A Design Overview of the 11kV Power Distribution Supply Network for the High Speed Rail System in Hong Kong

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Abstract:

Hong Kong is building a high speed rail system, namely the Hong Kong Section of the Guangzhou-Shenzhen-Hong Kong Express Rail Link (XRL), connecting the high speed railway network from Mainland China to the underground West Kowloon Terminus through 26km long twin-track tunnels.

A modern high speed rail system should provide reliable and effective services to the commuters. To this end, reliability and security of the power distribution supply network to meet the power demand requirements to the loads at the West Kowloon Terminus, Shek Kong stabling sidings, ventilation buildings and ancillary buildings are of great importance to ensure the reliable operation of the XRL.

This paper gives an overview of the design key features associated with the 11kV power distribution supply network for the XRL.

Keywords

High speed rail system, Express Rail Link, twin-track tunnels, 11kV power distribution supply network, West Kowloon Terminus.

1. INTRODUCTION

1.1 Background

The Hong Kong Section of the Guangzhou – Shenzhen – Hong Kong Express Rail Link (XRL) is the first high-speed rail system with trains operating at a speed up to 200km/h from the West Kowloon Terminus (WKT) through about 26 km long tunnels to the Hong Kong / Mainland boundary at Shenzhen.

The XRL will connect with the Mainland Section of the Express Rail Link at Shenzhen and the high speed line runs a further 116km north to Guangzhou at speed of up to 300km/h, with stations at Futian, Shenzhen North, Humen and Guangzhou South. It will effectively integrate Hong Kong to the 16,000km high-speed rail network in Mainland China. The alignment of the Hong Kong section of the XRL is shown in Figure 1.

The XRL system consists of one underground terminus with multi-platforms located at West Kowloon i.e. WKT, an Emergency Rescue Station (ERS) and a Stabling Sidings at Shek Kong (SSS). Along the XRL alignment, there are various ventilation/ ancillary buildings located at Mai Po, Ngau Tam Mei, Tai Kong Po, Pat Heung, Shing Mun, Kwai Chung, Nam Cheong, Mongkok West and West Kowloon to cope with the ventilation control requirements under different operation scenarios. High reliability and security of the power distribution supply network to meet the power demand requirements of these infrastructures are of great importance.

1.2 Design Basis and Criteria

In order to ensure the reliability of railway operation and minimize any possible interruption to the XRL due to power supply problem, a “dual independent 11kV power supply sources” regime for providing 100% back-up for emergency/essential loads will be adopted. The power supply system shall be able to maintain operations of all emergency/essential loads when one of the two separately derived 11kV CLP Power Hong Kong Limited (CLPP) infeed sources fails. This is to ensure that operation of the XRL will not be affected in case of failure of any one CLPP infeed supply source.

The CLPP 11kV power distribution supply network will cater for the following design criteria for XRL operation:

- any single equipment or infeed supply source failure will not affect the normal operation of the train services;
- the thermal ratings of 11kV feeders and services transformers shall satisfy the XRL services loads under both normal and single equipment failure scenarios;

