

Image courtesy of FMC Technologies

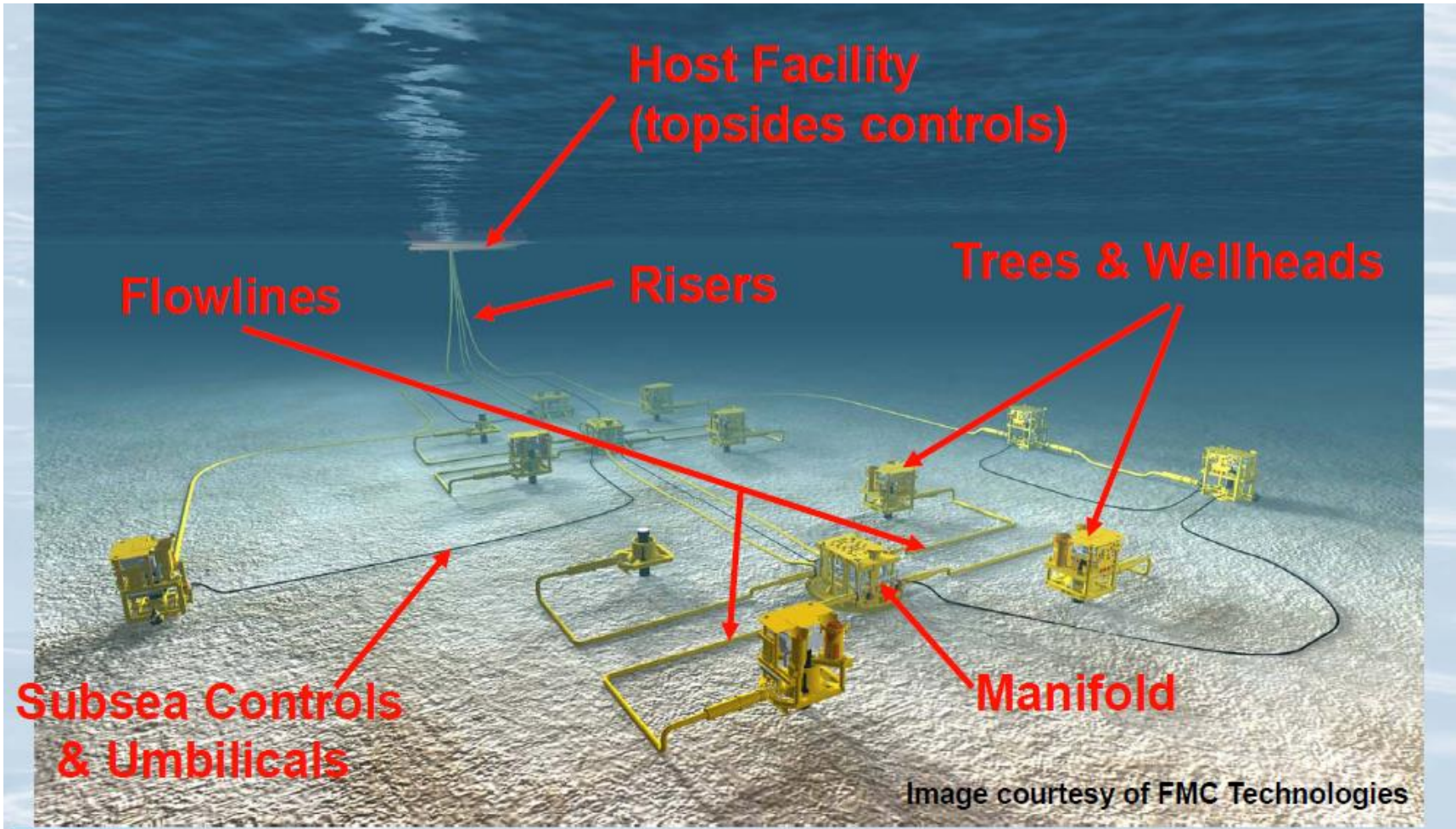
# Offshore Equipment

Yutaek Seo

# Lecture Plan

<b>1</b>	<b>Offshore projects with various equipment</b>
<b>2</b>	<b>Offshore pipeline design</b>
<b>3</b>	<b>Production facility</b>
<b>4</b>	<b>Process selection</b>
<b>5</b>	<b>Two phase oil and gas separation</b>
<b>6</b>	<b>Mechanical design of pressure vessels</b>
<b>7</b>	<b>Valve, Fitting, and Piping details</b>
<b>8</b>	<b>Compressors</b>
<b>9</b>	<b>Reciprocating compressors</b>
<b>10</b>	<b>Topside process design – gas processing system</b>
<b>Text book</b>	<b>- Printed materials: Topic 1, 2, 10 - Surface production operations, Vol. 2 (Gas-Handling): Topic 7, 8, 9 - Surface production operations, Vol. 1 (Oil-Handling): 3, 4, 5, 6</b>
<b>Rating</b>	<b>- Homework, Quiz 20% (March, May) - Midterm 30% (April) - Final 40% (June) - Attendance 10%</b>

