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1 PROJECT DESCRIPTION

This electrical project is the replacement of the existing main LV switchboard at Substation D at the Countess of Chester Hospital. The contractor is to include for all associated costs including the internal and external builder's works and the hiring of temporary generators required in providing the new services as described in this document and shown on the accompanying drawings

New electrical installations shall comply with current editions of BS 7671:2008, BS 7430:2011, BS 5839:2013 and Health Technical Memorandum HTM 06-01 .

1.1 SCOPE OF THE WORKS

The project consists of the following elements:-

- ✓ Builders work to modify doorways and create stepped access
- ✓ Provision of temporary mains cable links and connections to allow the phased works to proceed.
- ✓ Replacement of transformer LV termination box and LV tails.
- ✓ Replacement of existing LV main switchboard
- ✓ Replacement of local services mcb distribution board
- ✓ Renewal of existing small power and lighting services to HV and LV rooms
- ✓ Provision of new fire alarm systems to HV and LV rooms
- ✓ Provision of new mobile generator hook up facility.
- ✓ Substation earthing measurements + allowance for additional rods
- ✓ Earthing installation and modifications to new switchgear
- ✓ Provision of mains and control cabling
- ✓ Additional cable containment
- ✓ Cable terminations (temporary and permanent to suit phases)
- ✓ Testing and setting to works the installations
- ✓ Provision of temporary generator & connections to allow removals
- ✓ Provision of As Fitted documents and operation manuals
- ✓ Disconnection and removal of old redundant plant

The following elements of the existing installations at the substation shall be retained.

- ✓ Fixed standby emergency generator & fuel tank
- ✓ Generator control and change-over panel
- ✓ Essential services MCCB board (MB/GEN)
- ✓ Generator power, earthing & controls cabling

The contractor shall provide a full installation package providing the replacement switchgear, all interconnections and earthing plus testing, builders work and the disconnection and removal of the redundant equipment.

1.2 TENDER DRAWINGS

The following tender drawings are to be read in conjunction with the details containing in this specification.

Ref Number	Title	Status
20076/E01	Existing LV Schematics	Tender
20076/E02	Phase 1 works LV Schematics	Tender
20076/E03	Phase 2 works LV Schematics	Tender
20076/E04	Phase 3 works LV Schematics	Tender
20076/E05	Phase 4 works LV Schematics	Tender
20076/E06	Phase 5 works LV Schematics	Tender
20076/E07	Final Proposed LV Schematics	Tender
20076/E08	Existing Electrical Installation	Tender
20076/E09	Proposed Electrical Installation - Plant	Tender
20076/E10	Proposed Electrical Installation – small power & Lighting	Tender

Any discrepancy found between the drawings and details in this specification shall be brought to the attention of the Engineer during tender stage.

2 EXISTING INSTALLATION DESCRIPTION

Substation D feeds essential services (Pathology Labs) plus Admin facilities, Ambulance Services and adjacent Care homes (Pinetum building) at the Countess of Chester Hospital. One 500kVA transformer supplies a LV switch panel all located at ground floor level in a standalone brick build substation. A single 200kVA standby generator is located externally to the rear of the substation and this provides automatic back up to the Pathology Labs in the event of power failure via a change-over panel and a 4 way MCCB panel board.

The existing schematic diagram (20076/E01) for the installation is provided in the tender drawings. The substation comprises of an HV switchroom, a transformer room and a LV switch room, with an external compound for the generator and fuel tank.

HV cables enter the building from across the adjacent car park area at the side of the building and the LV sub-mains cables exit from both sides of the building via a duct along the side wall of the LV room.

3 RETAINED INSTALLATIONS

The HV rooms with recently upgraded ring main unit plus the oil filled transformer are to be retained. However, the transformer shall be modified to allow the installation of the new transformer tails feeding the new LV switchgear.

The generator, generator control and change-over panel plus essential services MCCB panel (MB/GEN) are also to be retained.

All outgoing cabling and circuits to the hospital and surrounding buildings shall be retained and services shall remain in constant usage throughout the project. The contractor shall ensure that the building supplies are available with a reliable generator back-up (either fixed or mobile) throughout the entire process of the new installation.

Existing cabling between the transformer change-over switchgear and the main LV switchboard shall be renewed to provide the new systems shown in the proposed schematic diagram supplied.

