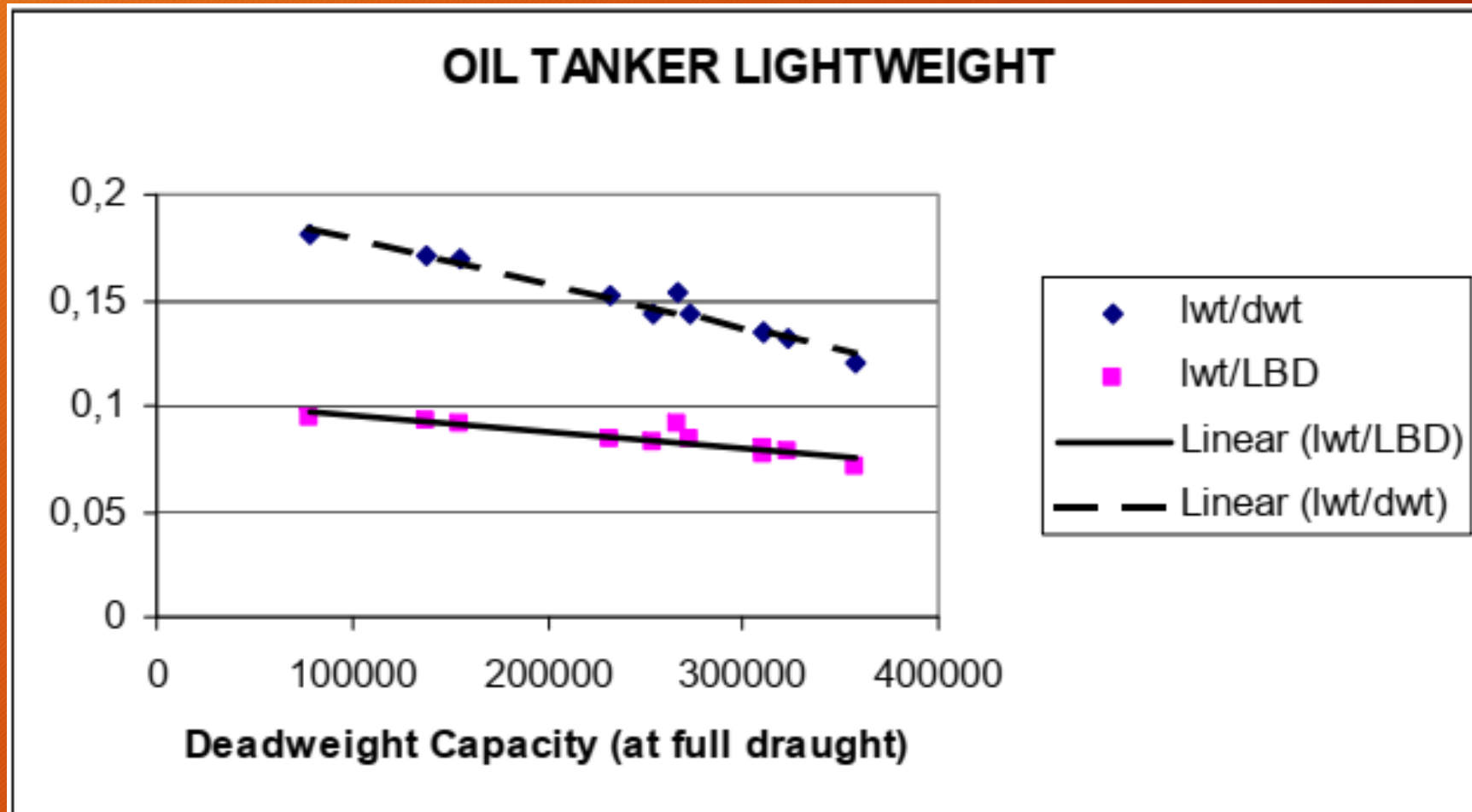
Main Dimension

- Largely determined by deadweight capacity
- Sometimes restriction of draught
- In North Sea and similar : risk of green water on deck / slamming on bow → ship shape with high freeboard at bow
- In benign areas : barge shape (cheaper to build)

FPSO DWT-Volume Ratio



Tanker Light Weight



Design Approach

- Determine the required storage capacity
- Start with an “educated” guess of dimensions
- Determine scantlings, based on Rules or first principles
- Check the required storage volume, weight capacity
- Include reasonable volume for water ballast
- Change dimensions and start again

The lwt/dwt statistics of tankers enable a bypass of the cumbersome determination of scantlings

Design Spiral - Hull Definition

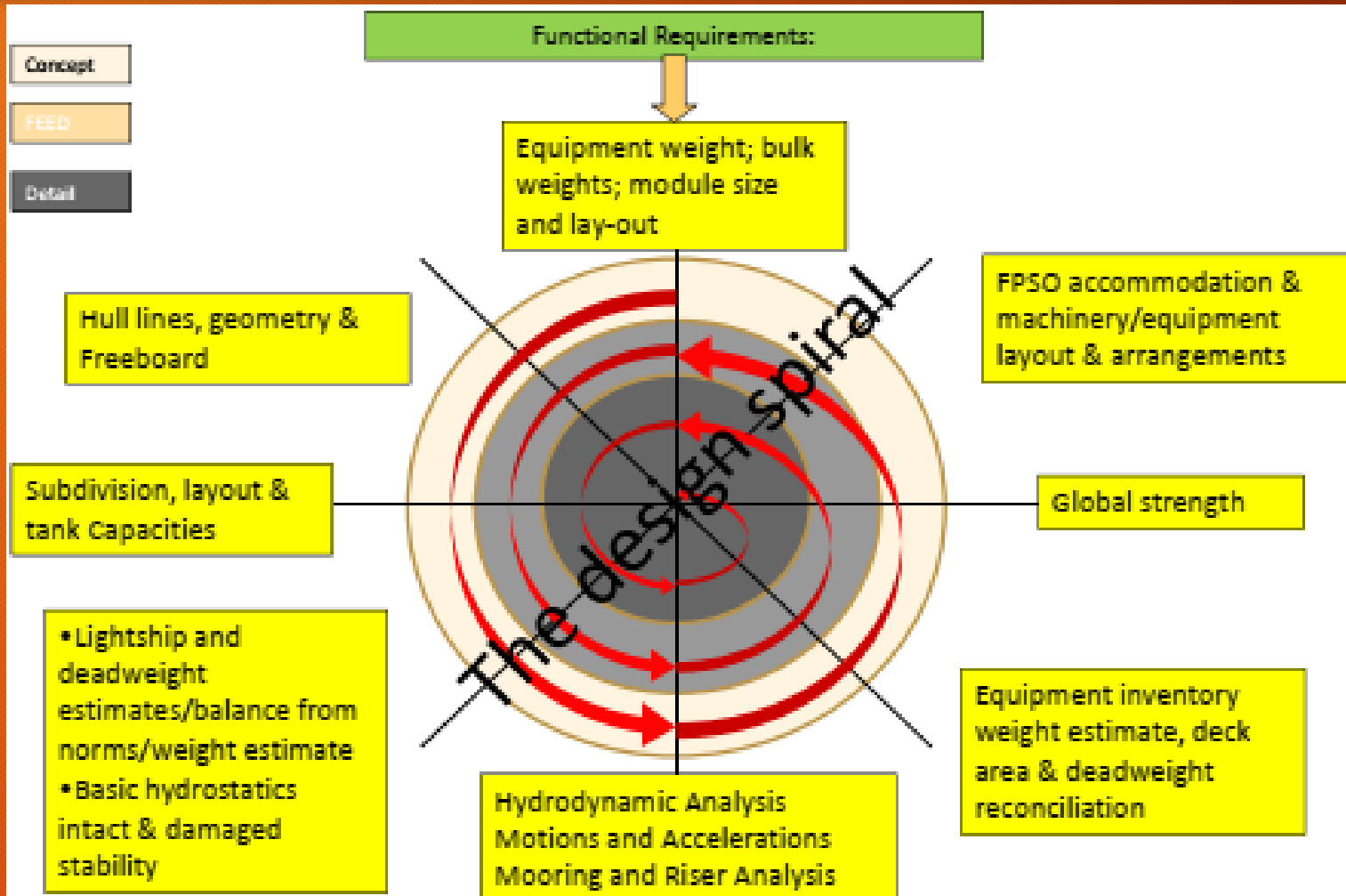
Objective :