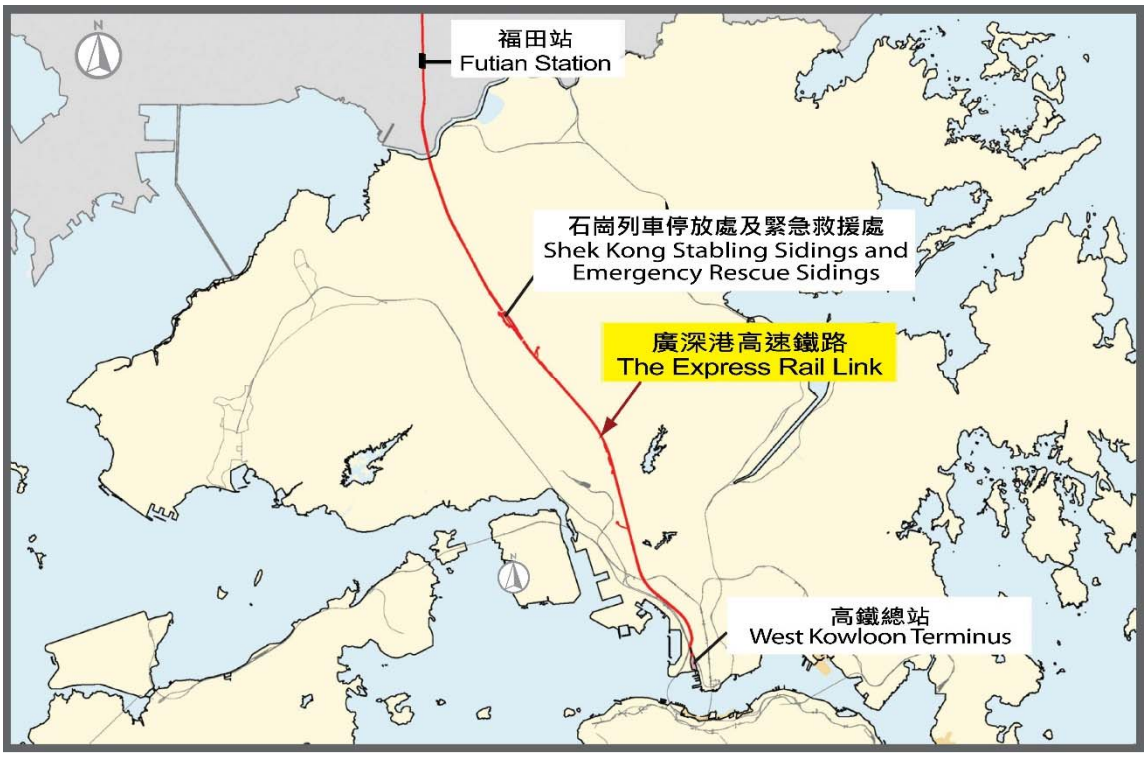

Fig. 1. Alignment of the Hong Kong Section of the Guangzhou – Shenzhen – Hong Kong Express Rail Link

- the number of 11kV feeders from the infeed source is determined by the load demand. The typical CLPP closed ring distribution configuration for different load demand is shown in Table 1.

CLP 11kV closed ring distribution configuration	Maximum load demand under single equipment failure	Maximum load demand under one infeed source failure
2-legged closed ring network	7MVA	14MVA
3-legged closed ring network	14MVA	21MVA
4-legged closed ring network	21MVA	28MVA

Table 1 Typical CLPP 11kV Closed Ring Distribution Configuration

2. SYSTEM DESCRIPTION

2.1 11kV Power Distribution Supply Network

In accordance with the load demand of the WKT, ERS, SSS, ventilation buildings and ancillary buildings, they are grouped into three load demand groups, namely West Kowloon Section, Tsuen Wan Section, and Mai Po Section.

CLPP will provide two independent 11kV infeed sources to each load demand group to establish the dual supply arrangement. Each CLPP 11kV infeed source will be derived from different CLPP 132/11kV primary substations and the 11kV closed ring distribution configuration is shown in Table 2 [1].

Load Demand Group	Source A CLPP Primary Substation/ 11kV distribution configuration	Source B CLPP Primary Substation/ 11kV distribution configuration
West Kowloon Section	Primary Substation A in Tsim Sha Tsui / 4-legged closed ring network	Primary Substation B in Tsim Sha Tsui / 3-legged closed ring network
Tsuen Wan Section	Primary Substation C in Tsuen Wan / 2-legged closed ring network	Primary Substation D in Tsuen Wan / 2-legged closed ring network
Mai Po Section	Primary Substation E in Mai Po / 3-legged closed ring network	Primary Substation F in Mai Po / 3-legged closed ring network

Table 2 CLPP 11kV Infeed Sources and the 11kV Closed Ring Distribution Configuration for XRL

The 11kV Power Distribution Supply Network for XRL is shown in Appendix A.

For each load demand group, the 11kV power will be

distributed amongst various load centres via the CLPP 11kV cable network. 11kV interconnection cables will be provided to interconnect the load demand groups, and at the strategic locations to interconnect sources A and B to enhance the security level of the 11kV distribution system.

Furthermore, 11kV switchgear panels will be provided at strategic locations for interconnection to external CLPP 11kV distribution rings to further enhance the security level of the 11kV distribution network for XRL.

