PRESENTATION OF TWO PLATFORMS:
The TPG500 For shallow waters, The SPAR for Deepwater.

Pierre-Armand Thomas Technip

May 25th, 2005
RANGE OF PLATFORMS FOR SHALLOW WATERS

TPG 500

UNIDECK - FLOATOVER

MOSS CONCEPT

FLOATING PRODUCTION

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TPG500 - KEY FEATURES

- Proprietary self-installing platform
- Field proven solution
- Fulfils fixed platform regulations
- Fixed but removable and reusable platform
- Low abandonment cost
- Designed with standard components
- Up to 500 feet (150m) water depth
TPG500 - LOW OFFSHORE COSTS

- Fully equipped & commissioned onshore
- Minimal offshore HUC phase - no requirement for HLV nor flotel
- Shorter weather window compared with a conventional platform installation
- Leg lowering, hull elevation and final locking within 24 hours
- Installation fully independent from tide
- Full reversibility at all stages

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BP HARDING & La Grande Arche (Paris)
MAIN COST & SCHEDULE DRIVERS

- Lower cost of engineering
  - Standard details & components

- Repetitive procurement process
  - Frame agreements
  - Proprietary items

- Simple hull construction
  - Mass production of leg nodes
  - « Manufacturing process » for leg assembly
  - Hull flat plate construction
  - Minimum equipment in hull
  - Large choice of fab yards
TPG 500 PLATFORM – CONSTRUCTION ADVANTAGES

- Construction on a quay or in a dry dock
- Large choice of yards world-wide
- Conventional offshore fabrication activities
- Low cost flat plate construction of the hull
- Leg components free issued to yard
- Large flat deck - min. equipment stacking
LEG TO HULL INTERFACE

- Shock pad
- Jackcase (4 pinions)
- Jackcase (6 pinions)
- Jackhouse
- Hull
- Top guide (Horizontal forces)
- Jacking system (Vertical forces, Self weight)
- Bottom guide (Horizontal forces)
- Locking system (dynamic vertical forces)

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Flexible design to match the elevated weight - selectable number of pinions

Typical # of pinions

- Harding: 90
- Elgin: 108
- Shah Deniz: 72

Hydraulic driven variable speed system

Typical jacking speed is 0.45 m/minute
JACKING SYSTEM

Jack Cases

Jack cases with gearboxes and hydraulic motors installed

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LOCKING SYSTEM

- Fully automatic procedure for locking and unlocking
- Optimised distribution of loads on the rack teeth
- 8300 tonne capacity per chord

Rack chock with lever arms
LEGS

TYPICAL LEG

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Forged nodes technology using hot forming and heat treatment during the forging process

Ensures 30 year fatigue life

Reduced horizontal load on chords

Repetitive Process

Proprietary Rights
FOUNDATION OPTIONS

- Piled (Elgin) or elevated
- Integrated Oil Storage
- For poor soil conditions
- Large Suction Skirt Foundation (Shah Deniz)
- Oil Storage (Harding)
- Traditional spud tanks

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EXECUTION

Fabrication in dry dock

Fabrication on quay

Hook-up & com quay side

Dry tow to site

Alternatively wet tow to site

Self elevation at site

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EXECUTION OPTION

Dry or wet tow from fab to integration yard

Moor quay side for topside installation

Topside Integration - 1

Topside Integration - 2

Topside Integration - 3

Topside integration & hull completion

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LEG ERECTION INSHORE, BUT IN DEEPWATER

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TPG 500: ONE CONCEPT - A RANGE OF APPLICATIONS

**BP HARDING (Completion 1996)**
- Drilling, Production Utilities and Quarters (DPUQ) platform
- Concrete Gravity Storage Base tank of 500,000 bbl
- 109 metres of water depth in the North Sea harsh environment (UK)

**ELF Exploration UK ELGIN & FRANKLIN (Completion 2000)**
- Production, Utilities and Quarters (PUQ) platform
- HP / HT gas condensate field (830 bar) requiring H₂S removal
- Self-piled foundations
- 92 metres of water depth in the North Sea harsh environment (UK)