- Validate and update initial sizing of hull - achieve frozen hull definition for accurate costing and FEED

Objective :

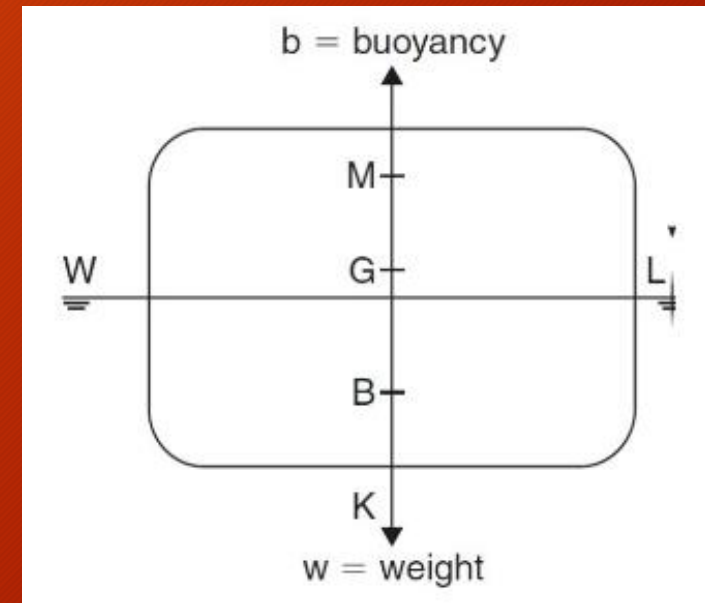
- Track around the 'design spiral' validating the initial hull sizing against the design requirements;
- Detail required to a level that de-risks the hull sizing and weights before FEED
- Margins include allowance for design growth at later stages
 - Hull & turret
 - Topsides weight and space
- At this stage investigations can be made into design options e.g. impact of fwd vs aft accommodation, tank layout etc