4 PHASING OF PROJECT

The installation of the new switchgear panel needs to be implemented in a logical sequence so as to avoid or reduce the impact of shutdowns to the electricity supplies. The details provided in the tender drawings shows a five step process to reach the final arrangement. This phasing approach should be adopted by the tendering contractor to enable a fair comparison between prices.

Post tender discussions may show alternative options that offer logistic or cost benefits to the Trust and these can be explored by the successful contractor as the installation of the works proceeds.

More details of the phasing can be seen in the Appendix 1 Project Delivery Plan and on the schematic drawings.

Whilst the implementation is to proceed in an agreed set of steps the project is in essence a single overall project and shall be implemented to an agreed time scale without breaks.

5 CDM REGULATIONS 2015

The contractor shall note that this project shall be undertaken in accordance with the CDM Regulations:2015 and shall be responsible for the provision of an acceptable Construction Phase Health & Safety Plan. The successful contractor shall be appointed as the Principal Contractor.

All necessary documents and notifications shall be in place before work commences on site.

6 ASBESTOS MATERIALS

It is known that the external facia boards to the building contains asbestos. The condition of these facia board is good and there are no existing services that are attached to the boards.

Whilst the boards could remain if un disturbed the Trust intend to undertake a removal of the contaminated materials and their replacement with new facia boards prior to the commencement of the planned electrical works described in this document.

However, due to the age and nature of the switchgear in the room it is considered likely that some asbestos materials will be present in the switchgear. These will be small scale and shall be removed from site and disposed of in a safe and approved fashion.

The contractors operatives shall all have recent asbestos awareness training certification and shall be responsible for reporting any other suspicious materials (if found).

7 CONTRACTORS CO-ORDINATION

The contractors shall include for the close co-ordination of the technical requirements set out in this tender. The contractor shall include for full site co-ordination with the Estates Engineers regarding the progress of the works, shut downs, and disruptions to parking areas for delivery's and the like.

All works shall be accompanied by a full and detailed Risk Assessment and Method Statement (RAMS). These documents shall include a site specific set of accurate details such as planned switching schedules for outages, safety padlocks and precautions for back-feed and by pass supplies plus arrangements for plant handling, off-loading and road way management etc.

8 REPLACEMENT LV SWITCHBOARD

The existing 1250Amp rated LV switchboard is to be replaced with a new floor standing front access 800Amp rated switch panel. This equipment is to be installed in the same location as the existing whilst the existing supplies are being maintained by alternative feeds and local generators.

More details of the electrical support works required before the installation of the new equipment and the phasing of the works are included elsewhere in this document. This section just details the requirements of the board alone

The contractor shall allow for the procurement, delivery, offloading, placement and fixing in room (including builders work), commission and testing of panel, and connection of supplies. The contractor should take particular note that the provision and delivery of the switch panel forms part of the phased programme for this project. The client will not be liable for payment of the equipment until delivered to site.

The new switchboard shall be provided to the following specification:-

- ✓ Environmental protection to IP 42 (BS EN 60439-1).
- ✓ Form Rating to Form 4b Type 6 [Group mounted] (BS EN 60529).
- ✓ Fault rated at 50kA for 1 sec minimum.
- ✓ Busbars hard drawn high conductivity copper air insulated.
- ✓ Cable entry from above (Incoming supplies).

- ✓ Cable exit to below and above (Outgoing circuits)
- ✓ Front cabling access to devices.
- ✓ Main transformer incomer MCCB – Fixed type O/C & E/F relays.
- ✓ Other devices fixed MCCB type (adjustable thermal magnetic O/L).
- ✓ Surge protection to BS EN 61643 to be provided to panel fitted as close as possible to the incoming breaker[1]
- ✓ Multi function metering with Modbus connectivity to be provided to all ways populated with devices as per the schematic.
- ✓ Multi function metering with Modbus connectivity to be provided to incomer device
- ✓ Ventilation – natural.
- ✓ All labels to be engraved type (black on white).

The switchgear shall be complete with appropriate gland plates to suit the cable types proposed and shall be fitted with identity labels and the multifunction meters to have Modbus connectivity.

A new section of rubber insulated safety matting is to be provided in front of the switchgear.