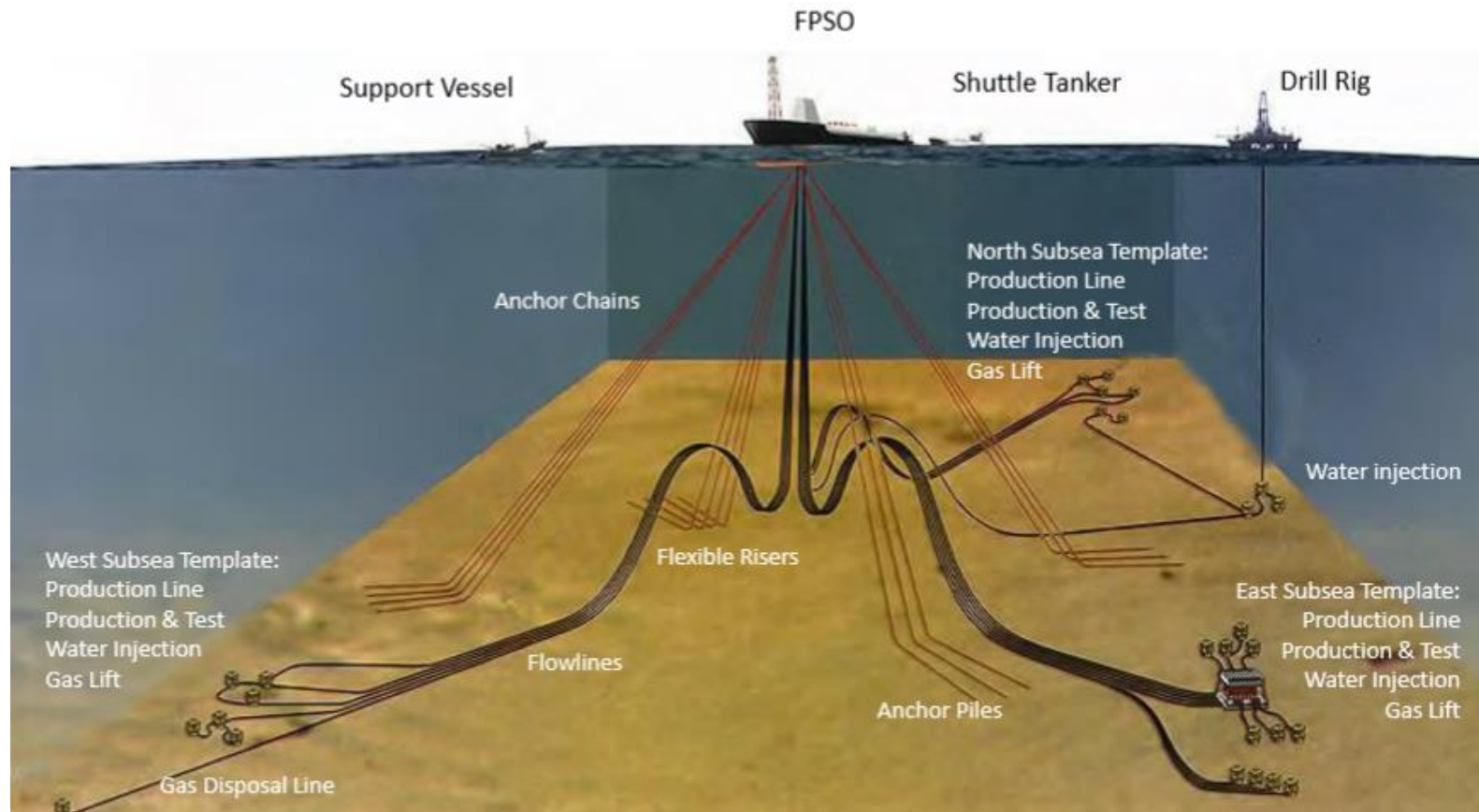
# Typical Field Layout





# Oil FPSO

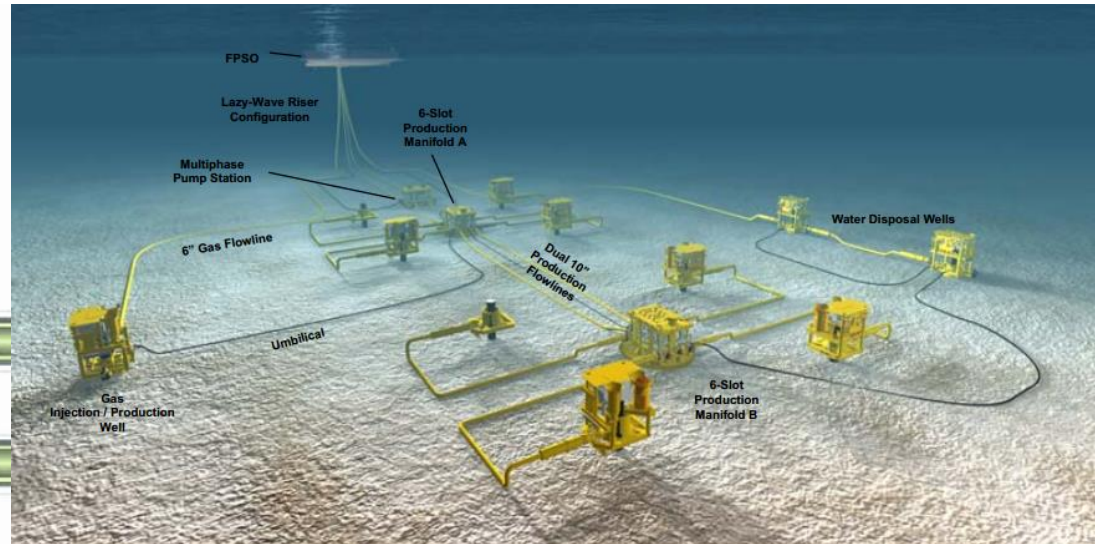
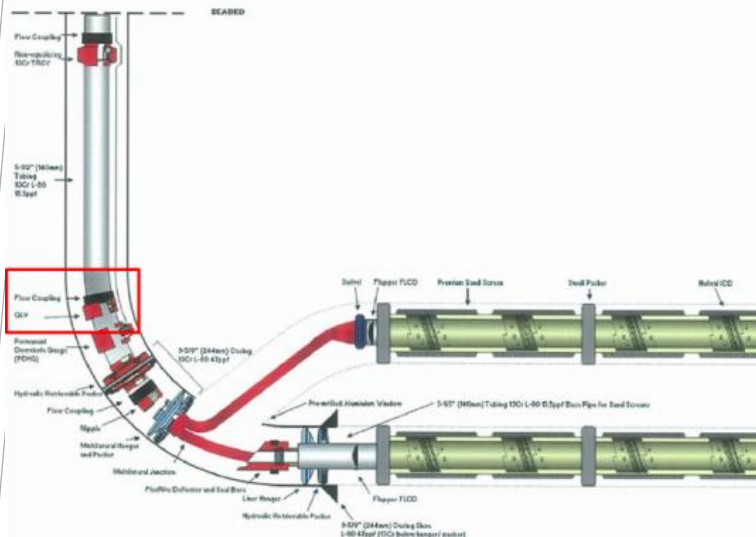
- Processes hydrocarbons from subsea template into oil, LPG, sales gas, etc.
- A converted tanker or purpose built vessel – may be ship shaped
- Eliminate the need for costly long-distance pipelines, which is effective in remote or deep water developments



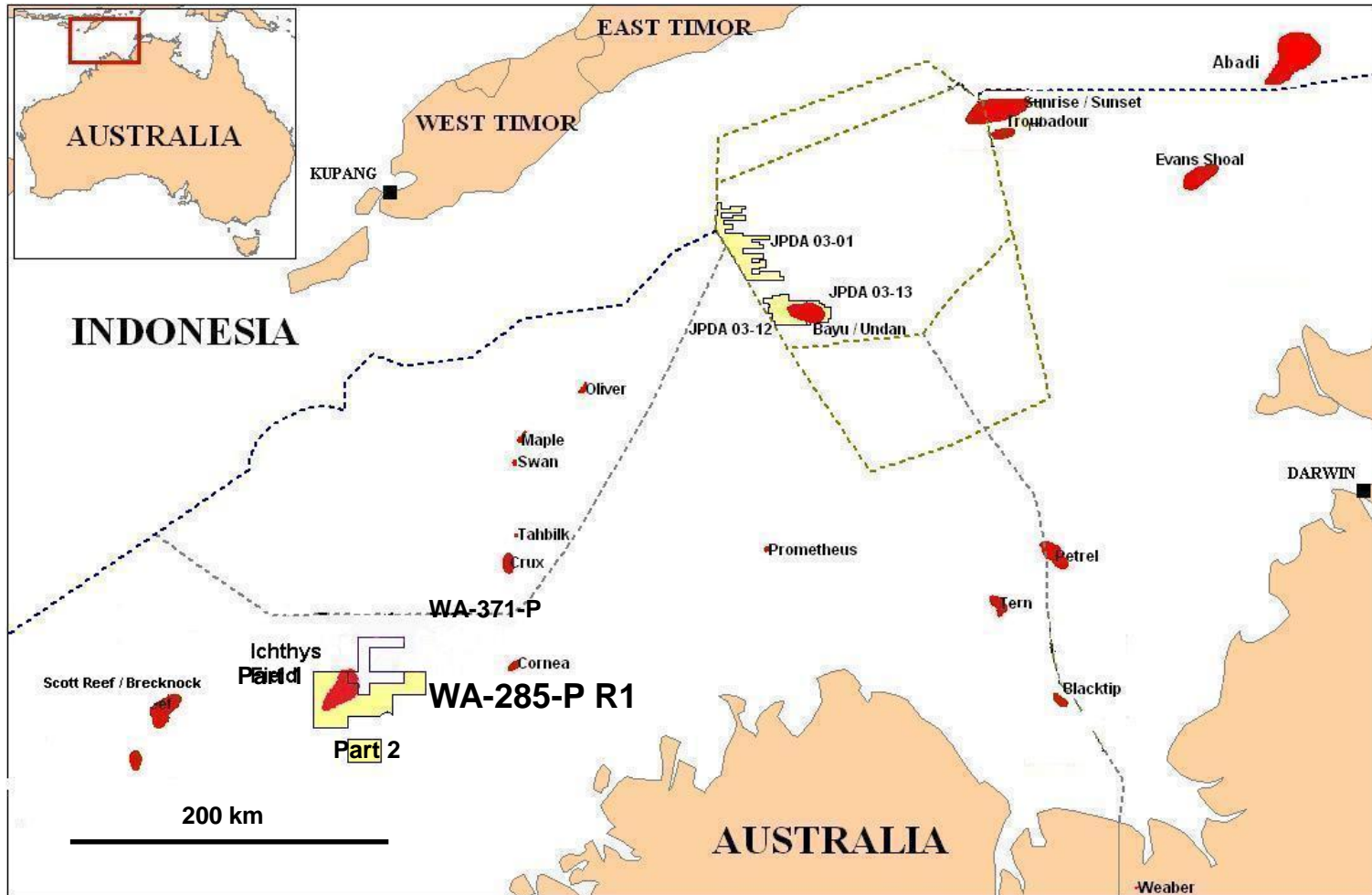
# FPSO in Western Australia

- Vincent oil field**

- : Located offshore Exmouth in Western Australia
- : Water depth 350m, 17° API crude from 8 wells
- : Oil column thickness 8.5 ~ 19.0 m
- : Total Liquid processing capacity 120,000 b/d with total storage capacity of 1.2 million barrels of oil
- : Water (150,000 b/d) & Gas (80 MMscf/d) Injection
- : Dual sided hull and disconnectable mooring