Design Spiral - Hull Definition

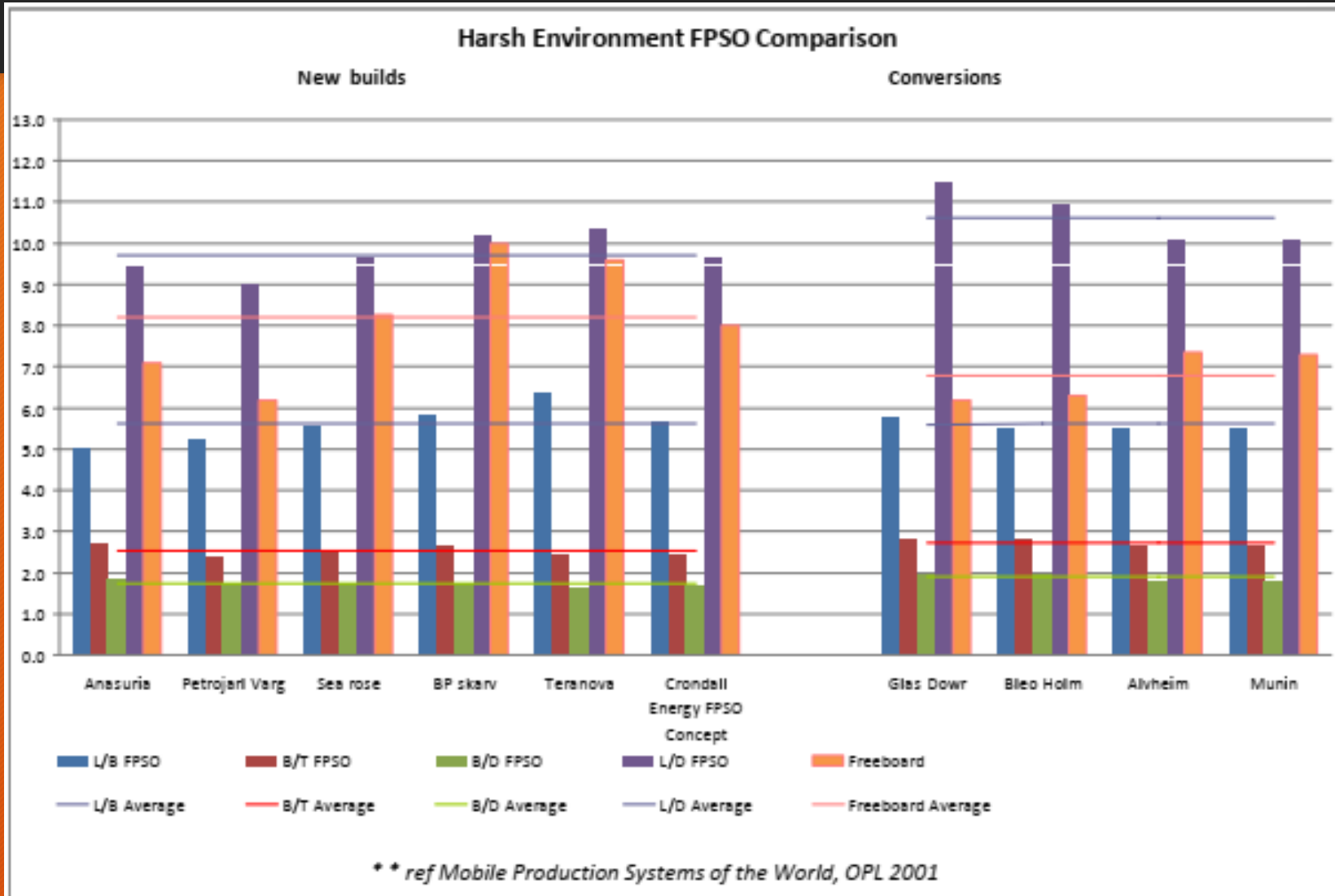


Check FPS0 Dimension

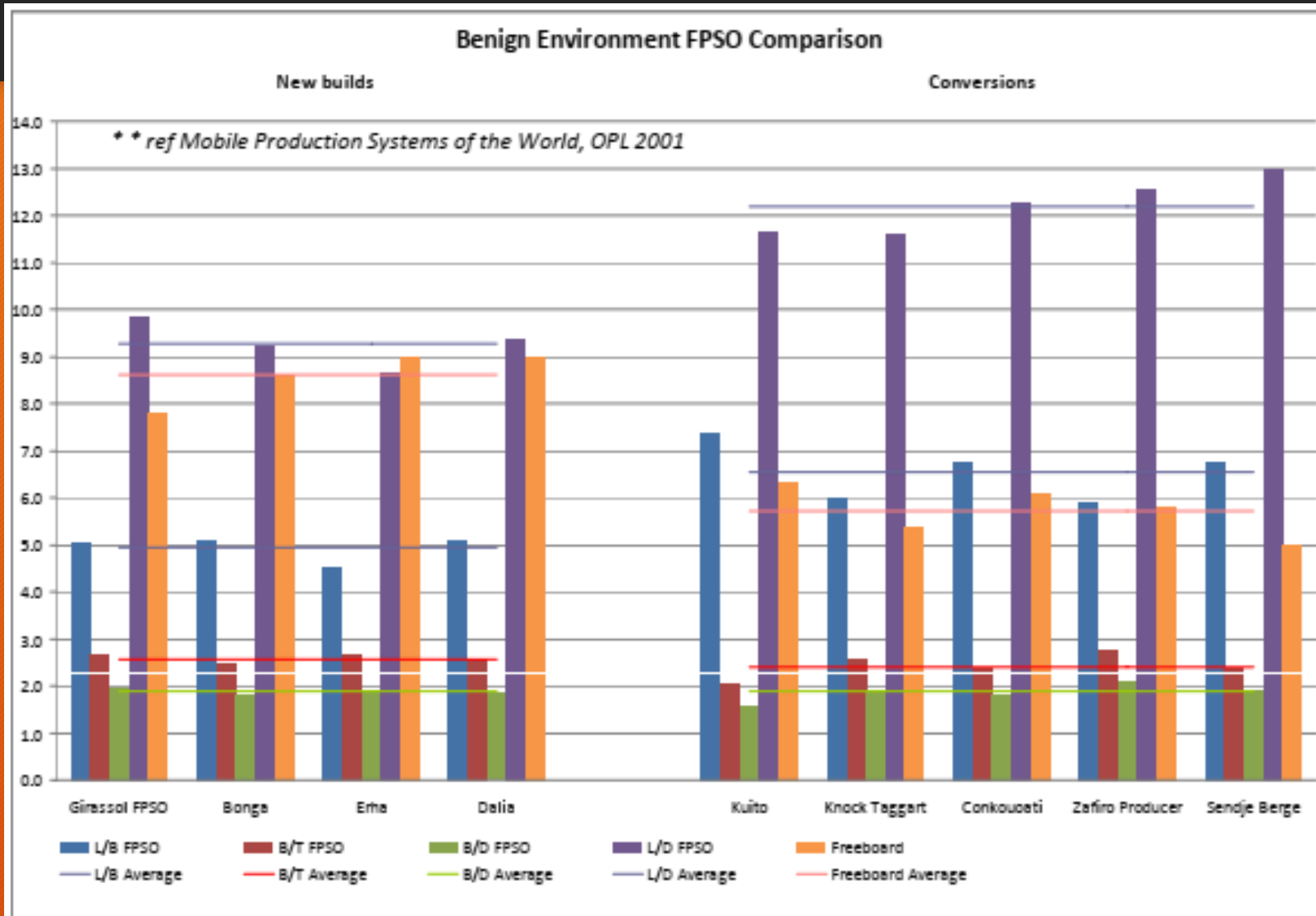
- Displacement = $\rho g C_B L B T$ + skin, appendices
- Displacement = lightweight (incl. process plant) + deadweight + suspended items (risers, anchor lines)
- Deadweight = cargo weight + fuel + fluids in systems + crew + miscellaneous
- $T_{max} = D - \text{freeboard}$
- Minimum freeboard determined by ship rules, for large tankers abt. 6 m
- Positive GM ($GM = MB + BK - GK$)
- Typical hull steel weight $\approx 13 \sim 16\%$ of displacement



Check FPSO Dimension



Check FPSO Dimension



FPSO can be Differentiate by

Construction	Conversion and new build
Shape	Ship-shapes or barge shapes
Cargo	Oil, LNG
Mooring	Spread moored, weather-vaning (turret) <ul style="list-style-type: none">- Internal turret- External turret
Offloading	Tandem offloading (oil product) or side-by-side (LNG product)

FPSO Shape

Barge Shape

- Benign area
- Normally new built
- Easier construction



Ship Shape

- North sea or similar
- Green water on deck
- Risk of slamming at bow
- High freeboard at bow
- Normally conversion

New Built Vs Conversion

New Built FPSO

- Field-appropriate design and fatigue lives are more easily achieved
- Technical, commercial and environmental risks are more easily managed
- Systems intended to survive harsh environments are more easily designable
- Re-sale and residual values are maximized and
- Reusability opportunities are improved

Conversion

- Capital costs are reduced
- Design and construction schedules are reduced
- More construction facilities are available and
- Overall project-supervision requirements are reduced

Design Arrangement

- Spread mooring or SPM
- SPM midship, internal in bow, external to bow
- Side or tandem offloading
- Flare tower or ground flare; position
- Separation between LQ and flare
- Heliport unrestricted access
- Process plant subdivision

Mooring

Soft Yoke (Nigeria)



Spread Moored (Nigeria)



Mooring

Internal Turret (UK)

