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

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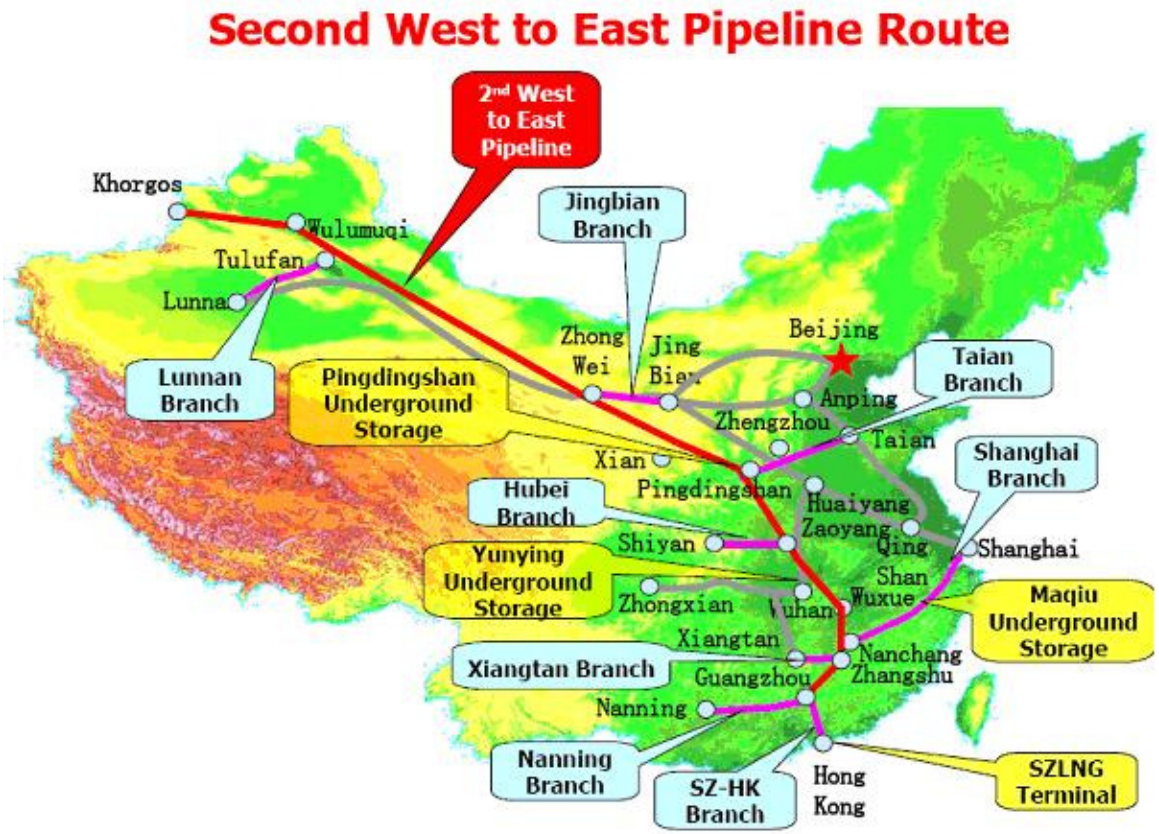
Contents

