Design for CPC New 36” Offshore Pipeline
CPC won the 25 years long term gas supply contract to Tatan power plant in July, 2003 from Tai-Power Company. In order to meet the contract requirements, CPC launched the project to build an Northern LNG Receiving Terminal in Taichung Harbor with a capacity of handling 300 million tons of imported LNG annually. An associated offshore gas transmission pipeline of 36 inch will be built from Taichung to Tatan. This new offshore pipeline will be integrated with the existing 36 inch offshore pipeline in Tunghsiao Governor Station to constitute a mutual backup system.
# CPC LNG OFFSHORE PIPELINE SYSTEM

## DESIGN CONDITIONS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DESIGN LIFE</strong></td>
<td>50 years</td>
</tr>
<tr>
<td><strong>CAPACITY</strong></td>
<td></td>
</tr>
<tr>
<td>Taichung to Tunghsiao</td>
<td>900 tons/hr</td>
</tr>
<tr>
<td>Tunghsiao to Tatan</td>
<td>600 tons/hr</td>
</tr>
<tr>
<td><strong>Max. OPERATING PRESSURE</strong></td>
<td>80 kg/cm² (G)</td>
</tr>
<tr>
<td><strong>DESIGN PRESSURE</strong></td>
<td>88 kg/cm² (G)</td>
</tr>
<tr>
<td><strong>SIZE OF LINE PIPE</strong></td>
<td>ID 882.6mm</td>
</tr>
<tr>
<td><strong>WALL THICKNESS OF PIPE</strong></td>
<td>14.3mm and 15.9mm</td>
</tr>
<tr>
<td><strong>MATERIAL OF PIPE</strong></td>
<td>API 5LX65</td>
</tr>
<tr>
<td><strong>CORROSION ALLOWANCE</strong></td>
<td>1.5 mm</td>
</tr>
<tr>
<td>Ground Horizontal Acceleration</td>
<td></td>
</tr>
<tr>
<td>Taichung to Tunghsiao</td>
<td>– 0.33g</td>
</tr>
<tr>
<td>Tunghsiao to Tatan</td>
<td>– 0.23g</td>
</tr>
</tbody>
</table>
APPLICABLE CODES

Line Pipe
- API 5L “Specification for Line Pipe”

Pipeline Mechanical Design
- ASME B31.8 “Gas Transmission and Distribution Pipeline System”
- DNV 1981 “Rules for Submarine Pipeline Systems”

Pipeline Offshore Stability
- PRCI (AGA) Level 2 “Submarine Pipeline On Bottom Stability”

Cathodic Protection
- DNV RP F103 “Cathodic Protection of Submarine Pipelines by Galvanic Anodes”

Installation Feasibility
- DNV 1981 “Rules for Submarine Pipeline Systems”
PIPETLINE ROUTE

Segment 0-1  Onshore inside Taichung Harbor
Segment 1  Offshore Taichung to Tunghsiao
Segment 0-2 & 0-3  Inside Tunghsiao Governor Station
Segment 2  Offshore Tunghsiao to Tatan
Segment 0-4  Onshore in Tatan
CPC LNG OFFSHORE PIPELINE SYSTEM

PIPELINE ROUTE

Segment 0-1 Inside Taichung Harbor

Total Length:
Approx. 5 Km (including 1.1Km HDD section)

Line Pipe Wall Thickness
15.9 mm.

Construction
HDD for Taichung harbor main channel crossing
## CPC LNG OFFSHORE PIPELINE SYSTEM

### PIPELINE ROUTE

#### Segment 1 – Taichung to Tunghsiao

<table>
<thead>
<tr>
<th>KP</th>
<th>0.0~1.1</th>
<th>1.1~5.0</th>
<th>5.0~36.3</th>
<th>36.3~38.5</th>
<th>38.5~39.5</th>
<th>39.5~40.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approx Max W.D (wrt CD)</td>
<td>&lt;10m</td>
<td>36m</td>
<td>53m</td>
<td>39m</td>
<td>20m</td>
<td>&lt;10m</td>
</tr>
<tr>
<td>Soil Type</td>
<td>sand</td>
<td>sand</td>
<td>clay</td>
<td>clay/sand</td>
<td>sand</td>
<td>rock</td>
</tr>
<tr>
<td>Wave (100 yr)</td>
<td>8.05m</td>
<td>8.41m</td>
<td>8.41m</td>
<td>3.81m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipe wall thickness</td>
<td>14.3mm</td>
<td>14.3mm</td>
<td>14.3mm</td>
<td>14.3mm</td>
<td>14.3mm</td>
<td>14.3mm</td>
</tr>
<tr>
<td>Coating thickness</td>
<td>120 (Pre)</td>
<td>120 (Pre)</td>
<td>85 (Pre)</td>
<td>105 (Pre)</td>
<td>120 (Pre)</td>
<td>120 (Pre)</td>
</tr>
</tbody>
</table>

