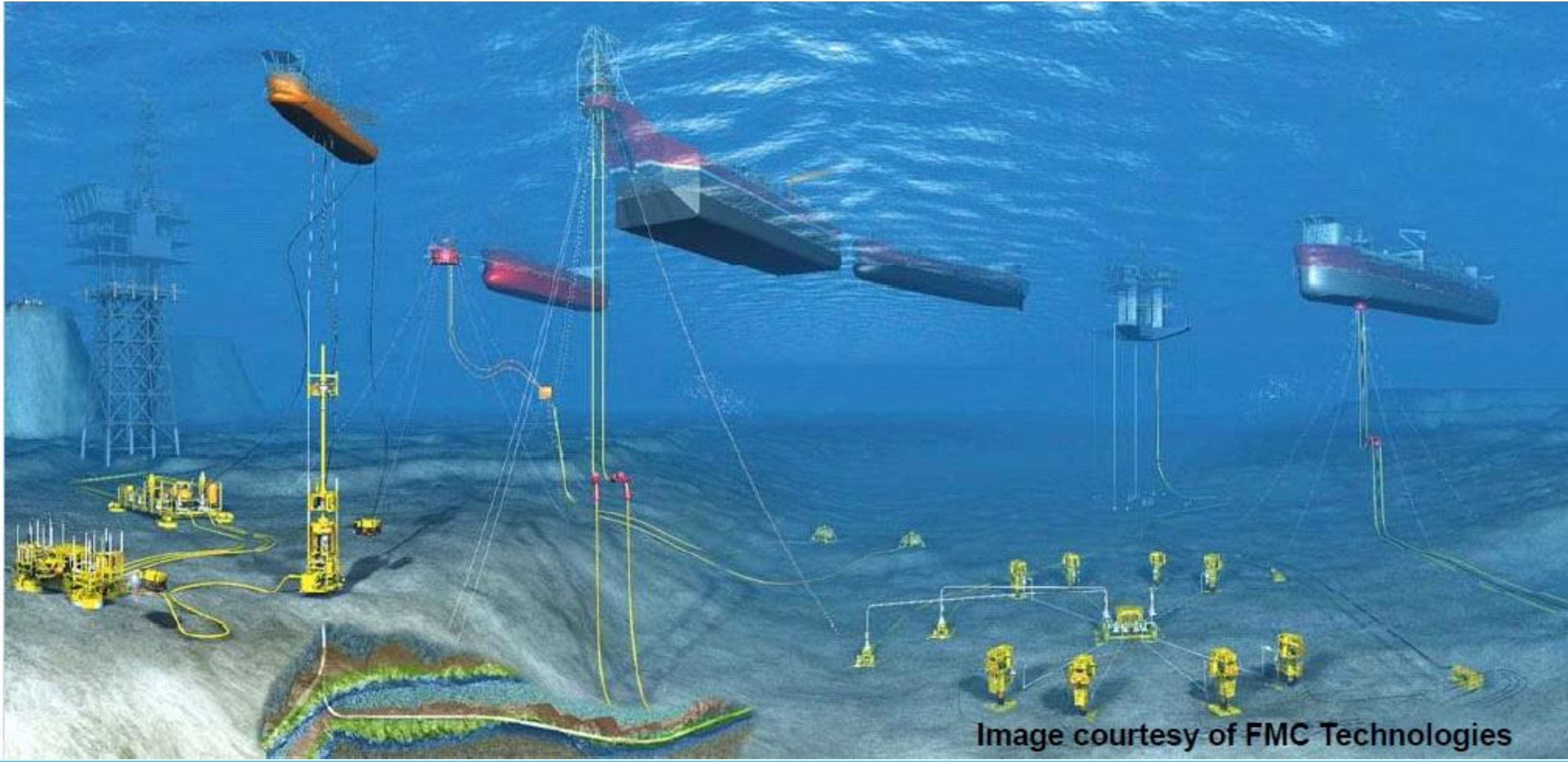
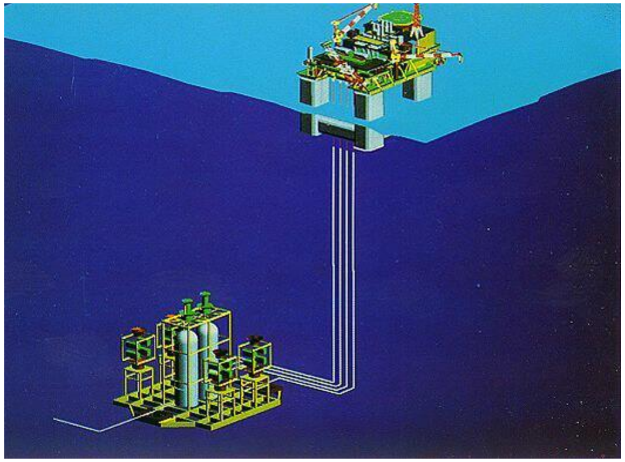


