SULTANATE OF OMAN

AUTHORITY FOR ELECTRICITY REGULATION

STANDARD OES-36

INDOOR DISTRIBUTION SUBSTATIONS

Contents

1 Introduction

This Oman Electrical Standard sets out requirements for indoor distribution substations. It covers minimum requirements for the location of the substation and space to be provided within the building. It addresses the requirement for unimpeded access for the placement and replacement of items of equipment during the life of the substation; the rights and obligations of those owning, constructing and using buildings containing substations; and those authorised to have on-going access for operational purposes, maintenance activities and for making connections to the substation. It also sets out the obligations on customers to ensure that the construction of substations in their buildings complies with the requirements of the Public Authority for Civil Defence and Ambulance.

2 Definitions

Customer	a Person who is Supplied with electricity at Premises for consumption at those Premises
HV	High Voltage
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IEC	International Electro-technical Commission
ISO	International Organization for Standardization
LV	Low Voltage
Network Operator	A licensed Distribution Operator or an exemption holder under the Oman Sector Law and Distribution Code
Public Authority for Civil Defence and Ambulance	The Authority in The Sultanate of Oman responsible for Civil Defence and Ambulance, in this context its responsibility for fire prevention
EMFs	Electric and Magnetic Fields

3 General

This Oman Electrical Standard applies to all indoor distribution substations and has been prepared to be fully compliant with the requirements of the Ministry of Housing, Municipalities, Network Operators, the Public Authority for Civil Defence and Ambulance and other relevant parties. The standard is divided into sections covering:

a) Substation Location and Access – specifying standard requirments for location, personnel and equipment access and the impact the substation has on its surrounding areas;
b) Space Requirements and Layouts – minimum space requirements for operator safety with example compliant layouts and criteria to be applied when these layouts cannot be achieved;
c) Construction – design and construction requirements for the substation to ensure access, operation and maintenance are not compromised; and
d) Electrical Design – detailing the electrical requirements and the method of construction inside the substation.

3.1 Precedence of Standards

In the case of any conflict of requirements the following order of precedence of documents and standards applies:

Oman Sector Law;
Oman Distribution Code;
Oman Electrical Standards;
Oman Directorate General for Specifications and Measurements Standards;
IEC & ISO Standards;
ANSI Standards, British Standards, DIN Standards; and
Other Internationally accepted Standards.

4 Co-ordination of building programme

Where a new or increased supply of electricty is required for a building the customer shall make an application to the Network Operator for the required electrical capacity.

Customers must ensure that they liaise with the Network Operator early in their design programmes to enable locations and layouts of necessary substations within the development to be agreed and incorporated into building plans, and for site works to be co-ordinated. The accommodation for low voltage switchgear, metering equipment, power factor correction equipment and any other items required by the customer or the network operator is to be confirmed at this early stage.

Construction drawings for the substation will be prepared by the Network Operator after the location and dimensions have been determined, such drawings will be based on this standard, good industry practice and drawings provided by the customer. Customers shall incorporate the Network Operator's construction requirements into their own drawings.

5 Substation Location and Access

A substation in a host building must be constructed with at least one of its boundaries on an outside wall of the building enabling underground cable access. The substation doors must be located in an outside wall and unobstructed vehicular access to them must be available 24 hours of every day of the year.

The substation location and access arrangements must be confirmed by all relevant parties before construction of the host building commences to ensure that future development of the site or surrounding land does not compromise the access provisions described in this Oman Electrical Standard.

5.1 Personnel Access and Egress

Substations in host buildings shall be located such that the Network Operator's authorised staff are able to gain access at all times without any dependence on building services staff.

The Network Operator will either provide door locks compliant with its standard locking system, or arrange to have an external key box fitted at the substation access door where a site-specific key is held, secured by a Network Operator's standard lock. This will restrict access to persons formally appointed by the Network Operator to gain access. No other person shall be allowed to either hold a key for the substation or enter the substation unless under the direct supervision of appropriately authorised Network Operator staff.

Every substation shall have at least two exit doors with unimpeded passages such that an operator can reach any exit door from any equipment operating position through a route of minimum width 750mm, free from any trip or other hazards.

5.2 Equipment Access

A vehicular accessible point at ground level must be provided to enable a crane to place substation equipment where it can be safely manoeuvred into position.

Where this access is not direct from a public highway, a level equipment loading area of minimum dimensions 2500mmx2500mm shall be provided. The loading area must have the same load bearing characteristics as the substation floor as detailed in Section 7.3.

5.3 Doors and Signs

5.3.1 Doors

Personnel access doors shall be provided, accessible by direct street access or using permanent, all-weather routes and shall always open outwards.

