〈**Case Study**〉

Malaysia Kelana Jaya Line Power Supply System

Malaysia, Kuala Lumpur, LRT, Neutral grounding system

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Abstract

In Kuala Lumpur, Malaysia, there are two lines of Light Rail Transit (LRT) lines: one KL Monorail and another line for city area rail transit. The LRT Kelana Jaya Line, included in the above lines, started operation in 1998 and is 29.4km in length connecting Gombak in the north side of the city of Kuala Lumpur to Kelana Jaya in the city of Petaling Jaya using a driverless train. On the Kelana Jaya Line, a recent upgrade project has been completed for the train from two cars to four cars, and for the four-car train, the power supply system was also upgraded, including a capacity upgrade for nine existing substations and the construction of two new substations with two 3000kW rectifiers.

1. Preface

The Kelana Jaya Line in Malaysia has a total length of 29.4km and 15 Traction Power Substations (TPSSs). In this upgrade project for the Kelana Jaya Line, we supplied, installed, and tested power supply equipment for a capacity increase for the nine existing TPSSs and two totally new TPSSs.

2. Power Supply System Configuration

On the system for the Kelana Jaya Line, 132kV power from the electric company is received at two Bulk Supply Substations (BSSs) and then it is stepped down to 33kV and distributed to each TPSSs. Fig. 1 shows this 33kV network.

At each of the 15 TPSSs, 33kV power is converted into 750V DC and fed to the power rails of the positive third and negative fourth rails.

3. Configuration of TPSSs

Fig. 2 shows the new TPSS, Abudulah Hukum, and the equipment in this TPSS are stated as follows:

3.1 Power Receiving

TPSS receives 33kV AC power from BSS through the cable line which leads along whole the Kelana Jaya Line. AC 36kV air insulated switchgear is applied for this 33kV power receiving. The outline of this switch-

