INTECSEA
WorleyParsons Group

Opportunities and Challenges in Deepwater West Africa Projects

Finding Petroleum - Finding African Oil

Mark Jones - INTECSEA (UK)

Royal Society of Chemistry, London 28th January 2015

Think Solutions.

Opportunities and Challenges in Deepwater West Africa Projects

- Agenda
  - Introduction
  - Technical Issues
  - Commercial Issues
  - Local Content
  - Summary

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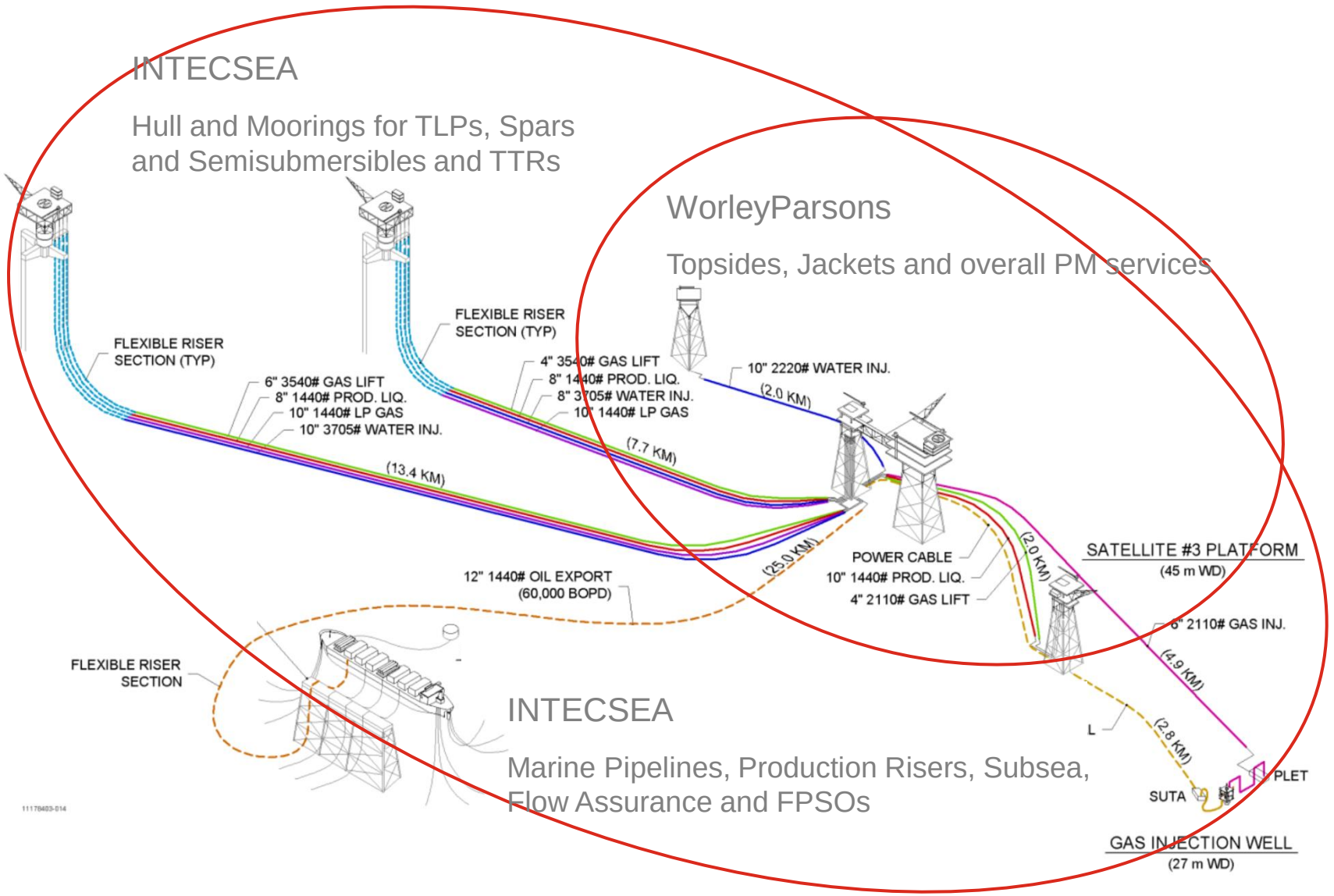
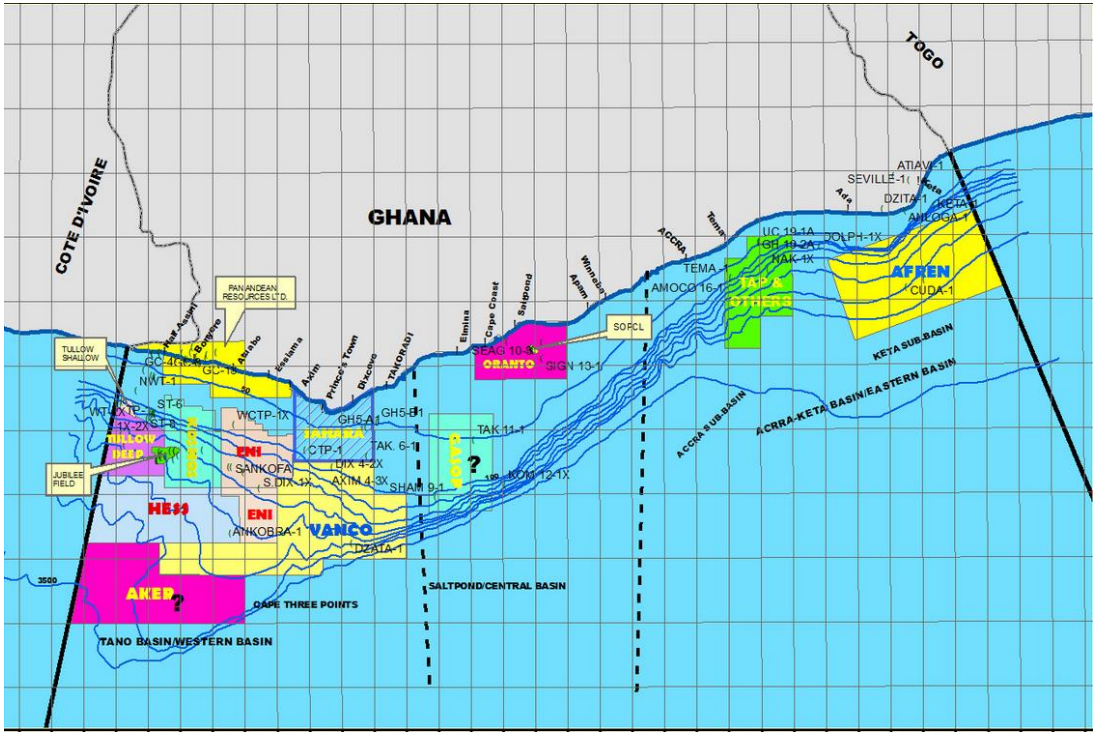

