機電工程署
EMSD

Feasibility Study and Preliminary Design of the On-shore Power System for the Kai Tak Cruise Terminal

Summary Report

June 2015

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1. Introduction

Background

1.1 The new cruise terminal at the southern end of former Kai Tak airport Runway, namely Kai Tak Cruise Terminal (KTCT), have two berths, which allow a maximum of three “Panamax Class” cruise ships, such as Sun Princess from Princess Cruises simultaneously or two “Genesis Class” cruise ships, such as Oasis of the Seas and Allure of the Seas from Royal Caribbean International. The first and second berth came into operation on 12 June 2013 and 28 September 2014 respectively.

1.2 Two bare plant rooms, each of around $500m^2$ located at the southern and northern ends of the Cruise Terminal Building, have been reserved for setting up onshore power system (OPS) at the KTCT.

1.3 OPS is a technology which allows berthing ships to shut down their auxiliary engines and rely on electricity from shore side, thereby minimizing emissions at berth.

1.4 In 2013, the Environmental Protection Department (EPD) engaged the Electrical and Mechanical Services Department (EMSD) to study the technical feasibility of setting up OPS at the KTCT, including gauging the readiness of cruise terminals and cruise liners to use OPS. Subsequently, URS Hong Kong Limited[1] was appointed to undertake the study, which commenced in November 2013 and completed in July 2014.

Objectives

1.5 The objectives of this study were to:

- assess the technical feasibility of installing OPS at the KTCT;
- carry out the preliminary design; and
- study the readiness of cruise liners to use OPS and overseas cruise terminals to support the use.

[1] Its name changed to AECOM Consulting Service Limited on 6 February 2015.

2. Study Findings

2.1 OPS System Design

Preliminary proposal of the OPS system

2.1.1 The OPS system needs to comply with IEC/ISO/IEEE 80005 international standard (Utility Connections in Port: High Voltage Shore Connection (HVSC) systems). This standard consists of two parts. The first part covers the hardware requirement and was published in July 2012. The second part is the requirement for software communication and is scheduled to be published in February 2016. The latter requirement only affects software programming and will not change the physical design and interface.

2.1.2 Preliminarily, two OPS units each with a maximum power at 25MVA can be installed, one at the northern plant room and the other at the southern plant room. There will be an underground cable system from the plant rooms to apron, eight shore power outlets and three sets of mobile cable management system at apron as well. The layout of the KTCT apron is shown in Figure 1.

