Traction Facility Renewal for the Kelana Jaya Line, Malaysia

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Abstract

Operated since 1998, the Kelana Jaya Line has a total length of 29km consisting of 25 stations. It is one of the major rapid transit railway systems situated in Kuala Lumpur, the capital of Malaysia.

We delivered an initial DC traction system during the 1st phase of this railway's construction. With an increase in the number of passengers, it became necessary to implement an expansion of traction substations and upgrade electrical facilities. Since 2008, the renovation of existing facilities along with facility expansion and upgrade was carried.

The Kelana Jaya Line-related project received orders for the upgrade of four traction substations, the related facility renovation, and three traction substations. Since 2015, we have supplied a series of traction power facilities.

1 Preface

The Kelana Jaya Line in Malaysia is a DC traction railway operated at 750V DC. As of 2015, a total of 16 traction substations were in service for the entire line. When this line began, the capacity per substation was 3MW. After a series of expansion projects of the traction power supply facilities, the capacity per substation was expanded to 6MW. Since 2008, the renovation works of existing facilities has been carried out. The work focused mainly on DC switchgears.

As the line-related project, capacity expansion and facility upgrade works for Kelana Jaya, Asia Jaya, Taman Melati, and Terminal Putra traction substations ware performed. In addition, facilities at Brickfields, Pasar Seni, and Damai traction substations were renovated. (These works are collectively called the "Project.") The main contractor for the Project is MEIDEN MALAYSIA SDN. BHD. We delivered a complete set for a DC traction facility (electrical construction work was conducted by MEIDEN MALAYSIA SDN. BHD.)

This paper introduces the specifications of equipment supplied for the expansion and update works of the facilities.

2 Outline of Upgraded and Renewed Facility

Fig. 1 shows a single-line diagram of the Kelana Jaya traction substation. Except for the Terminal Putra, the system configuration is the same for all other substations.

For upgrading work, a rectifier and rectifier transformer were newly installed since a new rectifier set was added to the existing rectifier set. A total of two rectifier sets run in parallel. This arrangement is effective in a stable DC power supply.

For system renewal work, DC switchgears and regenerated power absorbing controllers, "Automatic Assured Receptivity Units," ('AARUs') were renovated.

2.1 Rectifier Transformer

The rectifier transformer was supplied from MEIDEN SINGAPORE PTE. LTD. Table 1 shows the ratings of the rectifier transformer and Fig. 2 shows the external appearance of the 3300kVA rectifier transformer.

2.2 Rectifiers

Rectifiers were supplied by Meiden. Table 2 shows the ratings of the rectifiers and Fig. 3 shows the external appearance of a 3000kW rectifier. Fig.4 shows the main circuit diagram of the rectifier