8.1 Switchboard Procurement

The contractor shall include all costs associated with the overall procurement of the switchboard as detailed in this specification. The panel shall be as provided by Schneider their Style E arrangement. The following suppliers are client approved:-

- ✓ Lostock Ltd.
- ✓ B&S Group Ltd.
- ✓ Carville Switchgear.

The contractor may obtain alternative quotations from other panel builders for submission provided the equipment supplied is fully compliant with this specification and utilises equipment that can be maintained correctly. Equipment not compliant is liable to rejection.

[1] Surge protection to type 1,2 and 3, parallel connection operation with clear visual display of protector status on switchboard front.

8.2 SWITCHBOARD LOCATION & SIZE

The new main LV switchboard shall be positioned in the modified LV switchroom of substation D. The equipment shall be positioned directly over the existing cable trench as shown on the tender drawings.

The contractor is to allow for the delivery to site, access through the building and erecting / fixing in the switch room.

9 MOBILE GENERATOR HOOK UP POINT

The contractor is to allow for the provision of a mobile generator hook up facility at the substation. The phased delivery plan shows the hook up to be installed as the final step and so the dimensions of the hook-up must be considered before the installation of the new main switch panel to ensure that sufficient space is allowed in the setting out.

The hook up unit shall have castell interlocks fitted between the two non-auto isolators to prevent both devices from being closed simultaneously. Access to the mobile generator hook up terminals shall only be possible with the mobile generator switch OPEN.

With the mobile switch OPEN all live connections in the hook up unit shall be segregated from the mobile generator terminals making it safe to connect a mobile generator whilst the fixed generator is running and on load.

Both switches in the hook up unit shall be rated at 400A and shall be 4 pole units to provide correct selection of the source neutral.

The hook up unit shall bear the label "Generator Selection Unit" and the devices shall be labelled "Fixed Generator" and "Mobile Generator".

10 SUPPORT BUILDERS WORKS

The contractor shall provide an inclusive tender package to incorporate all remedial builders work necessary to form a finished installation. The scope of works required shall be as listed below. All new builders work shall be to a standard to match the existing substation construction in all respects.

The existing building has a flat roof with a brick wall construction solid concrete floor.

The contractor shall ensure that all minor modifications to the cable trench through the substation are included for including supports to accept the new switchgear.

No cable trench covers are installed in the existing arrangement. The contractor shall include for the provision of new loose fitting chequer plate covers to prevent debris from entering the cables ducts.

10.1 DEMOLITIONS / TAKE DOWNS

- ✓ New fire escape door opening to be formed in LV switch room

10.2 REVISED DOORS

- ✓ New 44mm, 914mm timber stained external door with internal fire escape push bar release as new secondary fire exit from LV switch room.
- ✓ A 300X300 (lockable) swing flap shall be provided in the lower portion of the door to be used to pass the mobile generator flexible cables from the car park area into the substation. This flap shall be bolted shut from the inside of the door under normal conditions.
- ✓ Overdoor lintel to be provided on new external door openings to suit the door opening and building construction.

10.3 ENTRANCE STEPS

- ✓ New concrete access steps to be formed between the existing tarmac pathway and the entrance door to the LV switch room. Steps to have 280mm runs (min) with 200mm risers (max).
- ✓ Galvanised steel hand rail with posts shall be provided to the left hand side of the new stairs. These are to be 50mm diameter and bolted to the building and steps.

All builders work to be provided in a phased operation to suit the planned progress of the project.

11 SUPPORT ELECTRICAL WORKS

The contractor is to include for all sundry and temporary electrical works that shall be required to allow the main project to proceed as described. The scope of these electrical works shall be as detailed below:

11.1 MULTI CORE CABLES & TERMINATIONS

A redundant multi core controls cable termination frame box is installed on the end wall of the LV switchroom. 4 multicore cables and one conduit are connected to this box. The box and all associated cabling are to be disconnected and removed.

The cabling shall be stripped out from the substation (all three rooms) and cut back to the point of entry.

11.2 TRIPPING BATTERY

A redundant dc tripping battery and 230V power supply is fitted in the lv switch room. This unit and internal batteries are to be safely disposed of and all associated cabling shall be stripped out of the building.

11.3 FIRE ALARMS

No fire alarm systems are fitted in the room at this time. Simple heat detectors (tilt switch type) are fitted in the two HV rooms. These are to be removed.