# INPEX - Ichthys Field



- Approximately 200 km from the mainland
- 250–270 m water depth



# Field Development Plan

## FPSO

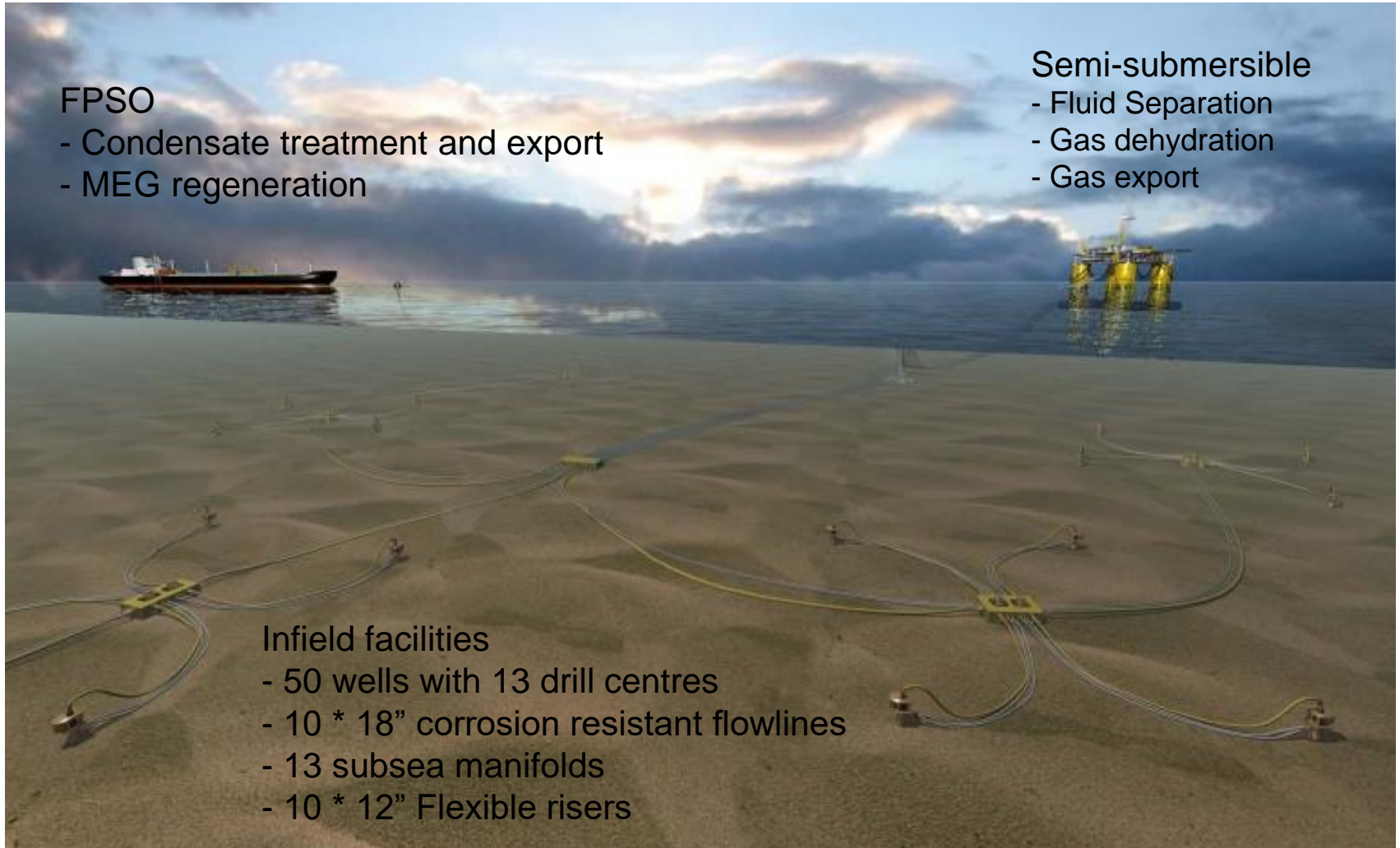
- Condensate treatment and export
- MEG regeneration

## Semi-submersible

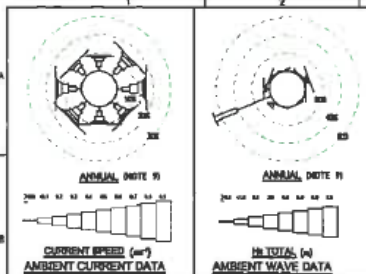
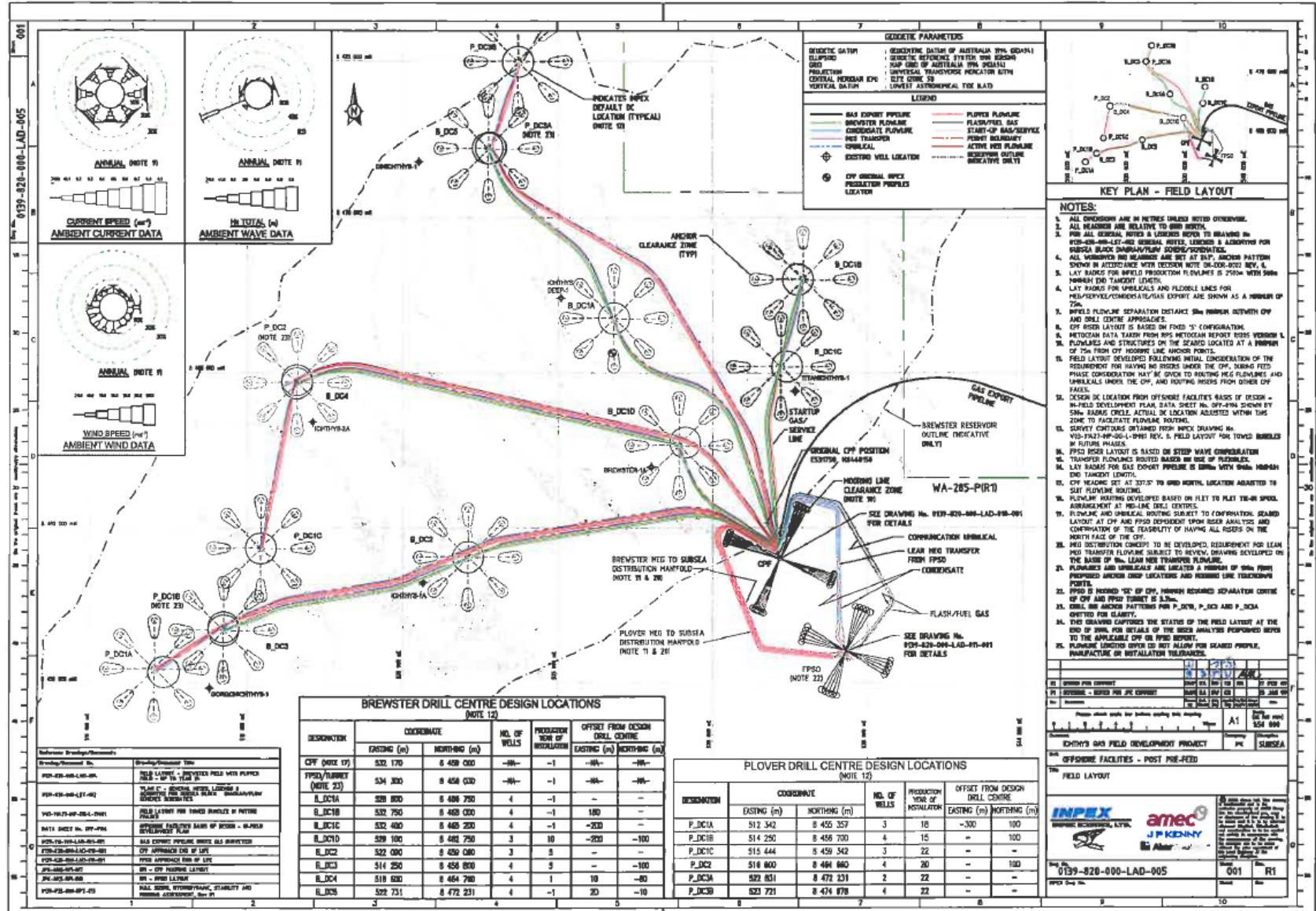
- Fluid Separation
- Gas dehydration
- Gas export

