
Symposium on Electrical and Mechanical Safety & Energy Efficiency
Engineering a Safe and Low-carbon Environment

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

25 Jan 2011

Contents

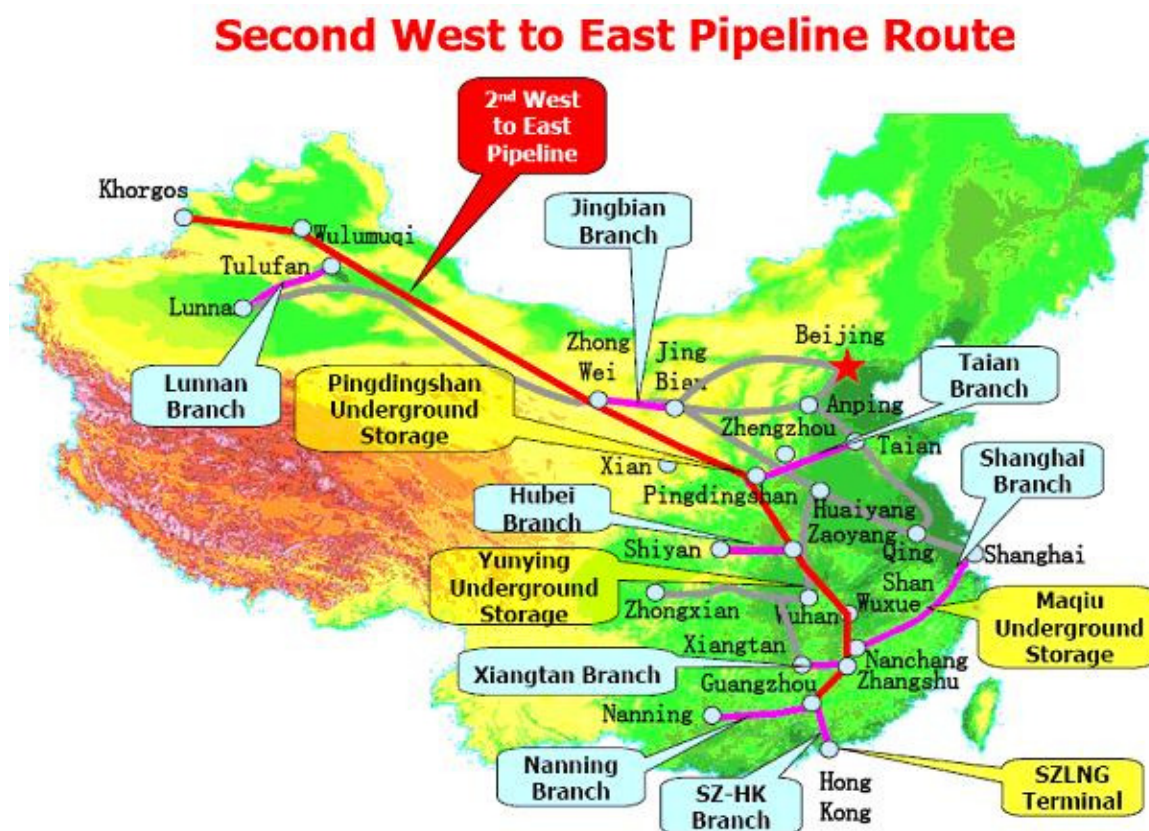
- **Introduction**
- **PetroChina's Second West-East Pipeline Project**
- **Project Background**
- **Dachan – BPPS Submarine Pipeline**
 - **Pipeline Design**
 - **Construction**
 - **Operation**
- **Conclusion**