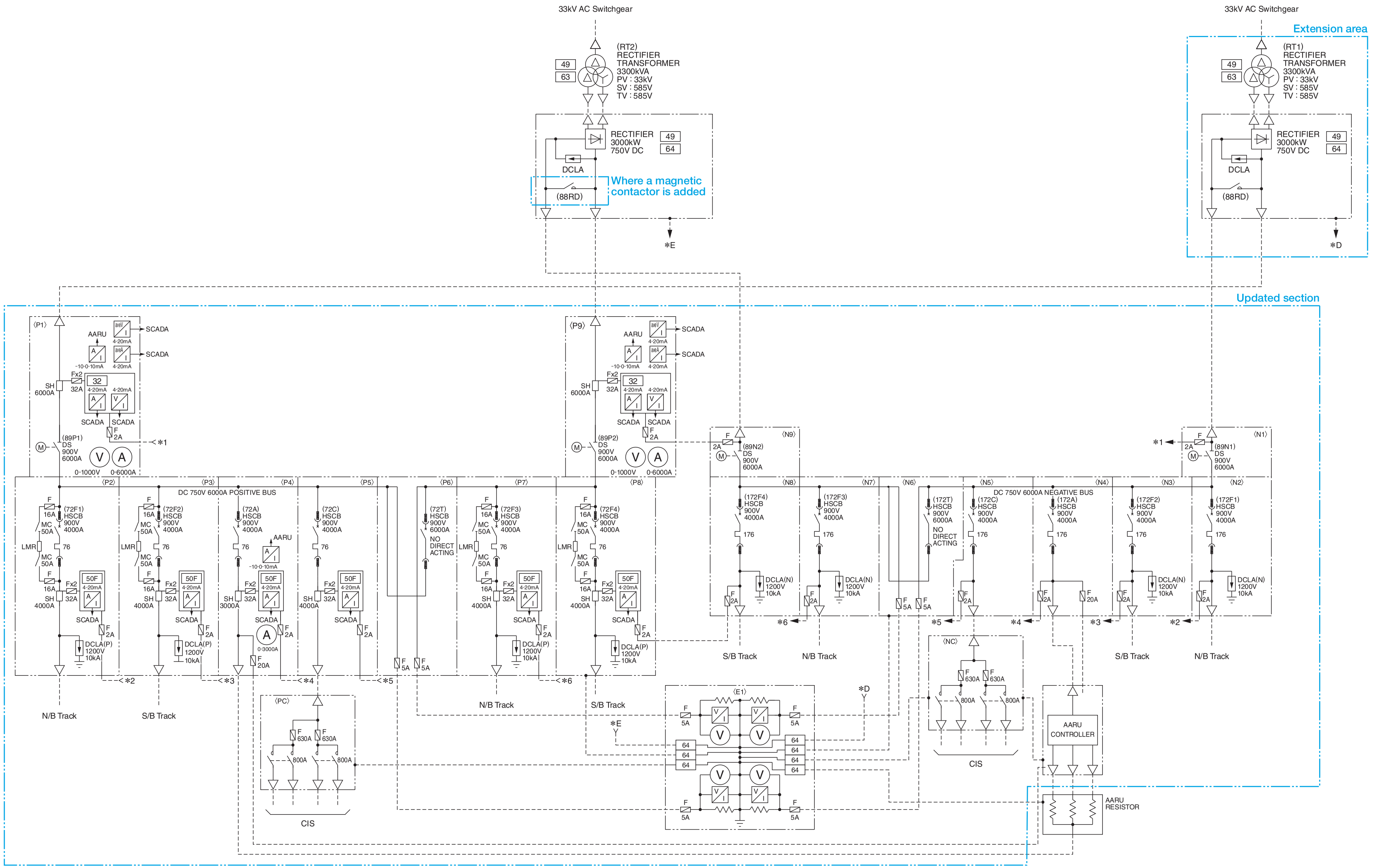

Fig. 1 Single-Line Diagram of Kelana Jaya Traction Substation

Except for the Terminal Putra traction substation, the system configuration is the same as all other substations. A single-line diagram of the Kelana Jaya traction substation is shown here as a typical example.

system. The rectifiers used in this project are equipped with a dummy load resistor intended to prevent a voltage rise at the time of a light load. A magnetic contactor was installed at the head of the dummy load resistor for the reasons described below.

(1) Circuit shutdown on the DC side at the time of the tripping of a 33kV AC circuit breaker

In the Project's system configuration, the DC incoming panel does not use a circuit-breaker but uses a disconnecting switch. Since the disconnecting switch does not have any current breaking capability, the magnetic contactor of the rectifier system breaks the current and then the disconnecting switch opens the circuit. Due to this system configuration change, the electrical circuit of the control panel in the upper stream 33kV AC switchgear was modified.

(2) Prevention of an inrush load current into the dummy load resistor during stopping period of the rectifier

After a traction substation is renovated, two rectifier systems operate in parallel. When one of the two rectifier systems stops running, its dummy load resistor becomes a simple load. As such, there is a risk that a load current might flow from the other rectifier system. To prevent this occurrence, a magnetic contactor is installed in the circuit, ahead of the dummy load resistor. It opens the circuit with the dummy load by using the magnetic contactor.

In this connection, the rectifier system in the existing facility was not equipped with any magnetic

Table 1 Ratings of Rectifier Transformer

Ratings of the rectifier transformer are shown.

Item	Ratings
Type	Silicone oil immersed transformer
Rated capacity	3300kVA
Rated primary voltage	F31.35-R33-F34.65kV (9 taps in 1.25% steps)
Rated secondary and tertiary voltages	585V×2
Overload capacity	Class6 (IEC60146) (100% continuous, 200% for 2h, 300% for 1min)
Rated frequency	50Hz
Winding	Primary: Delta, Secondary: Wye, Tertiary: Delta
Cooling	Natural air cooling

Table 2 Ratings of Rectifiers

Ratings of the rectifiers are shown.

Item	Ratings
Rated voltage	750V (at 100% load), 800V (at no load), 785V (at 0.5% load)
AC input voltage	585V
Rated capacity	3000kW
Overload capacity	Class6 (IEC146) (100% continuous, 200% for 2h, 300% for 1min)
Voltage regulation	5%
Cooling system	Natural air cooling
Configuration	Parallel 12-phase rectification

Fig. 2 3300kVA Rectifier Transformer

An external appearance of the 3300kVA rectifier transformer is shown. The primary voltage is 33kV and the secondary and tertiary voltages are 585V.