INTECSEA
Hull and Moorings for TLPs, Spars and Semisubmersibles and TTRs
WorleyParsons
Topsides, Jackets and overall PM services
INTECSEA
Marine Pipelines, Production Risers, Subsea, Flow Assurance and FPSOs
FLEXIBLE RISER SECTION (TYP)
6" 3540# GAS LIFT
8" 1440# PROD. LIQ.
10" 1440# LP GAS
10" 3705# WATER INJ.
(13.4 KM)
FLEXIBLE RISER SECTION (TYP)
4" 3540# GAS LIFT
8" 1440# PROD. LIQ.
8" 3705# WATER INJ.
10" 1440# LP GAS
(7.7 KM)
10" 2220# WATER INJ.
(2.0 KM)
12" 1440# OIL EXPORT
(60,000 BOPD)
(25.0 KM)
POWER CABLE
10" 1440# PROD. LIQ.
4" 2110# GAS LIFT
(2.0 KM)
SATELLITE #3 PLATFORM
(45 m WD)
6" 2110# GAS INJ.
(4.9 KM)
(2.8 KM)
PLET
SUTA
GAS INJECTION WELL
(27 m WD)
FLEXIBLE RISER SECTION

Ghana Offshore



Technical Issues

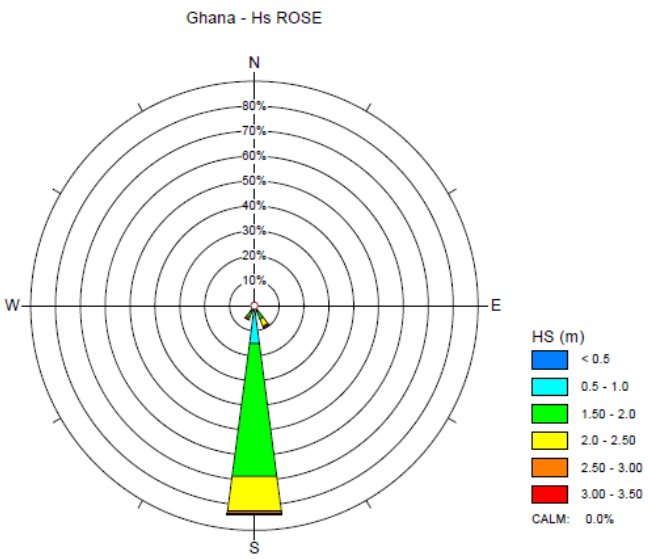
There are a multitude of technical considerations in the layout and development of a deepwater oil field.

Here are the three which are most pertinent to West African developments based on our experience.

- Metocean conditions
- Seabed geotechnical conditions
- Flow assurance

Technical Issues

- MetOcean Considerations



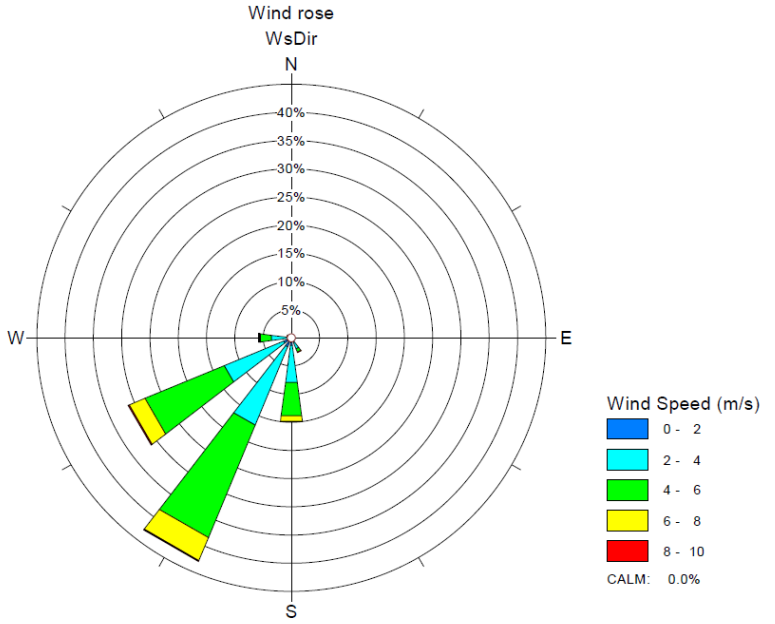
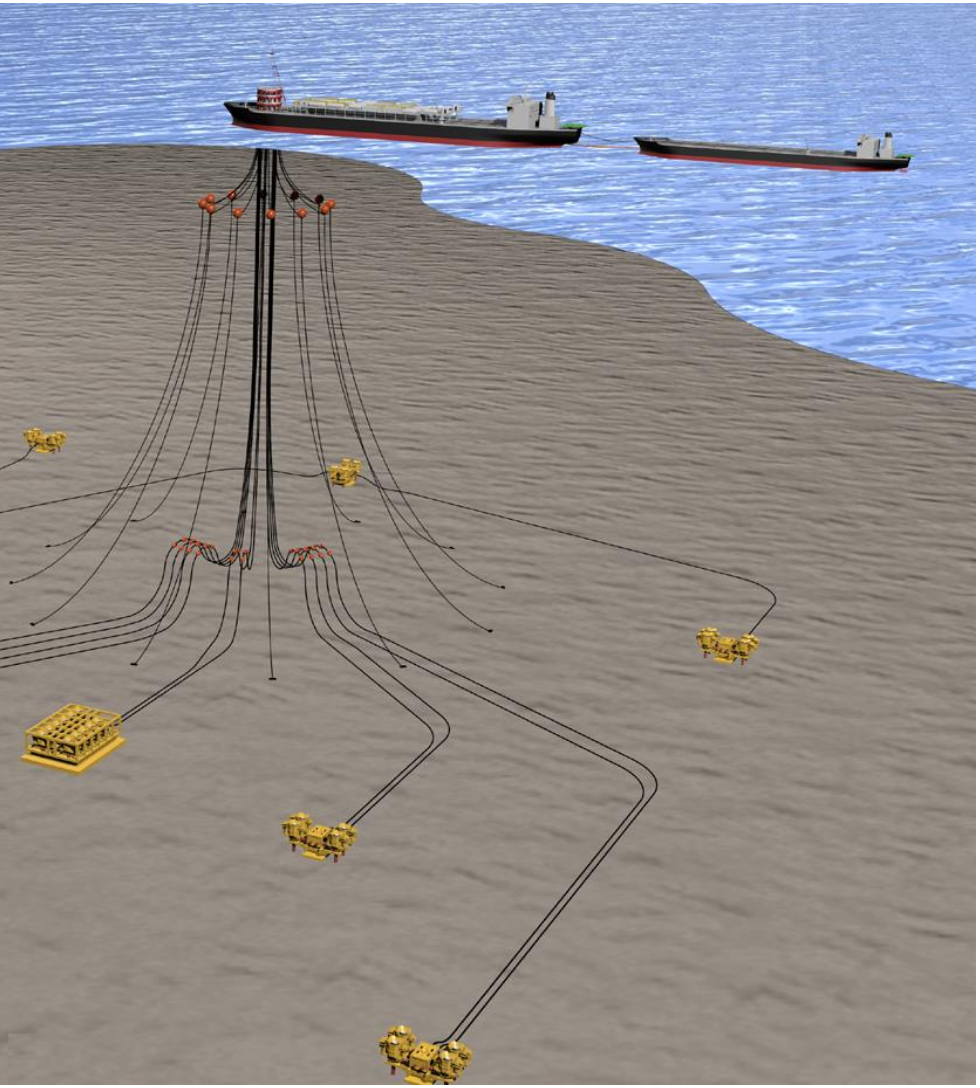