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

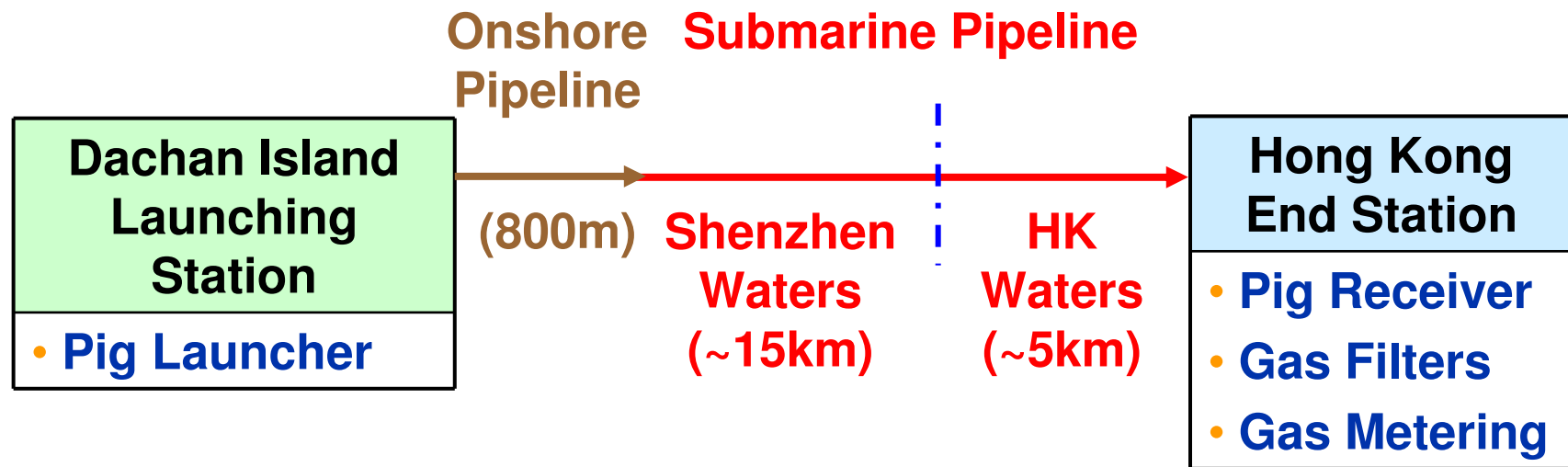
- China's first major energy project to transfer natural gas from outside
- From Khorgos Port (Xinjiang) to Guangzhou/Shenzhen and Shanghai