Offshore platform FEED

Yutaek Seo

Offshore platforms

Semi-submersible platform



- These platforms have legs of sufficient buoyancy to cause the structure to float, but of weight sufficient to keep the structure upright.
- Semi-submersible rigs can be moved from place to place, and can be ballasted up or down by altering the amount of flooding in buoyancy tanks.
- They are generally anchored by with chain, wire rope and/or polyester rope during drilling operations, though they can also be kept in place by the use of dynamic positioning.
- Semi-submersibles can be used in water depths from 200 to 10,000 feet (60 to 3,050 m).

FPSO

- FPSOs are large ships equipped with processing facilities and moored to a location for a long period.

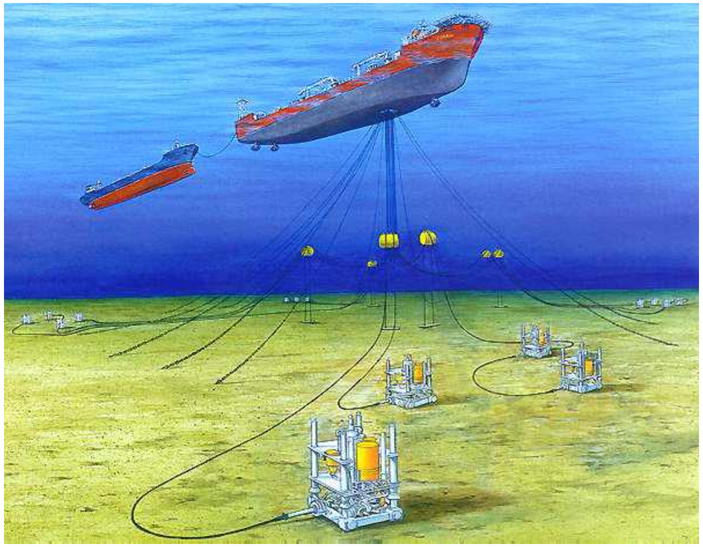
The main types of floating production systems are:

FPSO(floating production, storage, and offloading system),

FSO (floating storage and offloading system), and

FSU (floating storage unit).

- These ships do not actually drill for oil or gas.



Maintenance and supply

- A typical offshore platform is self-sufficient in energy and water needs, housing electrical generation, water desalinators and all of the equipment necessary to process oil and gas such that it can be either delivered directly onshore by pipeline or to a Floating Storage Unit and/or tanker loading facility.
- Elements in the oil/gas production process include wellhead, production manifold, Production separator, glycol process to dry gas, gas compressors, water injection pumps, oil/gas export metering and main oil line pumps.
  - All production facilities are designed to have minimal environmental impact.
  - Larger platforms are assisted by smaller ESVs (emergency support vessels) that are summoned when something has gone wrong, e.g. when a search and rescue operation is required.
  - During normal operations, PSVs (platform supply vessels) keep the platforms provisioned and supplied, and AHTS vessels can also supply them,as well as tow them to location and serve as standby rescue and fire fighting vessels.

Processes

- 3-Phase well fluid is received from Wells/Well Platforms and processed at Large Process Platforms generally consisting of the following four Major Processing Modules.
  - Separation (Oil, Gas and Produced water) & Oil dispatch
  - Gas Compression & dehydration
  - Produced Water Conditioning
  - Sea water processing & injection system

- These process complexes will also have the following:
  - Fire detection & Suppression system
  - Power Generation
  - Well services/drilling Modules
  - Water Maker/Utilities/Sewage Treatment
  - Living Quarters

Fire detection and suppression system

- Detection System
  - Gas Detection
  - Fusible Plug
  - Fire Detection
  - Smoke Detection
  - Heat Detection

- Suppression System
  - FIRE WATER PUMPS
  - Water Sprinkler
  - Dry Chemical
  - FM-200
  - CO2Extinguisher
  - AFFF SYSTEM

Escape / Abandon

- Escape Ladder
- Scramble Net
- Life Ring
- Life Raft
- Life Boat
- Jumping Rope

Utilities

- POWER GENEARTION –GAS TURBINE DRIVEN GEBERATORS
- WATER MAKERS-RO WATER MAKERS
- LIVING QUARTERS AND ASSOCIATED REQUIREMNETS LIKE LAUNDRY, GALLEY
- EMERGENCY DIESEL GENERATORS
- COMMUNICATION SYSTEMS

Thunder hose incident

- *Thunder Horse* was evacuated with the approach of Hurricane Dennis in July 2005. After the hurricane passed, the platform fell into a 20 degree list and was in danger of foundering.