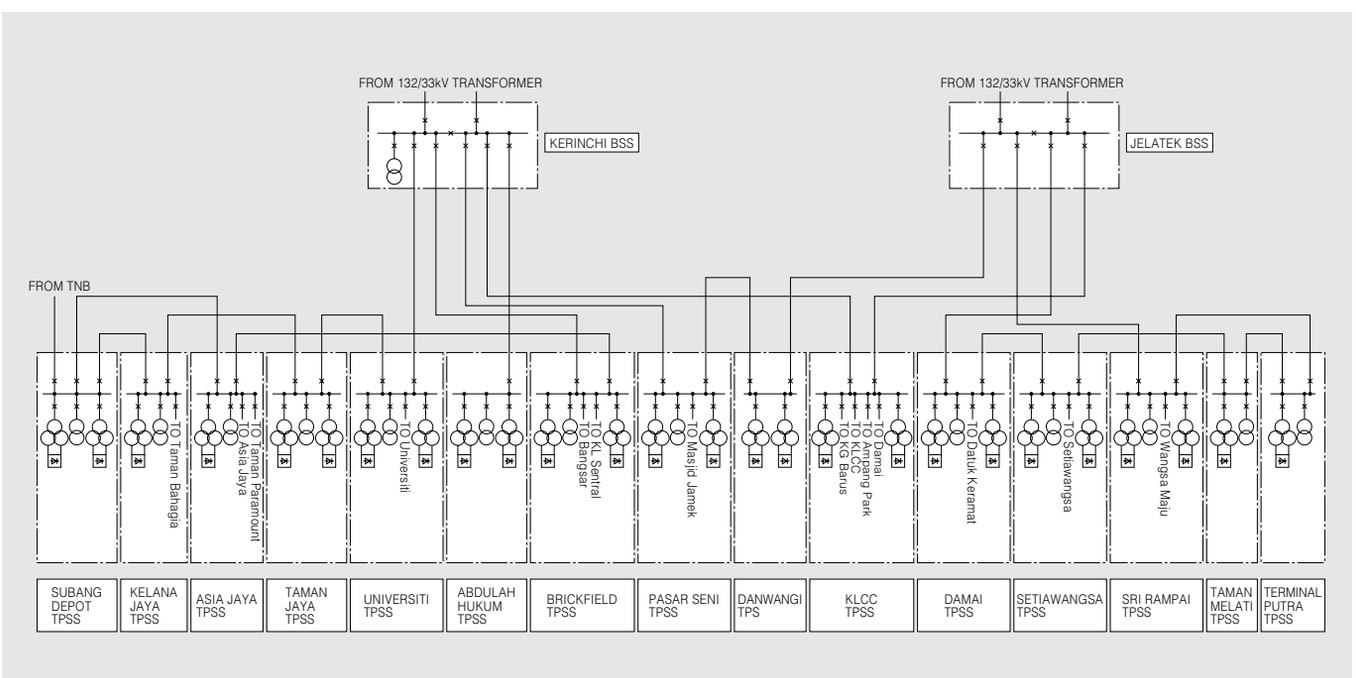

Fig. 1 Kelana Jaya Line 33kV Network

33kV network of all through line including all substations for the Kelana Jaya Line.