---

**Soil Type**
- <10m: rock
- 20m: sand
- 53m: clay
- 36m: sand

**Approx Max W.D (wrt CD)**
- <10m
- 36m
- 53m
- 39m
- 20m
- <10m

**Pipe wall thickness**
- 14.3mm

**Coating thickness**
- 120 (Pre)
- 120 (Pre)
- 85 (Pre)
- 105 (Pre)
- 120 (Pre)
- 120 (Pre)

---

**Segment 1 Profile of Taichung to Tunghsiao**

---

**Figures**
- Figure 1.1: Overview of the CPC Segment 1 Taichung–Tunghsiao NC Transmission Pipeline Route
CPC LNG OFFSHORE PIPELINE SYSTEM

PIPELINE ROUTE

Segment 0-2 & 0-3  Onshore Pipeline in Tunghsiao Governor Station

Total Length
- Approx. 500 m

Major Facilities
- 2 sets of pig launchers
- Metering Station
- Filters

Integration with Existing Gas Transmission System
- Yung Terminal and Northern Terminal can be as the mutual backup system.

[Diagram showing pipeline route with segments 0-2 and 0-3, Yung Terminal and Northern Terminal marked.]
CPC LNG OFFSHORE PIPELINE SYSTEM

PIPELINE ROUTE

Segment 2 – Tunghsiao to Tatan

- Total Length: Approx. 85.6Km
- Water Depth: 0~86 meters
- Sea Bed Soil
  - KP0~0.54 Hard Rock
  - KP1.0~3.0 Soil Liquefaction Area
    (Due to wave)
  - KP77.9~85.3 Hard Rock

---

Figure 1.3: Overview of the CPC Segment 2 Tunghsiao-Tatan LNG Transmission Pipeline Route

CHINESE PETROLEUM CORP.
Segment 2 – Tunghsiao to Tatan

<table>
<thead>
<tr>
<th>KP</th>
<th>0.0~1.2</th>
<th>1.2~3.2</th>
<th>3.2~10.0</th>
<th>10.0~13</th>
<th>13.0~17.3</th>
<th>17.3~22.4</th>
<th>22.4~27.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approx Max. W.D (wrt CD).</td>
<td>&lt; 10m</td>
<td>25m</td>
<td>52m</td>
<td>56m</td>
<td>59m</td>
<td>60m</td>
<td>61m</td>
</tr>
<tr>
<td>Soil Type</td>
<td>rock/sand</td>
<td>sand</td>
<td>clay</td>
<td>clay</td>
<td>clay</td>
<td>sand</td>
<td>sand</td>
</tr>
<tr>
<td>Wave(100年) (m)</td>
<td>3.18</td>
<td>8.41</td>
<td>8.52</td>
<td>8.52</td>
<td>8.52</td>
<td>8.52</td>
<td>8.52</td>
</tr>
<tr>
<td>Pipe Wall thickness (mm)</td>
<td>14.3</td>
<td>14.3</td>
<td>14.3</td>
<td>14.3/15.9</td>
<td>15.9</td>
<td>15.9</td>
<td>15.9</td>
</tr>
<tr>
<td>Coating Thickness (mm)</td>
<td>120 (Pre)</td>
<td>120 (Pre)</td>
<td>100 (Pre/Post)</td>
<td>75 (Pre)</td>
<td>100 (Post)</td>
<td>100 (Pre)</td>
<td>65 (Pre)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>KP</th>
<th>27.3~36.8</th>
<th>36.8~37.9</th>
<th>37.9~53.2</th>
<th>53.2~68.8</th>
<th>68.8~73.8</th>
<th>73.8~77.9</th>
<th>77.9 – 79.5</th>
<th>79.5~85.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approx Max. W.D (wrt CD).</td>
<td>60m</td>
<td>61m</td>
<td>70m</td>
<td>76m</td>
<td>82m</td>
<td>86m</td>
<td>77m</td>
<td>51m</td>
</tr>
<tr>
<td>Soil Type</td>
<td>sand</td>
<td>sand</td>
<td>sand</td>
<td>sand</td>
<td>sand</td>
<td>clay/sand</td>
<td>Rock</td>
<td>Rock</td>
</tr>
<tr>
<td>Wave(100年) (m)</td>
<td>8.52m</td>
<td>8.51m</td>
<td>8.51m</td>
<td>8.51m</td>
<td>8.51m</td>
<td>8.26m</td>
<td>8.26</td>
<td>8.26</td>
</tr>
<tr>
<td>Pipe Wall thickness (mm)</td>
<td>15.9</td>
<td>15.9</td>
<td>15.9</td>
<td>15.9</td>
<td>15.9</td>
<td>15.9</td>
<td>15.9</td>
<td>14.3</td>
</tr>
<tr>
<td>Coating Thickness (mm)</td>
<td>75 (Pre)</td>
<td>100 (Pre)</td>
<td>120 (Post)</td>
<td>65 (Pre)</td>
<td>75 (Post)</td>
<td>75 (Pre)</td>
<td>100 (Post)</td>
<td>100 (Pre)</td>
</tr>
</tbody>
</table>
Segment 0-4 Tatan Onshore