- The platform was designed for a 100-year event, and inspection teams found no hull damage and no leaks through its hull. Rather, an incorrectly plumbed 6-inch length of pipe allowed water to flow freely among several ballast tanks that set forth a chain of events causing the platform to tip into the water.

- The platform was fully righted about a week after *Dennis*, delaying commercial production initially scheduled for late 2005. During repairs, it was discovered that the underwater manifold was severely cracked due to poorly welded pipes. An engineering consultant said that the cracked manifold could have caused a catastrophic oil spill.

- The platform took a nearly-direct hit six weeks later from Hurricane Katrina, but was undamaged.


BP Thunder Horse Platform
REUTERS

Weight report for Integrated Deck concept

- General
  - Previous studies identified a range of development options at various flow rates.
  - The objective of the Pre-FEED Phase for the offshore facilities is to refine key engineering definition aspects and to perform work to enable the preparation of a basis of design for the subsequent FEED Phase.
- Purpose
  - The purpose of this document is to describe the weight control methodology used for the Pre-FEED phase, and to define the estimated weights and centres of gravity for the Central Processing Facility (CPF) based on the integrated deck concept.
- Work scope
  - This weight report covers the weights and centre of gravity (COG) of all component parts of the CPF including both the topsides and hull. Data for the hull scope has been incorporated in this report from the GVAC Hull Weight Report

- Weights and COG for the CPF are presented for five load conditions as follows:
  - Minimum Transport Weight (Dry);
  - First Gas Weight (Dry);
  - First Gas Weight (Operating);
  - Future Weight (Dry); and
  - Future Weight (Operating).

- Flexible riser static loads, mooring line loads and marine growth loads are included, as applicable, in the scope of this document.

- This weight report applies only for the integrated deck concept for the CPF.

- Definitions

    : Nett Weight – the nett weight is the weight of an item or group of items and excludes all contingencies.

    : Gross Weight – the gross weight is the nett weight multiplied by a factor, the contingency, to account for potential growth of the nett weight figure for a number of different effects.

    : Dry Weight – the dry weight condition is a topsides condition and refers to the weight of the item or group of items when it is in its final location on the CPF and the CPF is on station with NO inventory, fluids or operational materials present.

    : Operating Weight – the operating weight condition is a topsides condition and refers to the weight of the item or group of items when it is in its final location on the CPF and the CPF is on station with ALL inventory, fluids or operational materials present. This weight includes fluids and contents at their normal operating levels.

: Contingency – the contingency is a factor that is applied to the nett weight to calculate the gross weight. This contingency is in effect an estimate of the accuracy of the nett weight figure. It will reflect the state of the design and the methodology used to determine the nett weight.

: Live Load – live load is weight allowance that is added to the overall operating weight of the topsides to allow for temporary mobile items to be placed on the facilities. This will cover for items such as maintenance spares and equipment, scaffolding, drum storage, chemical tote tanks, containers, temporary pig launchers, etc., and items that are essential to plant operation but whose location and weight will either move around, is temporary or is not well identified.

- Topsides weight estimates have been performed using the proportional method. This involved utilising major equipment weights from the Pre-FEED equipment list and applying weight bulk factors for piping, instrumentation, electrical, structural and other items.

- Hull weight information has been used directly from previous data for columns and pontoons.

- Project layout information has been used to estimate centres of gravity location for each major equipment item.

Weight estimating methodology

- Basis of weight data
  - This weight report for the Pre-FEED phase summarises the predicted weights and associated centres of gravity for the topside structures designed by the contractor, and includes data for the hull structures designed by the contractor.
- The weight report has been prepared on the basis of the following documents,
  - CPF Equipment List;
  - Plot Plans;
  - Hull Weight Report; and
  - Hull Equipment List
- It should be noted that:
  1. No Live Loads are included.
  2. No weights on laydown areas or other unspecified weights are included.
  3. No weight has been included for hull ballast water.
  4. Flexible risers and mooring lines are assumed to be the only field installed items for the CPF additional amendments as noted in this report.