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

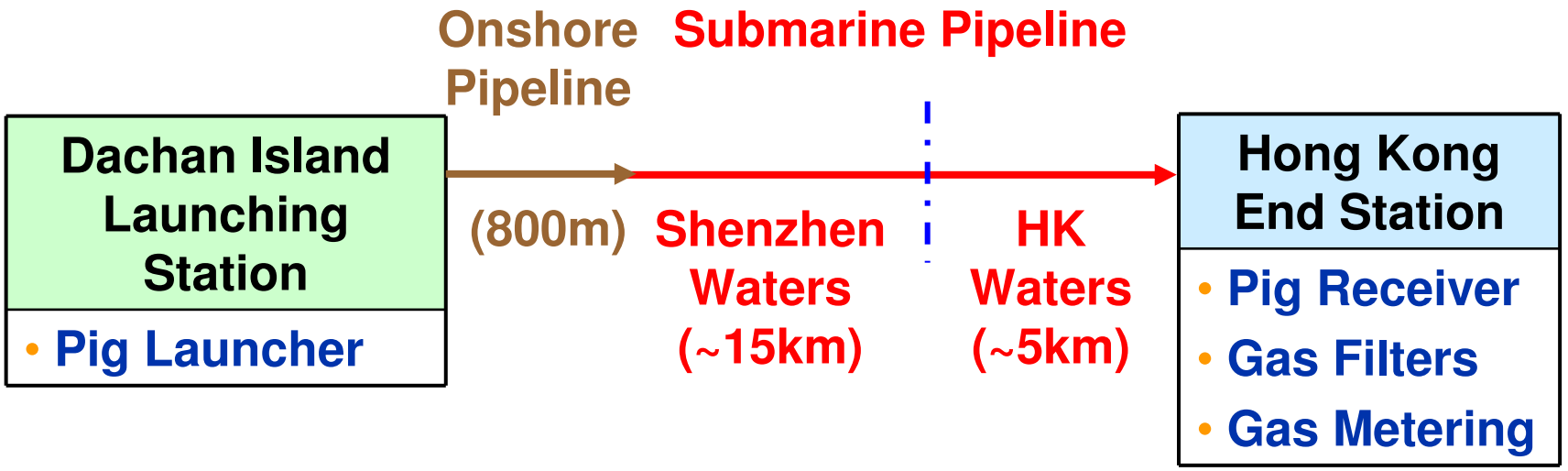
- China's first major energy project to transfer natural gas from outside
- From Khorgos Port (Xinjiang) to Guangzhou/ Shenzhen and Shanghai