11.4 TEMPORARY SUB-MAIN CONNECTIONS AND LINKS

The contractor shall allow for the provision of a temporary link cable to be installed between the old LV switchboard and the newer MCCB essential services MB/GEN. This is to be used on several occasions during the project to provide back feeds or by pass supplies to suit the work being undertaken.

This connection shall be provided as shown on the schematic diagrams but shall be securely **locked OFF** at both ends and shall be under the supervised control of an appointed competent person. This link shall only be energised following a safe method of working using an agreed switching schedule.

The link will comprise of a new 200A MCCB (Proteus) plus a 4 core 95mm XLPE/SWA/LSF cable. The cable is to be installed such that it does not obstruct future planned cable works and can be removed on completion of the works. It shall be of sufficient length so that it can be terminated on to both the existing AND the new LV panels during the various stages of the works.

Should the contractor wish to carry out the works in a different sequence to that described in this specification and this is no more disruptive to the operation of the hospital then any such cabling as may be required to suit this new sequence shall be deemed to be inclusive at no extra cost to the client.

11.5 LIGHTING & SMALL POWER

A 6 way SPN fuse board and a 2 way mcb 'garage unit' are fitted on the end wall of the LV switch room. The fuse board feeds local lighting and small power services in the substation and the garage unit feeds a set of street lights along Valley Drive

Both boards to be disconnected and all the existing internal services in the substation stripped out. The sundry small power and lighting systems shall be removed / re connected in a timely fashion to suit the overall project progress as shown on the tender drawings so that the new systems can be installed. The required new works are shown on the main drawings provided.

New replacement lighting and small power services shall be installed in all three rooms as shown on the tender drawings. This is detailed in the sections that follow.

12 TEMPORARY MOBILE GENERATOR

To suit the timing of the shut down operations the contractor shall allow for the provision of a temporary mobile generator to either provide an alternative supply or to act as secondary standby in the event of failure whist the new equipment or cabling is being installed and tested. This generator shall be a containerised unit complete with fuel storage, residential silencers, and flexible cables.

12.1 GENERATOR RATING

The generator shall be rated at 200kVA minimum based on stand-by rating factor. It shall be suitable for commercial loads with fully regulated output voltage and frequency.

12.2 FUEL CAPACITY

The generator shall be complete with a 48hour fuel reserve in built in the container or in an adjacent fuel pod. Re-fuelling of the generator if the unit is required to run due to mains or fixed generator outage failure shall be by the contractor but reimbursed through the contract. Fuel used by the generator running when the generator is used to provide alternative supplies during planned shut downs to carry out the works shall be at the contractors expense.

12.3 CONNECTIONS TO SWITCHGEAR

The contractor shall provide temporary flexible cable connections with the system during the project by connecting the temporary generator into the existing switchgear.

Temporary cables shall not be left trailing on the floor in an unsafe manner but shall be supported through the building or otherwise protected to avoid accidental damage or to avoid trip hazards.

12.4 DURATION OF GENERATOR SUPPLY

The contractor shall allow for the supply of the temporary generator and its availability on site to suit the programme and the requirements of the delivery plan.

13 CABLING SYSTEMS

The contractor shall include for all mains, control and earthing cabling required to provide a comprehensive installation as shown on the tender drawings. This shall be inclusive of trenching, builders work, containment, installation and termination.

13.1 INCOMING MAINS CABLING

The mains incoming cabling shall be replaced as part of this project in line with the phased work scope. Details regarding these circuits are given below.

The existing single core lead covered cables from the transformer will not be suitable for the new main panel. These are to be disconnected at the transformer cable box and removed.

To allow the new tails to be installed the existing LV cable box shall be removed and replaced with an air insulated box suitable with aluminium gland plate for the terminations of the new cables. The cable box shall be for top entry termination of the cables leaving the transformer. The replacement of the cable box will require the isolation (and earthing down) of the HV switch in the adjacent ring main unit.

All HV switching operations shall be performed by the client's authorised person by prior arrangement with 2 weeks' notice of dates and times.

New transformer tails shall be connected from the transformer terminals and installed through to the switch rooms up to the LV Panel. These shall be sized as shown on the drawings. The delivery plan provided shows this works in advance of the main switchgear replacement. This is to keep individual shut down period to a manageable time scale. The transformer tails will therefore require to be terminated into the old switchgear and then later re-terminated into the new switch panel.