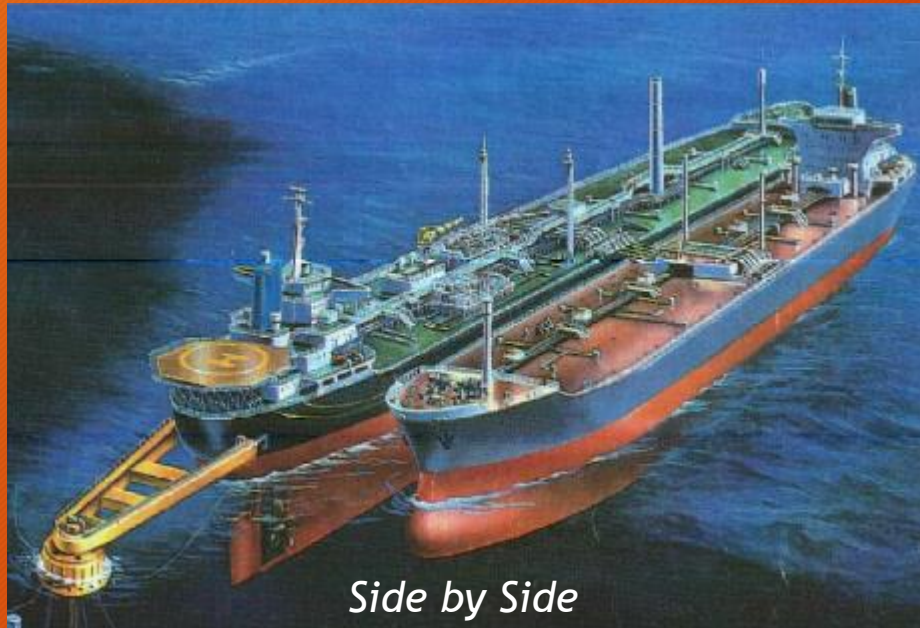


DP (China)

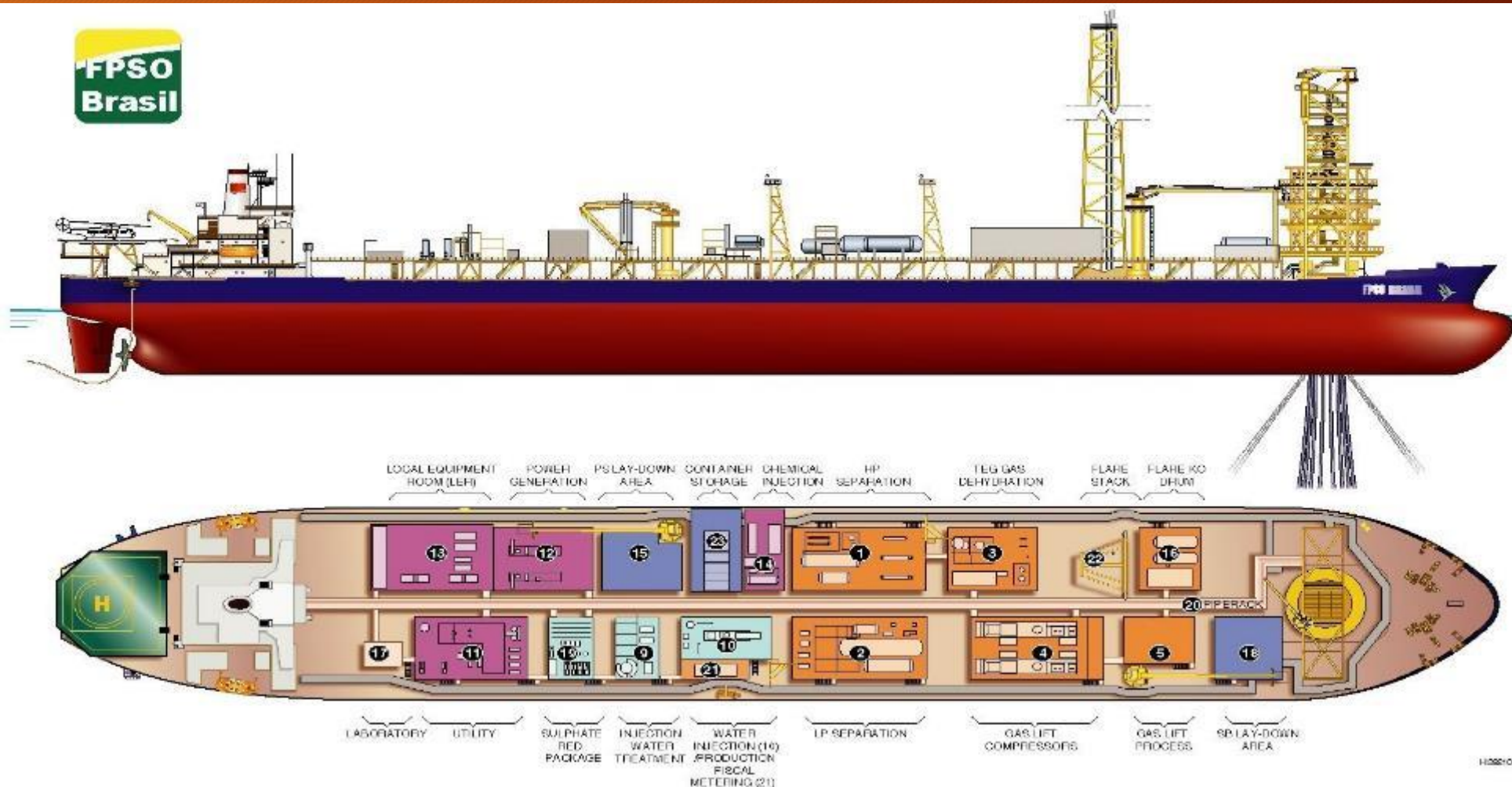


Offloading

- Usually within 24 hours
- Sea-state limits for mooring up and for remaining moored
- Shuttle tanker may be purpose built or a tanker of convenience