- Software clarification
  - The topsides weight estimates and COG are implemented using Dataconnect 2.7.9, a computer database system for weight data management.
  - The database is compiled with all equipment items, discipline bulks and structural elements and referenced by a unique tag number. A complete listing of all line items with weights and location is provided in Appendix I.
  - The weight control program reports overall weight and COG information broken down by area and weight condition. A fully itemised summary list on an area basis, listed by discipline, is also reported to enable full checking to be carried out.

- Five load conditions have been established as follows:
  - Minimum Transport Weight – refers to the weight of the CPF excluding any field installed items (e.g. flexible risers);
  - First Gas Weight (Dry) – refers to the CPF dry weight installed on station at a point in time when first producing gas;
  - First Gas Weight (Operating) – refers to the CPF operating weight installed on station at a point in time when first producing gas;
  - Future Weight (Dry) – future weight refers to the CPF weight at a point in the future when all identified future modifications up to and including Phase 10 operation have been installed; and
  - Future Weight (Operating) – refers to the CPF operating weight at a point in the future when all identified future modifications up to and including Phase 10 operation have been installed.

- Weight condition codes

  : The weight condition codes are used for this project to compile the different load conditions

- The five load conditions for the CPF are determined by combining the following weight condition codes:
  - Loadout Weight (Min Transport Weight) = A;
  - First Gas Weight (Dry) = A + D;
  - First Gas Weight (Op) = A + D + E;
  - Future Weight (Dry) = A + D + G; and
  - Future Weight (Op) = A + D + E + G + H.

Weight Condition Codes

Code	Description
A	Dry weight installed onshore - All permanent items installed onshore in their final location
D	Dry weight installed offshore - All permanent hookup items in final location
E	Content weight - all contents under normal operating condition, plus operating consumables
G	Future dry weight - all offshore installed future permanent items
H	Future content weight - all offshore installed future contents

Weight estimating

- Topside

: The proportional method for estimating weight relies upon the use of the major equipment list and the application of discipline factors to arrive at an estimate of the total discipline weight of the CPF topsides weight.

: The following bulk factors derived from similar projects have been applied directly to the predicted weight of each topsides equipment item:

- Piping 62% of the equipment weight;
- Instruments 16% of the equipment weight;
- Electrical 11% of the equipment weight; and
- Other bulks 20% of the equipment weight.

: Primary and secondary structural steel weights for the topsides are specific to the proposed development option, e.g. integrated deck or modular deck.

: A structural steel bulk weight factor of 47% of total topsides weight (i.e. equipment + bulks + structural) has been used for integrated deck areas, and

: 50% of total topsides weight for any future modules (i.e. future inlet compression modules M1 and M2, and future separation module M3).

: The reduced structural steel bulk weight factor for integrated deck areas has been derived through a comparison of weights for both the integrated deck and modular concept estimated using the deck area method and layouts produced during Pre-FEED.

: For the Intermediate Deck, an additional structural steel bulk weight has been applied to account for the primary structural steel required for the Intermediate Deck to support future modules.

: The additional primary structural steel weight is assumed to comprise 30% of the total of the module and additional primary steel weight.

: The listed bulk factors are applied to topsides equipment only.

: No bulk factors are applied for the following items:

- Accommodation;
- Helideck;
- Flare Tower;
- Caissons; and
- Risers and i-tubes.

: Bulk factors are not applied to these items, because either the weight of any bulks is included in the equipment/package weight, or there is minimal or no requirement for any supporting bulks.

: Unlike the above items, a structural steel bulk weight has been applied to account for the primary structural steel required for the integrated decks to support the MEG and Glycol Regeneration Packages.

- As in the case for future modules, the additional primary structural steel weight is assumed to comprise 30% of the total of the package and additional primary steel weight.
- No other bulk factors are applied for the MEG and Glycol Regeneration Packages as they are included in the package weight.

: No piping bulk factors have been applied to major manifolds (i.e. Train 100, Train 200, Future Plover) as the manifold weight itself indicates piping weights.

: The estimated weight for the living quarters (960 tonnes nett) has been taken from the CDP equipment list.

: The flare tower (300 tonnes nett) and helideck (110 tonnes nett) weight and COG have been included as separate items and not assumed to be included in the structural bulk factors used across the topsides.

: Operating weight has been estimated as an additional 10% of equipment and bulk weights for all topsides equipment and any topsides related equipment located in hull areas (e.g. caissons, lean MEG booster pumps).

- Columns

  : The weight information provided accounts for structural steel, equipment outfitting, mechanical equipment and bulks for electrical, HVAC, instruments, piping, corrosion protection and mechanical.