## Infield facilities

- 50 wells with 13 drill centres
- 10 \* 18" corrosion resistant flowlines
- 13 subsea manifolds
- 10 \* 12" Flexible risers



# Field Architecture



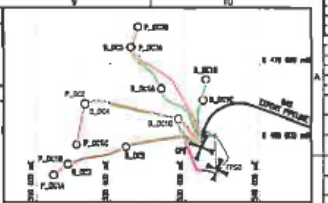
**GEOMETRIC PARAMETERS**

GEOMETRIC DATUM  
 OBSERVING DATUM OF AUSTRALIA 1984 (GDA84)  
 GEOMETRIC REFERENCE SYSTEM 2011 (GRS11)  
 GRID  
 DATUM USED TO AUSTRALIAN ITPA (GDA84)  
 PROJECTION  
 CENTRAL MERIDIAN 150°E  
 FALSE EASTING 500000  
 FALSE NORTHERING 10000000  
 SCALAR FACTOR 1.0  
 SPHEROID AUSTRALIAN 1984 (AAU84)  
 AXIS 6378137  
 FLATTENING 1/29825000  
 UNIT METRE

**LEGEND**

— HOUSING APPROACH FLOWLINE  
 — BREWSTER FLOWLINE  
 — CONDENSATE FLOWLINE  
 — FUEL GAS FLOWLINE  
 — FRESH WATER FLOWLINE  
 — START-UP GAS/SERVIVE FLOWLINE  
 — FRESH WATER FLOWLINE  
 — CONVENTIONAL  
 — ACTIVE WELLS FLOWLINE  
 — OBSERVATION OUTLINE  
 — OBSERVATION OUTLINE  
 — OBSERVATION OUTLINE

★ ORIGINAL OFF POSITION  
 PRODUCTION PROFILES LOCATION



- NOTES:**
- ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
  - ALL HEADERS ARE RELATIVE TO GRID NORTH.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-005.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-006.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-007.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-008.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-009.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-010.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-011.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-012.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-013.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-014.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-015.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-016.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-017.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-018.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-019.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-020.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-021.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-022.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-023.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-024.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-025.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-026.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-027.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-028.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-029.
  - FOR ALL GENERAL NOTES & LEGENDS REFER TO DRAWING No. P01-426-000-LAD-030.

**Reference Drawing/Revision**

Drawing/Revision	Revision/Description
P01-426-000-LAD-005	FIELD LAYOUT - BREWSTER WELLS WITH FLOWLINE PROFILE - UP TO DATE
P01-426-000-LAD-006	FIELD LAYOUT - BREWSTER WELLS WITH FLOWLINE PROFILE - UP TO DATE
P01-426-000-LAD-007	FIELD LAYOUT - BREWSTER WELLS WITH FLOWLINE PROFILE - UP TO DATE
P01-426-000-LAD-008	FIELD LAYOUT - BREWSTER WELLS WITH FLOWLINE PROFILE - UP TO DATE
P01-426-000-LAD-009	FIELD LAYOUT - BREWSTER WELLS WITH FLOWLINE PROFILE - UP TO DATE
P01-426-000-LAD-010	FIELD LAYOUT - BREWSTER WELLS WITH FLOWLINE PROFILE - UP TO DATE
P01-426-000-LAD-011	FIELD LAYOUT - BREWSTER WELLS WITH FLOWLINE PROFILE - UP TO DATE
P01-426-000-LAD-012	FIELD LAYOUT - BREWSTER WELLS WITH FLOWLINE PROFILE - UP TO DATE
P01-426-000-LAD-013	FIELD LAYOUT - BREWSTER WELLS WITH FLOWLINE PROFILE - UP TO DATE
P01-426-000-LAD-014	FIELD LAYOUT - BREWSTER WELLS WITH FLOWLINE PROFILE - UP TO DATE
P01-426-000-LAD-015	FIELD LAYOUT - BREWSTER WELLS WITH FLOWLINE PROFILE - UP TO DATE
P01-426-000-LAD-016	FIELD LAYOUT - BREWSTER WELLS WITH FLOWLINE PROFILE - UP TO DATE
P01-426-000-LAD-017	FIELD LAYOUT - BREWSTER WELLS WITH FLOWLINE PROFILE - UP TO DATE
P01-426-000-LAD-018	FIELD LAYOUT - BREWSTER WELLS WITH FLOWLINE PROFILE - UP TO DATE
P01-426-000-LAD-019	FIELD LAYOUT - BREWSTER WELLS WITH FLOWLINE PROFILE - UP TO DATE
P01-426-000-LAD-020	FIELD LAYOUT - BREWSTER WELLS WITH FLOWLINE PROFILE - UP TO DATE

**BREWSTER DRILL CENTRE DESIGN LOCATIONS**  
(NOTE 12)

DESIGNATION	COORDINATE		NO. OF WELLS	PRODUCTION VOTE OF INSTALLATION	OFFSET FROM DESIGN DRILL CENTRE	
	EASTING (m)	NORTHING (m)			EASTING (m)	NORTHING (m)
CPF (NOTE 17)	532 170	8 458 000	-	-1	-	-
FPD/FLUENT (NOTE 23)	534 300	8 458 030	-	-1	-	-
B_DC1A	528 800	8 458 750	4	-1	-	-
B_DC1B	532 750	8 458 000	4	-1	180	-
B_DC1C	532 480	8 458 200	4	-1	-200	-
B_DC1D	529 180	8 458 750	3	10	-200	-100
B_DC2	522 080	8 458 080	3	8	-	-
B_DC3	514 250	8 458 800	4	9	-	-100
B_DC4	518 630	8 454 780	4	1	10	-80
B_DC5	522 731	8 472 231	4	-1	20	-10

**PLOVER DRILL CENTRE DESIGN LOCATIONS**  
(NOTE 12)

DESIGNATION	COORDINATE		NO. OF WELLS	PRODUCTION VOTE OF INSTALLATION	OFFSET FROM DESIGN DRILL CENTRE	
	EASTING (m)	NORTHING (m)			EASTING (m)	NORTHING (m)
P_DC1A	512 542	8 455 357	3	18	-300	100
P_DC1B	514 250	8 456 700	4	15	-	100
P_DC1C	515 444	8 459 542	3	22	-	-
P_DC2	514 600	8 461 660	4	20	-	100
P_DC3	522 831	8 472 131	2	22	-	-
P_DC3B	523 721	8 474 878	4	22	-	-