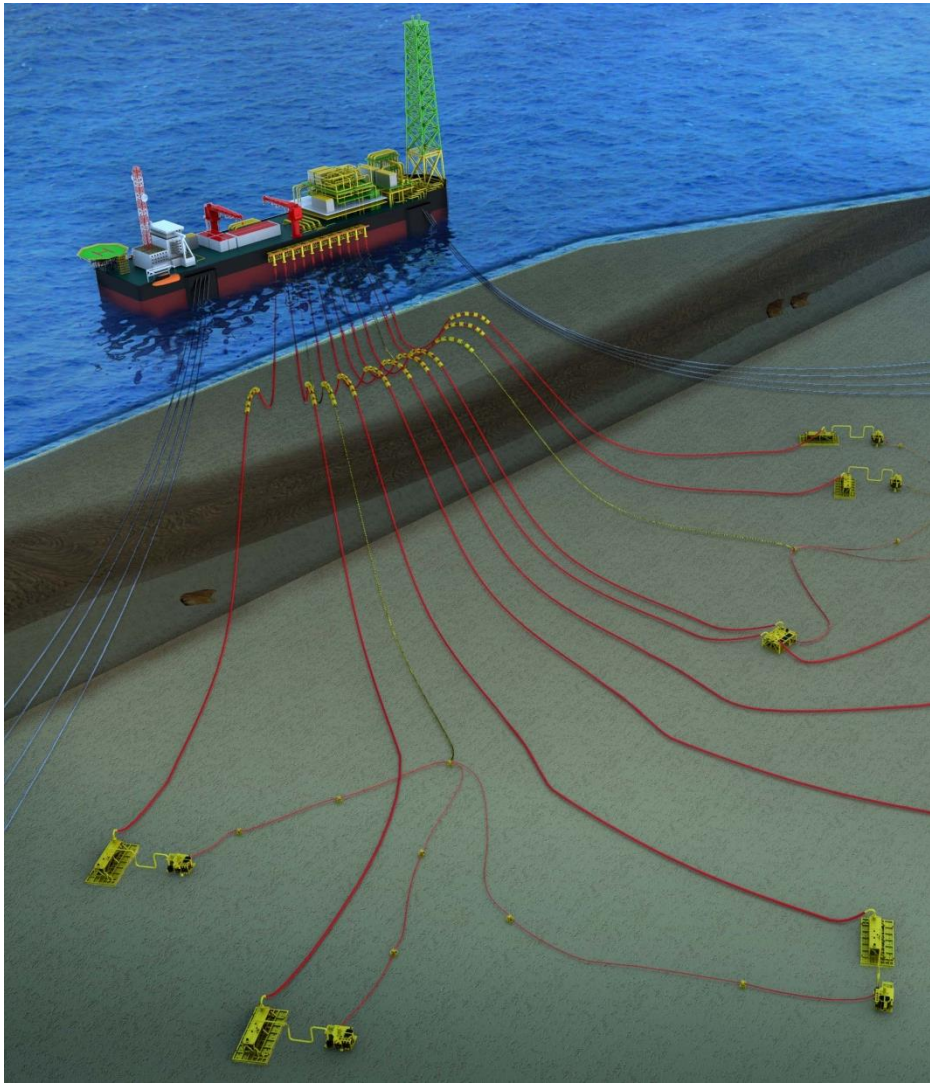
Figure 6-1 : Polar diagram of the directional distribution (%) of the wind speed.