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

Pipeline Project Background

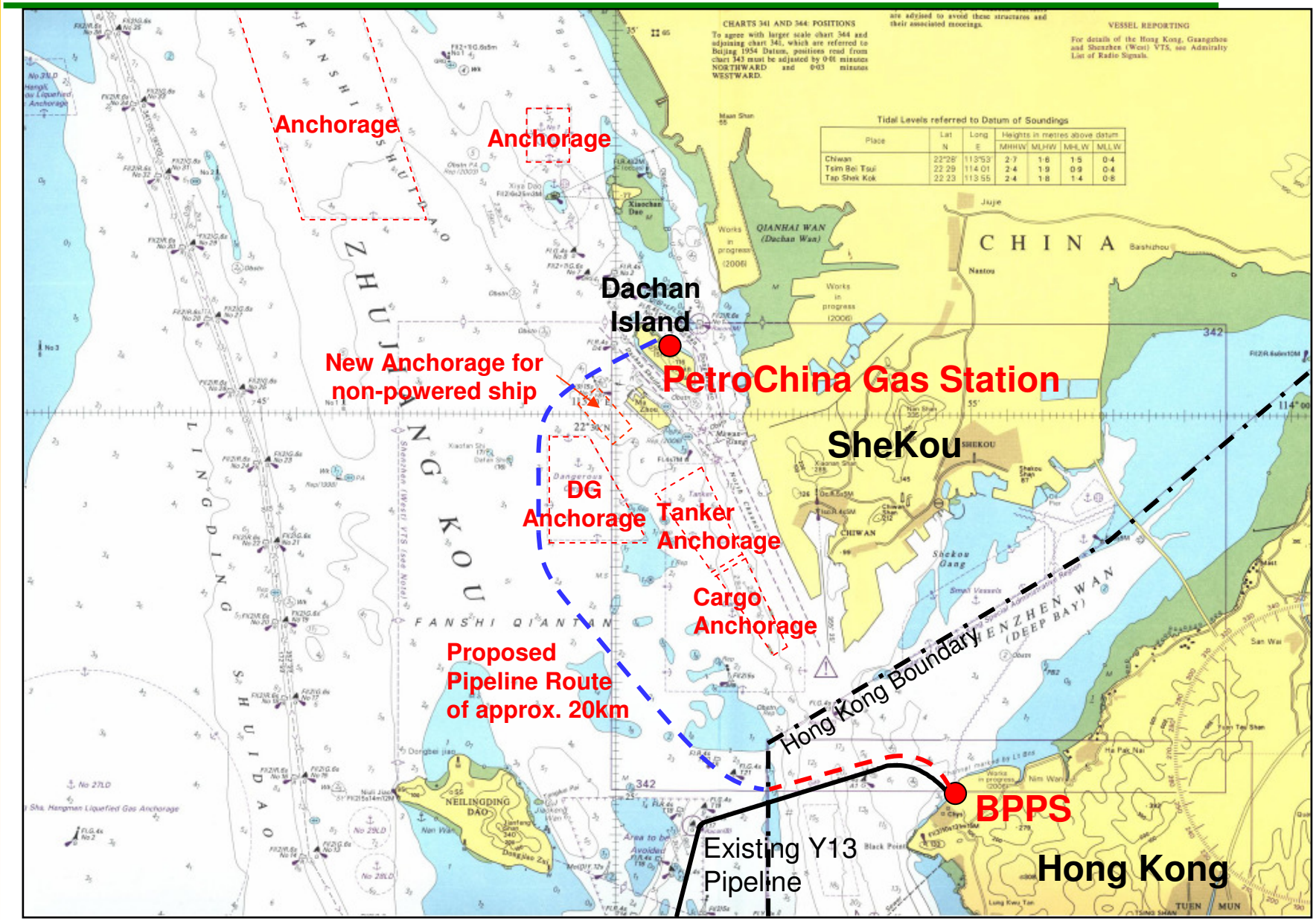
Battery Limits of JV Project



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

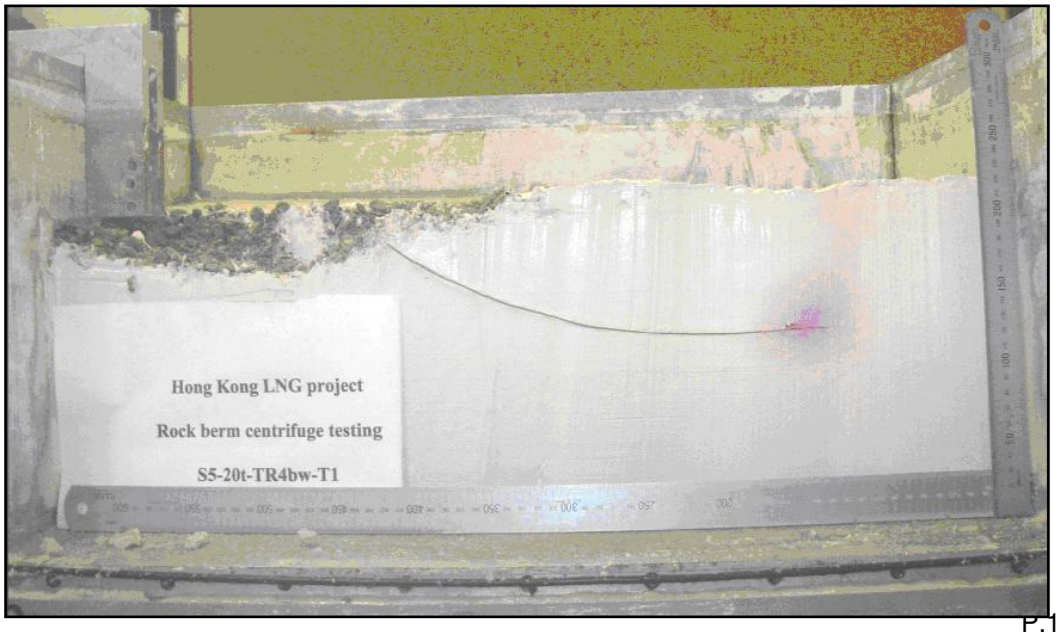
- Adopted European standard, DNV code for Submarine Pipeline Systems