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

Pipeline Project Background

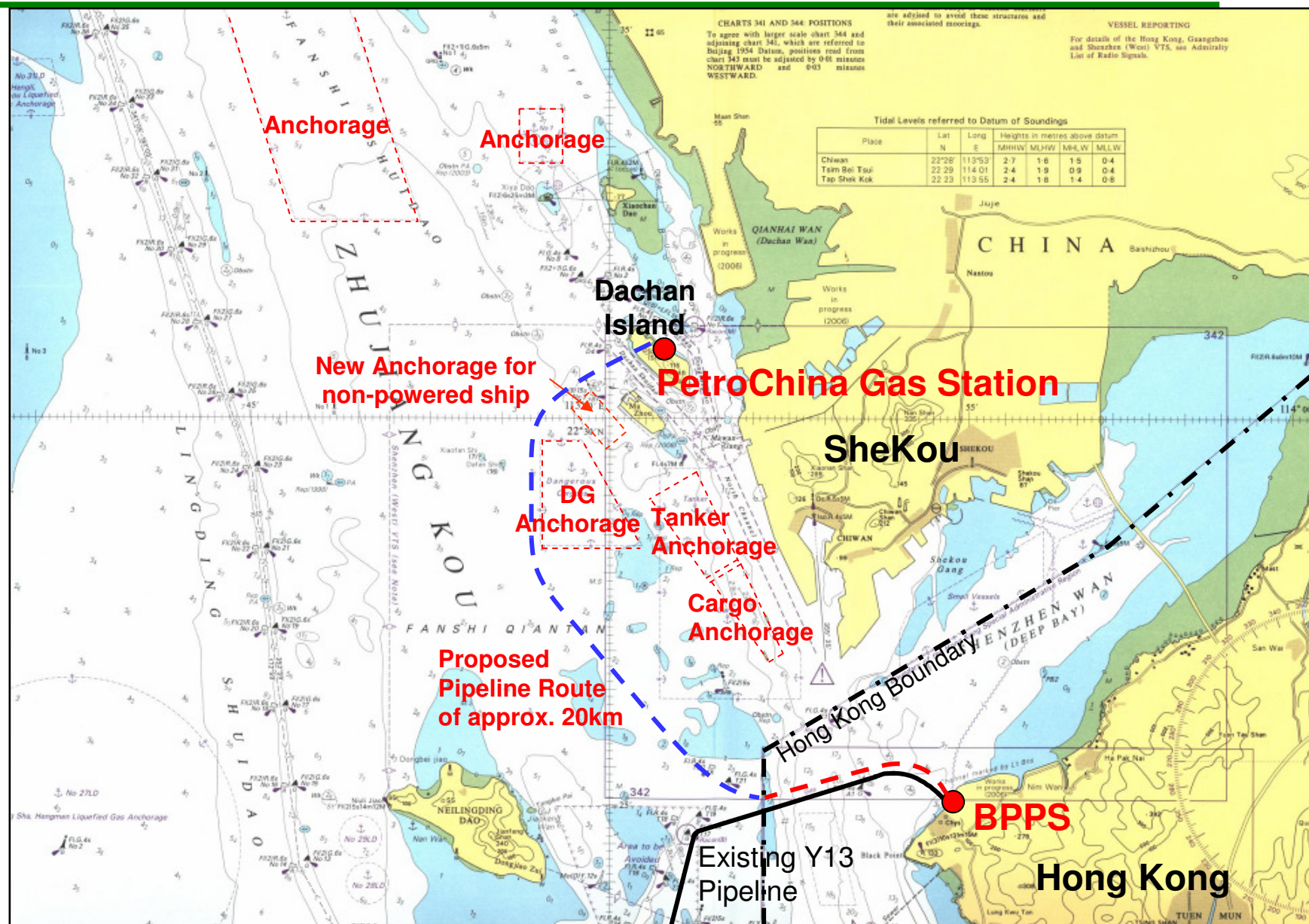
Battery Limits of JV Project



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



Submarine Pipeline Design

Pipeline Design Parameters	
Description	Details
Pipe Diameter	32 inch
Pipe Wall Thickness	22.2 mm
Design Operating Pressure	63 barg
External Corrosion Coating	3-Layer Polyethylene
Internal Coating	Epoxy
Concrete Weight Coating Thickness	60 – 80 mm

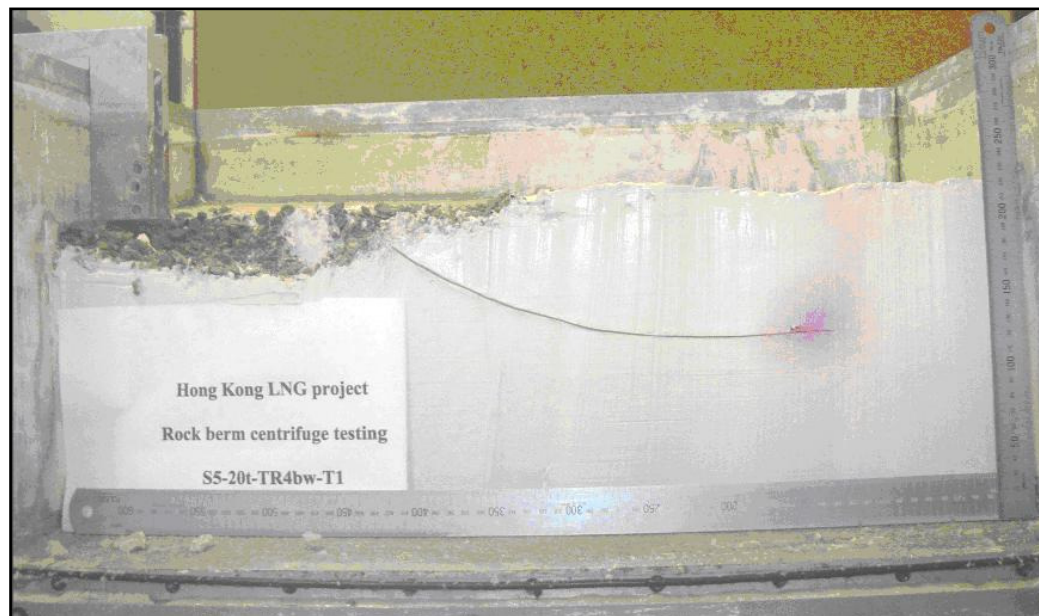
- Adopted European standard, DNV code for Submarine Pipeline Systems