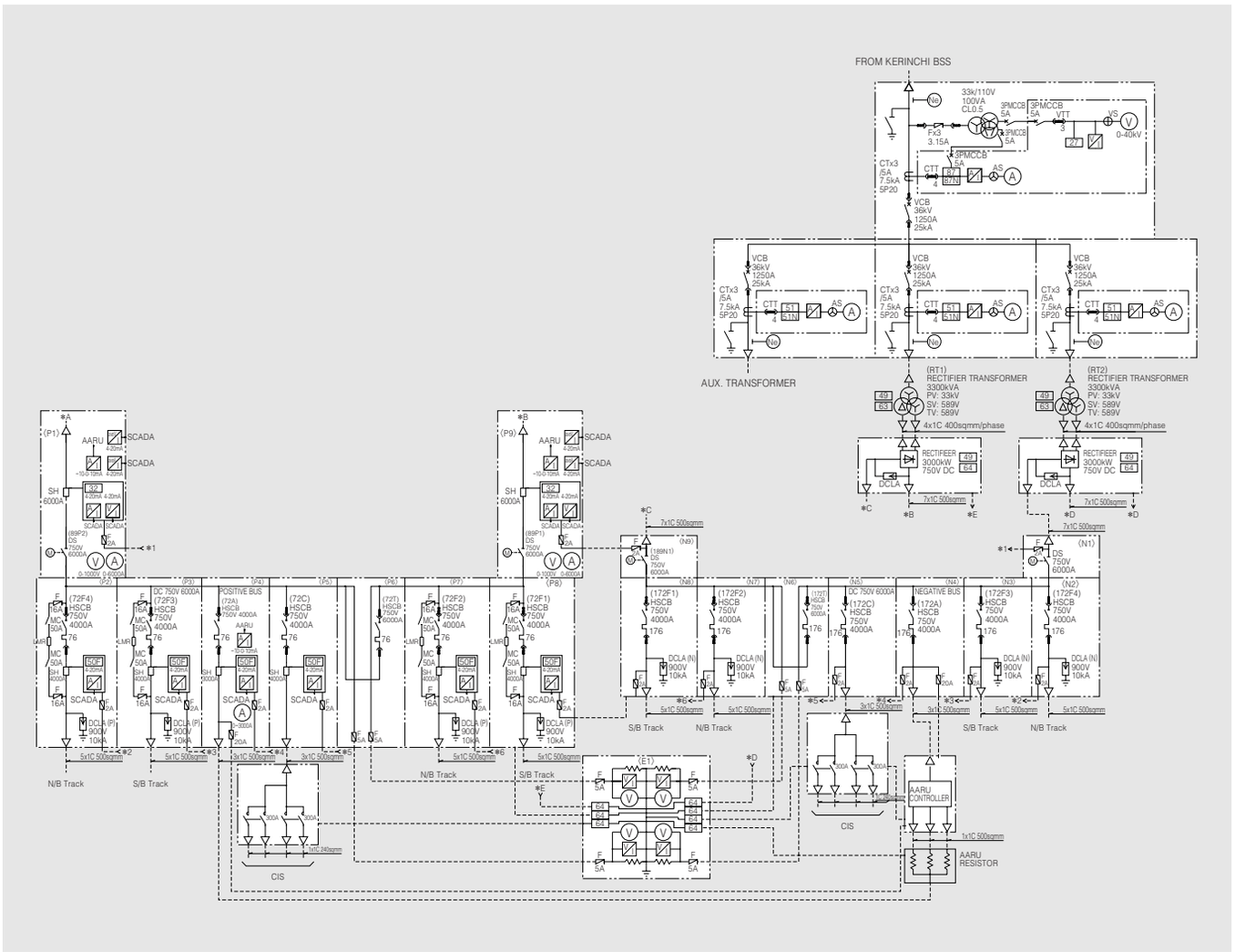

Fig. 2 Abudulah Hukum TPSS Single Line Diagram
Single line diagram of Abudullah Hukum TPSS power supply and distribution system.

Fig. 3 Outline of 33kV Switchgear
Outline of 33kV air insulated switchgear.

gear is shown on Fig. 3.

(1) Ratings of switchgear
  (a) Rated voltage: 36kV
  (b) Rated current: 2000A
  (c) Rated short time current: 25kA

(2) Ratings of Vacuum Circuit-Breaker (VCB)
  (a) Rated voltage: 36kV
  (b) Rated current: 2000A
  (c) Breaking current: 25kA

3.2 Power Conversion

In each newly established and/or upgraded TPSS in this project, two power conversion equipment sets consisting of the rectifier transformer and the silicon diode rectifier convert 33kV AC to 750V DC.

3.2.1 Rectifier Transformer

The rectifier transformer is an outdoor type, fluid immersed natural air-cooling unit. For insulation fluid, non-flammable silicone fluid is applied for fire protection. The winding configuration for this transformer is three windings for 12-pulse DC output. Two low voltage windings are cross-configured in order to minimize short circuits.

(1) Ratings
  (a) Rated capacity: 3300kVA
  (b) Rated primary voltage: 33kV
  (c) Rated secondary voltage: 585V × 2
  (d) Overload rating: Class VI (IEC 60146-1)

Fig. 4 Outline of Rectifier
Outline of rectifier, rated 3000kW natural convention air cooling type.

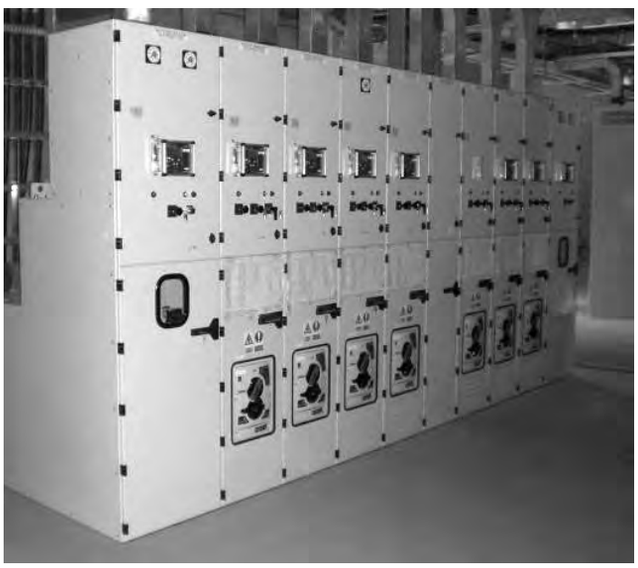

Fig. 5 Outline of Positive DC Switchgear
Outline of positive DC switchgear, applied our latest HICLAD-D.

(100%continuous, 150% 2 hours, 300% 1 minute)
(e) Primary tap: 33kV ±1.25%, ±2.5%, ±3.75%, ±5%

3.2.2 Rectifier

The rectifier is an indoor type, natural convention air-cooling unit. Each diode leg has a diode fuse for protection. The diode fuse has an alarm contact for blown fuses, and the system is designed so that the rectifier will continue normal operation even if any one leg fails and drops out of service. Therefore, the blown fuse detection alarm is configured so that the fuse on each leg activates the alarm only, but it requires two fuses to trip the rectifier. Fig. 4 shows an outline of the rectifier.