Doors shall be located and protected such that they cannot be obstructed by vehicles, equipment storage, site usage or any other means. Doors shall be protected from damage by vehicles using removable bollards or other effective means.

Locks and handles to suit the direction of opening as required by the Network Operator shall be provided. The locks shall be such that operation is by key only from the outside and by handle only from the inside.

Doors shall be provided with a ready means of securing them in the open position.

5.3.2 Signs

Durable, prominent signs shall be fixed on the outside of the substation doors to read:

Danger

THIS AREA MUST BE KEPT CLEAR AT ALL TIMES.

ACCESS TO ELECTRICAL DISTRIBUTION SUBSTATION

خطر

مدخل محطة توزيع كهرباء - يجب ترك هذه المنطقة خالية في جميع الأوقات

On the inside, the exit door shall be clearly labelled "**EMERGENCY EXIT – مخرج طوارئ**" and be fitted with a panic bar for emergency outward opening.

6 Space Requirements and Layout

The customer shall provide a realistic estimate of the maximum power requirements for the building in his application for a supply of electricity, in accordance with Section 4 of this Oman Electrical Standard.

The Network Operator will combine this requirement with his own network connection requirements for the substation, which will vary on a site by site basis, and will take into account, among other things, the existing distribution network at the location. Assumptions based on experience elsewhere must not be made.

Standard layout drawing no.: DWG/OES36/01 sets out an indicative layout for a substation containing a single 1000kVA transformer, one ring main unit and one low voltage feeder pillar. It provides for ducts into the substation for the Network Operator's cables; two high voltage and up to four low voltage entering / leaving the substation (with two spare ducts for high voltage and four for low voltage cables). It takes into account space requirements for changing the transformer in the event of fault / increased capacity and requirements for safe operator egress from operating positions at the ring main unit or low voltage feeder pillar.

Drawing nos.: DWG/OES36/02 and DWG/OES36/03 are also indicative and address the same criteria for sites with two and three transformers respectively.

Minimum ceiling height of the substation shall be 3000mm or 1000mm above the tallest item of plant, whichever is the greater.

The Network Operator will specify a substation layout applicable to the location.

For substations where one of the layouts in drawings nos.: DWG/OES36/01, DWG/OES36/02 and DWG/OES36/03 cannot be accommodated, or for substations requiring more than three transformers, site specific design proposals shall be developed by the Network Operator based on the following criteria and clearances:

Equipment shall be located with safety of the public and personnel working in the substation as a priority:

- HV and LV switchgear shall be positioned with operator positions as close as practicable to an exit door;
- There shall be a clear passage at least 750mm wide from each working position to all exit doors;
- A space of at least 1500 mm from the front of the high voltage and low voltage switchgear shall be allowed for safe operations; and
- All other clearances between items of equipment and between items of free standing equipment and the substation walls shall be at least 750mm to allow free air flow and safe replacement of any piece of equipment with the rest of the substation still energised.

7 Construction Requirements

The principal function of the substation is to accommodate and support the electrical equipment and ensure a safe environment for operational and maintenance staff who work within the substation and the safety of the general public.

Provision shall be made for the possible addition and/or alteration to the equipment including plant from other manufacturers.

Around the transformers the building shall be designed to retain integrity under a 10kN/m² ultimate overpressure load. The building shall be designed such that the catastrophic loss of a wall will not result in building collapse or collapse of structures above the substation.

7.1 External Appearance

Customers must liaise directly with the appropriate building permits department regarding acceptable external appearance of the substation, and ensure compliance with any requirements of the Public Authority for Civil Defence and Ambulance.

7.2 Walls and ceilings

7.2.1 Walls

The substation walls are to be concrete or solid masonry construction and must have sufficient structural strength to support any equipment and pulling eyes mounted on them.

7.2.2 Ceilings

It should not be necessary to suspend cables or other equipment from the substation ceiling. If in exceptional cases this does become necessary the ceiling structure and any load bearing fittings shall be designed for 1.5 times the heaviest item of equipment to be suspended from it in addition to any loads from above.

7.3 Floors

The substation floor, including position of trenches, ducts, cable trays etc. is to be formed in accordance with the Network Operator's drawings and specifications.

Floor(s) shall be designed to be capable of carrying a load 1.5 times the weight of the heaviest item of substation equipment to be installed on any four points, anywhere in the substation area.

The floor must have a level steel-trowelled finish.

If the substation floor is laid on natural or filled ground an appropriate waterproofing membrane is to be placed between the underside of the substation floor and the ground.

Services such as drains, sewers, piping or wiring are not permitted to pass through the substation, the ground below it, access passageways, ventilation ducts or the substation walls, floors or ceilings.