Fig. 3 3000kW Rectifier

An external appearance of the 3000kW rectifier is shown. A parallel 12-phase rectification system is adopted. The rated voltage is 750V DC.

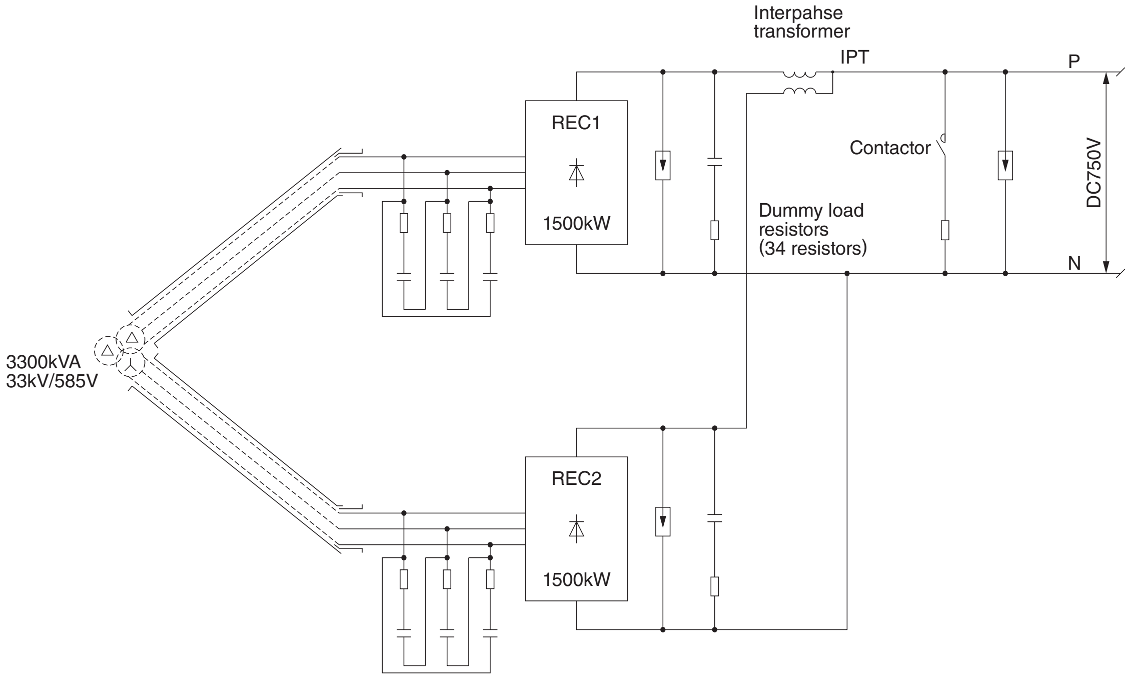

Fig. 4 Main Circuit Diagram of the Rectifier System

The main circuit diagram of the rectifier system is shown. Dummy load resistors and a magnetic contactor are installed on the DC output side.

Table 3 Rating of DC Switchgears

Rating of the DC switchgears are shown.

Item	Ratings
Type	HICLAD-D
Rated voltage	900V
Rated current	4000/6000A
Rated track time constant	100ms
Rated short-circuit current	180kAp/125kA
Protection class	IP3X
Rated insulation voltage	1.8kV

contactor. In order to remove the same issue of the new facility, we installed a magnetic contactor at the existing facility.

2.3 DC Switchgears

The DC switchgears were supplied from MEIDEN SINGAPORE PTE. LTD. Table 3 shows the ratings of the DC switchgears and Fig. 5 shows the external appearance of the equipment. The DC switchgears adopted for this project mainly consist of Disconnecting Switch (DS) panels, Circuit-Breaker (CB) panels, Controlled Isolating Section (CIS) panels, and earthing panels. For the CB panel, the HICLAD-D is adopted. The rated voltage is 900V and the rated current is 6000A for the bus-tie panel only and 4000A for the other panels. The incoming panel is a DS panel with the rated current of 6000A. The panel line-up is composed of a total of 9 panels: 4 panels for traction power (2 panels at the Terminal Putra traction substation), one bus-tie panel, one panel for AARU, one panel for CIS panel, and two for the DS panels. Since +375V is applied

Fig. 5 DC Switchgears

An external appearance of the DC switchgears is shown. This picture shows CB panel arrays installed on the positive side. Equipment on the DC side is composed of a negative-side CB panel arrays, CIS panels, and an earthing panel.

to the positive pole and −375V is applied to the negative pole in this project, the CB panel is installed on the positive side and on the negative side.