Location	Significant wave height	Peak Period
West Africa	3.14	19.2
North Sea	13.2	18.4
Gulf of Mexico	16.7	15.6

FPSO Mooring Options



Turret Type Mooring



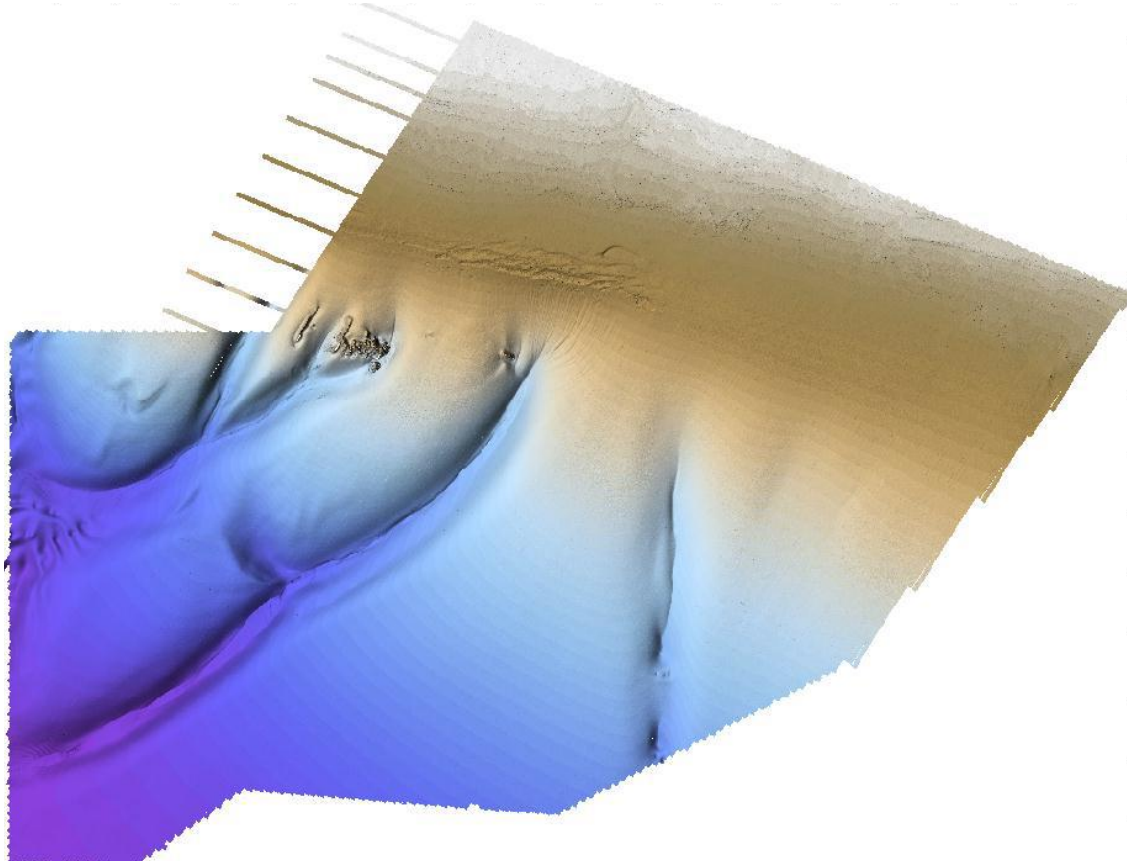
Spread Mooring

Ghana FPSO Mooring Selection

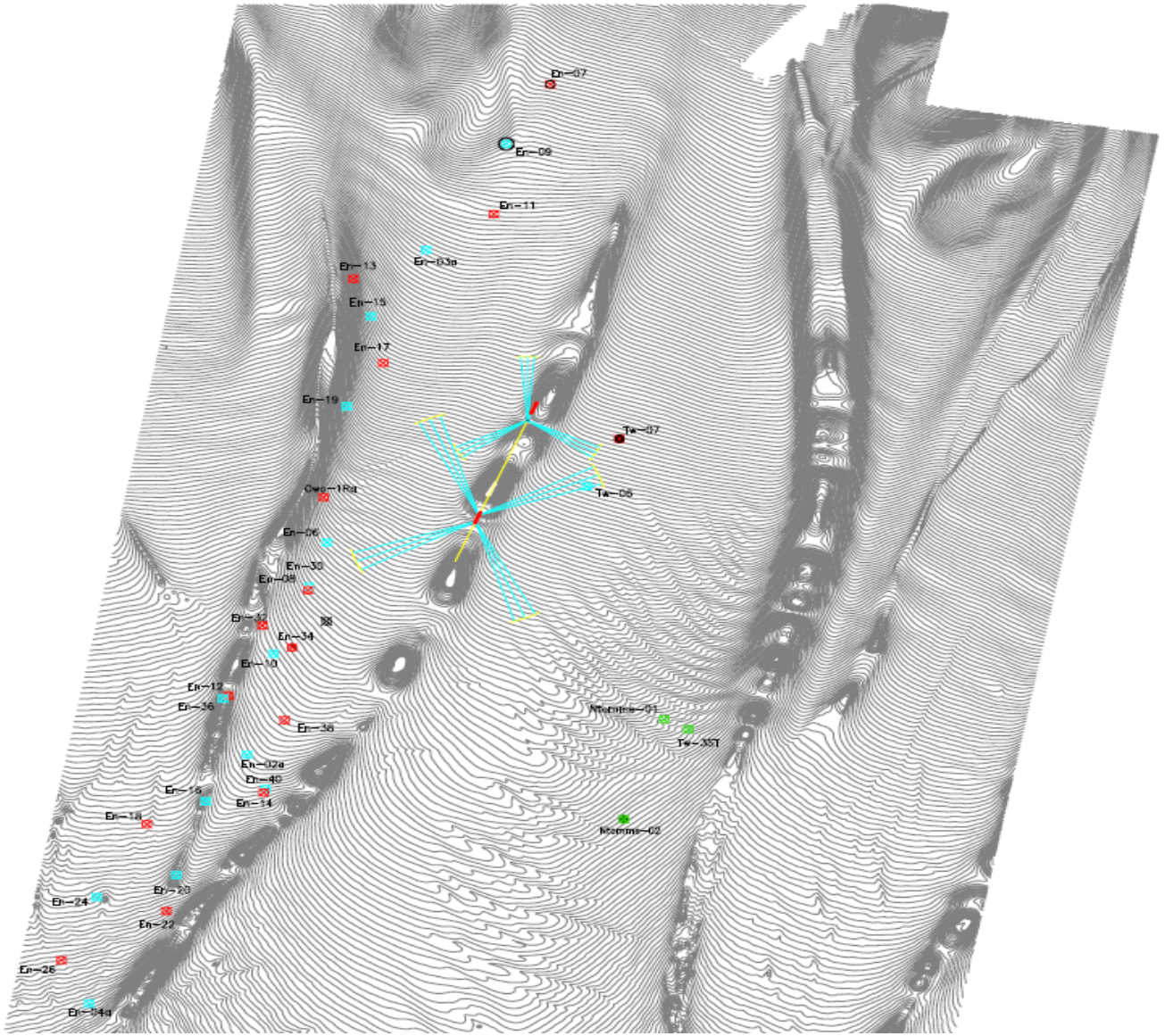
Operator	Field	Depth	Mooring	Service
Tullow	Jubilee	1100	Turret	2013
Tullow	TEN	1500	Turret	2016
ENI	Sankofa	900	Spread	2017
Hess	Cape 3 Points	2500	Turret	2018

