Developing Shtokman field – a unique international energy project

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Content

- Shtokman field overview
- Key technical features
- Subsea facility description
  - Overall
  - SPS
- Project status / achievements
Shtokman Development AG (SDag)

• Scope
  – Organize, design, finance, construct and operate during 25 years the “SHTOKMAN Phase 1 development”
  – Production plateau of 23.7GSM³/year, 7.5mtpa LNG - 5% gas for local market, the rest piped to the North Stream pipeline Project
  – SDag and its Shareholders support the technical & economical risks of the Phase 1 development.

• A single integrated and dedicated Project team Gazprom + Total + StatoilHydro

• Synergy of Russian and European cutting-edge skills and technologies
  – Sharing of knowledge and resources optimization
Shtokman field overview
SHTOKMAN Field

- Gas & condensate field in the Russian Barents Sea
  - Discovered in 1988
  - Super giant field: 3800GSm³ (135Tcf)
  - Water depth: 320-340m (1100ft)
  - Good gas quality and low GCF
  - Offshore at 550km (340mi) from Kola peninsula
  - 7 discovery/appraisal wells
- Too large to be developed at once,
  - Full field development in 3 phases of 23,7GSm³/year (~2.4Bscf/d) each (400,000bepd)
  - Phase 1: 7,5mtpa LNG & 11.2GSm³/y pipe gas
  - Onshore plant near Teriberka, 120km (75mi) eastward of Murmansk
SHTOKMAN field development

A phased but unique development… 2 large projects in 1 (OFF & ON)
Harsh environment: arctic conditions

- Harsh metocean conditions
  - Extreme conditions equivalent to Northern North-Sea, associated to rapid evolution of phenomena

- Polar Lows

- Icing
  - From atmospheric and sea-spray

- Low temperatures
  - Extreme lowest -40°C

- Snow
  - Twice more than in Sakhalin

- Polar night (3 month/year)
  - From Dec. to Feb.

- Darkness, fog…
  - \textit{Constant challenges to HSE}

- Metocean parameters were validated by extensive measurements
  - 8 years of observations on site & 1 year along trunkline
Ice & Iceberg conditions at Shtokman

- **Ice occurs once in 2.6 years.**
  - when occurs, stays in average 3.3 weeks but could be up to 3 months

- **First-year ice with**
  - thickness average 0.85 m, max 2.0 m
  - rare inclusions of second year floes (<50 m)
  - Ice ridges keel up to 21 m deep (locally)

- **Ice drift reversals occur**

- **Icebergs**
  - Collision probability with FPU about 0.2 in 50 years, if not managed
  - in open water and embedded in Sea Ice

*Shtokman field is unique by the combination of harsh metocean conditions and presence of ice and icebergs*
Shtokman Phase 1 development: main challenges

• **Technical challenges**
  – Size of the project
  – Remote location: 550km (340mi) from mainland
    • Open sea, no other nearby development
  – Arctic environment
    • Ice & icebergs, etc.
    • Polar lows
    • Icing
  – Environmentally sensitive ecosystem
  – Operating conditions
    • Weather season limitations autonomy
    • Complex logistics, EER response time
    • Winterization (Offshore & Onshore)

• **Organizational & human challenges**
  – Local content
  – Human factor.
Size of project

- Floater to process 71.2MSm³/d of gas (2.5Bcf/d), incl. FG
  - One of the biggest floater worldwide
  - Ice resistant & disconnectable
  - Topsides > 40,000t
  - Flare size
  - Turret size & number of risers
  - Emergency Evacuation & Rescue

- Dual dry 2-phase 36” trunklines:
  - unique compared to all other 2-phase and MPF pipelines:
  - Distance + rough seabed topography + diameter

- 7.5mtpa LNG plant
  - A mega LNG train in a very remote area
  - Utilities & support (600MW PGU, service harbor, camp, etc.)
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Key technical features for the subsea development (1/2)

• **Good quality gas**
  – No significant H₂S
  – No significant CO₂
  – Very low liquid content
  – Moderate reservoir temperature
    • Low condensed water content
  – Moderate reservoir pressure
    • 210 bar WHSIP

• **High deliverability wells**
  – Potential in excess of 10 Mm³/d
  – Top of the range Xmas tree (7”)
  – 16" OD flowlines with 14" ID risers

• **350 m water depth**
  – Deepwater diverless technology
  – Flexible pipe only choice for risers
  – **Trawling activity & template architecture**
Key technical features for the subsea development (2/2)

- **Arctic environment**
  - Need to accommodate FPU disconnection
    - Flexible risers
  - Seasonal installation
  - Risk of severe weather conditions

- **Large gas flow rate for export**
  - Avoid "singing risers"
  - Redundancy

- **Project size + expected 50 years operational life**
  - Conventional solutions
    - Hydrate prevention with permanent MEG injection
    - Looped flowlines
  - Minimum qualification
    - Wet Gas Flow Meters
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Subsea Europe Paris: Shtokman Development - October 2010