0139-826-000-LAD-005

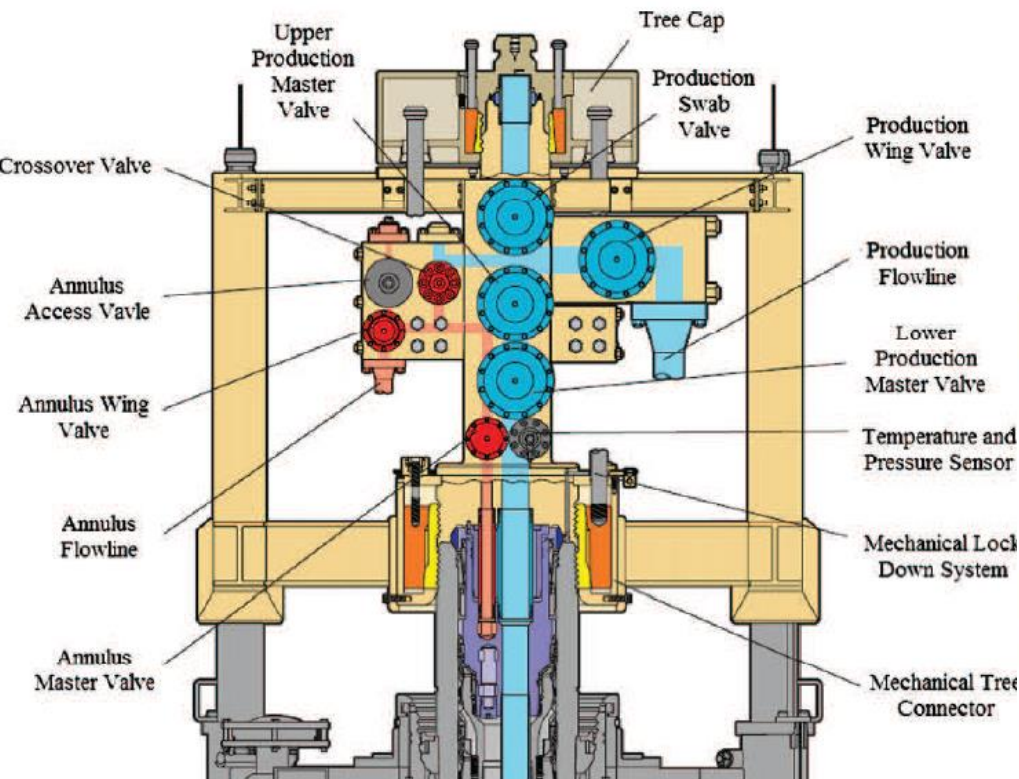
001 R1

INPEX  
AMPEC  
J.P. KENNY  
McALPINE

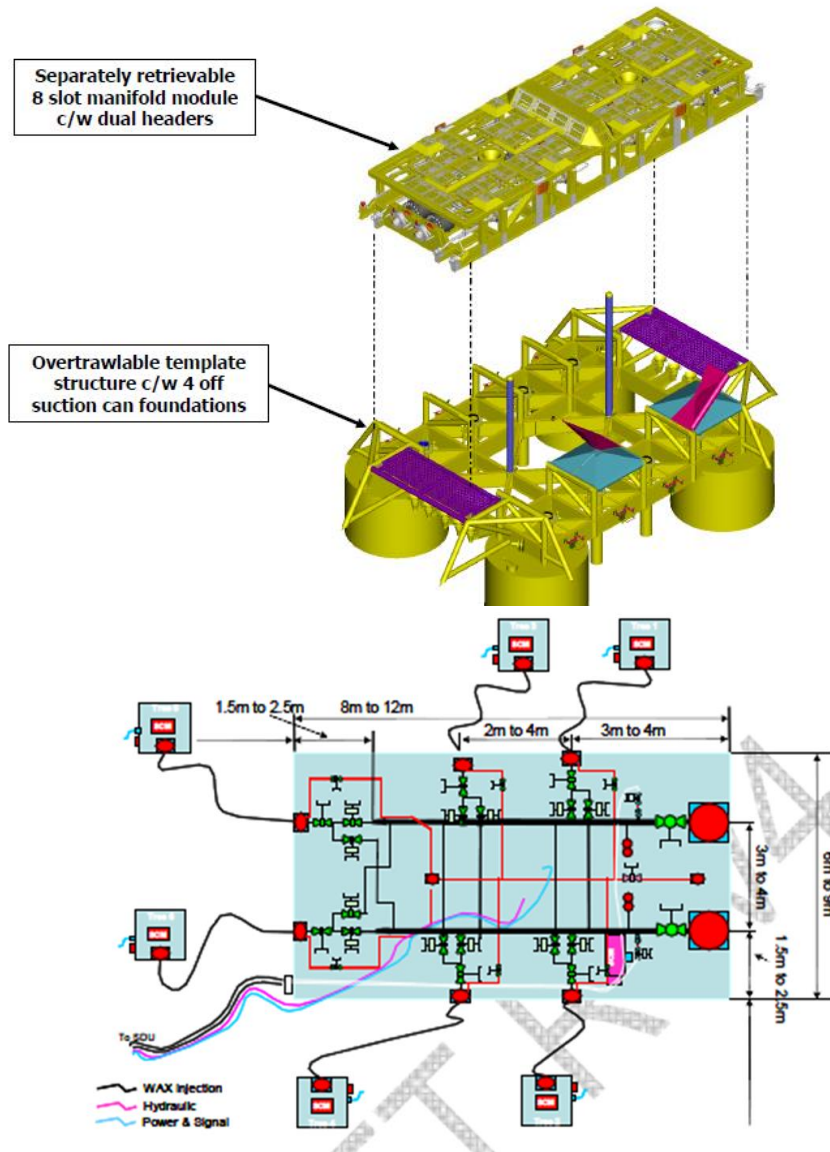


# Subsea Tree

- Primary production and safety device for a well
- Essentially consists of a number of valves to regulate flow and isolate the tree from the well, and monitor the production fluids



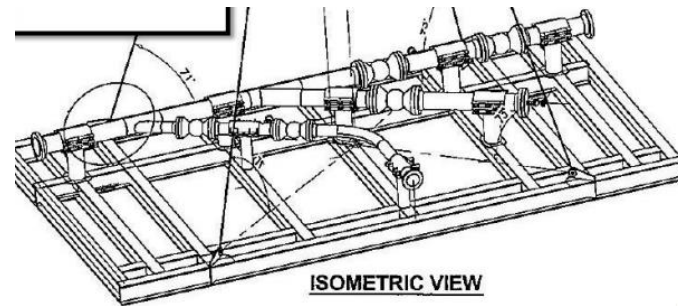
# Manifold/Template



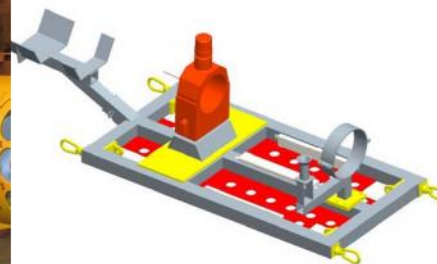
- A template is a seabed founded structure that provides a guide for other equipment
- A manifold is a system of piping and associated equipment used to gather produced fluids. Associated equipments may include
  - : Isolation valves
  - : Flowline connectors
  - : Xmas tree connectors
  - : Flow control chokes
  - : Umbilical termination and distribution

# PLEM/PLET

- PLEM (Pipeline End Manifold)
  - : Used to comingle 2 or more pipelines together and eliminate the need for additional risers



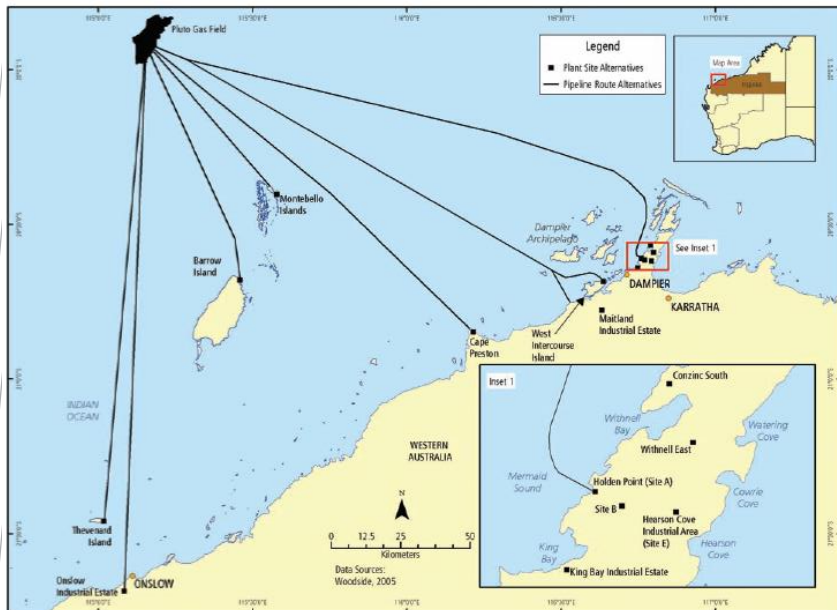
- PLET (Pipeline End Termination)
  - : Used to link manifold to the production pipeline