Technical Issues

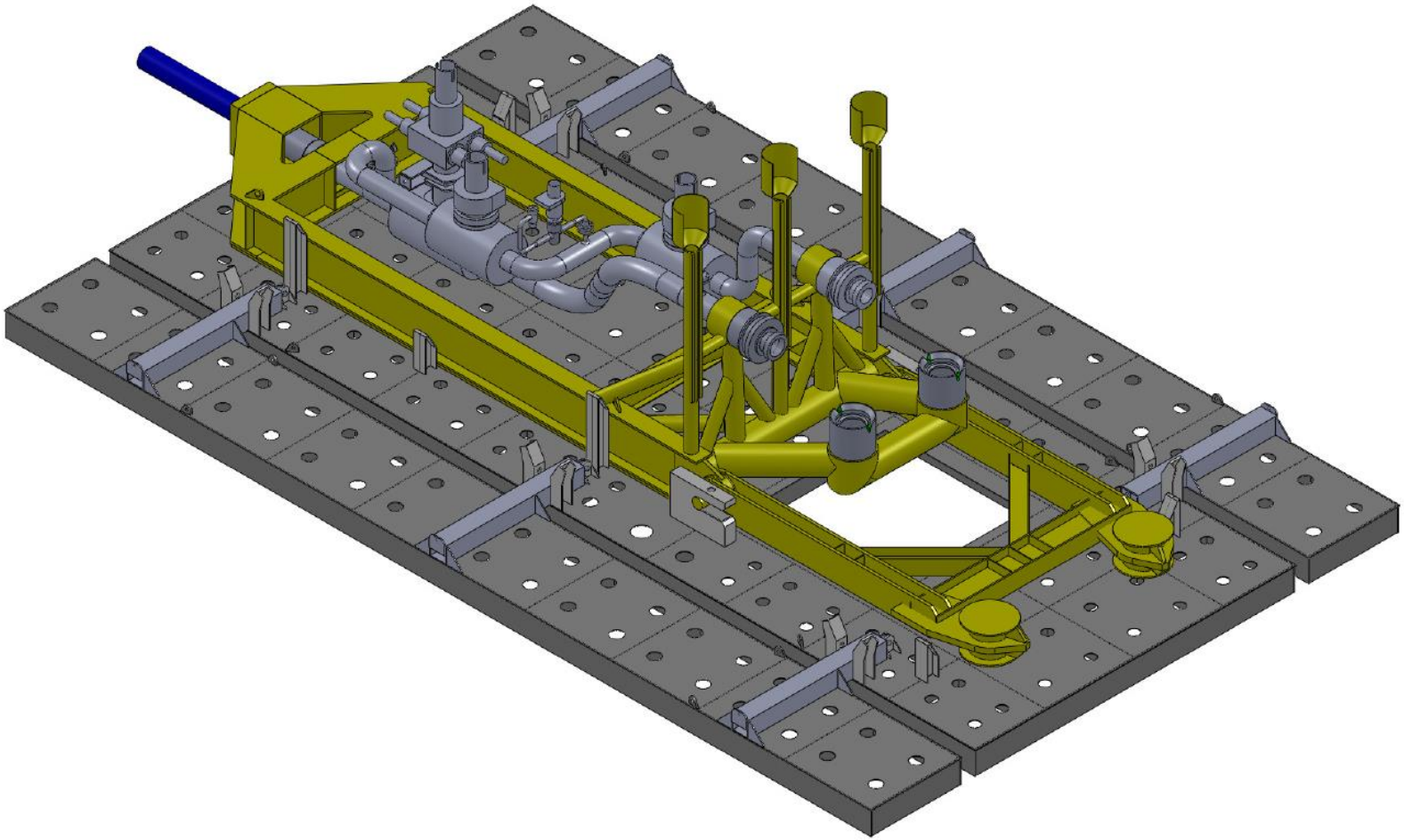
- Seabed Geotechnical Considerations



Seabed conditions

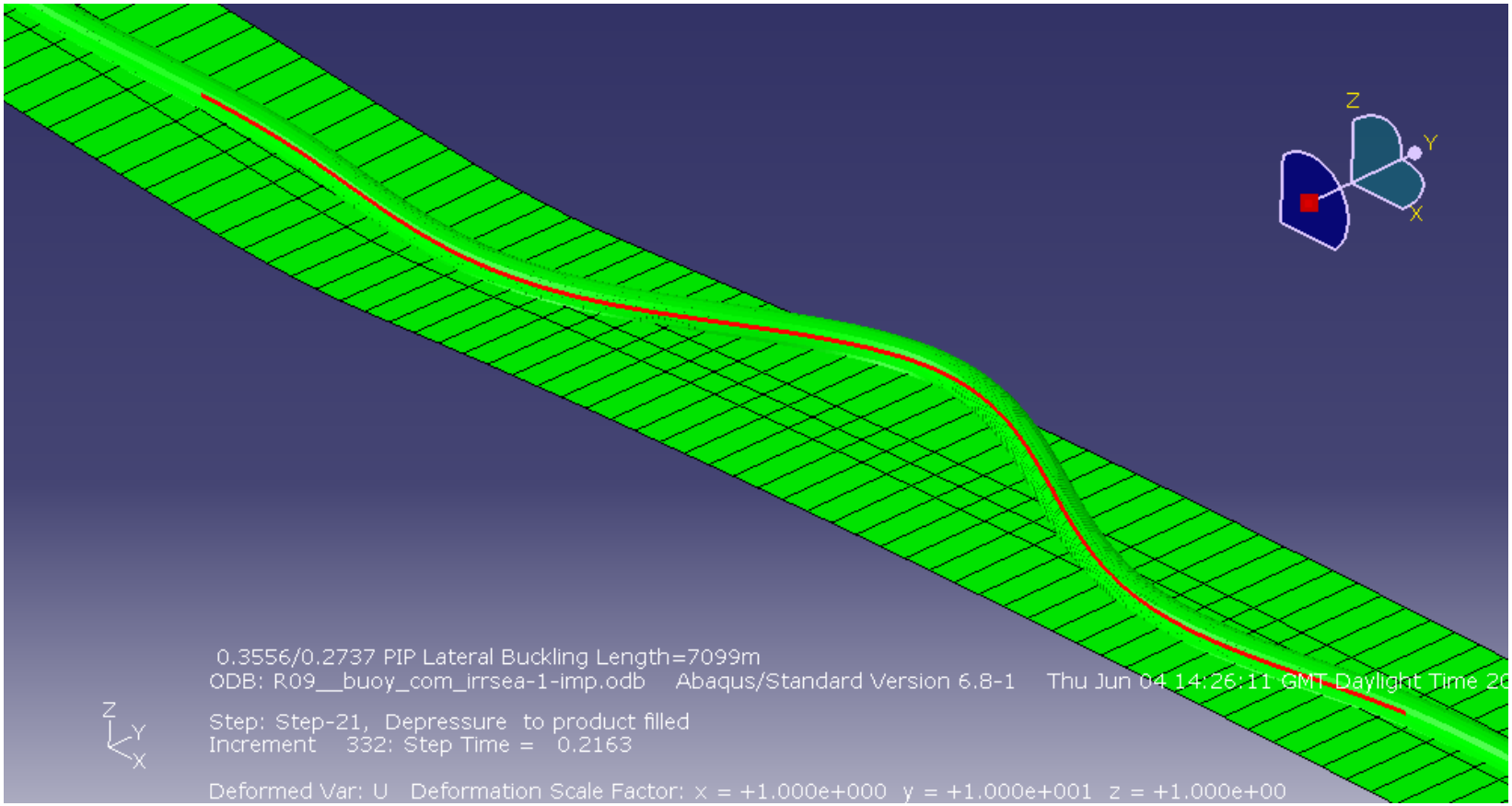


Seabed conditions



Seabed Conditions

Lateral Buckling
Reduces the probability of Spans
Pipe-soil interaction governs Lateral buckling design
Safebuck JIP provides guidelines on lateral buckling in such conditions



Flow Assurance