FPSO Design



FPSO Design



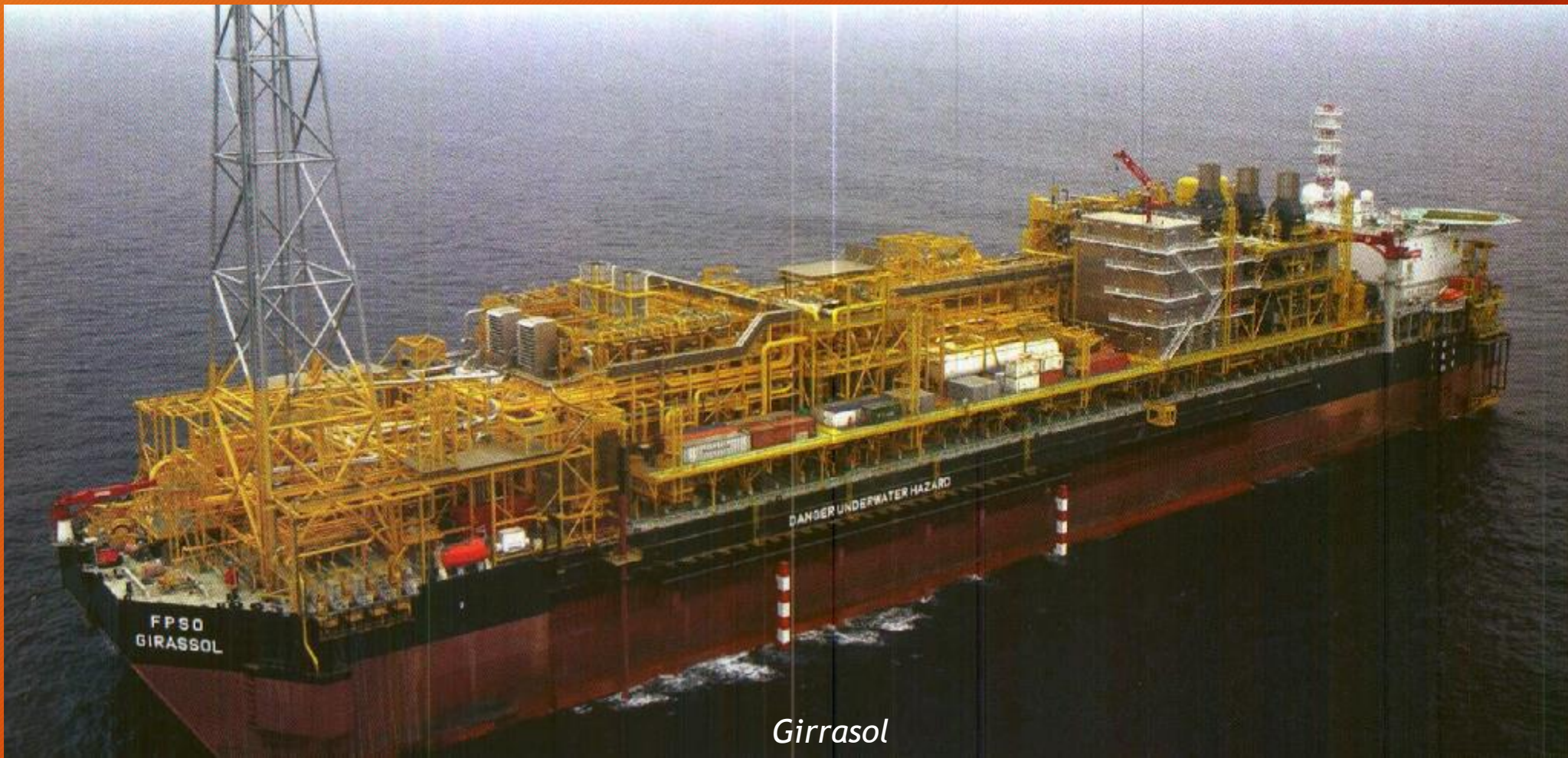
255 000 DWT

FPSO Design



BLEO HOLM

FPSO Design



Girrasol

LNG FSRU - New Built

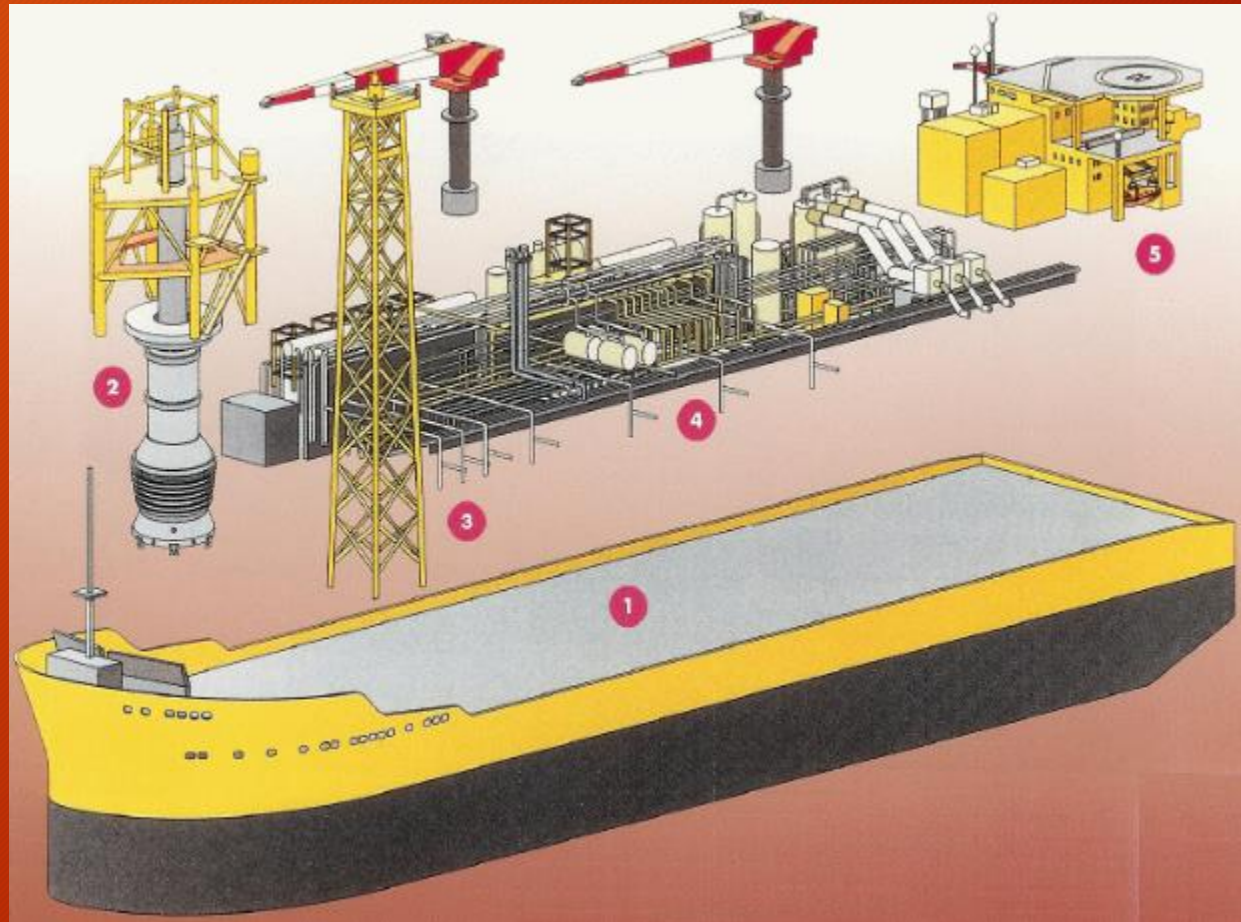


LNG FSRU - Conversion