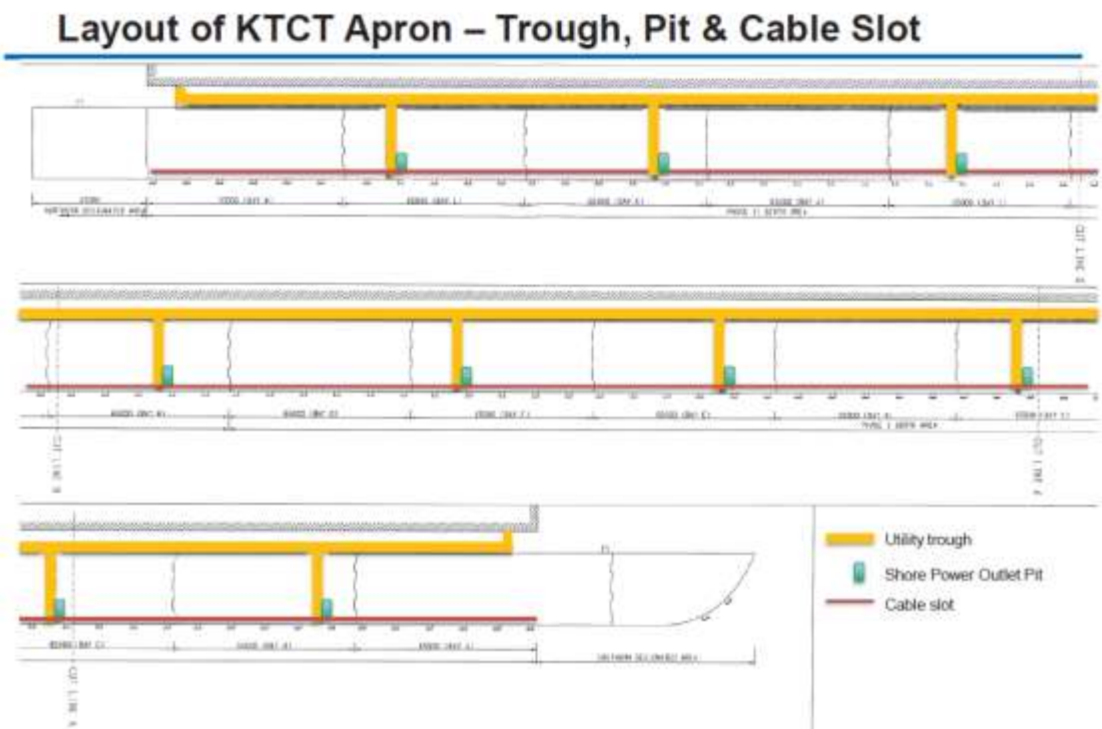

Figure 1: Layout of OPS system

2.1.3 Inside each plant room, there will be four main components - input transformers, frequency converters, output transformers and switchboards for incoming power and high voltage (HV) shore power distribution. Each OPS unit should flexibly provide a maximum power of 25MVA at either 6.6kV or 11kV as well as 50 Hz or 60 Hz in a safe and reliable manner. CLP Power (CLP) Hong Kong Limited can provide relevant power through HV cables from the CLP's transformer station. A schematic diagram of the base unit in each room is shown in Figure 2. In Hong Kong and most of the cities in Asia, dual frequency convertors are required to provide either 60 Hz for international cruises mainly coming from America or 50 Hz for other regions.