The CIS panel is a contactor panel that isolates the dead section. The earthing panel plays a role of maintaining the traction voltage at 750V DC at the time of earth fault protection for equipment in respective substations. For earth fault protection, each equipment unit is equipped with a frame leakage relay. These relays are gathered in the earthing panel. They are connected to the earthing wires of equipment casings (for a rectifier, DC switchgear arrays, and AARU control panels) and are used to monitor the occurrence of an earth fault. The traction voltage is maintained based on the earthing point inside the panel. Resistors are mounted on both the positive and negative sides and potentials of +375V and −375V are maintained, respectively. Based on the potential difference (+375V−〈−375V〉), the traction voltage of 750V DC is maintained for the railway line.

2.4 AARU

The AARU was purchased from ABB, Canada. Fig. 6 shows the external appearance of the AARU. The AARU is installed at each traction substation. It aims to stabilize the traction power system voltage by absorbing the regenerative power at the resistor (rheostat). Fig. 7 shows the AARU system configuration diagram. In this system, three sets connected in parallel are used. Each set is composed of a switch and a resistor. The system is mainly composed of the control panel (controller block and switches) and resistors. For this renewal work, existing resistors are used and only the control panel is replaced.

Fig. 6 AARU

An external appearance of the AARU is shown. Equipment shown is a control panel and resistors installed outdoors.

2.5 Blue Light System (BLS) Modifications

The BLS is a protection system for accident prevention in the case of a traction power supply stop. When the emergency traction power stop button is activated, it stops the supply of traction power in any arbitrary traction section. This system prevents electric shocks and personal injury. Fig. 8 shows the BLS button unit. This button unit is installed at both ends of each station platform and the way side of the rail tracks.

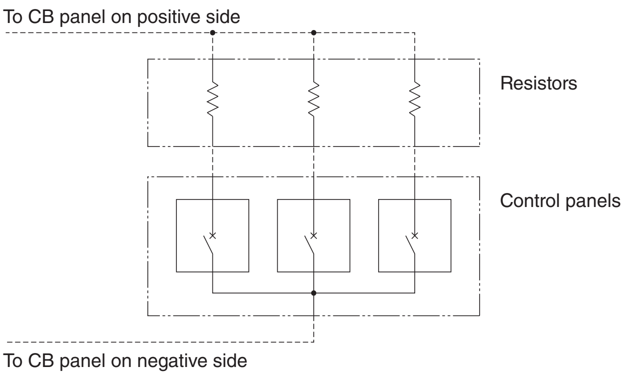

Fig. 7 AARU System Configuration Diagram

An AARU system configuration is shown. A single set is composed of switches and resistors. The whole system is composed of multiple sets connected in parallel.

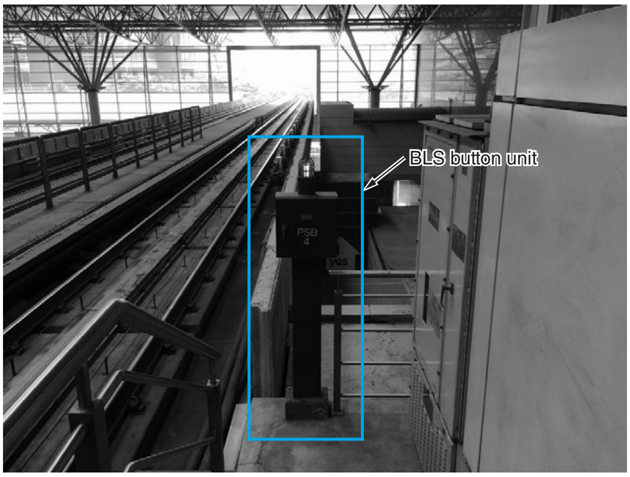

Fig. 8 BLS Button Unit

An external appearance of the BLS button unit is shown. In case of an emergency, a button connected to this unit is pressed to stop the traction power supply.

For the renewal work, the traction section is temporality changed because the related traction substation is shutdown. In this case, a bypass system is provided to the section gap of the affected traction section due to the renovation work of the traction substation. This arrangement allows the traction power supply from a nearby substation. After this temporary change of the traction section, the BLS is also temporarily changed. In order to extend the range of the power supply stop section to cover the one traction substation, we modified the BLS control panel. Thus we were prepared to prevent an accident during renewal work.

3 Postscript

The Project started at the end of 2015. The working schedule provided that one substation be updated in approximately one month. When one substation is completed, another substation begins renovation. As of November 2016, all processes were finished for the Terminal Putra, Damai, and Asia Jaya traction power substations. We are presently conducting renewal work for the remaining substations. All equipment necessary for system renewal were delivered to Malaysia and stored in a local warehouse.

Lastly, we would like to express our sincere gratitude to the Project-related people for their valuable advice and cooperation on designing, manufacturing, testing, and on-site installation work.