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

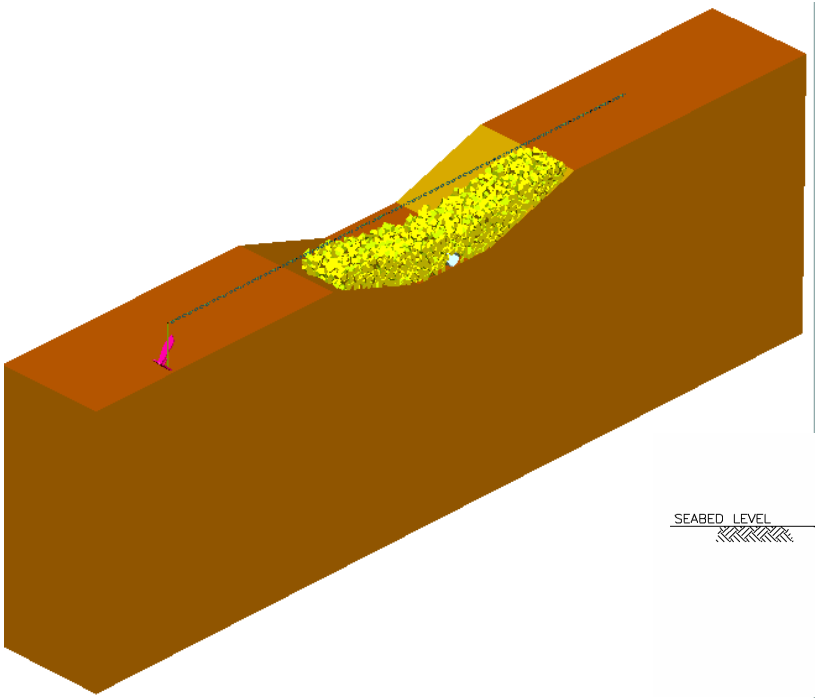
- Pipeline route traverses shipping channels
- Protection configuration determined through:
  - Risk-based probability study
  - DNV-RP-F107 – Risk Assessment of Pipeline Protection
- Protection design performances established from:
  - Mechanical study
  - Finite element (FE) analysis
  - Anchor drag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