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

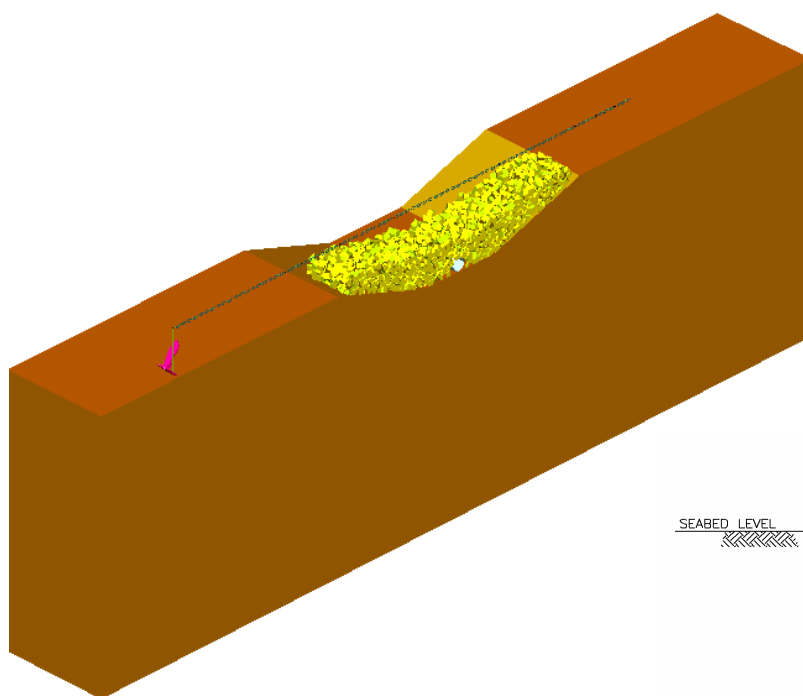
- Pipeline route traverses shipping channels
- Protection configuration determined through:
 - Risk-based probability study
 - DNV-RP-F107 – Risk Assessment of Pipeline Protection
- Protection design performances established from:
 - Mechanical study
 - Finite element (FE) analysis
 - Anchor drag centrifuge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