The substation enclosure must be free of encroachments into the floor and trench areas. Columns, beams and walls may occupy certain areas provided they do not conflict with locations for any equipment and their associated clearance requirements. Extra space may be required for the substation in order to cater for any encroachment.

Walls and Floors must be impervious to any spillage of mineral oil from transformers or switchgear.

7.4 Weather proofing

The area in which the substation is to be located shall be free from the risk of flooding and storm water damage and any drains provided must be to Omani best practice standards and kept in working order by the customer.

The proposal to build any substation must be supported by a flood risk assessment.

The siting of the substation with its floor level below the level of the building storm water system shall not be permissible.

The substation shall be constructed using reliable waterproof materials, waterproof construction methods and site drainage to protect the substation equipment against exposure to dampness and water throughout its life.

All necessary horizontal and vertical damp courses must be provided and the substation room shall have dry wall, floor and ceiling conditions before acceptance for installation of substation equipment.

Level actuated sump pumps may be required to be fitted by the customer if drainage is not adequate.

7.5 Pulling Eyes

Where required, anchors and/or pulling eyes are to be installed in the floor, walls or ceiling in the positions specified by the Network Operator and in a manner to achieve the working load specified.

Normal pulling eye requirements are as follows:

For cables - A single pulling eye cast into the substation floor.

For transformers - One or more pulling eyes cast in, or suitably anchored to, the floor or wall.

Pulling eyes must have a minimum working load of 1.5 times the heaviest expected load.

All anchors and pulling eyes shall be clearly and permanently stamped to indicate safe working load.

Pulling eyes located in floors shall be removable with the floor surface left level to avoid a trip hazard when pulling eyes are removed.

7.6 Cable access, ducts and trenches

7.6.1 Cable Access

A 3m wide, where practicable, and at no point less than 2m wide easement across any land not under public control, clear of all construction or other permanent obstruction is required for the installation and future maintenance of the Network Operator's underground cables associated with the substation.

7.6.2 Cable Ducts

The customer shall install ducts in accordance with OES 2 and any additional requirements of the Network Operator from the substation enclosure to 150mm beyond the property boundary. Bends shall have a minimum bending radius of 1800mm. All ducts shall be of material conforming to the requirements of OES 2 and the applicable Network Operator's Standards.

7.6.3 Cables inside substations

Cables inside the substation may either be routed to substation equipment via trenches or suitably supported on walls and across floors. Suitably supported busbar ducts may also be used on low voltage connections of higher current ratings.

Where cable trenches are used in substations trench walls must be able to support transformer loads applied to the substation floor within 300 mm of the cable trench. Trenches must be watertight and must not be connected to the outside drainage system.

Where cables are routed above floor level suitable trays or other supports shall be used. Where this is the case, the cables and their supports shall be designed not to create any tripping hazard in the substation and must avoid crossing egress routes from operating positions.

7.6.4 Cable Trench Covers

Trench covers manufactured of glass reinforced plastic (GRP) or other suitable material shall be provided and installed on all trenches. These covers must be constructed to support pedestrian traffic. Trench covers must be divided into sections weighing not more than 20 kg.

Trench covers shall be flush with the surrounding floor level and fitted to ensure negligible sideways movement.

7.7 Oil Containment

Where oil filled equipment is to be installed provision shall be made within the substation to contain any oil spillage in the unlikely event of a transformer or switchgear tank failure. Items of plant may be individually or collectively bunded to contain spillage. The containment must cater for 110% of the capacity of the largest oil containing item in each bunded area.

7.8 Fire protection

All substations shall comply fully with the requirements of Public Authority for Civil Defence and Ambulance for fire prevention and suppression. All indoor substations shall be designed to contain any products of a fire within the enclosure for a minimum period of 3 hours.

All separating walls, floors and ceilings between the substation and other parts of the building shall be constructed from non-combustible materials and constructed to provide 3 hour fire resistance.

Penetration of the 3 hour fire restraining walls shall be restricted to that which is absolutely essential. The 3 hour rating shall be maintained for any penetration of the walls, floors or ceilings for cables, pipes or other essential services (including internal sealing of busbar ducts) that have to pass through. Sealing the penetrations shall be achieved with materials demonstrated to satisfy the Public Authority for Civil Defence and Ambulance requirement to maintain the 3 hour rating.

All doors and frames shall have 3 hour fire resistance.

7.8.1 Additional precautions when oil filled equipment is installed

If any item of equipment filled with insulating oil is to be installed, Public Authority for Civil Defence and Ambulance requirements also call for a fire suppression system to be fitted.