  : Additional equipment in the columns required to provide topsides services is included in addition to the previous weight data. These items include lean MEG booster pumps and caissons for seawater, firewater and open drains.

  : Bulk factors are not applied to these items as the previous bulk weights are assumed to sufficiently cover any bulks required for these items.

  : Operating weights for the columns has been accounted for through specific operating loads for mooring loads and marine growth, as provided by the contractor’s hull weight report.

  : No operating weight has been included for hull ballast water.

- Pontoons

  : The weight information provided accounts for structural steel, equipment outfitting, mechanical equipment and bulks for electrical, HVAC, instruments, piping, corrosion protection and mechanical.

  : Operating weights for the pontoon has been accounted for through specific operating loads for fuel oil, MEG and freshwater, as provided by the contractor's hull weight report

  : No operating weight has been included for hull ballast water.

Contingency philosophy

- Topside

  : A contingency is a factor that is added to the nett weight to give the gross weight. This factor is a percentage of the nett weight.

  : The purpose of the contingency is to allow an assessment of the accuracy of the weight data and to allow for variations in the data as the design and fabrication of the facilities is progressed.

  : For the purposes of Pre-FEED, an overall contingency of 25% has been applied to the topsides scope.

- Hull

  : The values taken from the hull weight report are gross weights and therefore no additional contingency has been applied here.

  : A contingency of 10% has been applied to all hull weights/loads.

Co-ordinate system

- The co-ordinate system and origin used for the project are shown in following figure.
- The co-ordinate system used is the company's corporate standard as follows:

  +x (Northings) in direction of CPF North;

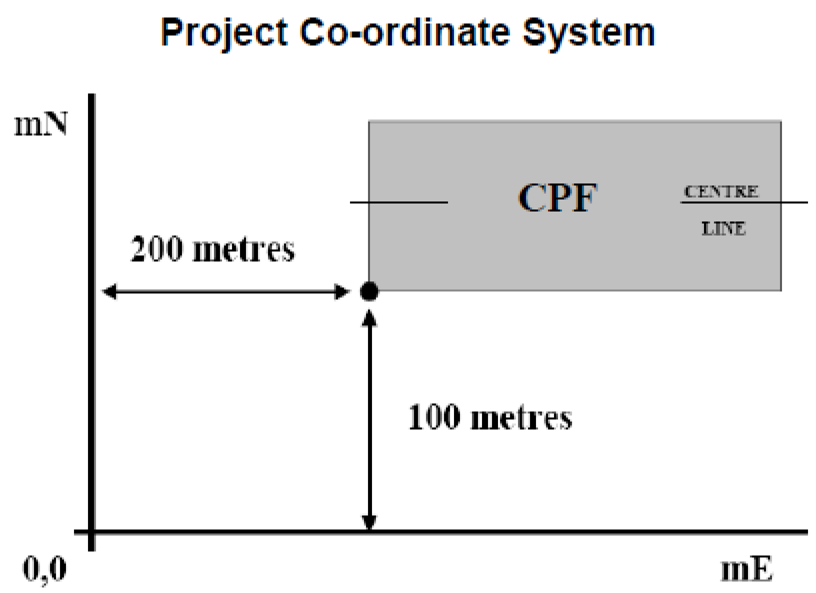
  +y (Eastings) in direction of CPF East; and

  +z vertically up.
- The origin of the co-ordinate system is based on the SW corner of the underside of the hull being been taken at the following location:

  x = 100m N;

  y = 200m E; and

  z = 0m.



Discipline code

- AR - Buildings / Architectural;
- CV - Civil;
- EL - Electrical;
- HV - HVAC;
- IN - Instrumentation;
- LC - Safety/Loss Control;
- MC - Equipment Mechanical;
- NA - Marine / Naval Architecture;
- PI - Piping;
- PL - Pipelines;
- SB - Subsea;
- ST - Structural;
- SS - Service Supports;
- TE - Telecommunications; and
- WE - Weight Engineering (Other).

