

Installation of Submarine Gas Pipelines
and Associated Facilities from
To Kwa Wan to North Point for Former Kai Tak Airport Development
Consultancy Services for Feasibility Study and Detailed Design
Environmental Impact Assessment Report



Appendix F3
Hazard to Life Assessment of Gas Pigging Stations

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1. Introduction

In view of the South East Kowloon Development Project which consisted of a trunk road Central Kowloon Route (CKR) and a new Cruise Terminal to be developed at the southern end of the former Kai Tak Airport (KTA) runway, the existing twin 400mm submarine gas pipeline that serves the gas supply from Ma Tau Kok (MTK) to North Point (NP) were requested to be realigned by the Hong Kong SAR Government in order to cope with these developments. The existing gas pigging stations at MTK and NP are required to be re-located accordingly.

The proposed new locations of the two gas pigging stations are shown in **Figure 2.1**.

2. Design Description and Review

2.1 Design of the Gas Pigging Stations

The existing gas pigging station in Ma Tau Kok (MTK) will be relocated to To Kwa Wan (TKW) and the existing gas pigging station in North Point (NP) will be relocated further east adjacent to Hoi Yu Street. The proposed gas pigging stations are used for conducting inspection of the submarine gas pipelines which transport town gas from Kowloon to Hong Kong Island. It consists of an instrument room and the associated above ground and underground pipes. During normal operation, the pigging facilities will be isolated from the pipelines in standby mode.

The design of the proposed gas pigging station makes reference to the recommendations of the Institution of Gas Engineers and Managers, UK. Furthermore, it will be governed by relevant ordinances such as the Gas Safety Ordinance, Buildings Ordinances, etc. Inside the proposed station, the proposed pigging pipeworks are planned to be located at least 3m from the site boundary as according to the international design standards.

2.2 Safety Management

2.2.1 Normal Operating Condition

The gas pigging stations will be equipped with CCTV systems which allow 24-hour monitoring of the activities within the gas pigging station. An air-conditioned instrument room, which stores the electronic equipment for data transmission to the Grid Control Centre, will be constructed in the proposed gas pigging station. As a result, the proposed pigging station will be monitored and controlled through the SCADA (Supervisory Control And Data Acquisition) system by the Grid Control Centre, which is manned 24 hours a day by competent control engineers. In case there is abnormal pressure change over the network, an alarm will be initiated and the Grid Control Engineer will take immediate action for investigation and remedy.

HKCG has developed its in-house guideline which details the procedures of general principles, safety procedures, procedures and recommendation for the maintenance of Above Ground Installations (AGIs)

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with inlet pressure exceeding 400 kPa. It also sets forth the requirement for operation and maintenance to ensure facilities in the gas pigging stations are in good condition.

HKCG will have regular inspections to maintain the pigging stations. In addition, the gas pigging station is subject to regular and surprise audits by the Gas Standards Office (GasSO) of Electrical and Mechanical Services Department (EMSD).

A permit-to-work (PTW) system will also be adopted for working inside the proposed TKW gas pigging station. It is to ensure no unauthorized entry to the gas pigging station and all operations are carried out according to the controlled guidelines / procedures. Emergency team is always stand-by and they will arrive at the scene within 30 minutes in case of emergency.

2.2.2 Emergency

Fire extinguishers will be provided for general fire fighting. Stringent rules to prohibit naked flame and smoking in gas pigging stations should be strictly complied to avoid potential fire.

In addition to the SCADA system, the fire alarm in the proposed pigging station will be linked to the Grid Control Centre where it will be directly linked to the Fire Service Department (FSD) or FSD's approved emergency centres. The firemen can arrive at the scene as rapidly as possible should a fire broke out.

HKCG always commits to achieve excellent safety record and there has not been any town gas incident record from the existing 19 gas pigging stations since they started operation in early 70's (i.e. more than 30 years).

3. Hazard Identification

3.1 Overview

The major hazard arises from the proposed gas pigging stations is mainly associated with the loss of containment events from the pigging facilities. This could occur as a result of the equipment / pipeline failure and lead to release of town gas.

3.2 Hazards during Construction of the Gas Pigging Station

Major hazards associated with construction will mainly arise from accidental damage to the underground utilities during excavation works when constructing the proposed gas pigging station. Detailed information on the underground utilities will be collected prior to conducting any excavation work, in particular the existing gas pipelines as required by Gas Safety Ordinance. In addition, excavation work is well controlled in Hong Kong. Hence the chance of damaging any utilities is very remote.

The construction of the new gas pigging stations will be carried out in accordance with the HKCG guidelines and the relevant statutory regulations. The facilities will not be filled up with any town gas during construction. Thus, the likelihood of construction works causing any damage to the existing pipeline or pipeline under construction and leading to a town gas release scenario is very remote.