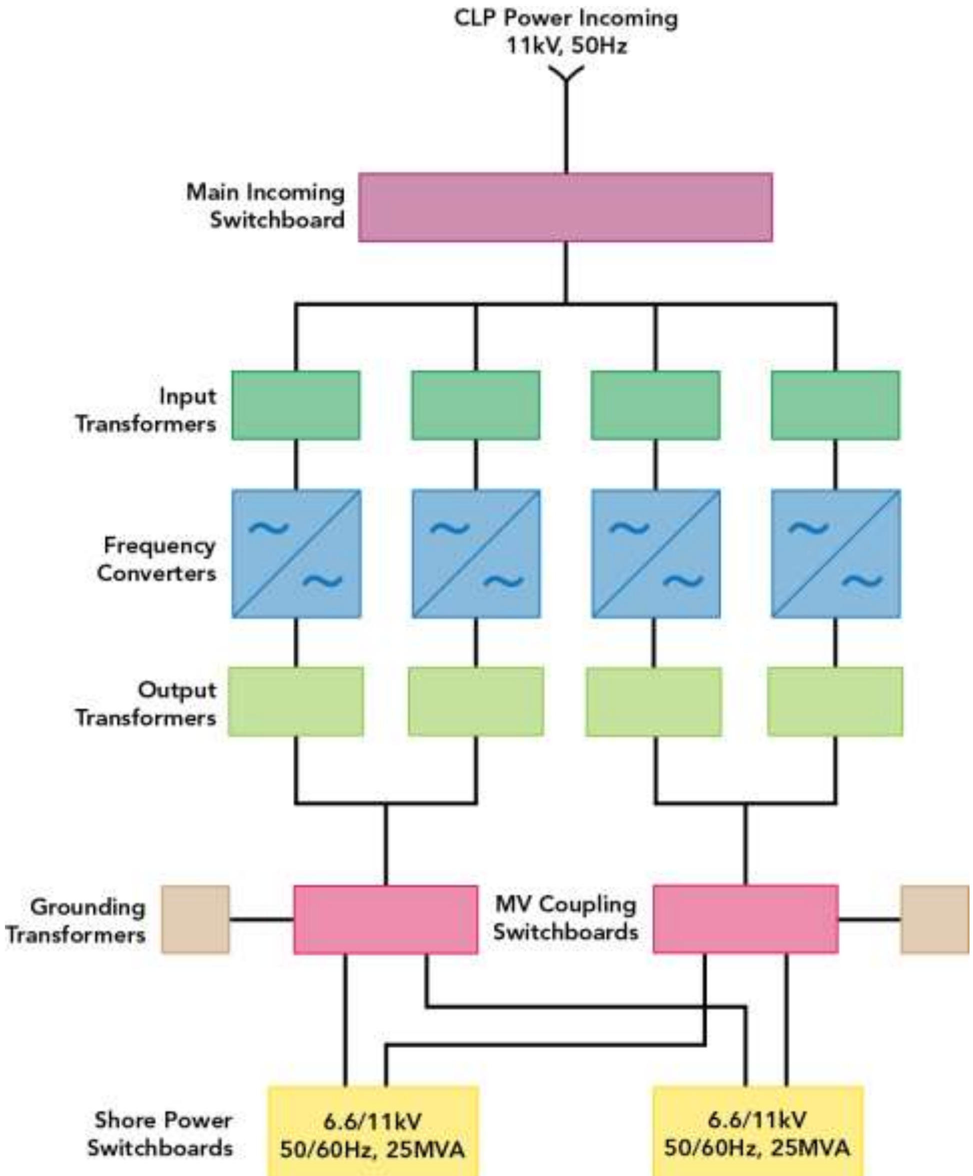

Figure 2 Schematic diagram of OPS unit in a plant room

2.1.4 To prevent flooding risk during heavy rainstorm, raised floor system, exterior wall and drainage system are recommended for the two plant rooms. According to the Code of Practice for Fire Safety in Building, both exterior and interior walls between each compartment are required to meet the fire safety requirements. An independent water-cooling system is also recommended as the current District Cooling System at Kai Tak area does not have provision/allowance for connection to the plant rooms.

2.1.5 Civil works modification has to be carried out to enlarge the existing cable slots at the apron for laying HV cables in future. It is suggested to break out the mass concrete between the slots and form an open trench to accommodate HV cables.

2.1.6 The underground cable system connects to eight shore power outlet boxes separated by about 100m at the apron. These outlet boxes provide connection points for a mobile cable car, which is equipped with a flexible crane for hooking up the cable to the inlet of shore room in the ship.

Estimated system costs

2.1.7 The overall capital cost of the proposed OPS system is estimated to be around $315 million at April 2014 price level. During operational phase, the annual maintenance cost and operation cost are estimated to be around $10 million and $4 million respectively at April 2014 price level.

2.1.8 The capital cost includes the engineering consultancy for detailed design work, OPS equipment, OPS berth system, structural and civil works, and allowances for contingencies. The estimates of the capital cost and recurrent cost are summarized in Tables 1 and 2 respectively.

Table 1: Summary for capital cost

Description	Estimated Cost ($ million)
Detailed Design Work	12
Base OPS system	
1. OPS Equipment in Plant Rooms	133.2
2. OPS Berth Systems	65.7
3. Structural and Civil Works	4.9
4. Risk Allowance[2]	40.8
5. Provision Sum for Price Fluctuations[3]	48.7
6. Provision Sum for MPF[4]	8.8
Total	**314.1** **315 (rounded)**

[2] Allowances for contingencies is estimated in accordance with the procedures or Estimation of Risk Analysis approach.
[3] Annual increment for price fluctuations is assumed to be 5.5% from Year 2014 to Year 2017.
[4] Mandatory Provident Fund (MPF) is assumed to be 3% of the sum of base OPS system.

Table 2: Summary for annual recurrent cost

Description	Maintenance Cost[5] ($ million)	Operation Cost[6] ($ million)
1. OPS Equipment in Plant Rooms	5.6	1.9
2. OPS Berth Systems	4.1	2.0
3. Structural and Civil Works	0.035	---
Sub-total	**9.7** **10 (rounded)**	**3.9** **4 (rounded)**
In total ***(Maintenance + operation)***	**13.6** **14 (rounded)**	

Feasibility of the OPS Project and Estimated Time for Completing the Project

2.1.9 The feasibility study confirmed that the OPS installation at the KTCT is technically feasible. If it is decided to install OPS at the KTCT, the project will be a capital works and needs to go through different stages of work including the preparation of Technical Feasibility Statement, detailed design, funding approval, tendering and construction. The process could take about 60 months to complete, subject to funding approval and structural and civil works at the apron[7].

5 The annual maintenance includes inspections, repair testing, parts replacement for transformers, switchgear, cooling system, automation system and mobile cable units etc. The maintenance cost is estimated to be the sum of 5-7% of its capital cost for OPS equipment in plant rooms and berth systems. For structural and civil work, the maintenance cost is estimated to be 0.5-0.7% of its capital works.

6 The annual operation cost includes trained labour and plants cost to operate the mobile cable units and to connect/disconnect cables from ships, assuming full operation over the year.

7 Structural and civil works can only be carried out in stages during the period when no cruise is berthing at the cruise terminal. It is assumed that 15% of the time can be allowed for such structural and civil works.

2.2 Survey results on OPS operation from Cruise Liners and Port Operators

2.2.1 Questionnaires were sent out in the first quarter of 2014 to 50 major ports/cruise terminals and 45 cruise liners worldwide including those in Asia. Follow-up information collection for 39 Asian ports was conducted in June 2014.