Platform topside

Select

1 IDENTIFY » 2 EVALUATE

Deliver

3 DEFINE » 4 EXECUTE

Improve

5 OPERATE

- Pre-feasibility screening studies
- Business model development
- Feasibility studies
- Conceptual design
- Cost estimating
- Contract planning

- Preliminary Engineering (FEED)
- Cost estimating
- Execution planning
- Detailed Engineering
- EPCM
- PMC

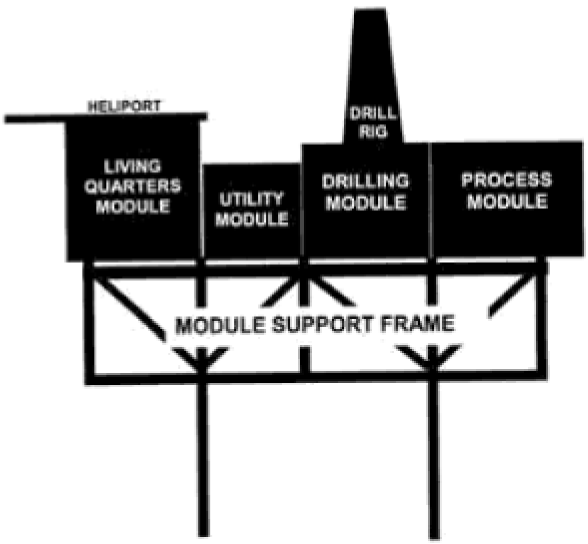
- Brownfield projects
- Portfolio delivery
- Asset management
- Business improvement
- Operations and maintenance support

Platform deck: Integrated vs Modular

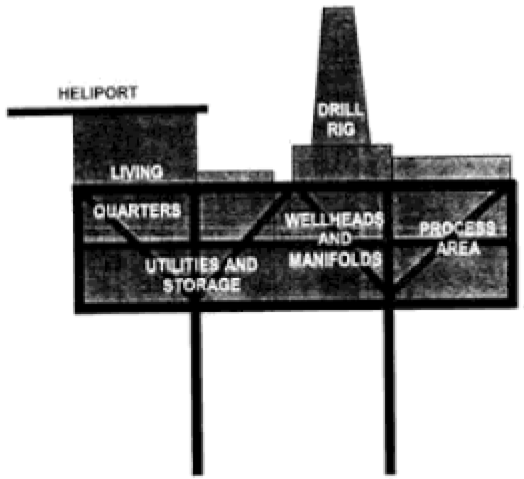
- If the production equipment is to be packaged into modules, a two way truss system called the module support frame (MSF) is utilized.

  : MSF consists of a system of horizontal girders and vertical and diagonal braces, which transfer modules load to the tops of platform legs.

  : Modular deck is used when the deck weight or geometry exceeds the available crane lift capacity or modules containing come of the production equipment will be added at later dates (such as a compression modules)



a) Modular Deck



b) Integrated Deck

- If the dry deck weight and geometry are within the available crane, an integrated deck configuration may be considered.
  : Integrated decks eliminate the need for module steel, which is only needed for lifting purpose and generally result in lighter structures.

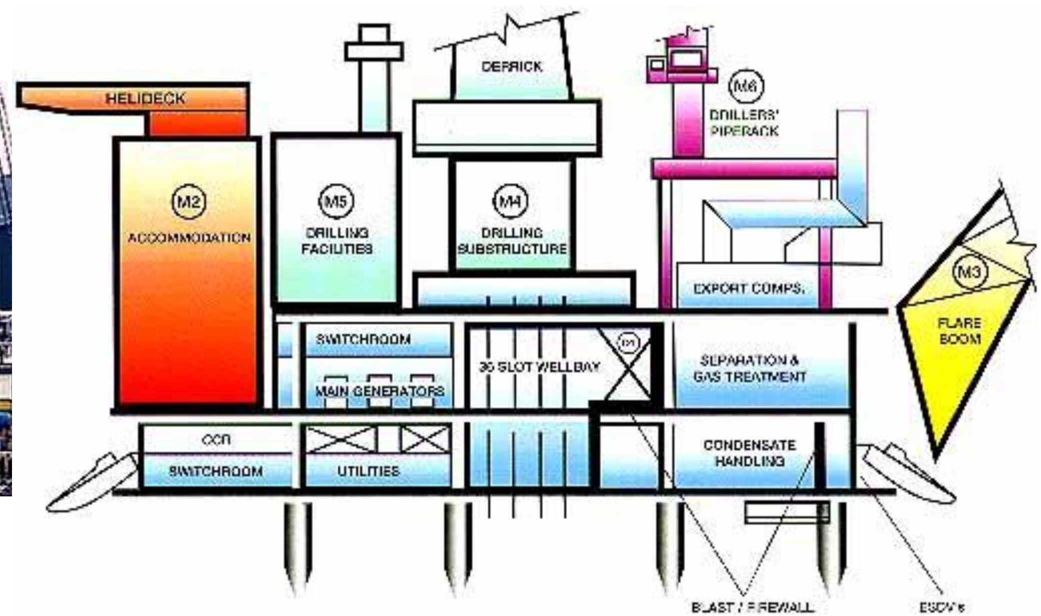
- In hybrid deck configurations, some of the utility, wellhead, and/or process equipment and storage may be placed inside the MSF, which would be installed in a manner similar to an integrated deck, followed by the installation of modules on tis top.