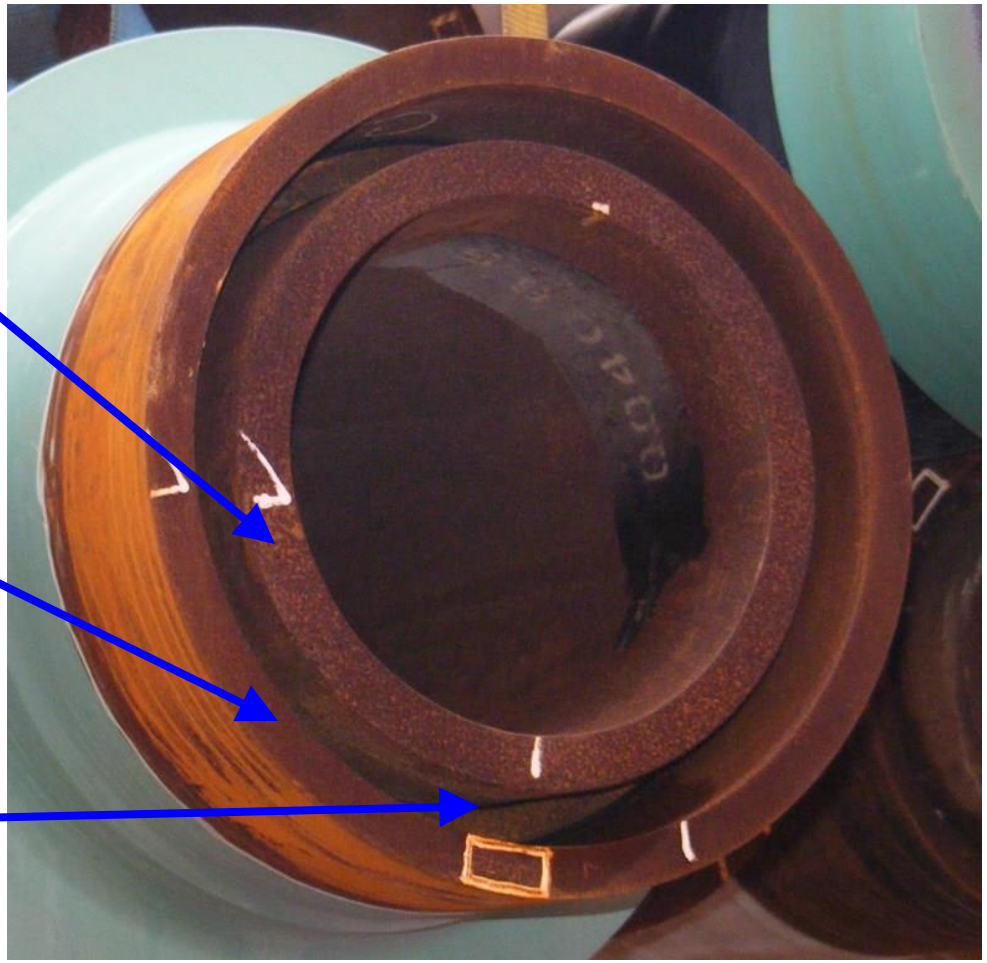
- Producing oil from very deep waters can provide many challenges for ensuring the flow of the fluid.
- Pressures can be boosted by gas injection or pumping.
- Temperatures need to be maintained in many cases to avoid waxing.
- Efficient pipeline design and insulation becomes crucial.
- In extreme cases Pipe-In-Pipe designs are used to provide maximum insulation.