**BP SHAH DENIZ (Completion Scheduled 2005)**
- Drilling, Production, Utilities and Quarters (PDUQ) platform
- Hull built in self-buoyant strips and suction can foundations
- HP gas field (750 bar)
- 101 metres of water depth in the Caspian Sea (Azerbaijan)
TPG 500 REFERENCES: SHAH DENIZ

Client: BP Exploration
Location: Caspian Sea, Azerbaijan
Date: 2001-2006
Facilities: Production, Drilling, Utilities & Quarters Platform
Scope: Conceptual, Basic and FEED Engineering and Procurement services Engineering and Supply of Proprietary items

Key data:
- 101 m water depth
- 20,000 tonne topsides with drilling facilities
- Suction can foundations
- 900 mmscfd gas
### Platform weight summary

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOPSIDES</td>
<td>9,300 tonnes (incl 3,200 tonnes of drilling equipment)</td>
</tr>
<tr>
<td>HULL</td>
<td>11,000 tonnes</td>
</tr>
<tr>
<td>LEGS &amp; RISERS</td>
<td>5,600 tonnes</td>
</tr>
<tr>
<td>FOUNDATIONS</td>
<td>3,300 tonnes</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>29,200 tonnes</strong></td>
</tr>
</tbody>
</table>
SITE PRESENTATION

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Route of existing and future oil export and Shah Deniz condensate export.

Sangachal terminal
Combined oil & gas processing facility

Route of Azeri project oil & gas subsea pipelines

Existing 24" subsea oil pipeline from Chirag.

Three 100km subsea pipelines:
- 26' gas line,
- 12” condensate line, and
- 4” mono ethylene glycol line (for hydrate control)

Shah Deniz development
Stage 1: East flank from TPG followed by subsea wells tie back.
TPG Strip Transportation Route from Singapore to Baku, Azerbaijan

TPG Strip Load out at KPF Yard in Singapore

Strip transport on Semi-Submersible Vessel

Tow across Caspian Sea from Astrakhan to Baku

Canal Tow from Rostov to Astrakhan

Sea Tow across Sea of Azov to Rostov

Strip float off Operation near Kerch, Ukraine

TPG Strip Load in Singapore out at KPF Yard

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MAIN CHALLENGES

- FOUNDATIONS
- STRIPS
- DRILLING OF WELL
  (limit of technology, reservoir, geology)
- PROCESS (pressure)
PLATFORM EVOLUTION – IMPACT OF WEIGHT INCREASE ON DESIGN

CONCEPTUAL

LEG SIZE (triangular)
(distance between chord)

16.00 m

DETAIL

17.00 m

CONCEPTUAL ELEVATION

RECENT DETAILED ELEVATION

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OVERVIEW

PLATFORM TOP LEVEL PLAN VIEW

Strip 0 : Process
Strip 1 : Wellbay / D.E.S.
Strip 2 : Drilling
Strip 3 : Utilities
  Main Power Generation
Strip 4 : Living Quarters
Well-bay arrangement

- West face Hull open structure
- 11k psi tree
- Spare slots
- Well slots on 4.8m x 3.0m centres
- Main flowline
- Dual Flowline jumper
- Pre-installed Flowline To spare slot
- Active Tensioning system
- Xmas tree Mezzanine deck
- Tensioning Accumulator bottles
- Hull double bottom
- 15k psi Wellhead
Drilling facilities - specification

- **Derrick**
  - 1,500,000 lbs capacity
  - 510 t setback capacity
  - 60,000 ftlbs @ 120 rpm topdrive
  - 3,000 hp drawworks

- **Mud System**
  - 3 x 2,200 hp mud pumps, 7500psi
  - 4000bbls tank capacity
  - 4 x high performance shale shakers
  - Provision for OBM cuttings transfer system