Installation of Breagh Alpha platform (2000 tonnes)

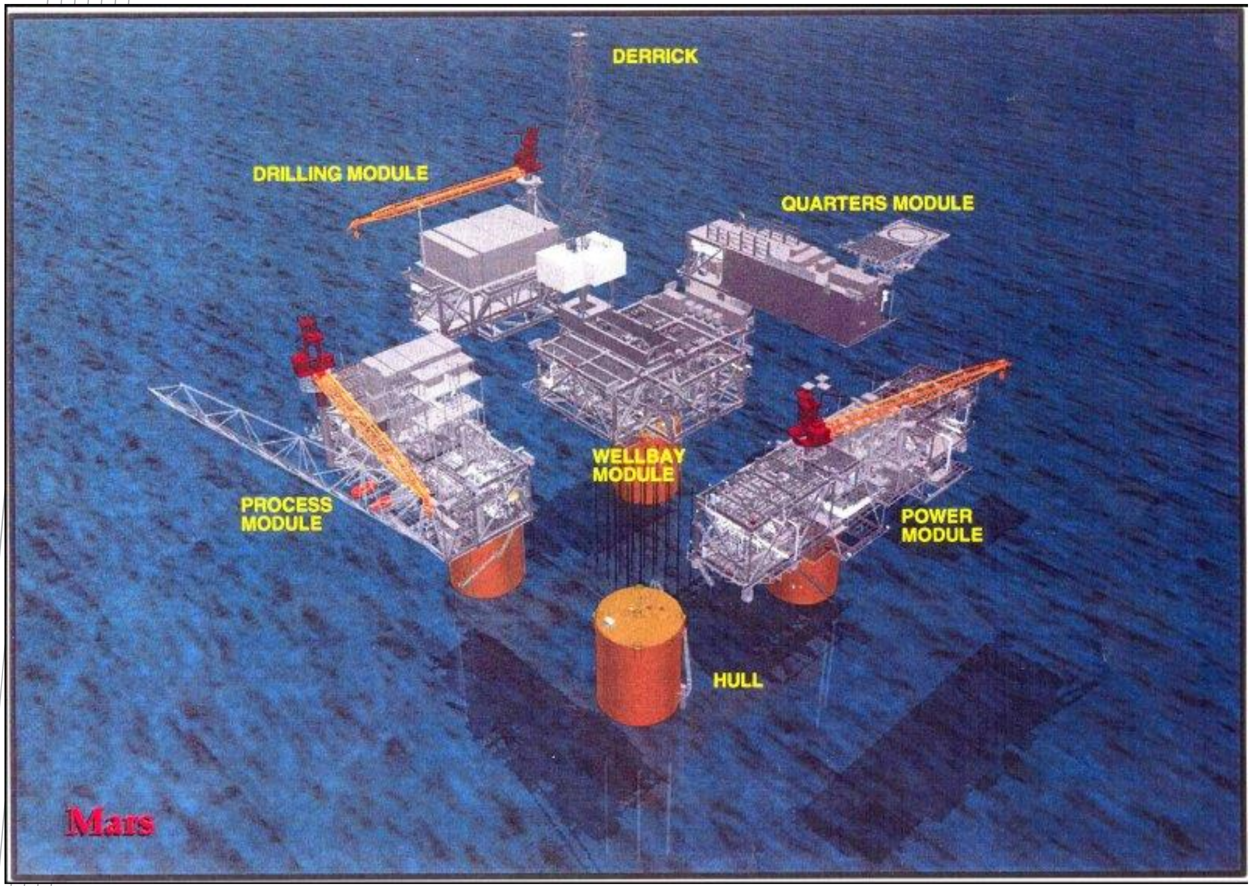
Britannia platform

Britannia platform, UK

- The seven major components comprising the platform topsides were built in Lowestoft and Teesside. These contain utility, drilling and production facilities, together with a 140-man accommodation unit. The heaviest unit is the integrated deck, weighing 11,000t, which required maximum use of the lift (this was one of the largest semi-submersible crane vessels available).



Modules for TLP



- Modules are units that make up the surface facilities on the deck section of the platform.
- Early in TLP development, industry discovered that it is cost effective to build the surface facility in separate units (modules), assemble them at shallow inshore location, and then tow them to the site.
- The modules that are part of a typical TLP include the wellbay, power, process, quarters, and drilling; they are secured to the deck, which is attached to the hull.