In this case the designs shall demonstrate that the substation is capable of being sealed to the necessary level to ensure the fire quenching gases of fire suppression systems will be contained in the substation for a period sufficient to extinguish the fire. Segregated air conditioning systems or forced ventilation with fire dampers must be fitted if cooling is required in the substation. Provision shall be made for safe inspection and maintenance of each fire detection, alarm and extinguishing system installed.

7.9 Noise

The substation design shall comply with the requirements of Ministerial decision 79/94 (Issuing regulations for noise pollution control in public environment issuing regulations for noise pollution control in public environment).

Transformers emit a constant low-pitched hum and further consideration must be given to the residential occupancy of the building and proximity of residential buildings when planning substation locations to avoid public nuisance complaints.

In all cases transformers installed in substations inside buildings shall be stood on anti-vibration pads suitable for the weight of the transformer.

7.10 Ventilation

Substations shall be designed with suitable ventilation in order to dissipate heat losses from the electrical equipment and to ensure that the maximum ambient temperature of the substation does not rise above 50^{o}C with all transformers operating at 100% rating.

Customers shall provide calculations for each substation individually based on substation size, equipment installed, building construction and other site specific parameters to determine if natural ventilation is possible or forced ventilation is required.

7.10.1 Natural Ventilation

Natural ventilation by means of vermin and weather proof louvered vents, directly to outside air shall normally be provided. Vents shall be positioned to provide maximum ventilation to the transformer but not create additional fire risk external to the louvers.

7.10.2 Forced Ventilation

The Network Operator will be responsible for any forced ventilation system. The system, comprising fans, ducting, inlet and outlet vents and control systems may be required to be designed, supplied and installed by the customer.

Forced ventilation systems shall be designed so that the inlet air is drawn through the circulation fan and then blown over the transformers and not the other way around. The outlet shall be ducted independently and directly to open air with sufficient separation between outlet and inlet vents to prevent recirculation.

Fans must be installed inside the substation and all wiring contained within the substation.

All vents should be kept clear of pedestrian areas and must be located to prevent entry of noxious gases such as vehicle exhausts or other pollutants.

Designs must be submitted to the Network Operator for approval who may also require to check for adequate air flow before final approval.

All vents are to be fitted with fire dampers.

Overpressure control flaps on ventilation systems shall stop overpressure less than 10kPa venting out through ventilation. Ventilation systems shall be designed to resist/contain these pressures.

Substation ventilation ducts shall not contain any other services, give access to other portions of the host building or form part of the ventilation system for the host building.

8 Electrical Design

8.1 Interface points / customers equipment

No customer-owned equipment is allowed in the Network Operator's substation.

Provision for metering, the customer's main switchgear and distribution board must be accommodated in adjacent rooms.

The customer shall provide the main connection cables from the customer's incoming switchboard(s) to the substation. The Network Operator will connect or supervise the connection of the customer's distribution board to the supply point on the low voltage board or the low voltage terminals of the transformer. These cables will become the property of the Network Operator and the equipment ownership boundary will be the incoming connections to the customer's main switch(es). This is to be specified in the customer connection agreement.

The Network Operator and the customer shall each satisfy themselves that the requirements of OES - 4 clause 2.8 are complied with regarding isolation and protection of their own sections of the installation.

Where no protection exists between the Network Operators transformer LV terminals & the Customer's main switch: -

(i) The Customer shall provide a main switch with access covers to all chambers that can be locked to prevent access to any live equipment on the supply side of the outgoing terminals (load side) of the main switch.
(ii) The Network Operator shall apply locks to the locking points of all chambers for danger of death notices to be displayed on the locked equipment chambers.

To prevent excessive, potentially damaging and dangerous current flows through the customer's network the Network Operator shall ensure that where there is more than one point of supply to the same premises there shall be no means of making a parallel connection between them through any part of the customer's network.

Distribution transformers with ratings above 2000kVA are to be installed only following a site-specific study addressing low voltage side short circuit levels, connections, switchgear, fusegear and protection arrangements, which has been approved by the network operator.

The Network Operator will specify the lighting and power requirements for the substation including emergency lighting requirements. Under the connection agreement terms of supply the Network Operator may ask the customer to supply and install these requirements.

8.2 Earthing

A buried earthing electrode system in accordance with OES 4 and meeting the Omani Distribution Code requirements shall be installed.

The substation must be constructed on a stable foundation which bears on soil or the basement structure of the host building. Where the foundation bears on soil, the soil must be clear of any obstruction or rubble, which could interfere with the installation of the earthing electrode system through the substation floor.