2.2.2 There are a total of 20 effective returns from ports / terminals including 11 Asian ports and a total of 11 returns from cruise liners.

2.2.3 For the questionnaires for cruise ports / terminal, the topics covered the current situation of OPS, future trends of OPS and other existing environmental performance measures. For the questionnaires for cruise liners, the topics of survey covered the OPS capabilities of the current and new cruise ships, future OPS plan, call history and calling plan of cruise vessels to Hong Kong, arguments to adopt OPS, and other possible measures to improve environmental performance at berth.

Responses from cruise liners

2.2.4 Among the returned cruise liners, there were 31 OPS-capable[8] ships and 8 OPS-capable ready[9] ships out of 162 international cruise ships in June 2014. Two cruise liners stated that their new builds in total of 7 ships will be OPS-capable while two other liners will have their new builds OPS-capable ready.

2.2.5 Based on the cruise schedule of the KTCT and Ocean Terminal of Year 2014 as of 24 June 2014, four out of 39 cruise ships that

8 "OPS-capable" means the ship is equipped with necessary equipment and shore power connection point and is ready to receive OPS.
9 "OPS Capable ready" means the ship's switchboards are equipped with breaker positions for adding shore power connection point (plug-in switchboard) at the later stage which do not involve large-scale of retrofitting works on the ship on-board electricity supply system.

calling Hong Kong were OPS-capable. Based on the KTCT cruise schedule of Year 2015 as of 24 June 2014, there would be 50 cruise-calls and only four calls would be ready to connect shore power while at berth. Hence, around 8% of the total calls scheduled for 2015 could be able to use OPS.

2.2.6 Based on responses from cruise liners, the main arguments for retrofitting cruise vessels with OPS are reputation/goodwill and environmental benefits, followed by environmental authority's regulations. Other environmental measures being considered by cruise liners include the use of clean fuel, scrubbers and particulate filters, reduction in load and fuel, implementation of ship energy efficiency management plan and energy efficiency measures on the hoteling ship consumption.

Responses from cruise ports / terminals

2.2.7 Among the 12 ports in the North America being surveyed, five have responded to the questionnaire. Among those five ports providing responses, four have advised that they are offering OPS. As to those without offering OPS, one cruise port indicated that they are considering a plan to offer OPS. Among the 11 responses from 60 Asian ports / cruise terminals being surveyed, none of them is offering OPS. Four of them indicated they are considering a plan on providing OPS within 5-10 years; seven did not have any OPS plan and 49 gave no responses. For those 14 European cruise ports, only three of them responded to the questionnaire. None of these three ports is offering OPS but all indicated that they are considering a plan to offer OPS. In Oceanian region, only one from three cruise ports responded to the questionnaire. This port indicated it is not offering OPS and is not considering offering OPS.

2.2.8 In the United States, port authorities usually own the OPS system (except Port of Seattle, which is owned by Cruise Liners) and hire an OPS contractor to operate and maintain the system for the ports.

2.2.9 Based on the feedback from cruise port/terminal operators and authorities worldwide, the reasons for ports not installing OPS include the low cost effectiveness of OPS, the lack of stakeholder's interest, the issue of power supply and the impact on the electric grid. Conversely, the main reasons for ports installing OPS are reputation/goodwill, environmental and social benefits, and requirement by environmental authorities. The responded port/terminal operators indicated that, apart from OPS, other possible measures to improve emission performance in a port include burning low sulphur fuel while at berth, slowing down when approaching the port and adopting stack emission control devices.

3. Summary

3.1 It is technically feasible to install the proposed OPS system comprising two OPS units, each of a maximum power of 25 MVA at dual frequency of 50 and 60 Hz and dual voltage of 6.6 KV and 11 KV. The proposed OPS system can serve simultaneously a maximum of three "Panamax Class" cruise ships or two "Genesis Class" cruise ships.

3.2 For Asian cruise terminals, a dual frequency OPS system is required to cater for cruises from America. The OPS system in the KTCT is thus comparatively more complex and costly than those in America. The estimated cost at April 2014 price level for the whole system is around $315 million for capital investment and around $14 million for annual maintenance and operation.

3.3 The survey reveals that OPS capable ships are not common worldwide. OPS is provided in some ports in the North America. There is no Asian cruise terminal providing OPS system at the moment. Only a few OPS capable ships are currently deployed in Asian region. Only 4 OPS-capable cruise ships out of 39 called HK in 2014. Based on the schedule of Year 2015 as of 24 June 2014, around 8% of the total cruise calls that will berth the KTCT could connect to OPS.

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