- One of the key decisions made prior to the deck member size selection is the determination of the deck elevation relative to the sea surface.

  : The deck elevation must be selected to provide a satisfactory gap between the wave crest and the deck structure.

  : Major Gulf of Mexico platform damage, including total platform and/or deck losses, has been experienced in the past due to platform decks being slammed by wave crests.

  : The standard industry practice is to provide a safety margin by providing an “air gap” between the elevation of the design wave crest and the bottom of the deck steel. (The crest elevation is for a nominal 100-yr return period wave)

- Shell's Mars TLP after Katrina hit

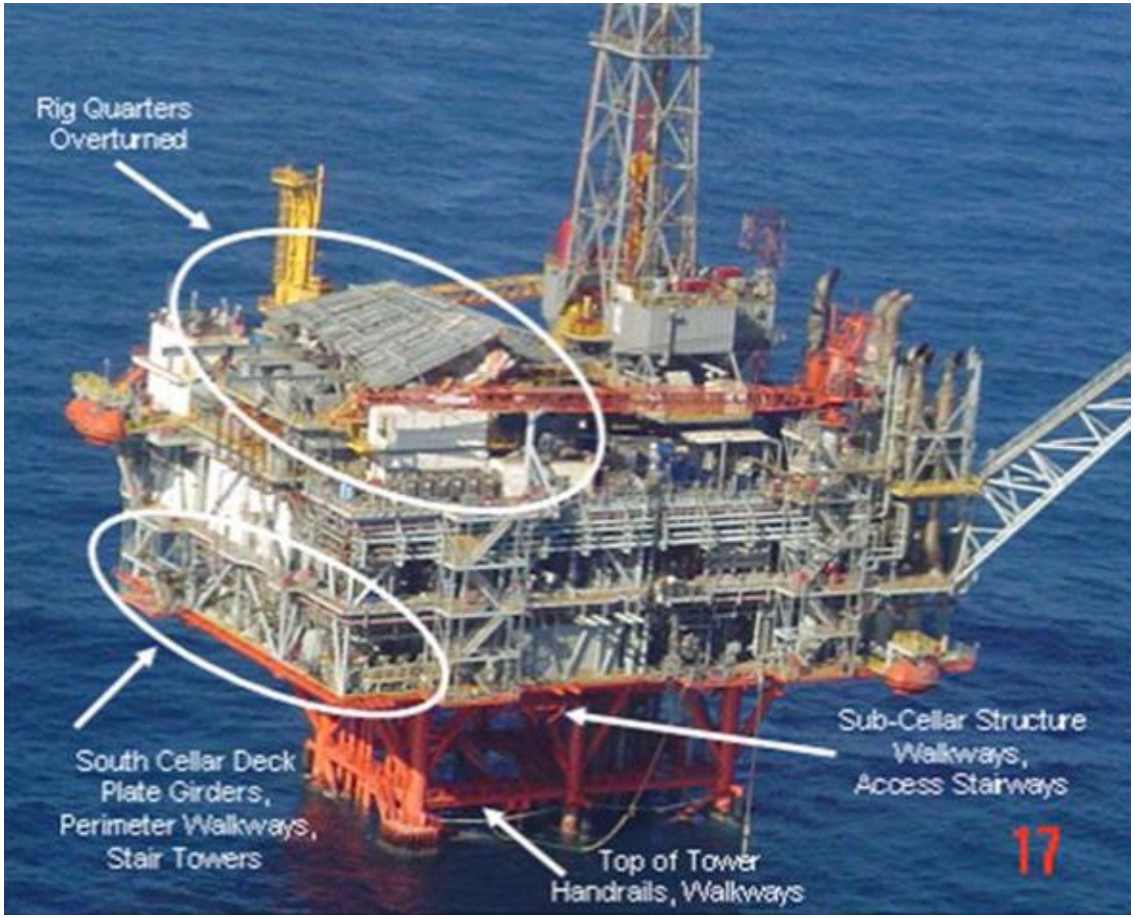
  : Repair to the lift of the 1,000 ton damaged rig substructure, and to the both of the Mars product export pipelines in 2,000 feet of water and the mooring of the Safe Scandinavia in 3,000 foot water depth.

  : Fully repaired with one million man-hours

- 2004 Hurricane Ivan – Chevron: Petronius platform

  : damaging crew quarters, deck structures, and production equipments

  : Shut-in for 175 days but has been ramped up to 100% of pre-hurricane levels



Thank you!