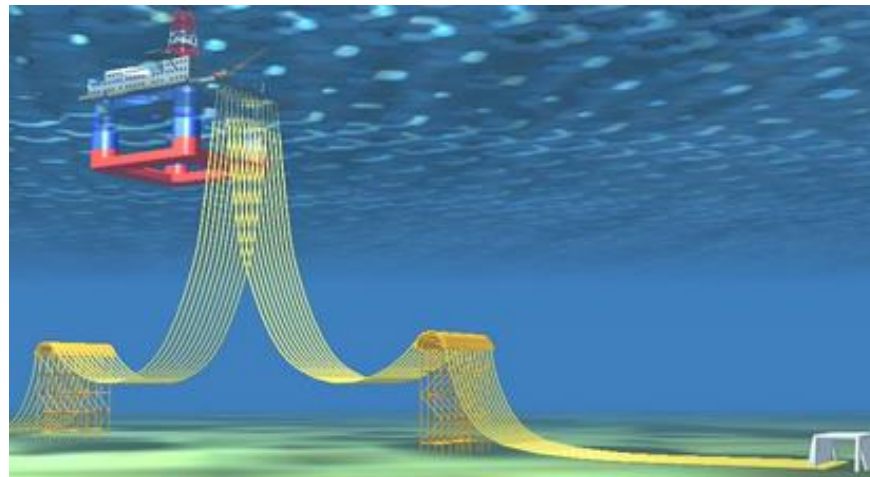
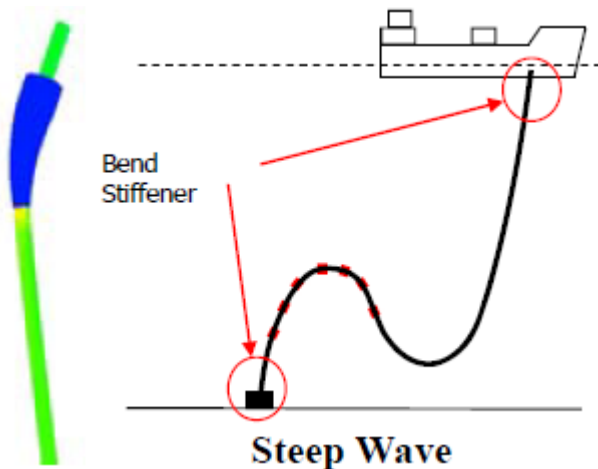
# Flowline

- Transport reservoir fluid to processing facilities
- Pipelines
  - : horizontal transfer from wellhead
  - : these may be very long
  - : may be rigid or flexible pipe
  - : commonly called flowlines

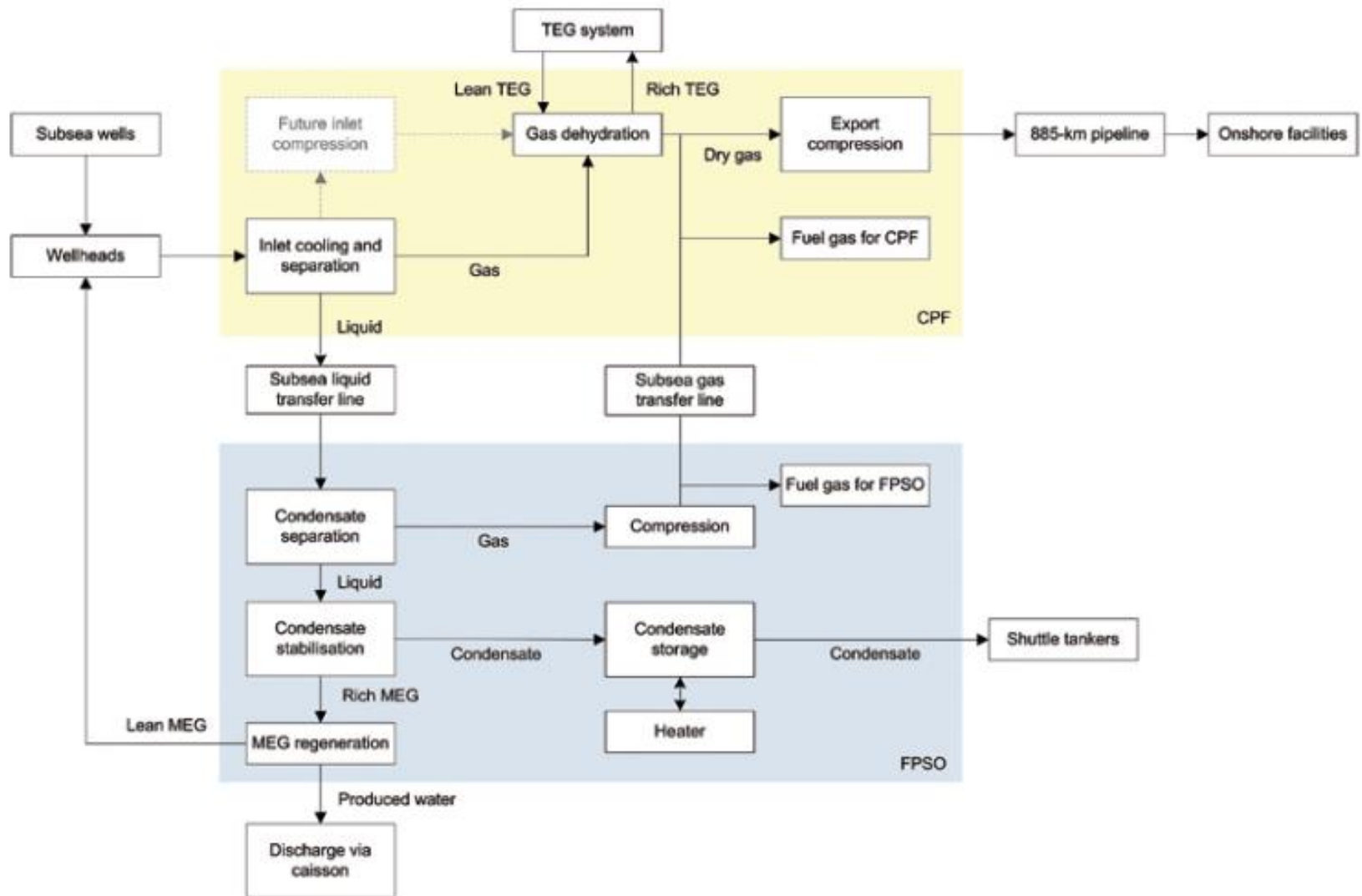


# Riser

- Vertical transfer to above surface processing facilities
- Either Rigid or Flexible
- Rigid risers normally for fixed platforms
  - : pre-installed inside jacket frame
  - : cost effective and added riser protection
- Flexible risers mainly for floating production system
  - : Flexibility and reliability
  - : Easy and rapid installation



# Offshore Process Flow Diagram





# CPF (Central Processing Facility)



- Design capacity of 1657 MMscf/d export gas
- 4 leg semi-submersible hull structure
- 4 group \* 7 mooring legs (28 total mooring legs)
- Inlet flow control and manifolding
  - : Each riser will have a topside choke
  - : Flowlines are connected by manifolds to three production trains
- Inlet separation system
  - : Inlet surge vessel to separate bulk liquids
- TEG gas dehydration
- Gas export compression
  - : Four trains of export compression (each sized for 33% of total throughput)
  - : Discharge at ~20 500 kPa to maintain export flow
- Inlet booster compression – Future option
- Condensate export to the FPSO
- Accommodation – 150 beds
- Utilities
  - : Chemical injection package, TEG regeneration, etc (Antifoam, Wax inhibitor, Methanol, Scale inhibitor, MEG, TEG, Subsea hydraulic fluid)

