



# Rail Systems

## Power System Infrastructure

### Introduction

Practice Engineers have been involved in National Rail infrastructure Projects since the early 1990's and for London Underground and Light Rail Systems including Croydon Tramlink and GMPTE Manchester Metro.

### National Rail Infrastructure

#### DC Third Rail

Involvement in national rail infrastructure grew out of asset replacement schemes within the Southeast of England including the requisite reinforcement works to facilitate the running of Eurostar rolling stock over the third rail system in the interim period prior to the conclusion of the Channel Tunnel Rail Link.

Works included the design and integration of 33kV gas Insulated Switchgear into various 33kV AC/750V DC traction substations around the south east of England including Selhurst, Ifield, Loughborough Junction, Maidstone Barracks and Normans Bay but to name a few.

Projects included 33kV switchgear replacements, whereby new three panel 33kV GIS switchgear comprising:-

- Two ring feeder circuit breakers fitted with
  - I. Alstom Translay S (MBCI)
  - II. Overcurrent & Earth Fault
- Rectifier transformer feeder.

were replaced. Space would be found for the 33kV switchgear indoors within the precincts of the existing substation, this enabled the switchgear to be delivered, installed, cold commissioned and the 33kV

cables terminated and tailed out to closing joint positions without the need for an outage.

The Network Rail 33kV distribution system makes extensive use of oil assisted 33kV paper lead cables, which required specialist oil stop and trifurcating joints.

Other projects included transformer rectifier replacements requiring ONAN Dy11d0 transformers of up to 12MW to be replaced together with 12 pulse bridge rectifiers and positive pole DC switchgear. This apparatus could be located in existing substations or if insufficient room was available modular steel buildings would be used.

#### Thameslink Ludgate Cellars Substation.

Acting on behalf of the Development Branch of EDF Energy, Kedvale Consultants was approached after a tender enquiry was received for the construction and installation contract on a turnkey basis. The substation was part of a substantial upgrade to the Thameslink rail infrastructure aimed at increased capacity.

The substation is unique in the fact that it is at a point on the network where the 25kV OLE pantograph system typically used north of the river Thames stops and the 750V DC third rail system starts to provide traction motive power onwards to Brighton.

The original brief from Network Rail conceived the substation as being fabricated from a number of modular buildings interlocked together similar to concepts employed by temporary construction cabins.

Kedvale Consultants sought offers from vendors for the various electrical apparatus obtaining outline design data and manufacturing durations in order to build a comprehensive design and build Gantt chart programme. Kedvale also started to plan a sophisticated change over strategy minimizing outages in order to maintain services.

In expending a construction programme and a change over strategy it was beginning to be realized that the interlocked modular building strategy caused to many program constraints for an efficient electrical strategy.

Kedvale immediately produced conceptual layout drawings for all plant rooms and started to look for a competent civil contractor with whom to build a collaborative relationship in order to conceive a construction solution which would complement the electrical strategy.

The requirements of the brief were:-

- Network Rail approved civil contractor with appropriate design and build credentials.
- Provision of recycled stabilised ground with a reinforced ground bearing slab and overlying bundled reinforced concrete slab foundation.
- Steelwork fabrication and erection for traditional steel portal frame.
- Aluminium mesh cladding system supported off a secondary frame
- Construction of a reinforced concrete Ribdeck blast floor to support significant static and dynamic loading of HV switchgear and associated cabling and provide containment from a blast of the underlying transformer rectifier units furnishing DC power.
- Steel supported raised access floor to house switchgear and light current SCADA and protection panels.

After consultations with the client detailed negotiations and design reinforcement was concluded with Dyer & Butler of Southampton.

Kedvale Consultants represented the client in presentations with Network Rail in order fully explain the construction, design, delivery and essential phasing of the civil and electrical elements of the contract works. The completed substation is the largest structure of its kind in Europe and was designed to provide a one house fire protection and a design life of 60 years.

## Light Rail Projects

### GMPTE Manchester Metro.

Acting on behalf of the Development Branch of EDF Energy, Kedvale Consultants was asked to provide a full range of services so as to enable a complete tender package to be submitted. The enquiry was for the provision of 11 or 6.6kV traction substations along metro extensions between central Manchester and Rochdale and again between the city centre and Manchester Airport.