Two 11kV feeders will be provided for the supply to the high voltage chillers at WKT.

CLPP will install 11/0.38kV transformers at WKT, SSS and ancillary buildings to obtain power from the 11kV switchboard and step down the voltage to 380V for distributing the power within the station and ancillary buildings. The typical CLPP 11/0.38kV transformer capacity of 1,500kVA and 2,000kVA transformers will be provided to suit the load demand. In addition, dedicated transformers will be provided at WKT for non-railway operating loads, including loads for Custom, Immigration and Quarantine (CIQ) facilities and Station Trading Area (STA).

MTR will install the LV switchboards to connect the CLPP's 380V power supply and to further distribute the supplies to other down-stream LV switchgear to provide the essential and non-essential power supplies to various loads in ventilation/ancillary buildings, SSS and WKT.

About half of the service loads of each load demand will be fed from Source A supply. The remaining loads will be fed from Source B. Interlock and changeover control circuits will be provided at LV switchboards in such a way that failure of either Source A or Source B will trigger non-essential load-shedding and the essential loads will be taken up by the other side. Since the 11kV distribution network will be supplied and installed by CLPP, the 11kV equipment will be remotely controlled and monitored by the CLPP Tai Po System Control Centre. The Main Control System will also enable XRL Operation Control Centre located at SSS to monitor the status of the 11kV transformer breakers.

2.2 11kV Closed Ring Configuration

The 11kV power supply system for the three sections (West Kowloon Section, Tsuen Wan Section and Mai Po Section) of the XRL (Appendix A) would be configured as follows:

(a) West Kowloon Section

West Kowloon Section would be fed by Primary Substations A and B in Tsim Sha Tsui respectively. The load demand of West Kowloon Section as reviewed by MTR and CLPP would be about 35MVA. To meet such load demand and dual independent power supply sources design principle, two 11kV rings would be provided by CLPP, that is one 4-legged ring with infeed source from Primary Substation A and one 3-legged ring with infeed source from Primary Substation B. Upon loss of 11kV power supply from either Primary Substations A or B, the other healthy power supply source would be able to maintain the power supply to the emergency/essential electrical loads at West Kowloon Section.

Furthermore, in order to meet the dual independent power supply sources design principle at 0.38kV level, duplicated 11/0.38kV transformers would also be provided for each main switchboard, that is one transformer from Primary Substation A ring and one from Primary Substation B ring.

(b) Tsuen Wan Section

Tsuen Wan Section would be fed by Primary Substations C and D in Tsuen Wan respectively. The load demand of Tsuen Wan Section as reviewed by MTR and CLPP would be about 8MVA. To meet such load demand and dual independent power supply sources design principle, two 11kV rings will be provided by CLPP, that is one 2-legged ring with infeed source from Primary Substation C and one 2-legged ring with infeed source from Primary Substation D would be provided. Upon loss of 11kV power supply from either Primary Substations C or D, the other healthy power supply source would be able to maintain the power supply to the emergency/essential loads at Tsuen Wan Section.

Similarly, duplicated 11/0.38kV transformers would also be provided to meet the dual independent power supply sources design principle at 0.38kV level (i.e. dual sources from Primary Substation C ring and Primary Substation D ring respectively).

(c) Mai Po Section

Mai Po Section would be fed by Primary Substations E and F in Mai Po respectively. The load demand of Mai Po Section as reviewed by MTR and CLPP would be about 18MVA. To meet such load demand and dual independent power supply sources design principle, two 11kV rings will be provided by CLPP, that is one 3-legged ring with infeed source from Primary Substation E and one 3-legged ring with infeed source from Primary Substation F would be provided. Upon loss of 11kV power supply from either Primary Substations E or F, the other healthy power supply source would be able to maintain the power supply to the emergency/essential loads at Mai Po Section.

Likewise, duplicated 11/0.38kV transformers would also be provided to meet the dual independent power supply sources design principle at 0.38kV level (i.e. dual sources from Primary Substation E ring and Primary Substation F ring respectively).

2.3 11kV Supply Distribution Network Equipment

All equipment will be supplied in accordance with CLPP standard and specification and compliant with MTR railway safety requirement. The agreed special requirement of the 11kV distribution network in XRL application is as follows:

- All 11kV cables installed within XRL premises and tunnel shall be 3/C XLPE/SWA low smoke halogen free and flame retardant cables.