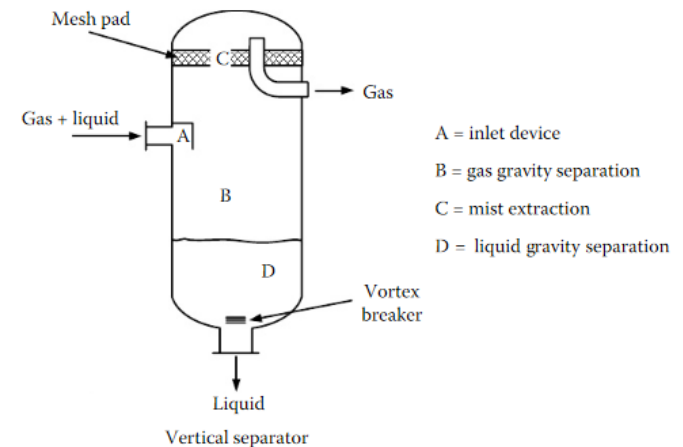
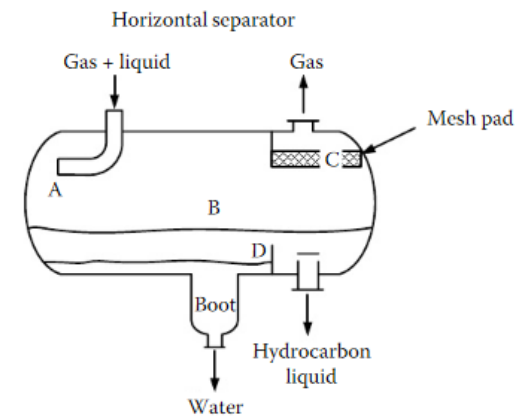
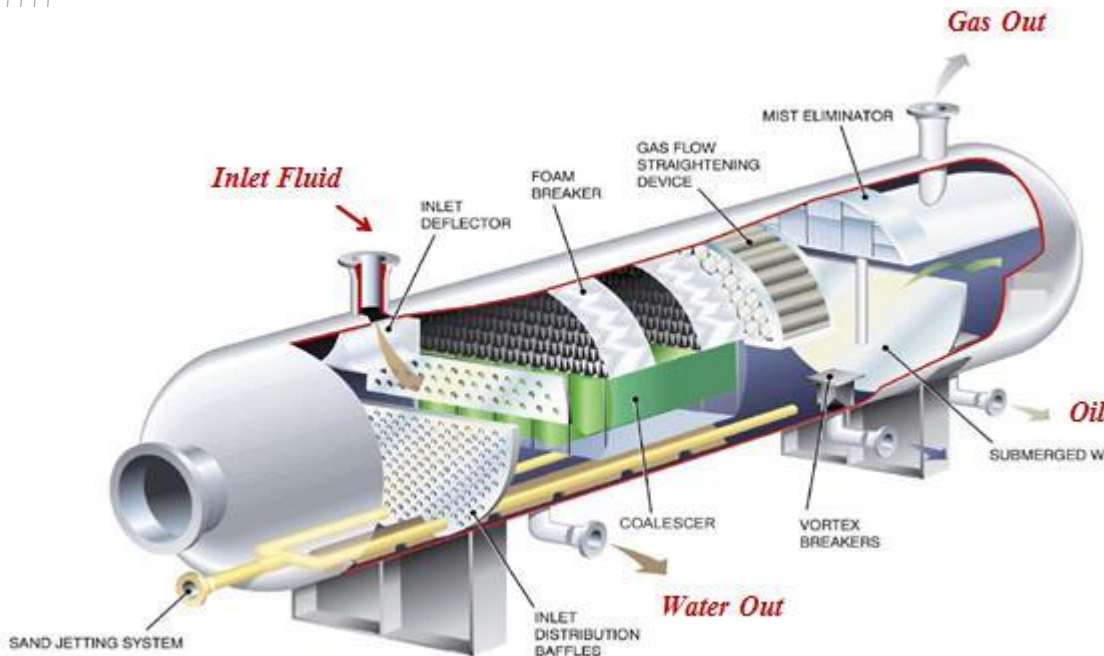
# FPSO (Floating Production Storage and Offtake)



- Weather veining turret mooring
  - : 3 group \* 7 mooring legs (21 total)
- 12 path swivel
- Product storage of 1.2 million barrels
- Condensate treatment and stabilization
  - : Series of 3-phase separators, coalescers, and heat exchanger to stabilize the condensate up to 85 000 bpd
  - : Main tank capacity – 150 000 m<sup>3</sup>
- Mercury removal from condensate and water
- Flash gas compression
- MEG regeneration unit
  - : 2 \* 50% MEG regeneration plants
  - : Max. lean MEG injection of 100 m<sup>3</sup>/hr
  - : MEG storage tank capacity – 13 500 m<sup>3</sup>
- Produced water treatment facilities
- Condensate export system to shuttle tankers

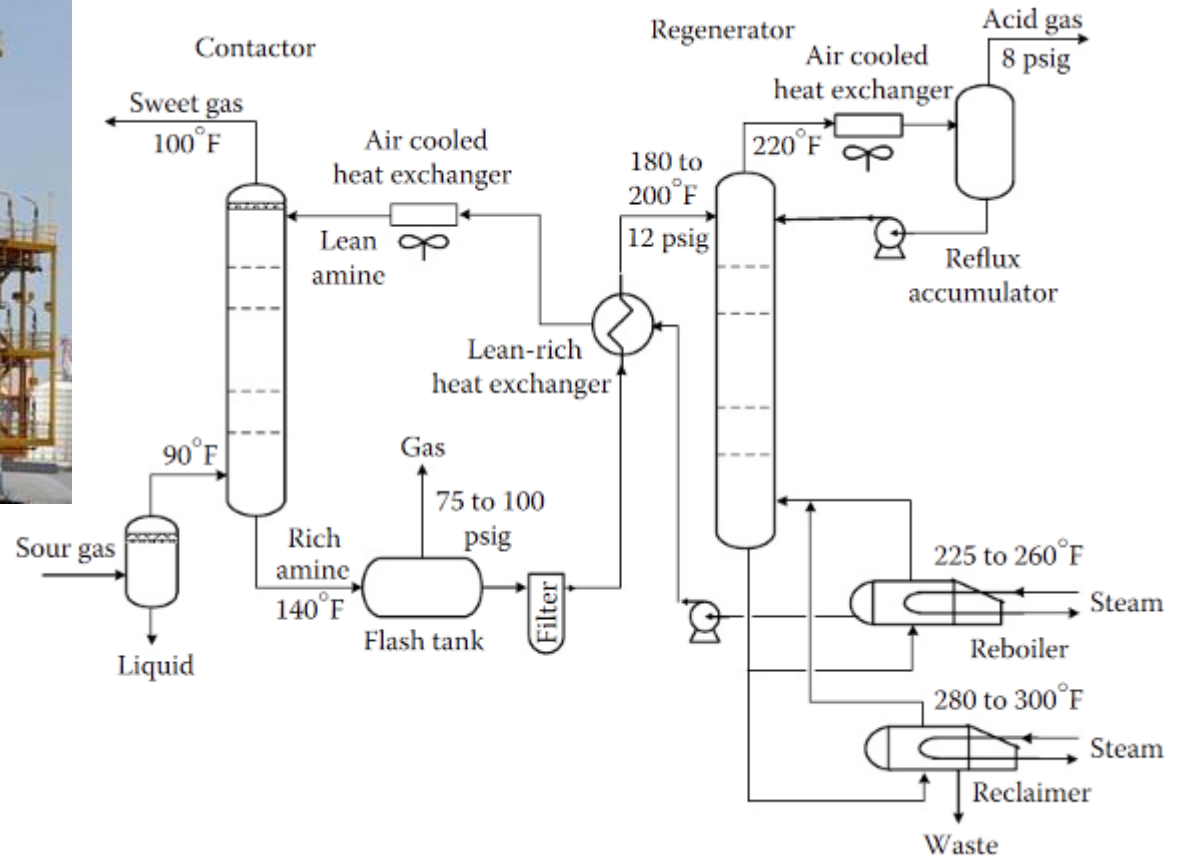
# Inlet separation

- Following figure shows a schematic of gas-liquid separators and indicates the four types of separation:
- Primary separation
- Gravity settling
- Coalescing
- Liquid collecting





# Acid gas removal with MEA

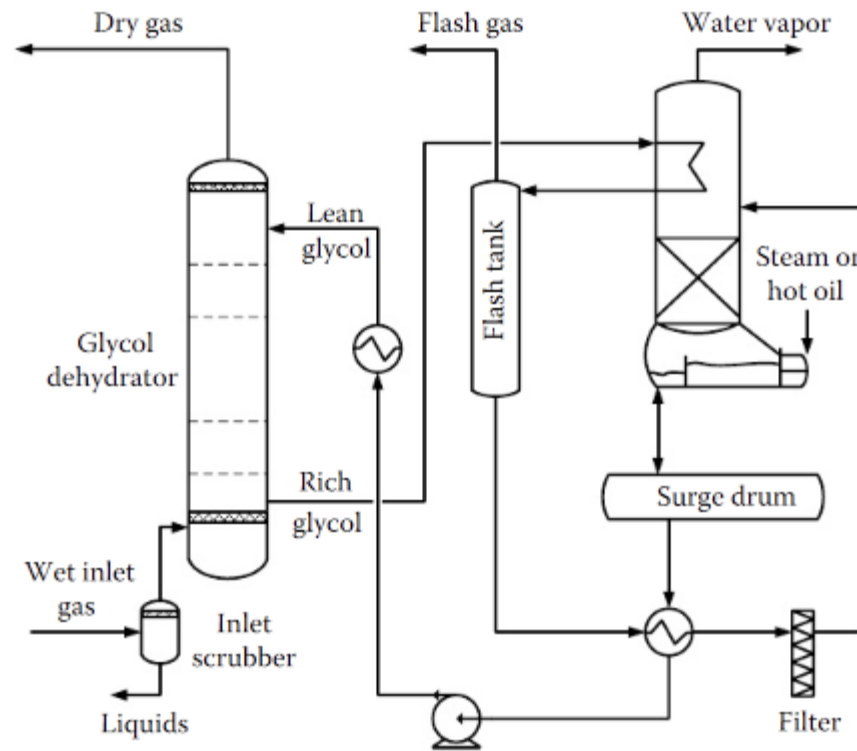


PFD of MEA treating process.