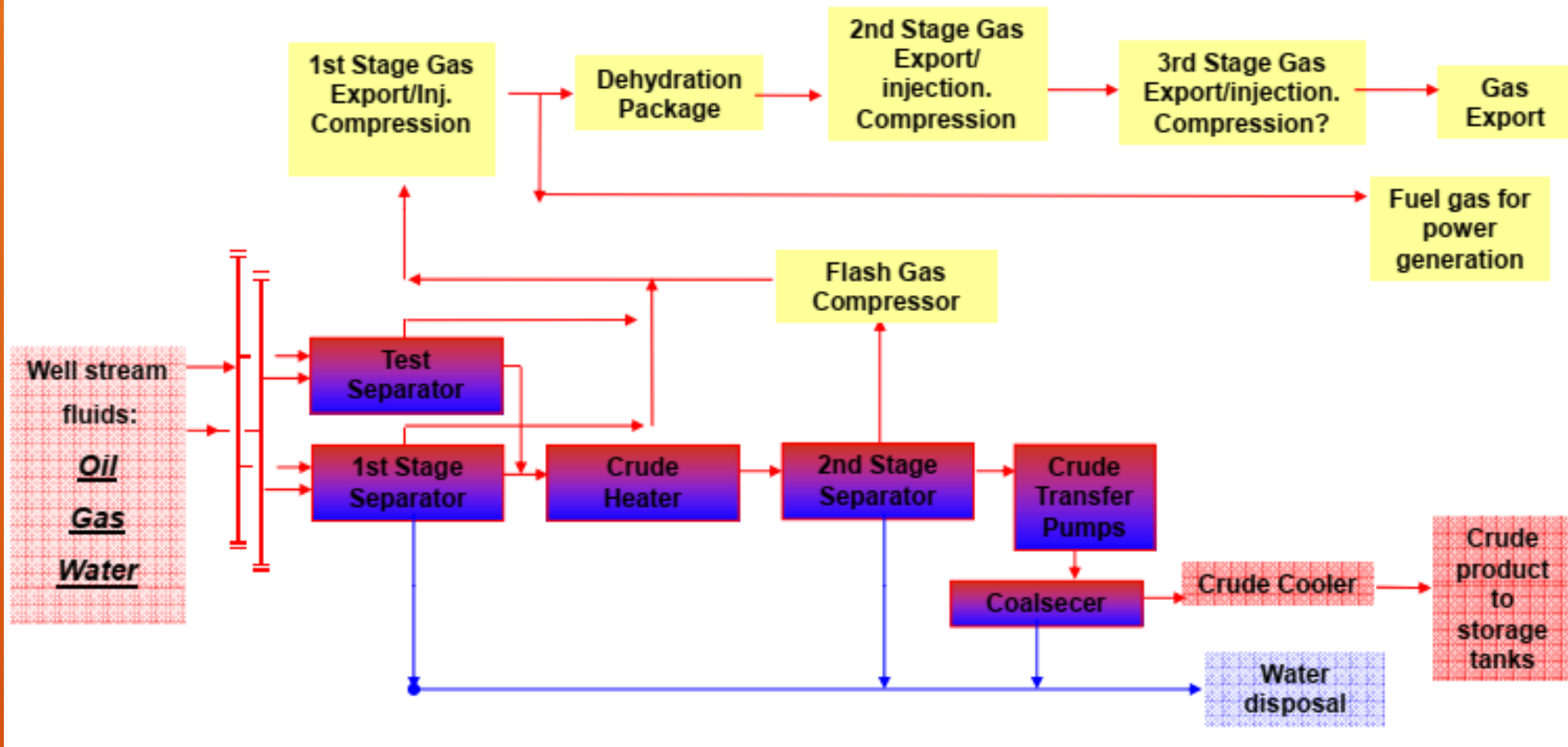


Process Plant

- At elevation above maindeck
- Subdivided in functional Pre-Assembled Units (PAUs), “pancakes”
- Weight and size determined by available lifting device and transportation device