(1) Ratings
(a) Rated capacity: 3000kW
(b) Rated input AC voltage: 585V × 2
(c) Rated output DC voltage: 750V (12 pulse)
(d) Overload rating: Class VI (IEC 60146-1)
(100% continuous, 150% 2 hours, 300% 1 minute)

3.3 DC Power Distribution

The DC Distribution system for the Kelana Jaya Line applies the thrid and fourth rail system, and the neutral point between the positive and negative lines is grounded through 375 ohm grounding resisters. Thus, the positive pole of +375V and the negative pole of −375V against the rated voltage between positive and negative equal 750V. So circuit-breakers are applied to the negative pole.

The DC distribution system consists of the positive DC switchgear, negative DC switchgear, earthing panel for neutral grounding, and the Automatic Assured Receptivity Unit (AARU).

3.3.1 Positive/Negative DC Switchgear

For the positive and negative DC switchgear, the same numbers of corresponding Circuit-Breakers (CBs) are configured for both positive and negative on a one-to-one basis for each switchgear. Those consist of the rectifier isolator, feeder circuit-breaker, bus-tie breaker, controlled isolated section feeder breaker, and AARU feeder breaker.

Each switching device is controlled on a one-to-one set of positive and negative, and only one control command controls both devices. Each set of devices is monitored so that their status remains the same, and an alarm is activated in case the switching state differs between devices.

On the track feeder circuit, load measuring is conducted. When the negative CB is closed, load measuring will start, and after the status is confirmed, the positive CB will close. In case load measuring finds an abnormal condition on the load side circuit, the negative CB will open and will lock out both positive and negative CBs. This lockout will be applied to the above-mentioned circuit with one-to-one positive and negative logic.

The protection relay is digital electronic and has normal overcurrent protection, delta-I, di/dt protection, and load measuring and re-closing functions. This relay is equipped only in the positive cubicle, and it gives a trip command to both the positive and negative cubicles when the protection function is operated. Fig. 5 shows the outline of the positive DC switchgear.

(1) Ratings for the DC Switchgear
(a) Rated voltage: DC 900V
(b) Rated current: 6000A
(2) Ratings of isolator
(a) Rated voltage: DC 900V
(b) Rated current: 6000 A
(3) Ratings of DC high speed CB
(a) Rated voltage: 900V DC
(b) Rated current: 4000/6000A
(c) Breaking current: 125kA

Fig. 6 Outline of Earthing Panel
Outline of earthing panel – the DC neutral point is earthed in this cubicle through a grounding resistor.

Fig. 7 Outline of AARU Controller
Outline of AARU controller equipped with thyristor switches.

3.3.2 Earthing Panel

The earthing panel has 375 ohm grounding resistors to ground each positive and negative line with positive to earth and negative to earth voltage meters and an alarm function in case the voltage rises from a ground fault. Fig. 6 shows an outline of the earthing panel.

3.3.3 AARU

AARU is installed to ensure way side dissipation of energy from electric-breaking transit trains, making sure that only the power that needs dissipating is dissipated. AARU consists of a resistor to dissipate the regenerative power and a controller with a thyristor switch. The controller and resister consist of three units, and each unit is controlled to turn on and off independently in order to adjust the power consumed by the resistor.

The thyristor switch is triggered by voltage to detect the regenerative power from the transit train. When voltage exceeds the set value, the thyristor switch will close and energize the resistor circuit. This switch is controlled to open after a set time from closing or when the rectifier output current exceeds a set value. Fig. 7 shows an outline of the AARU controller.

(1) Ratings
  (a) Rated voltage: 787.5V
  (b) Maximum voltage: 900V
  (c) Resistance value: 1.017 ohm/unit

4. Postscript

Kuala Lumpur is a major city with a population of 1.8 million (5 million in the metropolitan area) but has only four city commuter rail lines, so automobiles are the main means of transportation within the city area. Now, the Malaysian government is moving toward a modal shift and is planning to open many rail projects. This Kelana Jaya Line upgrade project is one of those programs that will take Kuala Lumpur into a modal shift.

Lastly, we would like to express our special thanks to the project-related people and members.