- **18 ¾” 15,000 psi BOP**

- **Well Intervention**
  - Rig Assisted HWU for perforating
  - Wireline through derrick or simultaneously
  - From main deck

- **Future Provisions**
  - Centrifuges
  - Installation of CTU
  - 21 ¼ 5m BOP and/or diverter
Foundation options reviewed
- spud cans
- pre-installed piled structure
- suction cans

Suction can design assurance obtained
- NGI, Prof Houlsby

Solution adopted
- design for 600mm settlement
- provide re-jacking contingency
- impacts wellbay, trees, tensioners, flowlines & export risers

Offshore Installation of Suction can
EXECUTION PLAN

- HULL
  - PREFABRICATED AS 4 MAIN STRIP IN SINGAPORE
  - ASSEMBLY IN BAKU

2801 t
88m x 16m

3182 t
88m x 16m

2814 t
71m x 16m

2278 t
53m x 16m
STIRPS IN SINGAPORE
LEG ASSEMBLY IN BAKU

LEG SECTIONS ASSEMBLY AND SKIRT-CANS FABRICATION

RACK TO RACK WELDING

WINDOW WELDING
LEG ASSEMBLY IN BAKU

LEG SECTIONS ASSEMBLY AND SKIRT-CANS FABRICATION

X BRACING PREPARATION

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LEG ASSEMBLY IN BAKU

LEG SECTIONS ASSEMBLY AND SKIRT-CANS FABRICATION

LEG SECTION JIG
(Leg sections assembly 50 m length)
LEG ASSEMBLY IN BAKU

LEG SECTIONS ASSEMBLY AND SKIRT-CANS FABRICATION
LEG ASSEMBLY IN BAKU

LEG SECTIONS ASSEMBLY AND SKIRT-CANS FABRICATION
PLATFORM INTEGRATION / SEQUENCING

1st Boom Change To First SIM Main Boom 36m JIB

Step 57
North/South Cranes and Rooms Lifted—For Early Comm And Usage

Step 68
Pipe Rack Module on Strip 3 Is Lifted In Place.
PLATFORM INTEGRATION IN BAKU

PLATFORM INTEGRATION / SEQUENCING

STEP 89
- Pipe rack module on strip 2 is lifted in place. Infill between piperacks 2-3 completed.

STEP 810
- Rig ballasted to even keel.
- The bottom part of leg No. 1 is lifted in place. Tandem lift 2x CO4000-111.
PLATFORM INTEGRATION IN BAKU

PLATFORM INTEGRATION / SEQUENCING

STEP 120
THE MANIFOLD MODULE ON NORTH ZERO HULL STRIP IS LIFTED IN PLACE USING PLATFORM RINGER @ 34m LIFT RADIUS

STEP 121
THE RIG IS JACKED DOWN, MOVED TO A NEW POSITION TO SUIT 32m OPERATING RADIUS OF RINGER AND JACKED UP.

STEP 122
THE MIDDLE PART OF LEG NO. 3 IS LIFTED IN PLACE.

STEP 123
DRY WELL DAY TEMPERATURE WELLS REMOVED AND TUNNEL BETWEEN ZERO STRIPS IS LIFTED IN PLACE.

STEP 124
THE TOP PART OF LEG NO. 3 IS LIFTED IN PLACE.
FABRICATION YARDS

- JACKING/LOCKING
  - FABRICATED IN FRANCE (CMD/REXROTH)
  - ASSEMBLY OF LOCKING IN SINGAPORE
  - ASSEMBLY OF JACKING IN BAKU
RANGE OF PLATFORMS FOR DEEPWATER

Spar et Deep Blue

DPS-2000

FPSO

EDP
Spar Functions

- Drilling
- Workover
- Production
- Wellhead
- Oil storage and offloading
- Any combination of the above
## Spar Capabilities