Typical FPSO Process



FPSO – Conversion

Demolition of Existing Deck Structure

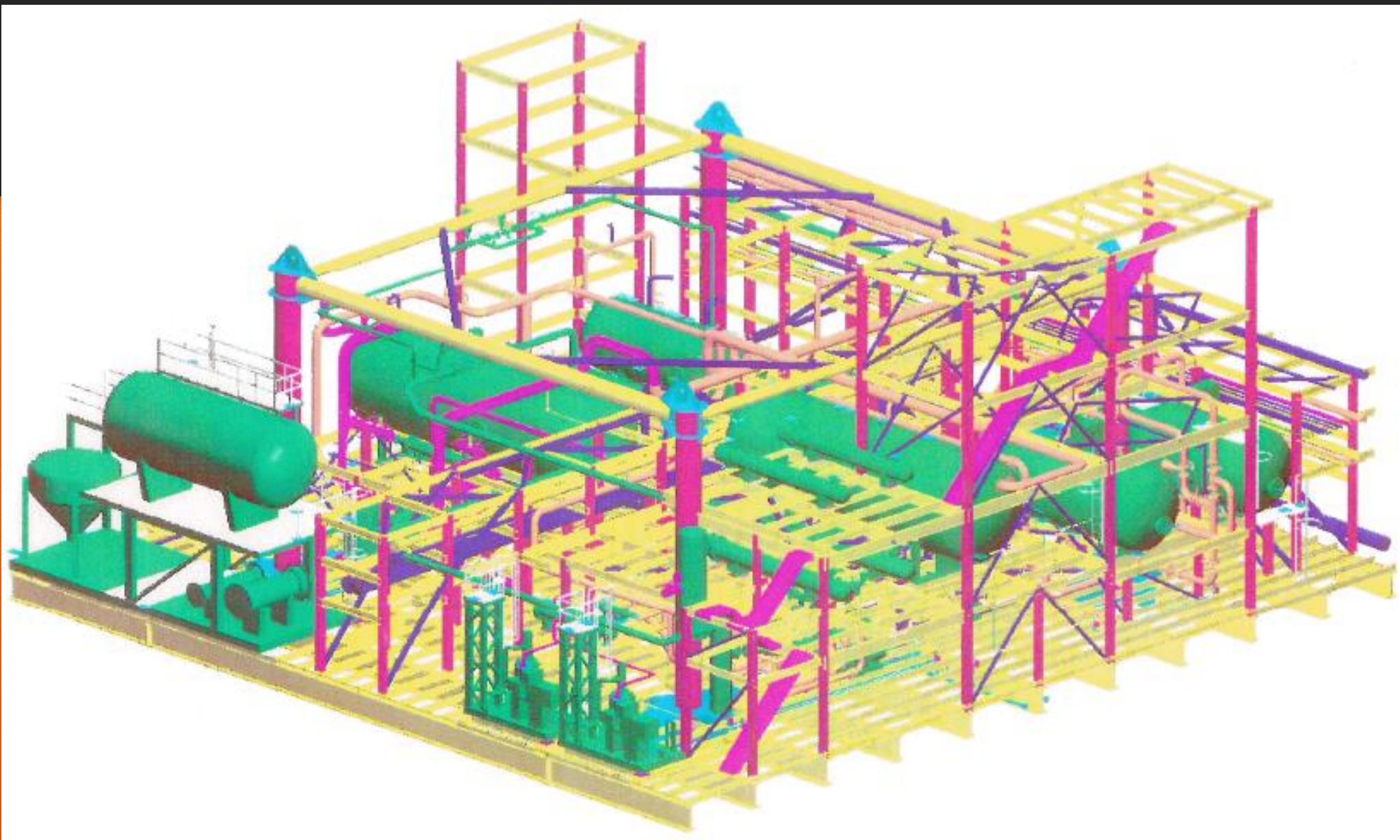


Elevated Deck

- Typically 2.5 m above (closed) main deck
- Minimizes impact of green water
- Provides natural ventilation
- Separates (explosions in) topsides from cargo tanks
- For Northern North Sea:
 - Green water : elevation above still water to be taken 18-22 m at bow, 10-12 m midship and stern

Typical (FPSO) Process Plant

- Separation Oil, Gas, Water
- Stabilized crude oil storage
- Gas handling - compressors, dehydration
- Water cleaning & disposal
- Cooling and heating
- Flare
- Injection : gas, water, chemicals
- Gas lift
- Utilities



CSU Module - ABB Lumus Global



CSU Module - Load out

Structural Weight Process Facilities

- Depends on flat versus 3D Pre-Assembled Units (PAU)
- Typically 30-40 % of total PAU weight
- Self bearing structure for
 - Load out
 - Installation by heavy lift
 - Decoupling from ship's hogging/sagging

Assembly

- "Pancake approach" saves time (ideally)
- Normally will add more weight
- Planning and logistics are essential
- Don't wait, expedite





