Kikeh – Malaysia’s First Deepwater Development
LOCATION
KIKEH FACTS & FIGURES

- Discovered July 2002: First Oil August 2007
- 120 km NW of Labuan in South China Sea
- Water depths of 1,280 – 1,370m
- Multiple reservoirs @ depths around 3,000m
- 34 Development wells – 16 are subsea
- Design rates:
  - 120,000 BPD Oil
  - 150 MMSCF/D Gas
  - 260,000 BWPD Water Injection
- 80:20 partnership between Murphy & Petronas Carigali Sdn Bhd
EQUIPMENT SUPPLY

• Equipment from 3 EPCIC Contracts:

• Technip (Technip/Subsea 7 JV)
  – 5 x flexible risers; 8 x flexible flowlines
  – 7 x riser/umbilical holdback suction anchors

• Aker Kvaerner Subsea
  – 16 x trees (+ tree running tools)
  – 1 x IWOCS
  – 5 x manifolds c/w suction piles
  – 4 x steel tube electro/hydraulic umbilicals; 1 x power/fibre optic umbilical
  – 15 x rigid jumpers
  – 5 x SDUs
  – 48 x EFLs; 27 x HFLs
  – HPU, EPU, MCS, 2 x TUTA (topsides controls equipment)

• SBM
  – Gravity Actuated Pipe (GAP™)
Risers

Subsea Drill Centres

FTL

Flowlines

FPSO

DTU
• Weather-vaning FPSO with turret drove selection of flexible risers
• Seabed topography drove selection of flexible flowlines
• Eliminated subsea connection between risers and flowlines – continuous from manifold to FPSO
• Single pipelay vessel

5 x flexible risers from Flexi-France, France
• 2 x 7” production (insulated)
• 2 x water injection (8½”, 10”)
• 1 x 8” gas injection

8 x flexible flowlines from Wellstream International, UK
• 2 x 7” production (insulated)
• 5 x water injection (6”, 8½”, 10”)
• 1 x 8” gas injection
RISERS / FLOWLINES

7 x riser/umbilical holdback anchors
by HL Engineering, Lumut, Malaysia

- 1 x 8.5m dia. x 8.5m long, 90 tonnes
- 4 x 7m dia. x 8.5m long, 81 tonnes
- 2 x 5m dia. x 4.8m long, 34 tonnes

Pipelay - avoiding seabed obstacles but minimizing length of high cost flexible flowline product
TREE

- Manifold
- Flowline
- Suction Pile
- Jumper
- EFL
- HFL
- SDU
- UTH
- Umbilical
- Tree
TREES

• Horizontal trees selected to:
  – Eliminate requirement for costly and space consuming special dual bore completion riser and emerg. disconnect package
  – Reduce any future completion workover time & cost as tree can be left in situ

Note: additional cost of extra BOP riser run (associated with horizontal tree) was all but eliminated by rig moonpool - large enough to skid entire riser to one side during tree running
TREES

16 x 10,000 psi side valve (horizontal) trees
- Tubing hanger c/w dual wireline plugs
- ROV retrievable choke insert
- ROV retrievable SCM
- 8H/1E penetrations through tubing hanger
- manufactured by AKS, Norway and assembled initially by AKS, Norway (trees 1-8) then latterly AKM, West Port, Malaysia (trees 9-16)

• 3 x production (insulated), 41 tonnes
• 12 x water injection, 38 tonnes
• 1 x gas injection, 38 tonnes
Manifolds (and drill clusters) were selected

- to allow the development drilling programme to commence ahead of manifold delivery
- to increase subsea architecture flexibility
- to simplify transportation and installation, i.e. smaller and lighter with moonpool deployment possible
- to simplify manufacture in Malaysia
- to allow workovers without shutting in adjacent wells
MANIFOLDS

5 x manifolds by AKPSAP, West Port, Malaysia)
  • 1 x 4-slot production (double header, flowloop, actuated valves), 76 tonnes
  • 3 x 4-slot water injection (single header, ROV valves), 48 tonnes
  • 1 x 2-slot gas injection (single header, ROV valves), 35 tonnes

5 x suction piles by Oilfab, West Port, Malaysia
  • 1 x 6.5m dia x 13m long, 63 tonnes
  • 4 x 6.5m dia x 10m long, 45 tonnes
Rigid jumpers with vertical connections were selected as these were favoured design in GoM (FEED engineering contractor).

Designed to be installed by single ROV.

14 x 16m jumpers (3 insulated) by AKM in Labuan, Malaysia.