<table>
<thead>
<tr>
<th>Capability</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water depth</td>
<td>1,000 to 10,000 ft</td>
</tr>
<tr>
<td>Well slots</td>
<td>0 to 40</td>
</tr>
<tr>
<td>Oil throughput</td>
<td>to 400 Mbopd</td>
</tr>
<tr>
<td>Gas throughput</td>
<td>to 750 MMscfd</td>
</tr>
<tr>
<td>Topside payloads</td>
<td>1,500 to 45,000 s. tons</td>
</tr>
<tr>
<td>Hull diameters</td>
<td>20 to 200 ft</td>
</tr>
<tr>
<td>Hull drafts</td>
<td>280 to 800 ft</td>
</tr>
<tr>
<td>Storage</td>
<td>5 to 10 days production</td>
</tr>
</tbody>
</table>
SPAR ADVANTAGES

Dry Trees
- Reduced drilling time (optimized to operators program)
- Reduced drilling costs
- Workovers

Proven Execution Model

Flexibility

Decoupled system

Unconditional Stability
SPAR AT FABRICATION YARD IN FINLAND
SPAR RAOs

RAO comparison - Surge

RAO comparison - Heave

RAO comparison - Pitch

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COMPARISON OF PLATFORM MOTIONS

100 Year Storm

- Truss Spar (500 ft Draft)
- Cell Spar (435 ft)
- Extendable Draft Platform (246 ft.)

Max Heave, ft.
Max Pitch, deg
Deck Accel., gx10
Pitch RMS, deg
DRILLING OPTIONS

Pre-Drill  Offset Drill  Platform Drill
OFFSET DRILLING

DB-50  NEPTUNE SPAR  MODU

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Winching equipment
- Rotary winches (wire)
- Linear winches (wire)
- Chain windlasses or capstans
- Chain jacks or devil’s claws

Fairleads
- Rotary-type
- Bending shoe type

Stoppers
- Passive
- Active
Mooring System (Typical for Technip Spars)

- **Mooring Arrangement:**
  - 3 x 3 grouped legs (Boomvang, Nansen, Gunnison, Horn Mountain)
  - 3 x 4 grouped legs
  - 4 x 3 grouped legs (Diana)
  - Mixture of 3 and 4 grouped (Mad Dog – 11, Genesis - 14)
  - 4 x 4 grouped legs (Holstein)

- **Mooring Size:**
  - Typical: 5 ¾” (146 mm) dia. R4 studless chain, 5” (127 m) dia. wire
  - Max. 6 ¾” (171 mm) dia. R4 studless chain, 5 ¾” (147.5 mm) wire
  - Max. 10 ¼” (260 mm) dia. polyester
On-vessel Mooring / 2

- Chain jacks:
  - Hydraulic, 1 air-cooled HPU - less than 200 HP
  - Pulling capacity abt. 500 tons
  - Stopper capacity same as chain MBL
  - Turndown sheave
  - “Removable” chain jack system possible
**Anchor Point**

- Base case assumption is suction anchor:
  - Diana (21 ft dia. x 105 ft, 290 stons)
  - Horn Mountain 918 ft x 94 & 91 ft, 200 stons
  - Holstein (18 ft dia. 126 ft, 290 stons)
  - Mad Dog (18 ft x diff. lengths, 25 ft dia. x diff. lengths, up to 250 stons)
  - Red Hawk (18 ft dia. X 78 ft)
Conclusions

- Mooring technology exists today to moor in 2400 meters water depth
- Several enhancement to existing technology can be still studied to make moorings more cost effective
- Polyester and wire options are both feasible
- Lowering and installation tools and procedures exist today to safely and successfully install the moorings in 2400 meters water depth
DECK INSTALLATION METHODS

Floatover

Heavy Lift

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EXAMPLES: PULL TUBE HULL EQUIPMENT

- Kerr McGee Boormvang & Nansen
  - Pre-Installed Pull Tubes
EXAMPLES: PORCH – SCR INTERFACE

Porch interface suitable for FlexJoint or Taper Stress Joint
Hydro pneumatic tensioners
RISER BENEFITS

- Risers shielded from highest currents
- Risers shielded from wave forces
- Minimal wave frequency motions reduce dynamic excitation of riser to almost zero
- Low heave
DRY TREE RISERS
Spar Top Tension Riser System – Air Cans