: Contactor operates at pressure up to 70 bar. Flow rates to reclaimer are 1 ~ 3 % of amine circulate rate

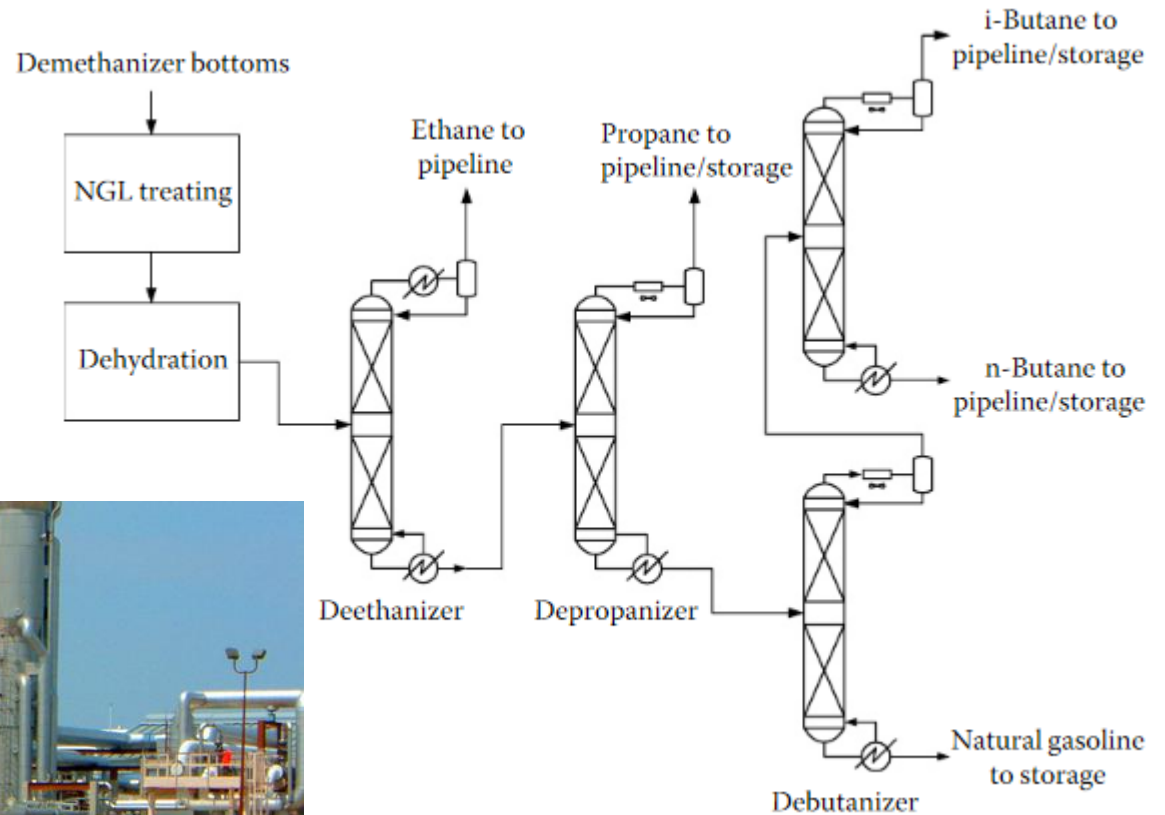
# Gas dehydration using TEG

- A typical, simplified flow sheet for a glycol absorption unit



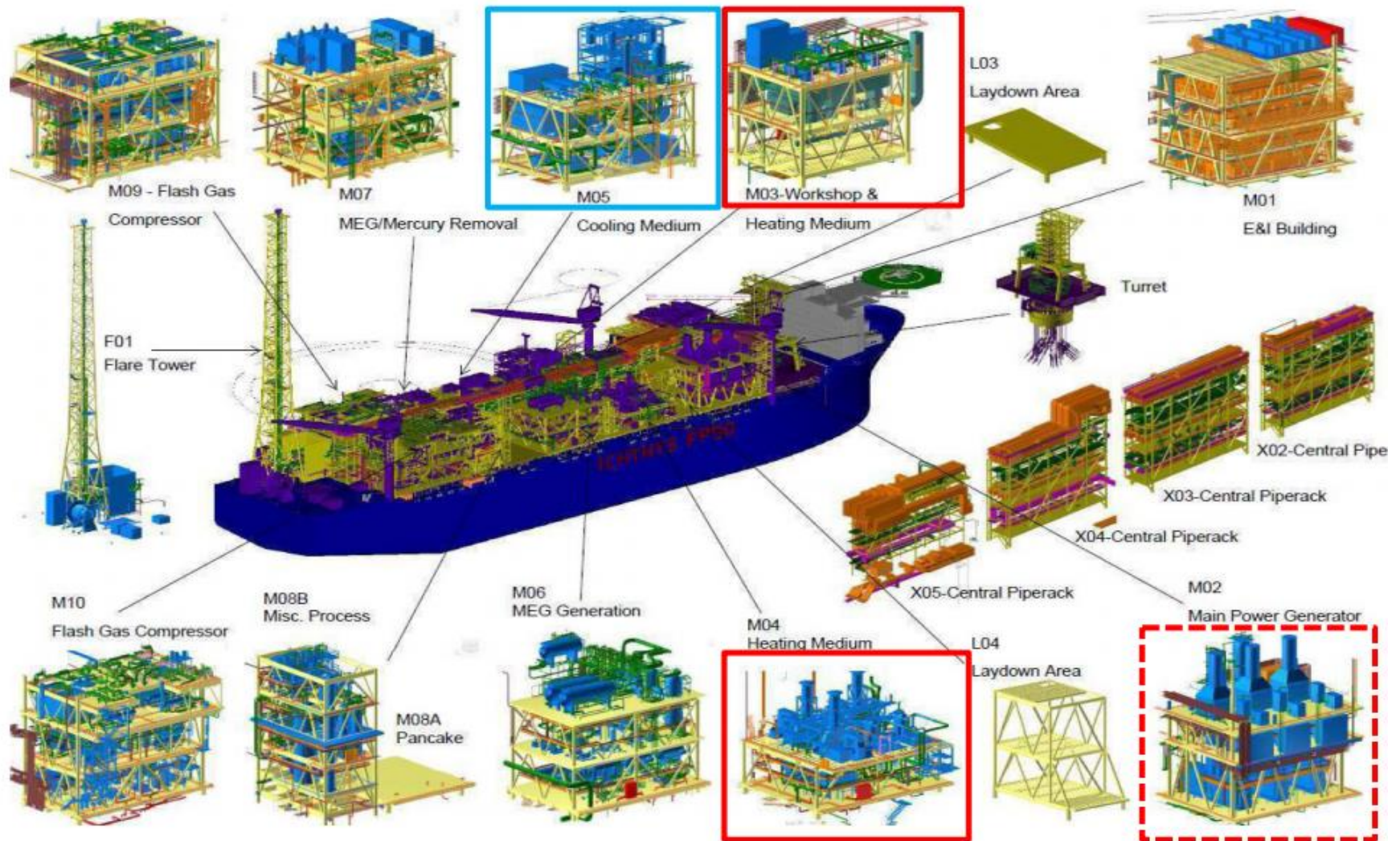
# NGL recovery

- Extensive fractionation of NGL





# Offshore facilities on topside





Thank you!