OTC-24958-MS
Middle East to India Deepwater Pipeline (MEIDP)
Crossing of the Owen Fracture Zone

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The Middle East to India Deepwater Pipeline (MEIDP) Project

- MEIDP 1 will be the first in a series of pipelines supplying gas to the Gujarat coast of India, from the vast available resources in the Middle east, by the **safest, most economic** and **reliable** means.

- The SAGE MEIDP Project is envisaged as an transmission pipeline **Infrastructure project** allowing transportation of multiple sources of Middle East Gas to the West Coast of India.

- In May-June 2013 SAGE undertook a **multi-million $ Geophysical Survey** of the pipeline route across the Arabian Sea.

- Assessments are now underway in all key areas along the route.

- This presentation gives details of the pipeline crossing of the **Owen Fracture Zone (OFZ)** and the **Fault movement analysis** performed to confirm the pipeline is safe on the planned route.
MEIDP Details

• Potential Start Points
  – Chabahar, Iran
  – Ras al Jafan, Oman
• End Point- South Gujarat
• Diameter 27.2”, 32.9-40.5mm WT (DNV OS-F101)
• Flowrate 1.1BSCFD (31.1mmscmd)
• Maximum Depth- 3,450 meters
• Length- 1,200- 1,300 kilometers
• Project to be executed over 7 year period
• Pipeline Construction over 2 years
MEIDP Survey Route

Qalhat Seamount

Omani Slope
At the MEIDP Crossing the Owen Fracture Zone is characterized by two main structures:

- The deep basins of the Dalrymple Trough and horsetail in the North
- An arch formed bathymetrical high in the South

The Owen Fracture zone stretches for more than 1200km with the Dalrymple Trough forming the last 350km at its Northeastern end and reaching a depth in excess of 4000m. The bathymetric high is about 6km wide and approx. 19km long, rising to 2630m water depth at its shallowest part.
The stratified sediments and slump deposits that exist north of the Qalhat Seamount diminish rapidly as the route descends into the canyon of the Dalrymple Horsetail. Coming out of the canyon the route enters an area with very uneven seabed and crosses several ridges of displaced blocks that probably trace active and inactive faults of the Dalrymple Horsetail.
This fault is the tectonic plate boundary of the Indian and Arabian plates.
- A strike-slip right lateral fault
- Moving at a slip rate of 3mm/year (7mm/yr max).
- Fault forms a 200m deep canyon 1.3km wide at MEIDP crossing
Pipeline Installed on 3D Seabed from survey across the Owen Fracture Zone

Spanning / Contact

Equiv. Stress

OTC-24958-MS, MEIDP Crossing of the Owen Fracture Zone, Ian Nash
There were 3 spans of note observed in the OFZ.

- Maximum Span Lengths approx. 130m
- Maximum Span Heights approximately 1.2m
PGA Profiles and 475yr Isolines

PGA Values @OFZ
1000yr = 0.60g
475yr = 0.37g
200yr = 0.20g
3D Analysis of Effects of 1000yr - 7m Fault movement on MEIDP during Operation using 200m corridor of 3D Seabed

Crossing the Fault in direction of Strike-Slip Movement

Crossing the Fault against the direction of Strike-Slip Movement

Spanning

Spans Length Increase ✓

Equiv Stress

Slight Stress Increase ✓

Spanning

Pipeline Buckles X

Equiv Stress

Stress at Yield X
1000yr Fault movement Summary Results
+7m Correct Routing, -7m Incorrect Routing

vonMises Stress

- Installation
- Operation
- -7m Movement
- +7m Movement
- 90% SMYS
- SMYS
- Faultline
- Bend 1 TP2
- Bend 2 TP1
## Possible Intervention Equipment for OFZ

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Owen Fracture Zone Water depth Range</th>
<th>Pre- lay Intervention</th>
<th>Post- lay Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3000m-3250m</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Trenching Machine</strong></td>
<td>Current maximum working depth 2050m. Upgrade required to reach 3500m.</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td><strong>Mass Flow Excavation Spread</strong></td>
<td>Current maximum working depth 3000m. Upgrade required to reach 3250m.</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Rock Dumping (Fall Pipe) Vessel</strong></td>
<td>Current maximum working depth 2000m. Vessel/Fallpipe upgrade required to reach 2500m. Vessel modification and strengthening required to reach 3250m.</td>
<td>?</td>
<td>?</td>
</tr>
<tr>
<td><strong>ROV for Installing Mattresses, Mechanical Supports &amp; Post- lay VIV Strakes</strong></td>
<td>Current maximum working depth 4000m.</td>
<td>✓ ✓ ✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Pipeline Repair System</strong></td>
<td>Current maximum working depth 3000m. Upgrade required to reach 3500m.</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
Conclusion

The Owen Fracture Zone (OFZ) is a significant feature to be crossed by MEIDP and due account of the potential seismic event associated with a slip rate of 7mm/yr must be taken into account in design.

The assessments made of installation across the OFZ and operation during a seismic slip event indicate that with correct routing, the pipeline can cross this plate boundary fault safely and without major intervention.
Acknowledgements / Thank You / Questions

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