The existing cabling is clipped direct to the ceiling using cables straps. New ladder racking shall be provided from the transformer bay to the switchroom. The integrity and strength of the ceiling is un confirmed so the contractor shall allow for the racking to be supported off the brick walls rather than by drop rods from the above.

New single core armoured cables shall be laid flat spaced by twice the cable diameter along the full length of the route. Trefoil arrangement is not necessary and will result in larger cables sizes being required.

13.2 MODIFICATIONS TO OUTGOING CABLING

All existing outgoing cabling from the existing main LV panel shall be modified and re-terminated to the new LV switchgear. All works shall be undertaken in a progressive and phased approach so as to:-

- ✓ Reduce the disruption to the hospital activities
- ✓ Co-ordinate with Estates staff recommendations and dates
- ✓ Keep shut off times to a minimum
- ✓ Carry out working in a safe and controlled fashion

The works are to be planned by the contractor in advance giving the Estates a minimum of 10 working days' notice of any intended shut downs. Shut downs to all clinical areas must be planned to be undertaken out of normal working hours with generator or mains alternative feeds provided .

In general (and where possible) the existing cables are to be shortened and re-terminated onto the new switch board. Where it is believed that this will not be possible this is indicated in the table at the end of this section.

Whilst short shutdowns for some circuits will be acceptable the majority will need to be carried out either out of working hours or with the additional cover of a temporary mobile generator to supply the load.

Final arrangements regarding the Trust's requirements shall be agreed on site as the works progresses. However the contractor shall allow for the provision of a 200kVA mobile generator to be on hire to suit the overall programme. This generator will be used to provide local connections at the Pinetum building to enable the cables to be isolated and moved from the old panel to the new whilst the load is supplied by the generator. Costs for this generator are to be shown where indicated in the summary of tender.

13.3 TEMPORARY CABLING INSTALLATIONS

In order to carry out the installation works as described in this specification and as shown on the drawings it will be necessary for the contractor to provide some temporary cable links and modifications to allow the works to proceed.

The contractor shall have included to provide all such installations in his tender offer.

The installation of temporary cabling shall be such that the installation is safe for use, and no danger is present in the building. Cables shall be supported but not fixed/cleated to the same standard as would be expected for permanent cabling.

13.4 NEW CABLING INSTALLATIONS

New outgoing circuits are necessary where the installation topography has changed. New circuits are indicated in the summary table below:

13.5 CABLING SUMMARY TABLE

Ref	Destination	cable	comments
1	Pinetum	1x4/c 240mm	Shortened / re-terminated
2	Moston Lodge	1x4/c 95mm	Shortened / re-terminated
3	St Johns Ambulance	1x4/c 35mm	Shortened / re-terminated
4	Local Dist. board	2x1/c 16mm PVC	Replaced
5	Martindale	1x4/c 95mm	No work required
6	Martindale (Cytox)	1x4/c 50mm	No work required
7	C/O to MB/GEN	1x4/c 95mm	Replaced
8	LV Panel to C/O	4x1/c 150mm	Replaced
9	Generator to C/O	4x1/c 150mm	Re-terminated

14 NEW FIRE ALARMS

The contractor is to allow for the provision of a new stand alone fire alarm installation for the substation building. This shall comprise of an open protocol conventional 2 zone fire alarm panel with manual and automatic detection, sounders and beacons as shown on the drawings.

The fire alarm installation shall confirm to BS 5839:2013 and shall be configured in two zones:

Zone 1 Substation building

Zone 2 Fixed generator canopy

Fire alarm cabling shall be carried out using FP200 soft skin fire rated cabling fixed direct to the building fabric using steel clips. Detection in the substation building is to be using optical smoke detection and detection in the generator canopy is to be by rate of rise heat detection. Manual call points in each room by the exit doors.

Internal and external fire sounders are to be provided with flashing red beacons provided externally at the front of the building plus adjacent to the generator.

The fire alarm system shall not be connected to inhibit the generator.

14.1 REMOTE MONITORING of FIRE ALARMS

The fault and fire conditions in the new fire alarm panel shall be remotely monitored by linking the new system with the existing fire alarm installation installed in the adjacent Moston Lodge building. This link shall be provided by the installation of a radio transmitter / receiver system and a suitable interface unit to connect to the Moston Lodge system.