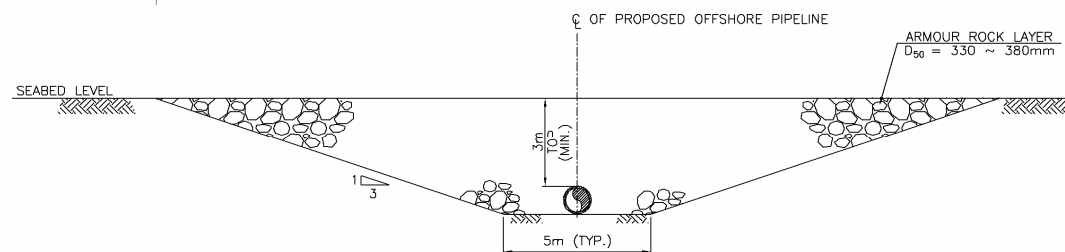
Anchor Drag Centrifuge Test

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

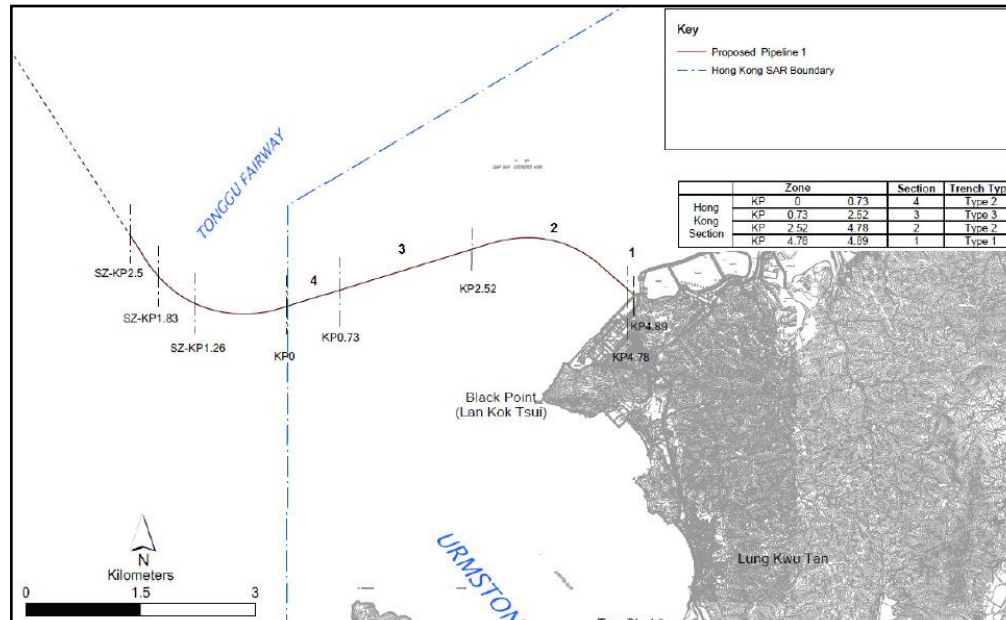


Protection Design for 19-tonne Anchor

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/drag**

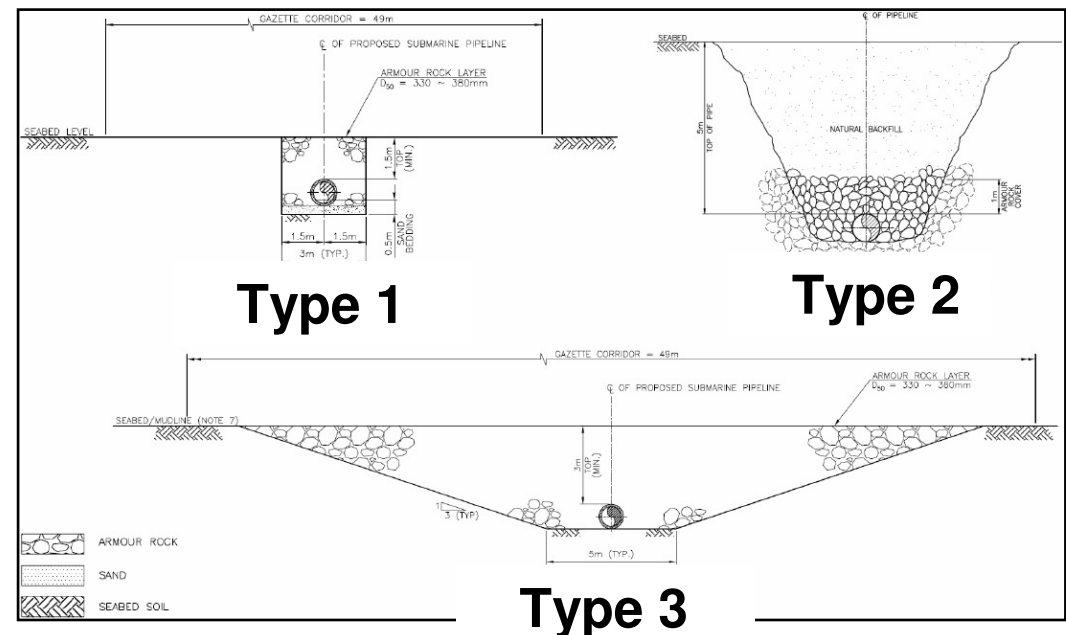
Quantitative Risk Assessment (QRA)



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

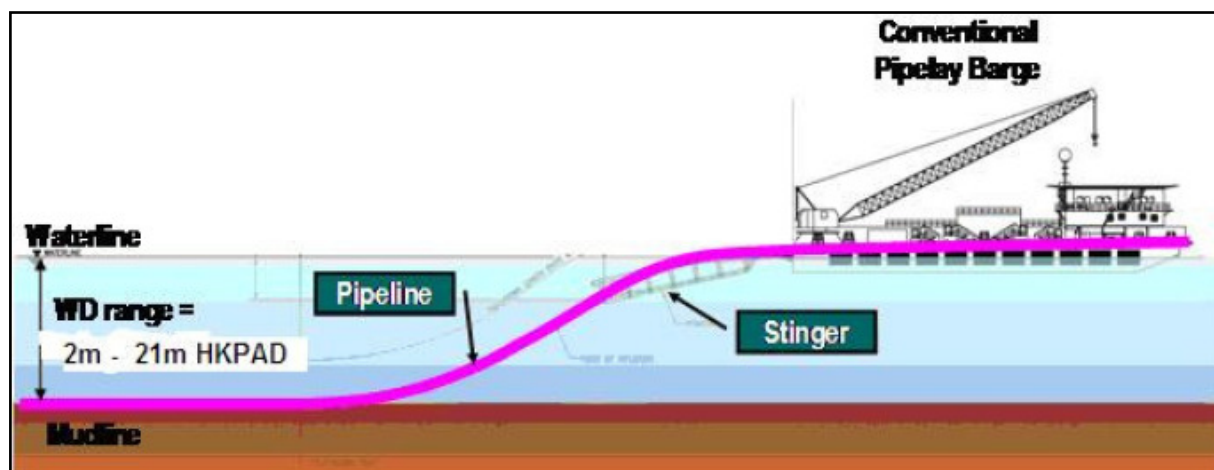
- Joint constructability workshops between CAPCO and PetroChina
- Risks at critical locations reviewed and appropriate mitigation methods incorporated into construction plan
- Marine Traffic Management Plan developed with local authorities requirements