Subsea facilities

- 6 x 4 Slots Production Templates
- 6 x 14" ID Infield Flexible Risers
- 6 x 14" ID Export Flexible Risers
- 6 x 16" ND Flowlines
Subsea architecture - schematic

<table>
<thead>
<tr>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td><strong>Template</strong></td>
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<tr>
<td>6 x 4-Slots templates</td>
</tr>
<tr>
<td>(2 templates in series on 3 drill centers)</td>
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<tr>
<td><strong>Flowlines</strong></td>
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<tr>
<td>6 x 16&quot; ND</td>
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<tr>
<td><strong>Risers connection to Flowlines</strong></td>
</tr>
<tr>
<td>Single valve and connectors on simplified IRB</td>
</tr>
<tr>
<td><strong>Infield Risers</strong></td>
</tr>
<tr>
<td>6 x 14&quot; ID Rough bore</td>
</tr>
<tr>
<td><strong>Export Risers</strong></td>
</tr>
<tr>
<td>4 x 14&quot; ID Smooth bore</td>
</tr>
<tr>
<td><strong>I-tubes</strong></td>
</tr>
<tr>
<td>18 I-tubes for Risers and umbilicals</td>
</tr>
<tr>
<td><strong>Infield pigging</strong></td>
</tr>
<tr>
<td>Topside to topside via riser, flowline &amp; pigging loop on template</td>
</tr>
<tr>
<td><strong>Flow Control Module</strong></td>
</tr>
<tr>
<td>Subsea choking and subsea Wet Gas Flow Meter</td>
</tr>
<tr>
<td><strong>Umbilical architecture</strong></td>
</tr>
<tr>
<td>Umbilical with derivation to control the IRB</td>
</tr>
<tr>
<td>+ 2nd template in daisy chain</td>
</tr>
<tr>
<td><strong>Installation</strong></td>
</tr>
<tr>
<td>Flowlines: 16&quot;ND can be laid as well in S-lay, J-Lay or reel lay</td>
</tr>
<tr>
<td><strong>Drilling</strong></td>
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<tr>
<td>3 drill centers -&gt; limited rig moves achieved by skidding</td>
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Export system general arrangement
Trunkline riser base and PLEM configuration with built-in redundancy

- 16" By pass
- 2 Umbilicals
- 4 x 16" spools
- Foundations
- Modules

- 16" remotely operated valve
- 16" ROV operated valve
- 36" ROV operated valve
Design: 2x36” trunklines to shore

- **TWO phase flow design – optimized solution with two 36” trunklines**
  - Nominal export rate per trunkline = 35 MSm3/d
  - Full capacity per line = 38 MSm3/d
  - FPU discharge pressure about 150 bara, arrival pressure 60 bara (packed up to 110 bara)
  - Onshore slug catcher capacity 2500 m3 (in two parts)
Subsea IMR and monitoring philosophy

- **Design life philosophy**
  - Category 1: 50 years service life (structural/static)
  - Category 2: 30 years service life with potential extension through Inspection
    - Capability to retrieve (e.g. manifold)
  - Category 3 <30 years service life
    - Modular design replaceable by Shtokman installation means (e.g. choke module/risers)

- **Production parameters monitoring at drilling centres**
  - Classical: P, T Hydrate inhibitor flow
  - Wet gas flow meters (with emphasis on formation water detection)
  - Sand production detection (acoustic + erosion & momentum sensor)
  - Acoustic leak detection (1 per template)

- **Production line inspection**
  - Looped configuration allowing surface to surface round trip internal pigging by intelligent pigs
  - External inspection (CP, visual inspection, geophysical survey, FLET)

- **Trunkline inspection**
  - Subsea pig launcher and receivers designed to accommodate intelligent pigs
  - External inspection

- **Riser and riser system monitoring**
  - Annuli venting and monitoring + polymer coupons monitoring
  - Visual inspection (including in the I tubes)
  - Midwater arch buoyancy
Subsea Intervention and ROV Services

- Typical ROV operations required will be:
  - Assistance during ROT operations and subsea construction work
  - Operation of various ROV skids/tools (i.e. tie-in tools, torque tools)
  - Replacement of flying leads / cables / hoses.
  - Cleaning and high pressure water jetting
  - Replacement of subsea control modules, choke modules and other replaceable equipment
  - Visual inspections of subsea installations and pipelines
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Status (offshore part)

• Main technical options selected for base case
  – Offshore concept, sub-sea system, marine infrastructure configuration, onshore process…
  – FEED (launched in Dec. 07) completed
  – Compensated call for tender for FPU completed
  – Qualification programmes completed for the subsea part

• Decision to de-couple LNG from Offshore scheme

• Moving towards two distinct final investment decision (FID)
  – One for offshore scheme
  – One for LNG plant

• Call for Tenders for Subsea, FPU, Trunkline in progress
Thank you!