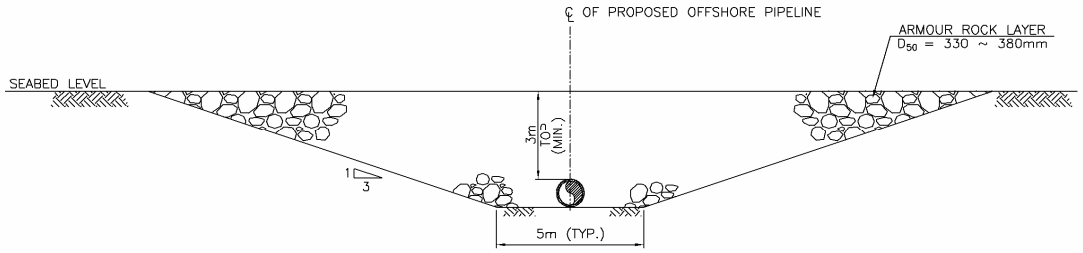
Anchor Drag Centrifuge Test

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

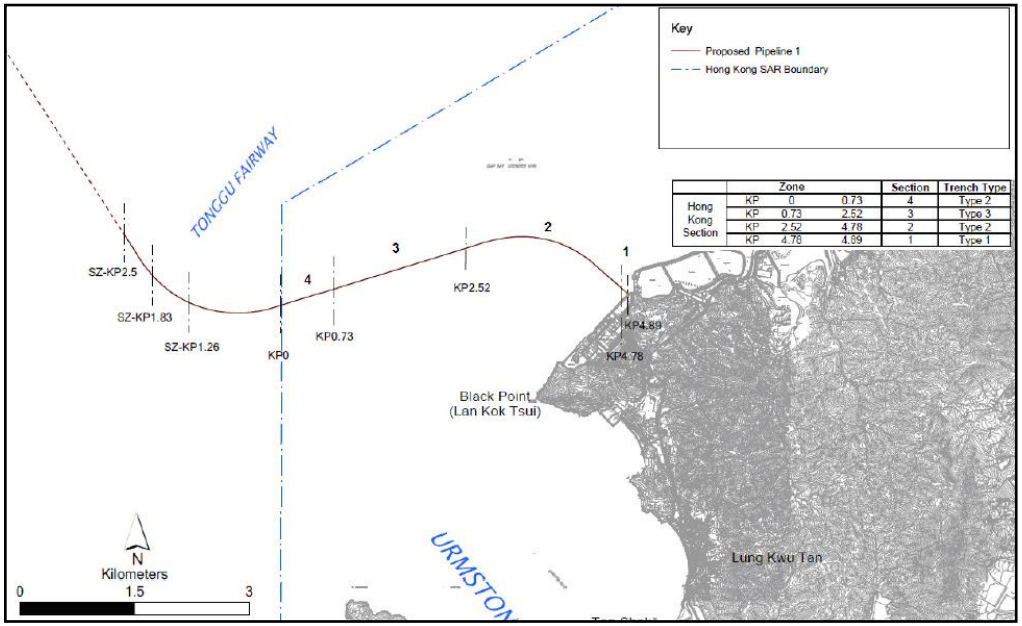


Protection Design for 19-tonne Anchor

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/drags

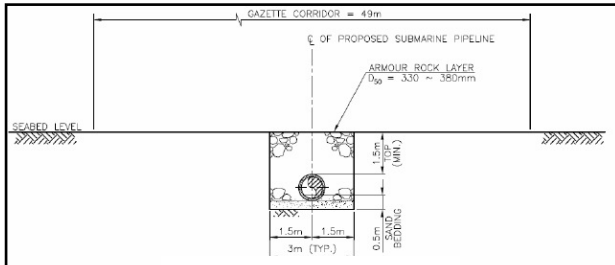
Quantitative Risk Assessment (QRA)



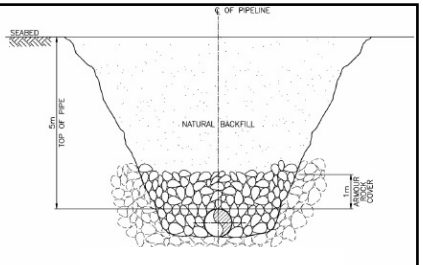
Pipeline Sections for QRA

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

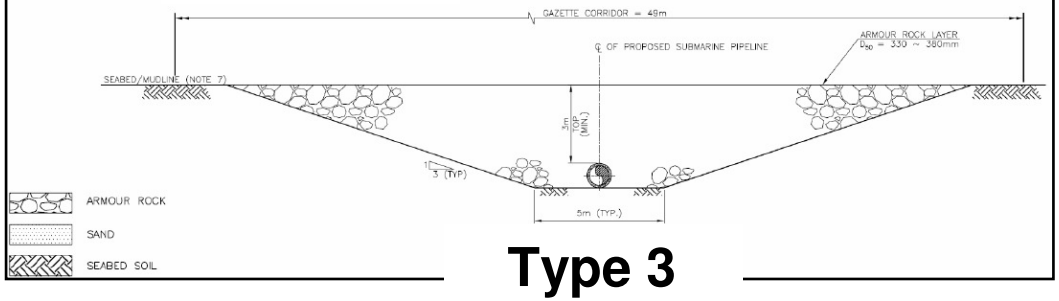
QRA conclusion: Risks for all pipeline sections in HK water acceptable per HK EIAO