Landed out  Cone engagement
JUMPERS

Jumper measurement between tree and manifold by ROV deployable “taut wire” tool

Insulated – 12.2 tonnes
Uninsulated – 9.7 tonnes
UMBILICAL

- Manifold
- Jumper
- Tree
- Flowline
- Suction Pile
- EFL
- HFL
- UTH
- SDU
- Umbilical
• Steel tube (Duplex SS) E/H/C umbilicals – no armouring
• Dynamic section in low “lazy wave” configuration with 31 buoyancy modules per umbilical
UMBILICALS

Manufactured by AKS

...Norway

Before pull-in

After pull-in

Bullnose

I-tube (FPSO)

Bend Stiffener Connector

Bend Stiffener

Pigtails
CONTROLS - SDU

SDU structures kept separate from manifold to reduce maximum structure size

5 x SDUs, standard design with varying nos. electrical connectors & J-plates - AKS, Australia
CONTROLS - FLYING LEADS..... 
...OR NOT

- **EFL**
  - 40 to 120m long
  - Min bend radius = 0.3 m
  - **Flexible** cable
  - Tronic connectors, weight in water = 2.4 kg
  - Overall weight in water for 120m EFL = 54 kg

- **HFL**
  - 40 to 120m long
  - Min bend radius = 1 m
  - **Stiff** steel tubes
  - Cobrahead connectors, weight in water = 200 kg
  - Overall weight in water for 120m HFL = 1105 kg
CONTROLS - SCM

• Principle components:
  – SEM (electronics module)
  – Solenoid operated hydraulic DCVs (directional control valves)
  – Accumulator
  – Hydraulic fluid filters
  – Wet mate connectors (electric)
  – Self sealing couplers (hydraulic)

• 16 x SCM, compatible with all 3 tree types – single design and common spares – manufactured by AKS, UK and assembled initially in UK and latterly by AKM, West Port, Malaysia
CONTROLS - TOPSIDES

Hydraulic Power Unit (HPU)

Master Control Station (MCS)

What, no yellow paint?

AKS, UK and Australia
FLOW ASSURANCE

• Passive insulation on
  – Trees
  – Jumpers
  – Manifold
  – Flowlines
  – Risers

• Chemical injection – via umbilical
  – Hydrate inhibitor (tree & downhole)
  – Wax inhibitor (tree & downhole)
  – Scale/Corrosion inhibitor (downhole)

• Operating procedures
  – Hot oil flushing, flow loop circulation
  – Line conditioning pre/post shutdown
  – Pigging
SYSTEM INTEGRATION TEST (SIT)

• Critical onshore fit up test prior to offshore installation

• Actual components
  – Tree
  – Manifold
  – Suction pile (pile top)
  – SDU
  – Rigid jumper
  – HFL
  – EFL

• Mock components
  – ROV
  – Flowline connector
INSTALLATION

• 4 distinct phases for installation of subsea equipment

PHASE 1
• (July 2006 – Present) :- trees run on drill pipe from MODU (Diamond Offshore)

Ocean Rover

Tree
PHASE 2A
- (Nov 2006 – Dec 2006) :- suction piles, manifolds & SDUs by medium size construction vessel with heave compensated crane (TS7)
PHASE 2B

- (Dec 2006 – Feb 2007) :- flowlines, risers and umbilicals (wet parked) by deepwater flexible pipelay vessel (TS7)

Deep Pioneer

Flowline
PHASE 3

- (July 2007) :- recovery from seabed and pull-in of wet parked risers and umbilicals to FPSO turret by anchor handling tug with A-frame (TS7)
PHASE 4
- (Apr 2007 – Present) :- rigid jumpers, HFLs and EFLs by vessels including AHT, rig and Field Support Vessel (Murphy/Oceaneering)

Rigid Jumper

Armada Tuah 100
AND NOW FOR SOMETHING COMPLETELY DIFFERENT…

….A SUBSEA IMPOSTER?
FTL or GAP™

• Once decision made to have 80% oil production from “wellhead only” DTU, requirement for fluid transfer lines (FTL) to/from FPSO born

Bundle:
- 1 x Carrier pipe
- 4 x rigid pipelines
- 1 x umbilical

Carrier pipe – EEW, Korea
Towheads – SBM, Bintulu, Malaysia
Rigid pipelines – Sumitomo, Japan
Flexibles - NKT, Germany
Umbilical – AKS, Norway
Tethers – Vicinay, Spain

Towhead

Slack tether chains

1600m

1300m

Taut tether chains

Towhead

Flexible pipes & umbilical

DTU

FPSO
• SBM GAP™ offered several advantages
  – Ambient water temperature increased from 3°C (at seabed) to 16°C at 180m
  – Reduced slugging in 1.3km near-horizontal pipelines
  – Pressure and temperature drops reduced by reducing overall flowpath from 4km (seabed) to 1.8km
  – No impact on seabed congestion
  – Able to be assembled by SBM in Bintulu, East Malaysia

....FIRST EVER PIPE BUNDLE USED IN A DYNAMIC MID-WATER CONFIGURATION
GAP™ - TOWHEAD
GAP™ - LAUNCH
GAP™ - GOING UNDER

After submerging to depth:

- Tether to DTU
- Tether to FPSO
- Connect flexibles
- Lay umbilical
- Install spools

Deepest saturation dive in Malaysian waters (200m)
IN SUMMARY

• Kikeh was not highly demanding for current subsea technology – not HP, not HT and not ultra deep

• The effort required to transport and import from around the world and fabricate and install deepwater equipment in a new deepwater region should not be (but, of course, always is) underestimated

• Subsea in Malaysia?....OK lah!