3.3 Hazardous Scenarios from Pipelines in the Gas Pigging Stations

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3.3.1 External Causes

Natural Hazards

Natural hazards such as earthquake, storms, typhoon, subsidence and tsunami may cause potential damage to the gas pigging stations and lead to loss of containment. The section will discuss the credibility of loss of containment due to these natural hazards with respect to Hong Kong geographical location.

Earthquake

Hong Kong is situated on the southern coast of mainland China and facing the South China Sea. Hong Kong is not located within the seismic belt and according to Hong Kong Observatory, earthquakes occurring in the circum-Pacific seismic belt which passes through Taiwan and Philippines are too far away to affect Hong Kong significantly.

Subsidence / Landslides

Excessive subsidence may lead to failure of the structure and ultimately loss of containment scenario. However, subsidence is usually slow in movement and such movement can be observed and remedial action can be taken in time. Besides, the land where the proposed pigging station will be located was reclaimed long time ago. Soil condition is considered rather stable; also there are no hilly regions nearby. The probability of town gas leak due to subsidence or landslides is considered to be remote. In addition, there has not been any reported case of leak of town gas in the gas pigging stations since it started operation by HKCG in early 70's.

Lightning

Lightning sparks could ignite the combustible gas in air. The gas pigging stations will be equipped with the lightning protection system similar to all gas pigging stations in Hong Kong that can effectively protect the station equipment from lightning, hence lightning strike causing a release of town gas is not considered further in the assessment.

Severe Environmental Event

Loss of containment due to severe environmental event such as typhoon or tsunami (large scale tidal wave) is not possible as the gas pigging station will be designed to withstand wind load for local typhoon while is the locations of the gas pigging stations will not be threatened by tsunami with Hong Kong Island located between Victoria Harbour and South China Sea.

Aircraft Crash

The distance between the nearest flight arrival flight path and the TKW/NP gas pigging stations is more than 4.5km apart. The distance between the TKW/NP gas pigging station and Chek Lap Kok International Airport is over 8km which has been identified as the key criteria for the consideration of airfield accident. It is considered that the gas pigging station is not covered by critical takeoff and landing phases; hence the failure caused by aircraft crash is not considered further in the assessment.

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Ship Collision at Seafront

Though the gas pigging stations are located near seafront, ships passing the seafront are mostly small in size, low in profile and speed. Seawalls provide sufficient buffer and protection to prevent direct impact to the gas pigging stations. Ship collision at seafront leading to failure of gas facilities failure is not considered further in the assessment.

External Fire

External fire means the occurrence of fire event which lead to the failure to the facilities in the gas pigging station. The gas pigging station will be bounded by a 3m high solid concrete boundary wall which makes the propagation of fire from outside unlikely. Suitable fire extinguishers will be provided in the gas pigging station and stringent procedures will be implemented to prohibit smoking or naked flames to be used onsite. Flame detection systems will be installed at gas pigging station for detection of fire. In case of external fire, the flame detection systems will initiate an alarm to the 24-hour manned Grid Control Centre, the grid control engineer will take immediate action and FSD will be contacted immediately. The critical valve of the gas transmission pipeworks can be remotely shut down if necessary.

Operational Error

HKCG in-house Transmission Operation Procedures (TOP) will be strictly followed and only well-trained personnel is authorized to open/close any valves. In addition, the design of pig launcher / receiver has interlock system which avoids gas leakage. Hence, the probability of pig launcher and pig receiver failure due to operational error is very unlikely. In fact operation errors leading to pig launcher and pig receiver failures have not been reported in other HKCG gas pigging stations.

Third Party Damage

Third party damage (TPD) on land pipes inside the gas pigging stations includes the damage to pipes due to drilling, hammering and excavation works, etc. In fact, the potential of TPD damage to the land pipes depends on the surrounding environment. Pipe wall thickness, buried depth, concrete cover and design factor will all have influence to whether a TPD would result in pipe damage.

In Hong Kong, utility mapping will be conducted to identify any underground utility within the site before any construction work commences. Diversion works will be carried out if there is conflict with the development. In addition, excavation / trenching are well controlled in Hong Kong. Gas Safety Ordinance requires utility undertakers to obtain drawings of existing gas pipelines prior to any excavation. HKCG has daily patrol to existing IPB pipelines. These could minimize the risk of damaging any existing underground utility. The risk of TPD causing pipe leakage and loss of containment is credible and has been considered in this assessment.

3.3.2 Internal Causes

Corrosion

Internal corrosion could occur due to the presence of moisture and contaminants in the gas. The proposed pipeline will carry dry town gas which is not expected to have any moisture. The pipe will be coated with appropriate coating materials internally and externally to prevent corrosion. Regular inspection and maintenance will be carried out for gas pipes to ensure the pipe integrity.

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Material Defect

Material defect of pipeline including welding failure and mechanical strength failure could occur for various reasons. Selection of pipe materials will follow international standard to ensure material quality. Welding of pipe materials will be subject to 100% non-destructive tests which can ensure all the welds are acceptable. The proposed pipeline will be subject to strength test and leak test after construction which would prevent any mechanical failure due to material defects. However, historical data showed that material failure leading to loss of containment is credible and it will be included in our assessment.