- All pilot or fibre cables installed within XRL premises and tunnel shall be low smoke halogen free and flame retardant cables.

CLPP 11kV equipment and XRL LV supply equipment will be accommodated in separate rooms as demarcation between CLPP and XRL equipment and to satisfy the Fire Services Department requirements. The CLPP 11kV equipment receiving power from different sources will be accommodated in separate rooms for underground transformers [2].

2.4 Check Metering System

The check metering system comprises the digital energy meters, metering server and communication equipment. Digital energy meters as check meters will be provided at each CLPP metering point. The check meters will be provided for the 25kV traction power supply system, 11kV feeders at WKT and LV E&M services loads at WKT, ventilation buildings, ancillary buildings and SSS.

The metering server with energy meter management system and communication equipment will be provided at WKT for meter reading via the LAN network. The energy meter management system is able to perform the back end summation of any group of the energy meters.

3. CONCLUSION

This paper describes briefly the 11kV power distribution supply network of the XRL. The load demand for E&M services of XRL will be divided into three load demand groups. Two independent 11kV infeed sources derived from different CLPP primary substations will be provided for each load demand group. The CLPP 11kV distribution network will be interconnecting individual load centres within the load demand group to form a closed ring network. Each load demand group will be interconnected to enhance the security level of the 11kV power distribution supply network.

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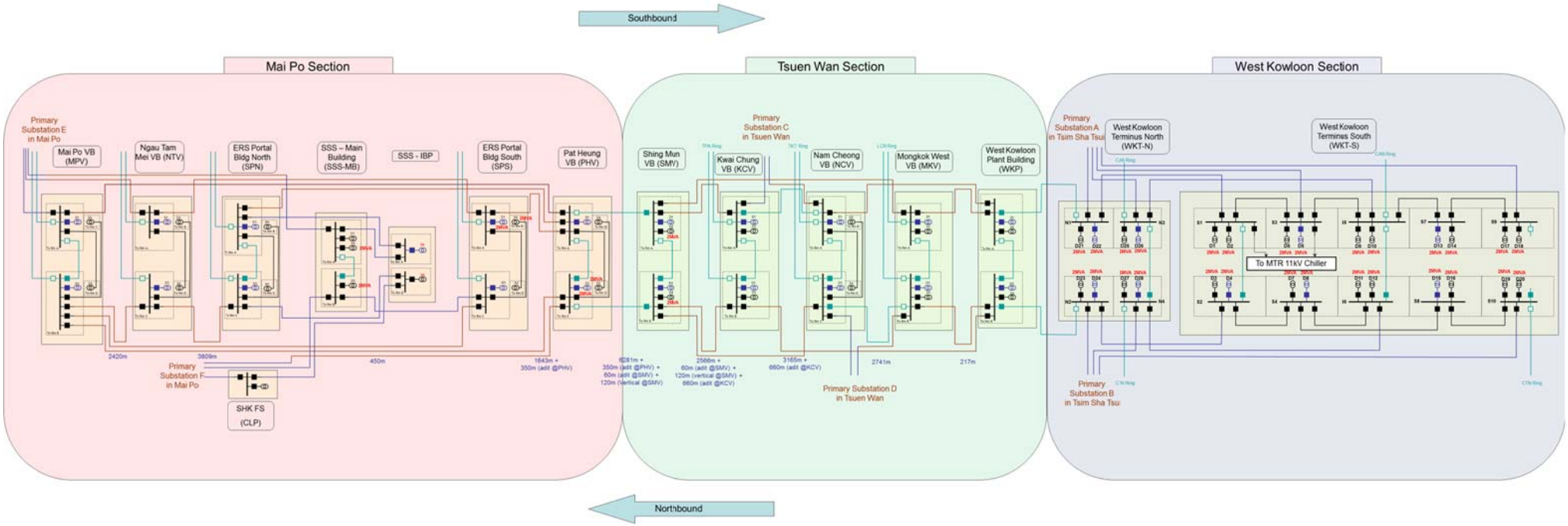
11kV Power Distribution Supply Network for XRL



Appendix A