PIP Configuration

Inner Pipe Wall Thickness is about 25 mm, D/t ~10-15

Outer Pipe Wall Thickness is about 21 mm, D/t ~15-20

Aerogel Insulation around the Inner Pipe and Spacers every 4 m

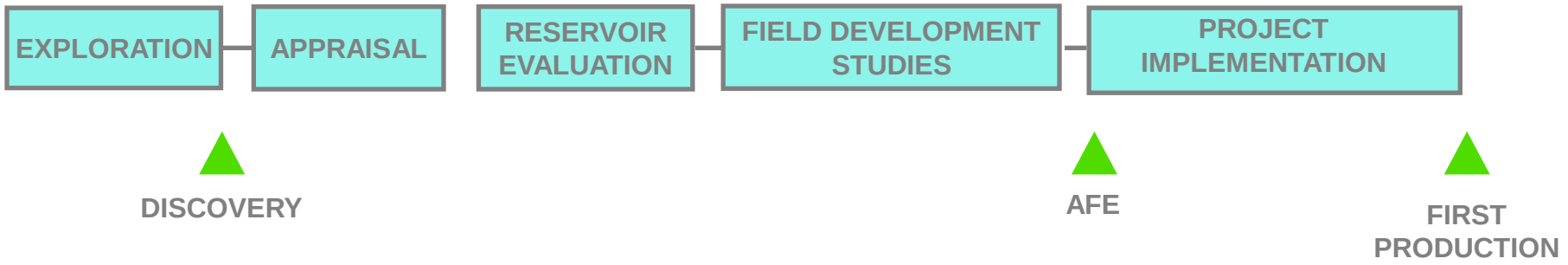


Commercial Issues

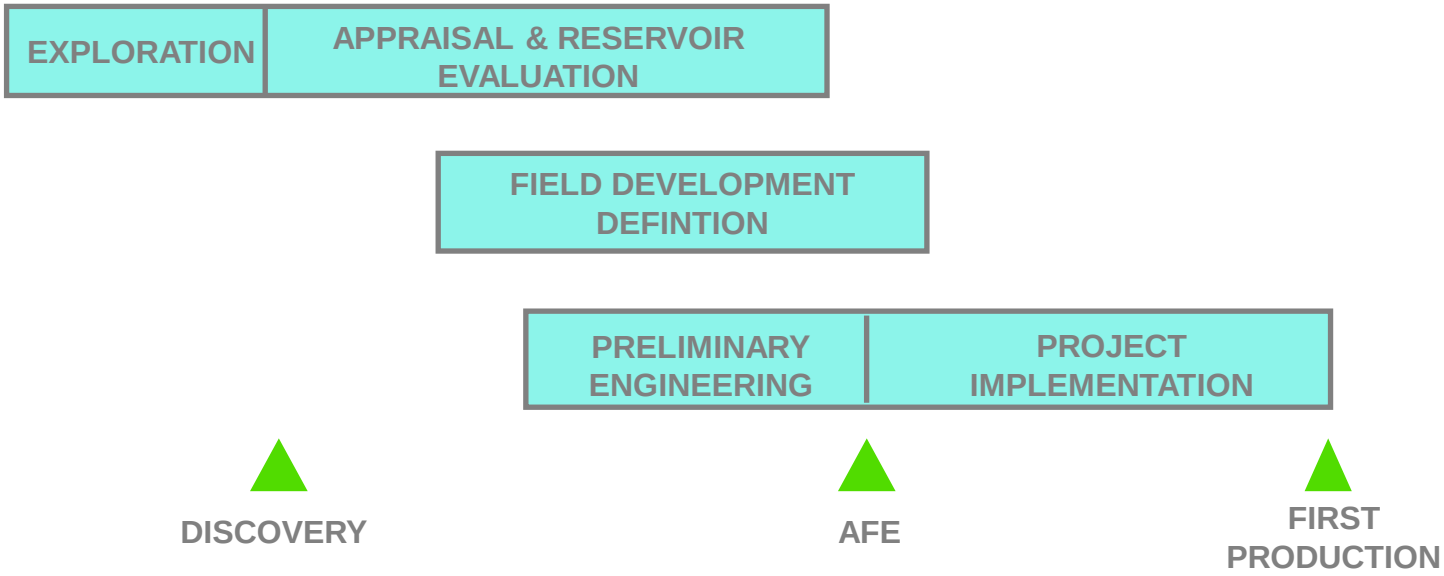
- Fast Track Projects
- Gas Export

Fast Track

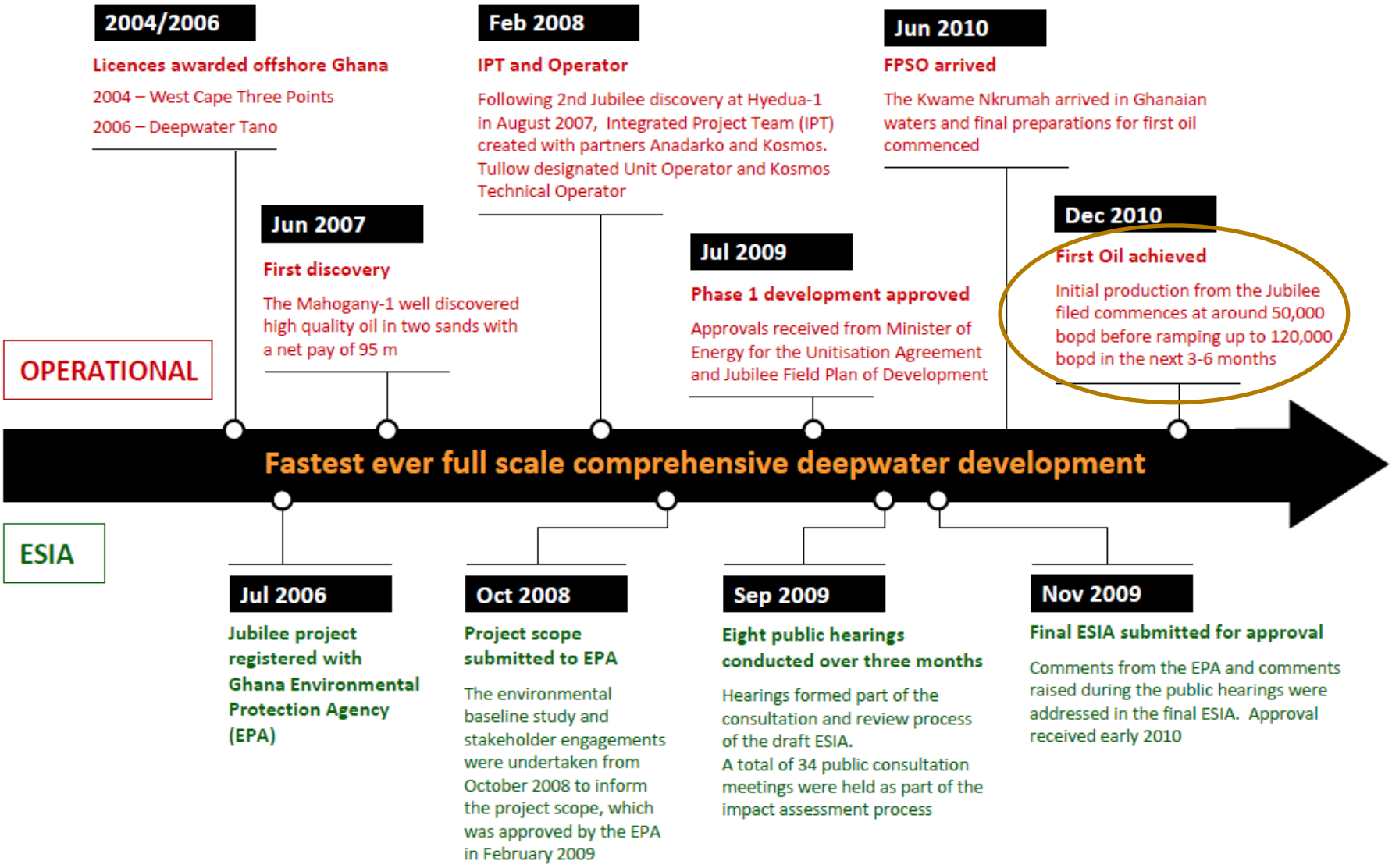
Traditional Development



Fast Track Development



Fast Track – Jubilee, Ghana



Fast Track

- Fast track developments look attractive from an NPV perspective. However, working on assumptions, because of lack of definition, has the potential to cost the company a lot more money than the time saving can expect to achieve.

- It was over 30 months before the projected production could be achieved for Jubilee. This required additional wells to be drilled and subsea equipment to be added

- The cost - circa $1,000 million CAPEX + over 2 years of lower than projected income

Fast Track

- Some areas that can cause this lack of definition are:
  - Number of wells, top hole locations and drilling programme
  - Completion Design
  - Flow Assurance – Chemical injection requirements, pressure ratings, temperature issues etc
  - Infield Flowline and Pipeline routing, and loadings to structures.
  - Operation and commissioning philosophies
  - Interface definitions between the Subsea Production System and drilling, Floating Production System, Installation, commissioning and operations

Fast Track – Risk Management

- Technical Bid Appraisal

Score	Definition
0	No supporting documentation was submitted and/or the tendered solution is not compliant with requirements at all
1	Significant non compliances for major aspects and/or poorly documented proposal
2	Some of the key requirements are addressed but several non-compliances still exist
3	Only minor non compliances and/or draft design meets requirements
4	Adequately documented full compliance with requirements

- A risk analysis shall be carried out for all items from the bids that score lower or equal than 2 or outstanding qualifications (where appropriate) that have not been resolved.

Fast Track – Cost Risks

No	Severity	% of contract value (%)	Euro	Could happen in E&P industry Practically Non- credible occurrence	Reported for E&P industry Rare occurrence	Has occurred at least once in company Unlikely occurrence	Has occurred several times in Company (Global) Credible occurrence	Has occurred several times in Company (Business Unit) Probable occurrence	Happens several times in one SPS Supplier Contract Likely / Frequent occurrence
1	Slight impact	<0.5	€ 2,732,400	2	13	0	1	0	3
2	Minor impact	> 0.5 - 1	€ 5,464,800	0	0	0	0	2	2
3	Moderate impac	>1 - 5	€ 27,324,000	0	0	0	1	1	0
4	Major impact	>5 -10	€ 54,648,000	0	0	0	0	0	0
5	Extensive impac	>10	€ 54,648,000	0	0	0	0	0	0

Fast Track – Cost Risks

Bidder	Technical Risk Cost Normalisation
A	US$ 12,569,000
B	US$ 29,031,000
C	US$ 12,295,000
D	US$ 11,407,000

Commercial Issues

- **Gas Export**
- Many West African Countries do not have infrastructure to use the gas produced from offshore fields.
- A large investment will be needed to develop the electricity national grids, power generation, LNG or chemical plants that use surplus gas.