- Landfall point – 1 Km southern of the inlet of Shin-Wu river.
- LFP to Isolation Station – approx. 3 Km.
- Isolation station to Metering station – approx. 3 Km.
BASIC DESIGN

1. Pipeline Strength Design
   - Offshore Pipeline Wall Thickness 14.3/15.9 mm
   - Onshore Pipeline Wall Thickness 15.9/25.4 mm
   - Buckle Arrestor Wall Thickness 21/24 mm

2. Corrosion Protection Design
   - Internal Epoxy coating for 36” line pipe.
   - FBE or 3-Layer PE external coating.
   - Installation of Sacrifice Aluminum Anodes for Offshore Pipeline.
   - Impressed Current CP system for Onshore Pipeline.
3. On Bottom Stability Analysis

- **Analysis Software**
  PRCI Stability Software (Developed by Pipeline Research Council International, Inc)

- **Analysis Level**
  Level 2 – Simplified Quasi-Static Analysis based on (1) realistic hydrodynamic forces, and (2) realistic pipe embedment calculated by quasi-static simulation of wave induced pipe oscillations.

- **Two cases of pre-trenching and post-trenching are analyzed.**

- **Environmental Conditions used for Analysis**
  5-year return period wave and current data used for installation.
  100-year return period wave and current data used for operation.

- **Analysis Result**
  Concrete coating thickness of 65mm, 75mm, 85mm, 95mm, 100mm and 120mm are recommended used in this project.
4. HDD for Taichung Harbor Channel Crossing

- Pipeline ID: 882.6 mm
- Pipe Wall thickness: 15.9 mm
- External Coating: FBE or 3-Lay PE
- Concrete Coating Thickness: 61 mm
- Min. Radius of Curve: 1200 mm
- Approx. Horizontal Length: 1.1 Km
5. Pipeline Burial/Protection

- Pipeline burial is required throughout.
- Burial Depth
  - Offshore: 1 meter cover to top of pipe
  - Shore Approach: 3 meters cover to top of pipe
- Post trenching is not allowed in the sand-wave location.
- At shore approach and sand wave area, pre-trenching is required.
- Natural backfilling is applied in the offshore portion and mechanical backfilling in the shore approach area.
6. **Mitigation Measures for Soil Liquefaction**

Pipeline route passes through 3 soil liquefaction locations, gravel and armor rock cover is the recommended mitigation measure, the EPC contractor may select alternates.

7. **Shore Approach Scour Analysis**

The results of hydraulic model test by Chung-Kung University indicate that the exposure of buried pipeline of 3 meters cover due to scour will not occur in the shore approach area in Taichung, Tunghsiao and Tatan during service life.
BASIC DESIGN

8. Pre-commissioning

1) Hydrostatic Pressure Test:
   Onshore aboveground pipeline: 132 kg/cm²
   Onshore underground pipeline: 110 kg/cm²
   HDD string: 110 kg/cm²
   Offshore pipeline: 110 kg/cm²

2) Cleaning:
   to the level of the volume of received debris less than 5 liters.

3) Drying:
   to the level of a dew point below -20°C.

4) Nitrogen Purging:
   to the level of oxygen content less than 2% by volume.
END.