Cans

Guide

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TYPICAL DRY TREE PRODUCTION RISER SYSTEM
TOPSIDE FLEXIBLE JUMPERS

Design Drivers
- **Fluid Properties**
  - Pressure
  - Temperature
  - Composition
- **Stroke Motion**
  - MBR
  - Clashing with Structure
  - Tension / Bending
  - Fatigue
KEEL JOINTS

Truss Spar
9 5/8" Production Riser
Keel Joint Sleeve

Classic Spar
9 5/8" Production Riser
Retrievable Keel Joint Sleeve
Examples: Porch Hang-off Locations

- **ExxonMobil Diana**
  - Hard Tank

- **KMG Gunnison**
  - Soft Tank
Hull Piping & SCR Pull-in Equipment
TRUSS SPAR, CELL SPAR AND EDP

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WHY A TRUSS SPAR?

- More optimal structure
  - Replace high weight midsection with more efficient truss structure

- Higher damping allows reduction of draft
  - Single piece fabrication and transport brings cost, schedule advantages

- Extra wellbay real estate is cheaper than with a classic spar

- Reduction of drag loads in current-dominated areas allows reduction of mooring component sizes, costs
Water Depth - 3,600 ft
Diameter - 90 ft
Draft - 493 ft
Topsides Payload - 7,700 tonnes
Hull Steel Weight - 10,700 tonnes
TTR Production Risers - 9 slots
Workover/offset drilling
Export - SCRs
BARGE HARRY AT THE END OF ASSEMBLY RAILS
BP HOLSTEIN DRILLING AND PRODUCTION SPAR

DRILLING SYSTEMS
- Sail Area
- Drill Package Transit Speed

TOPSIDES
- Seachest
- Utilities to Hull
- Overboard Discharges
- Material Handling
- Hull-to-Deck Connection
- Spar Deck Layout
- Liquid Storage in Hull Tanks
- Weight and C.G.
- Sail Area
- Disposal Caisson

WELL SYSTEMS
- Future Flowlines
- Umbilicals
- Well Bay Arrangement
- Riser Loads
- Riser Stroke
- Center Well Size
- Number of Wells
- PRT Support Frame Loads
- Size of Slots
- Vessel Motions

BP HIGH VALUE COMMODITY
- Mooring Wire
- Mooring Chain

HOLSTEIN INSTALLATION TEAM
- Weights
- Towout
- Upending Analysis
- Hull-to-Deck Connection
- Setting of Decks
- Installation Aids

MARDI GRAS TRANSPORTATION SYSTEM
- Export Riser Pipe in Hull
- Riser Guide Pipe in Hull
- Riser Porch
- SCR Chain Jack Platform
- Installation Aids
- Testing

GEOTECHNICAL
- Soils Data (For Mooring)
- Geohazards (For Mooring)
WHY A CELL SPAR

Less Expensive to Build
- Simple Design - Automated Design
- Standard Design - Duplication
- Automated Fabrication
  - Machine Rolled Cells (Cans)
  - Submerged Arc Welding

Schedule Incentives
- Reduced Engineering Effort & Time
- Fast Hull Fabrication
- Standard Topsides Modules
  - Do Not Optimize
  - Lease Existing Equipment
CELL SPAR

RED HAWK

THIS IS THE FIRST APPLICATION OF A CELL SPAR (2004)

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EXTENDABLE DRAFT PLATFORM (EDP)

- Extendable Draft Platform (EDP) pour forage et/ou production et/ou opérations sur puits existants
- Tous les systèmes de la plateforme sont testés à terre, travaux de démarrage en mer réduits au minimum
- Convient pour de grosses exploitations, en eaux très profondes et un nombre important de puits

Composé de :
- Pont de type barge
- Installations de traitement situées sur le pont
- Jambes (buoyant column + truss)
- Ponton (amortisseur de pilonnement)

Remorquage en mer

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