- Development options are being restricted by the desire to prevent offshore flaring of associated gas.
- Associated gas can be used for fuel for the FPSO, oil recovery enhancements such as gas lift and reinjection into the reservoirs to maintain wellhead pressures.

Local Content

Exploration and Production Drilling Phases

- Storage and inspection of
  - Wellheads
  - Casing
  - Tubing
  - Mud supply
  - Chemicals
  - Drilling equipment etc.
- Welding of conductors to Wellheads
- Etc.

Local Content

During Installation and Commissioning Phase

- Site received tests on the Subsea Production System equipment
- Site Integration tests
- Assembly and welding of rigid jumpers
- Storage of the
  - Xtrees and tooling
  - Connection system tooling
  - PLETS, FLETS and small manifolds
  - Controls equipment
  - Installation and commissioning spares
  - Capital and spares for operations
  - Miscellaneous running tools and handling equipment
- Testing of Xtrees including gas testing tanks
- Simple maintenance of equipment

Local Content

During Operational Phase

- Maintenance, repairs and refurbishments on commissioned Subsea production systems.
- Management and replacement of spare parts
- Long term storage and preservation
- Support for shutdowns, interventions, work overs, sidetracks and other asset support activities
- Maintain integrity and certification of hardware and tooling through refurbishment, preventive maintenance and replacement
- Management and replacement of obsolete components and equipment
- Recording and management of all required certification documentation

Dedicated SPS support base has the potential to employ up to 40 locals

Training

- Recruit, hire and train an indigenous workforce – to operate the Service facility & deliver all necessary support required for operation of the offshore field
  - On-the-job training,
  - In-house and external training courses
  - Workshops and seminars using expert in-house personnel
- Utilize (and develop) local supply chain – for goods and services required to support the all in-country operations
  - Qualify and include suitable suppliers in Approved vendor lists
  - Implement partnerships with local companies to develop those goods and services that are not available
  - Support local companies in their development with the aim of building capacity and capability to the level required by the Oil and Gas industry

Technology Transfer

- Send Selected indigenous staff other locations in the world to gain exposure and experience on similar projects
- Mentoring
- Graduate development programs. Recruitment and development of graduates from local universities and nationals being educated overseas
- Scholarships. Sponsorship of selected students focussing on female students to pursue engineering programs currently dominated by males

Summary

- There is enormous potential for deepwater developments in West Africa.
- There are also significant challenges which need to be addressed and overcome
- These are not only technical but involve development of local infrastructure, skills base and resources
- In todays low oil price market, these challenges are even more important.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