Kedvale set about designing a template substation incorporating the following apparatus:-

- HV metering ring main equipment
- Fiscal metering
- DNO Outstation
- DNO Tripping supply
- Client 11kV disconnecter
- 1500kW 12 Pulse rectifier
- Client tripping supply
- Positive Switchboard
- Negative bonding
- Protection and control
- Client outstation

Once the template substation was conceived spatially, construction methods were investigated to give minimum cost and site erection time.

Site visits were expedited and a craneage contractor consulted and lifting and handling plans were conceived for

A full take-off of the requisite switchgear and associated apparatus was undertaken and a full cost model was produced to as to price the entire project.

Consultation with the incumbent DNO so as to ascertain the means of connection to the 11 or 6.6kV distribution system for all traction substations.

## Underground London Underground Subsurface Line Upgrades

### Neasden BSP.

Kedvale Consultants undertook the specification of a new double bus bar 22kV switchboard in preparation for a new DNO bulk Supply Point comprising two 132/22/22kV YN/yn0/yn0 66MVA power transformers. The 22kV switchboard also included three Coupling Transformer feeders for 22/11kV 20MVA units to be located at Harrow On The Hill LU substation.

In addition to the 22kV switchboard a substantial single bus bar 11kV switch board was specified to control local distribution feeders.

Kedvale developed an evolution strategy so as to install the new switchgear and cold commission the new switchboard together with its attendant protection and control while maintaining the old switchgear in service. There after a significant change over strategy was created with attention paid to Emergency Return to Service timescales so as to have contingencies for plant and apparatus failure on the local network.

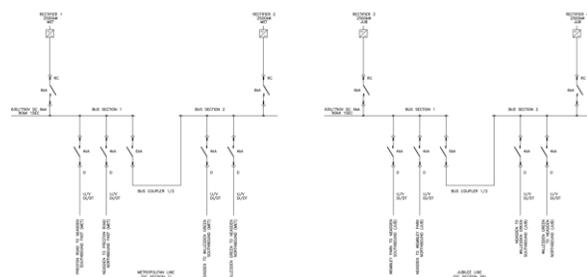


Figure 1 Neasden DC Distribution

### Harrow on the Hill

To provide reinforcement to this part of the LU system three 22/11kV 20MVA Coupling Transformers were to be installed together with a new 11kV 2500A double bus bar primary switchboard comprising 25 panels. Two 500kVA Znyn0 earthing and auxiliary transformers were also provided.

In addition to the primary 11kV switchboard a smaller secondary 11kV single bus bar switchboard was provided for domestic loads such as transformer/rectifier units.

The existing three transformer rectifier units rated at 11/0.63kV, 1500kW were also replaced with six larger 2500kW 11/0.7/0.63kV 12 pulse units.

Two new 750V DC switchboards were also installed one for the positive and one for the negative pole. Each DC switchboard consisted of four bus sections with bus bars and incomers rated at 6kA and traction feeders rated at 4kA.

The clear challenge from the onset was how to install a completely new substation insofar as electrical apparatus was concerned without compromising on safety and availability and power system integrity.

The three coupling transformers formed the starting point as the accommodation for these was external to the substation, hence a banded area containing the foundations for three transformers was constructed and a substantial ducting system designed and installed so as to facilitate installation of the 11kV incoming cables.

Fortunately, there was a significant area of un-used floor space where long since removed mercury arc rectifiers were once housed. This provided an opportunity to commence the installation of the new apparatus in a non-intrusive manner. Kedvale in close liaison with the project structural conceived a means to install the new 11kV switchgear which required



- Replacement of Hawkgas 24 by means of roof located modular building.
- Replacement of existing protection relay panels by means of roof located modular building.
- Use of RIBB (resin Impregnated bus bars) so as to ameliorate the need for breakers at each end of a cabled bus interconnector hence saving switchgear footprint.
- Asset replacement of substation 11kV switchgear so as integrate protection and control facilities within the switchboard and thereby free up floor space previously occupied by enclosures containing induction pattern relays.

Kedvale were able establish project programmes and hence determine construction durations, outage durations and project costs to enable the client to determine the optimal course of action..