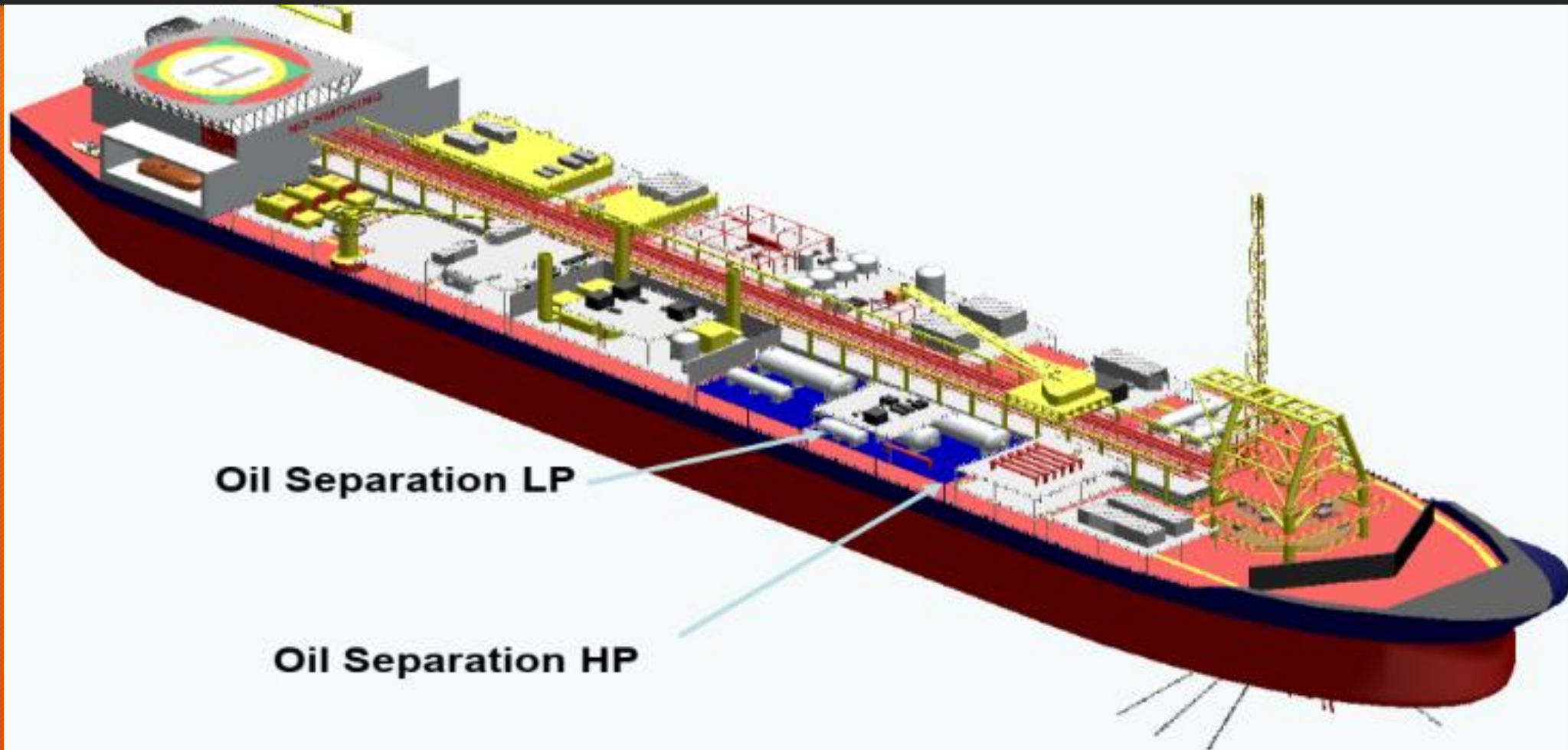
Lifting Provision



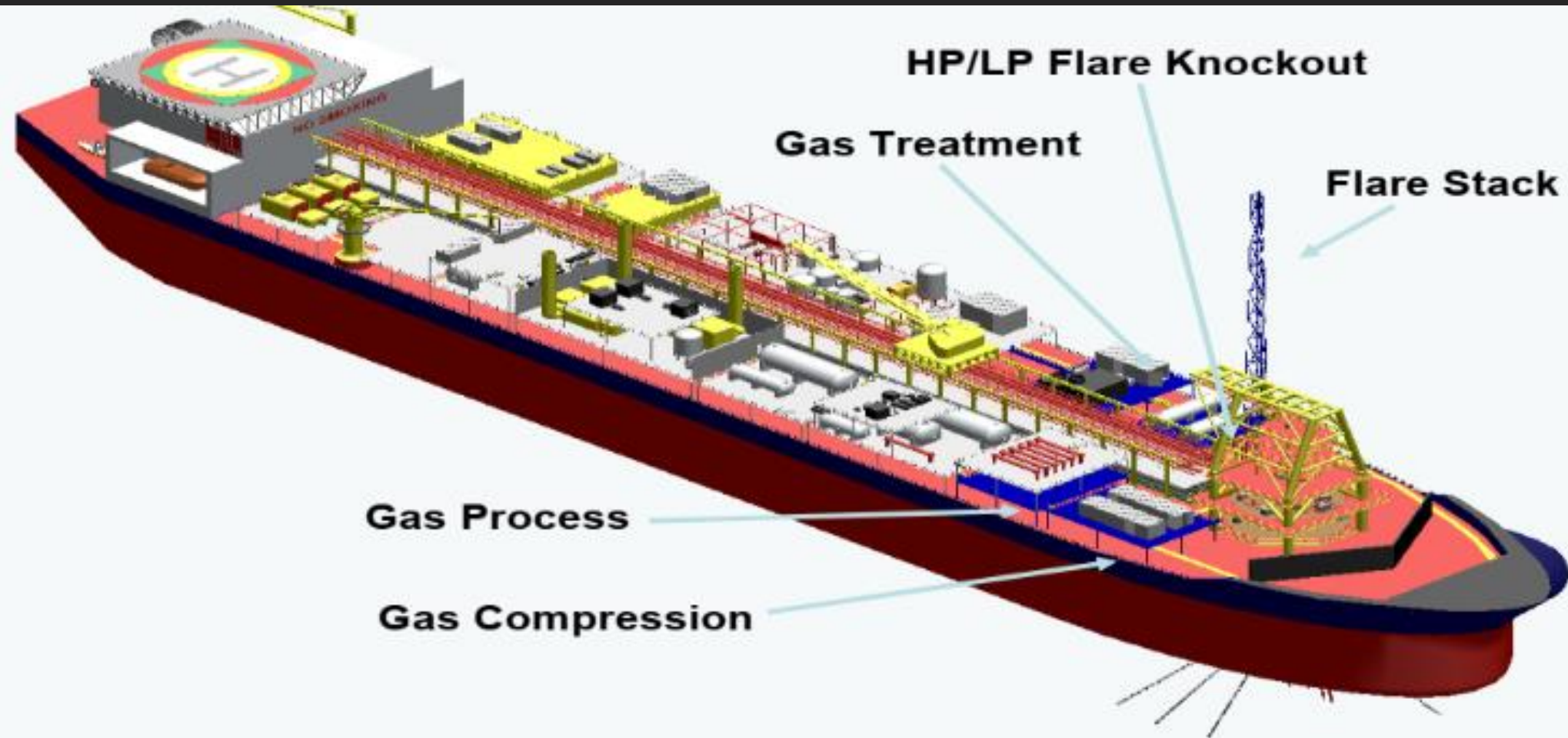
Typical Complete Topside



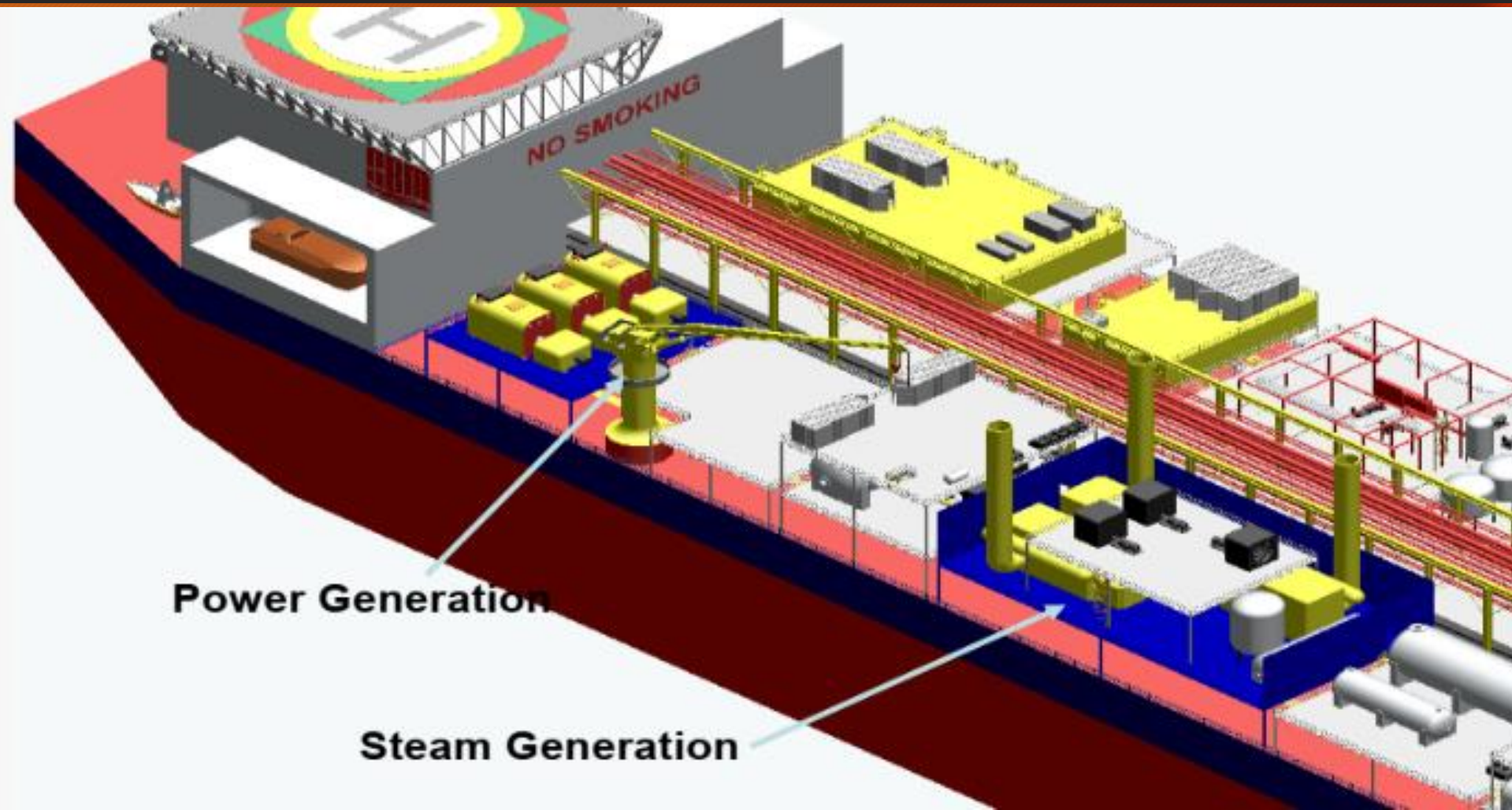
Oil Separation Module



Gas Compression Module



Steam Power Generation



FPSO System