3.3.3 Pig Launcher / Pig Receiver

In the TKW/NP gas pigging station, a pig launcher / receiver will be installed which allows pigging operations to be carried out. Normally, the pig launcher / receiver will be isolated from the pipelines. According to HKCG's past record, pigging will normally be carried out once in every ten years. Stringent procedures have to be followed when carrying out the pigging operation for the inspection of the submarine pipeline. An interlock system will be provided to ensure the pigging operation is undertaken in a safe manner. Brief description of the pigging operation together with illustration can be found in **Appendix F2**.

4. Risk Assessment

4.1 Risk Ranking for the Gas Pigging Stations

4.1.1 During Construction

As discussed previously, construction of the gas pigging station does not impose any risk of town gas leakage since the proposed facilities will not be filled up with town gas during construction phase, hence, they will not impose additional risk to the surrounding population and the risk level is low.

4.1.2 During Operation

Risk mitigation measures have already been adopted in the design of the gas pigging station to lower the risk level as shown below:

1. The gas pigging station at TKW is set-back at least 25m from the edge of seawall which can prevent damage caused from ship collision. Though the gas pigging station at NP is located near seafront, the gas pigging station is shielded by the structure of the Island Eastern Corridor and protected by the seawall.
2. The pipes inside the proposed pigging stations at TKW and NP will be at least 3m away from the boundary of the pigging station which complies with the international safety standard.
3. A 3m high solid concrete boundary wall will be built around the TKW gas pigging station which can further enhance the security of the gas pigging station from external interferences.
4. Implementation of existing HKCG's well-defined and stringent operation and maintenance procedures for the gas pigging station which further reduce the occurrence of gas incidents.
5. An air-conditioned instrument room, which stores the electronic equipments for data transmission to the Grid Control Centre, will be constructed in the proposed gas pigging station. As a result, the proposed pigging station will be monitored and controlled through the SCADA (Supervisory Control And Data

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Acquisition) CCTV system by the Grid Control Centre, which is manned 24 hours a day by competent control engineers.

- Utility mapping will be conducted to identify any underground utility within the site before any construction work commences. Drawings of the existing gas pipelines must be obtained prior to any excavation as required by the Hong Kong Gas Safety Ordinance. Daily patrol is adopted by HKCG to minimize the risk of pipe damage.

As a well adopted practice, a school has already had an established emergency escape route and fire drill in its standard fire safety procedures. HKCG will maintain regular liaison with nearby schools and stand neatly to answer any query.

The qualitative risk assessment of failure of the gas pigging station based on different failure causes is shown in **Table F1** according to the risk rating criteria in **Table 7.1**. The likelihood of a loss of containment scenario is based on the causes considered in **Section 7.5.4**. According to the risk matrix, for any high risk item, further risk mitigation measures should be considered as necessary to reduce the risk; for moderate risk item, further risk mitigation measures should be considered to reduce the risk to as low as reasonably practicable; and low risk item, further risk mitigation measures are not considered necessary since the risk is considered broadly acceptable.

Table F1: Risk Assessment of Different Failure Causes of the Gas Pigging Stations during Operation

Scenario	Likelihood of Occurrence	Consequence to Public	Risk Level
External Causes			
Natural Event			
• Earthquake	Rare	Moderate	Low
• Subsidence / Landslides	Rare	Moderate	Low
• Lightning	Rare	Moderate	Low
• Severe Environmental Event	Rare	Moderate	Low
Aircraft Crash	Rare	Moderate	Low
Ship Collision at Seafront	Rare	Minor	Low
External Fire	Rare	Moderate	Low
Operational Error	Rare	Moderate	Low
Third Party Damage	Rare	Moderate	Low
Internal Causes			
Corrosion	Unlikely	Minor	Low
Material Defect	Rare	Moderate	Low
Pig Launcher / Receiver			
Pig Launcher / Receiver	Unlikely	Minor	Low

The risk of the proposed gas pigging stations is assessed to be low and acceptable. Therefore, no further risk mitigation measures are required.

5. Summary

A risk assessment study has been conducted for the relocation of the existing submarine pipeline and the associated facilities. The assessment has considered various failure causes for town gas leakage. Based

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on the evaluation of potential safety impacts, the risk associated with the proposed realigned gas facilities is considered low. Notwithstanding the low level of risk, risk minimisation measures have been incorporated into the design to further lower the risk and safeguard population in vicinity.

Though it can be concluded that there are no insurmountable risks associated with the construction and operation of the proposed gas pigging stations based on the risk ranking analysis, a quantitative risk assessment has been conducted by HKCG. Both the individual risk and societal risk results for the submarine gas pipelines and the two gas pigging stations have been found "Acceptable" as per risk guidelines in Hong Kong. Therefore, it can be concluded that the risk level of the Project to the surrounding public is low and acceptable.