Safety Knows No Borders: Submarine Gas Pipeline from PRC to BPPS

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Introduction

- More natural gas as fuel to meet emission standards
- Current gas supplies forecast to start depletion in 2012/13 – require gas replacement
- Memorandum of Understanding on Energy Co-operation signed in 2008
- CAPCO, a joint venture between ExxonMobil and CLP Power, is working with PetroChina to jointly develop a submarine gas pipeline linking Dachan Island to BPPS
- Safety management is key
PetroChina’s Second West-East Pipeline Project

- China’s first major energy project to transfer natural gas from outside
- From Khorgos Port (Xinjiang) to Guangzhou/Shenzhen and Shanghai

- Total length: ~8,600 km
- Capacity: ~30 Bcm/yr
- Maximum design pressure: 120 bar
- Fully operational in 2012
Pipeline Project Background

Battery Limits of JV Project

Onshore Pipeline

Dachan Island Launching Station
- Pig Launcher

(800m)

Submarine Pipeline

Shenzhen Waters (~15km)

HK Waters (~5km)

Hong Kong End Station
- Pig Receiver
- Gas Filters
- Gas Metering
Submarine Pipeline Route Selection

- Physical constraints considered:
  - Anchorage areas
  - Marine dredging / disposal areas
  - Submarine utilities
  - Marine vessel fairways
  - Reclamation areas

- Risk constraints considered:
  - Populated areas
  - Areas with risk related activities

- Optimum pipeline route concluded with:
  - Collaborative effort between PetroChina & CAPCO
  - Reviews with PRC and HKSAR authorities
Dachan – BPPS Submarine Pipeline Route

Anchorage

Anchorage

New Anchorage for non-powered ship

PetroChina Gas Station

SheKou

Dachan Island

DG Anchorage

Tanker Anchorage

Cargo Anchorage

Proposed Pipeline Route of approx. 20km

Existing Y13 Pipeline

Hong Kong Boundary

BPPS

Hong Kong

P.7
### Submarine Pipeline Design

<table>
<thead>
<tr>
<th>Pipeline Design Parameters</th>
<th>Details</th>
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<tbody>
<tr>
<td><strong>Pipe Diameter</strong></td>
<td>32 inch</td>
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<tr>
<td><strong>Pipe Wall Thickness</strong></td>
<td>22.2 mm</td>
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<tr>
<td><strong>Design Operating Pressure</strong></td>
<td>63 barg</td>
</tr>
<tr>
<td><strong>External Corrosion Coating</strong></td>
<td>3-Layer Polyethylene</td>
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<tr>
<td><strong>Internal Coating</strong></td>
<td>Epoxy</td>
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<tr>
<td><strong>Concrete Weight Coating</strong></td>
<td>60 – 80 mm</td>
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- Adopted European standard, DNV code for Submarine Pipeline Systems
Submarine Pipeline Design

- Factors considered in the design:
  - Input from regulatory authorities
  - Bathymetry and soils information from route survey
  - Interfaces with other sea users
  - Mechanical protection of pipeline
  - Gas supply from PRC sources
  - Gas demand conditions for BPPS
Mechanical Protection against Anchor

- Pipeline route traverses shipping channels
- Protection configuration determined through:
  - Risk-based probability study
  - DNV-RP-F107 – Risk Assessment of Pipeline Protection
- Protection design performances established from:
  - Mechanical study
  - Finite element (FE) analysis
  - Anchor drag centrifuge tests
Mechanical Protection against Anchor

- 3-D non-linear FE analysis with ABAQUS
  - Incorporates complex interactions between anchor, chain, soil, rock and pipeline
- Rock protection of 2 m and 3 m cover for protection from 5-tonne and 19-tonne anchors

Finite Element Analysis with ABAQUS

Protection Design for 19-tonne Anchor
Quantitative Risk Assessment (QRA)

- To assess potential risks associated with pipeline operation
- Resulting risk levels compared against HK Risk Guidelines
- QRA considered loss of containment due to all possible events
- Major risk contributors:
  - Corrosion
  - Material defects
  - Third party damage from ship anchor drops/drags
Quantitative Risk Assessment (QRA)

Pipeline Sections for QRA
- KP0–0.73: Type 2
- KP0.73–2.52: Type 3
- KP2.52–4.78: Type 2
- KP4.78–4.89: Type 1

QRA conclusion: Risks for all pipeline sections in HK water acceptable per HK EIAO
Safe Operation Design

- Safety overpressure systems at Dachan and BPPS
- Overpressure protection at BPPS with High Integrity Pressure Protection Systems
- In case of emergency:
  - New GRS isolation by ESD valves
  - Provisions provided in GRS facilities for automatic blowdown
  - Provision made for depressurisation of submarine pipeline by manual blowdown through vent stack at Dachan
Construction Safety

- Joint constructability workshops between CAPCO and PetroChina
- Risks at critical locations reviewed and appropriate mitigation methods incorporated into construction plan
- Marine Traffic Management Plan developed with local authorities requirements

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Proposed Dredging Plan for Urmston Road and Safety Mitigations
Construction Safety - Pipeline Installation

- Marine Traffic Impact Assessment
  - Assessed potential impacts to marine traffic and facilities
  - Developed mitigation measures
- Geophysical survey to further confirm Y13-1 pipeline location before construction
- Environmental constraints addressed during construction planning stage

![Diagram of Conventional S-Lay Pipelaying Method](image)
Construction Safety – Shore Approach

- Ensure no over-stressing of pipeline during installation
- Stress checks to determine pipeline burial transitions and vertical radius
- Typical shore pull operation

Illustration of Shore Pull Operation
Operation Safety

- Operational Safety Management System critical
- Regular external and internal inspection to assure pipeline protection and integrity
- Develop Pipeline Emergency Procedure
- Consult key stakeholders to integrate with in emergency response procedures
Conclusion

- Close management and interfaces are essential
- Contracting strategy developed to secure effective management and rapid communication
- Ensure effective safety management process integrated and implemented through pipeline’s life-cycle
- Safety truly does not have a border!