Before the radio link system is installed the contractor shall provide a radio signal strength survey at the hospital. This survey is to ensure that the distance between the buildings (estimated at 80m) is consistent with a reliable radio link. The survey is to also verify that there are no forms of interference present that would adversely affect the radio link and to confirm the best locations for the aerials.

Assuming the radio survey is successful the link to the substation from Moston Lodge shall include the following:-

- Existing analogue addressable fire panel in Moston Lodge to be programmed to accept the radio link signal as a new zone on the fire panel.
- The new zone to be called "Substation D"
- Provision of transmitters and receivers and associated power supplies as necessary at both ends of the connection.
- The installation of external aerials on both buildings
- The provision of FP200 cabling and terminations at both ends between fire panel, transceivers and aerials.
- Radio system commissioning, testing and verification
- Moston Lodge fire panel / system re-commissioning following modifications
- Modification of Moston Lodge zone chart to include the new substation as a fire zone.

The Moston Lodge fire system is linked to the main Static Systems fire alarm system by a cable link. Fault or fire condition reported from Substation D shall be re-transmitted to the main hospital fire panel using the existing Moston Lodge link.

15 NEW LIGHTING & SMALL POWER

The new internal services and the retained street lighting services at the substation are all to be fed from a new three phase mcb distribution board fitted on the side wall of the LV switchroom as shown. This board shall be as manufactured by Schneider their Isobar 4 equipment with mcb, rcbo, labels, schedules and blank ways plus incoming isolator. The board shall be a 6 way TPN board complete with 125A incoming isolator and outgoing devices as shown on the schematic drawings.

The board shall feed the following new services:-

- ✓ Internal lighting (mains and emergency)
- ✓ External lighting with automatic dusk to midnight / 5am to dawn operation
- ✓ Background (tubular) heaters with thermostats
- ✓ 13 Amp sockets in each room
- ✓ Generator canopy lighting
- ✓ Fire alarm (& radio link) systems

In addition the board shall also be used to re-feed the street lighting along Valley Drive and the photo cell lighting controls that can be re-used.

Wiring for new lighting and small power services shall all be provided using single core LSF insulated cables run in steel galvanised conduit. Cable sizing as shown on the schematic.

On completion the board shall have an engraved legend showing board ref and source. A typed internal way schedule shall be provided showing circuit details giving cable sizes, protection details and circuit description.

15.1 LIGHTING

The contractor shall allow for a new lighting installation in the substation and adjacent generator compound and canopy.

New luminaires shall be as supplied by Thorlux their Thoroproof twin 58W T8 units as TP10414J.

Luminaires are to be fixed direct to ceilings / walls using conduit boxes fixed to the structure.

Where emergency fittings are shown these shall be provided by the provision of integrated battery / inverter packs to the fittings indicated on the tender drawings.

The existing bulkhead light fittings fitted externally are to be replaced with new combined mains / emergency bulkhead fittings. The contractor is to provide a Thorlux Mercian unit with 42W TC-T lamp and integral battery pack as type EMR 9955J.

New metal clad surface light switches shall be provided internally for each room. Key operated emergency test switches being provided as shown.

15.2 HEATING

Background heating is to be provided in the HV and LV rooms by the provision of new tubular heaters. These are to be as supplied by Dimplex their ECOT4FT (160W) with integral thermostatic control.

The heaters are to be fixed direct to the wall at a height of 400mm above the floor. Connection to the adjacent fuse connection unit by a heat resistant 3 core flex.

15.3 SMALLPOWER

The contractor shall provide surface mounted metal clad sockets (1 number) in each room as shown on the drawings. Sockets are to be 400mm above the finished floor and wired on a single ring main circuit. The ring main circuit shall have 30mA residual current protection as shown on the schematic drawings.

16 SUBSTATION (HV/LV) EARTHING

The main earth bar in the transformer room is linked to the HV switchgear, the transformer and the LV panel by copper tape. A stranded cable connection is also made to the earth bar via a disconnect link. This stranded cable is to an external earth nest arrangement.

No earth rod inspection chambers can be seen near the substation and the extents of the earth nest is unknown.