Type 1



Type 2



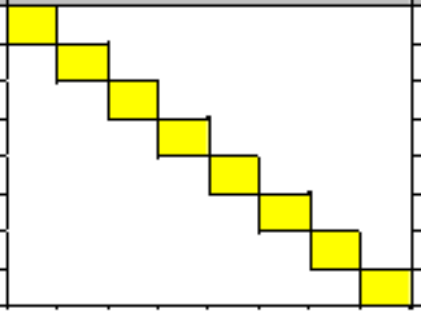
Type 3

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

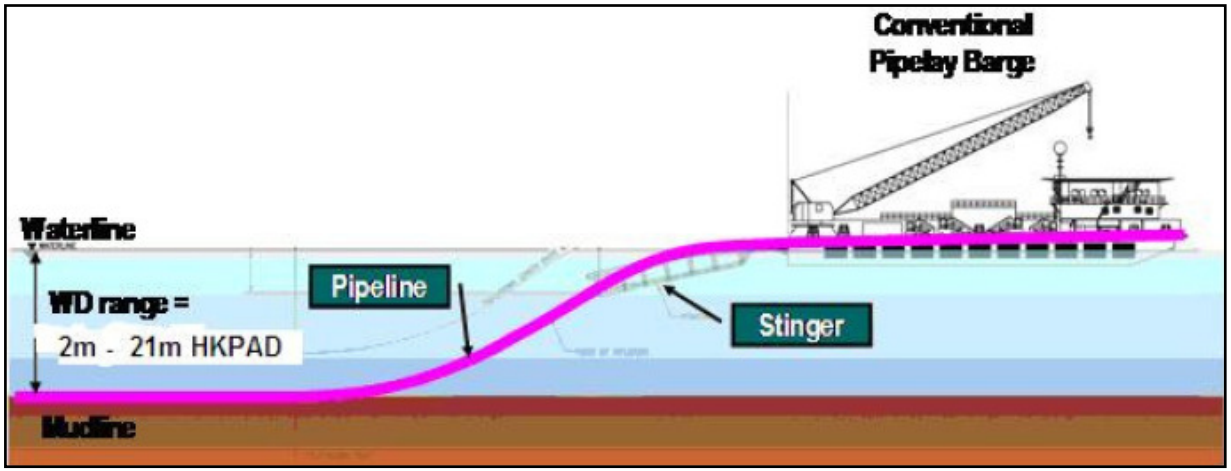
- Joint constructability workshops between CAPCO and PetroChina
- Risks at critical locations reviewed and appropriate mitigation methods incorporated into construction plan
- Marine Traffic Management Plan developed with local authorities requirements

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

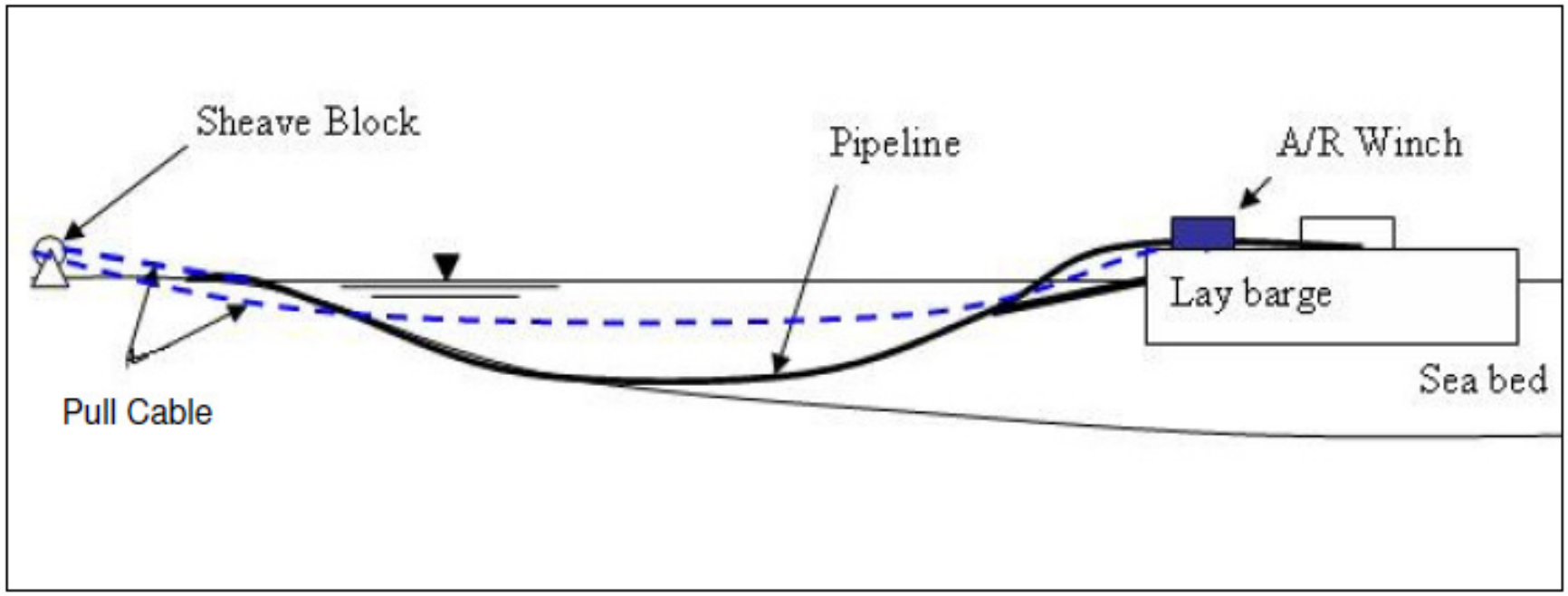


Illustration of Shore Pull Operation

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!

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