Navigation Space West (m)	Proposed Navigation Space During Dredging Operation	Navigation Space East (m)	Navigation Management
0		700	2-way traffic navigation east of Dredger
100		600	2-way traffic navigation east of Dredger
200		500	1- way navigation East of Dredger at either from north or south bound
300		400	1- way navigation and traffic separation recommended
400		300	1- way navigation and traffic separation recommended
500		200	1- way navigation West of Dredger at either from north or south bound
600		100	2-way traffic navigation east of Dredger
700		0	2-way traffic navigation east of Dredger

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



Conventional S-Lay Pipelaying Method

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

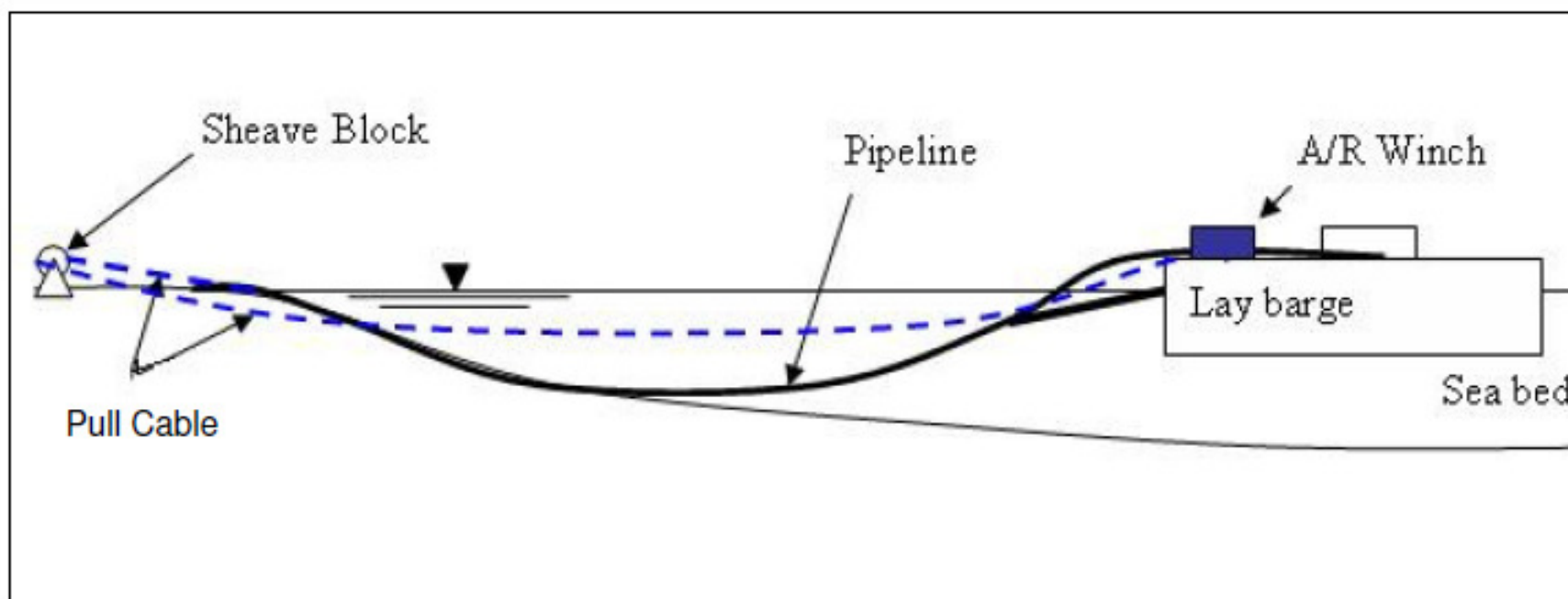


Illustration of Shore Pull Operation

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!