In order to verify the effectiveness of the earth nest the contractor shall include for the provision of an earth resistivity test of the existing substation earth. The substation earth cannot be disconnected whilst the substation is operative so this test must be carried out during phase 3 when the transformer is isolated.

The contractor shall carry out an onsite measurement of the existing earth rod installations. Earth resistivity tests for each of the earth rod positions shall be provided along with a total earth resistance measurement to ensure the overall system is below the 1 Ohm required to combine the HV and LV earthing systems.

The results shall be presented as an overall earthing report (as required in BS-EN50522:2011) indicating both the system earth impedance and the expected EPR (Earth Potential Rise) at Sub D based upon likely HV single phase to earth faults at the substation. Should the EPR exceed the limit of 430V then remedial measures shall be agreed to limit the rise to acceptable levels.

In addition to undertaking a resistance measurement of the existing earth nest the contractor shall also undertake a soil resistivity test to determine how many additional earth rods may be required to bring the EPR to less than 430V.

In order to incorporate some allowance for additional earth rods the contractor shall include for 4 new earth rods each driven 6m depth, spaced 12m apart with earth inspection chambers and interlinking bare 25x3mm copper tape.

The new earth system is to be connected to the earth bar in the transformer room. Should additional earth rods be necessary these shall be installed as a variation to the contract. If less than 4 rods are required then the cost shall be apportioned using the itemised cost in the summary of tender and the contract value reduced as necessary.

17 EARTHING AND BONDING

The Contractor shall be required to provide new earthing and main equipotential earth bonding conductors and connections to the new installations as indicated on the Tender Drawings. The whole of the system shall be earthed to the incoming supply cable in accordance with the requirements of the 17th edition of the Regulations for Electrical Installations (BS 7671). The impedance between the earthing point and part of the metal work of the installation shall not exceed 0.5 ohm.

The installation will be designed to give an earth loop impedance low enough to clear the protective devices under fault conditions. Tests for earth-loop impedance shall be made, and their values recorded on the testing sheets.

Main Earthing Point

The existing sub-station D main earth bar and electrodes shall be retained and re-used to serve the new LV panel. The main earth bar is in the transformer room. The neutral earth link for the system shall be provided within the new LV switch panel

Earth Nest

Existing substation earth nest to remain unchanged.

Earth Bonding

The earthing of all conduits, cables, boxes, fittings and exposed metal panels of the switchgear and associated equipment shall comply with the requirements of BS7671:2008 (IEE Wiring Regulations) and British Standard BS7430:2011 (Earthing).

The Contractor shall include for the provision of correctly sized earth bonding conductors and cables that shall be terminated to the equipment.

Connections to services shall be made by means of purpose made clamps and a metal tab worded "Safety Electrical Connection. Do Not Remove".

Main earth bonds shall be made to the following items:

- ✓ Generator engine, generator panel, (existing)
- ✓ LV Panel
- ✓ Mobile generator hook up panel
- ✓ Local dist. board

The installation will be designed to give an earth loop impedance low enough to clear the protective devices under fault conditions. Tests for earth-loop impedance shall be made, and their values recorded on the testing sheets.

The extraneous conductive parts of all separate metallic services shall be connected to earth. This shall include central heating, natural gas, water and exposed metallic parts of the building structure.

18 TESTING AND COMPLETION CERTIFICATES

The whole of the installation shall be inspected and witness tested on completion in the presence of the Contract Administrator.

The Contractor will provide the necessary labour, material and calibrated test instruments for carrying out these tests and shall give the Contract Administrator seven days notice of the date it is proposed to carry out the test.

19 OPERATING AND MAINTENANCE MANUALS

The Contractor shall provide Operating and Maintenance manuals and "As Installed" drawings for all the systems installed or modified as a part of this project.

Contractor shall:

- ✓ include full operating, servicing and overhaul instructions, diagrams and parts schedule with order reference for use with the switchgear and its mechanical and electrical parts.

- ✓ comprise properly bound, illustrated manuals.
- ✓ include all necessary cautionary notices to safeguard operatives.
- ✓ include three copies of each set of instructions and charts.

All information supplied shall be reproduced in paper format in ring binders, plus an electronic version supplied on disk containing both documents in .PDF format and full .DWG (AutoCAD) versions of drawings.

APPENDIX 1

Project Delivery Plan