Depending upon soil conditions and hence the extent of the earthing system required, earthing system electrodes may extend ten metres or more into the ground below the substation. If the substation is constructed on a suspended floor slab, the earthing system is to be installed at the lowest level of building excavation directly below the substation footprint.

The Network Operator's approved drawings will indicate the earthing system to be used, including the expected location and the number of electrodes to achieve the designed earthing resistance values. Until the earthing systems are installed and measurements taken the values cannot be confirmed and, in some cases, additional electrodes may need to be installed outside the substation area to achieve satisfactory earth resistance values. The entire earthing system installation shall be approved by the Network Operator prior to being covered. The customer shall give sufficient notice to indicate when this work can be carried out.

The customer shall ensure that the earthing system connections are brought through the floor into the substation.

All exposed metal work within the substation shall be electrically bonded to the earthing system. This includes metal doors and frames and reinforcing metalwork in the floor. All earthing connections will have a minimum cross sectional area of 70mm^2 copper.

If any part cannot be adequately bonded, it must be constructed from a suitable insulating material.

The customer shall provide a connection point to the floor reinforcing at a convenient location as advised by the Network Operator's representative.

8.3 Combined HV and LV earthing

The preferred earthing arrangement for indoor substations is a combined HV and LV earthing arrangement, with a combined resistance to earth not exceeding 1 ohm.

For measurement purposes, the earthing system is to be stand-alone, i.e. not be connected to the earth bar of any switchboard other than the earth bar inside the substation and not connected to the host building's reinforcing bars with the exception of reinforcing in the floor and walls of the substation enclosure itself which must be electrically separated from the remainder of the host building.

It must be separated by at least 5m from the host building's lightning protection earth connection.

The earth cable size shall be adequate for the maximum prospective short circuit level at the substation and in all circumstance no less than 70mm^2 copper.

8.4 Segregated HV and LV earthing

If the requisite resistance to earth value for a combined HV and LV earthing system cannot be achieved, separate HV and LV earthing systems, each having a resistance to earth of not more than 10 ohms shall be installed. In this case, the LV neutral earthing system shall be insulated and separated electrically by a distance of at least 3m from the HV substation earthing system (bonded metal doors, exposed metal, reinforcement, HV cable screen earth, etc).

The HV and the LV earthing systems must be separated by at least 5m from the host building's lightning protection earth connection.

8.5 Electric and Magnetic Fields (EMFs)

The substation shall be designed such that EMF levels remain within the ICNIRP maximum recommended exposure levels at the substation boundary.

The typical substation layouts associated with this standard achieve ICNIRP requirements with current equipment specifications purchased by Network Operators.

If additional EMF shielding is considered necessary the customer shall appoint an approved EMF consultant to determine the extent of any additional shielding.

Installation of any proposed shielding shall be subject to the Network Operator's acceptance.

SULTANATE OF OMAN

AUTHORITY FOR ELECTRICITY REGULATION

STANDARD OES-36

DISTRIBUTION SUBSTATIONS INSIDE BUILDINGS

User Notes of Guidance

Contents

1 Introduction

These user notes of guidance explain the background to some of the requirments of Oman Electrical Standard (OES) 36 and are aimed at helping all of those who through their work have to refer to or comply with OES 36.

Oman Electrical Standard OES 36 sets out the requirements for distribution substations operated by Licencesed Network Operators which, due to shortages of suitable sites in urban areas, have to be located within customers' premises.

OES 36 sets out specified requirements for the location of the substation and the space that must be provided within the building footprint to ensure adequate supplies of electricty can be made available to the building and to connect to the local distribution network. It further goes on to address the essential requirement for unimpeded access for delivering items of plant during the life of the substation and the critcal importance of 24 hour acess for operational staff.

It also sets out the obligations on Developers to ensure that the construction of substations in their buildings complies withthe requirments of the Public Authority for Civil Defence and Ambulance (PACDA).

One of the prime objectives of OES 36 is ensuring the safety of those who occupy the building in which the substation is placed, the general public and the Network Operator's Staff who are required to operate in the substation to maintain supplies of electricty to the building and its surroundings.

2 Definitions

Section 2 contains some definitions of terms that appear in the standard, some of which may be unfamiliar outside the electricity supply sector.

Customer	a Person who is Supplied with electricity at Premises for consumption at those Premises
HV	High Voltage
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IEC	International Electro-technical Commission
ISO	International Organization for Standardization
LV	Low Voltage
Network Operator	A licensed Distribution Operator or an exemption holder under the Oman Sector Law and Distribution Code
Public Authority for Civil Defence and Ambulance	The Authority in The Sultanate of Oman responsible for Civil Defence and Ambulance, in this context its responsibility for fire prevention

3 General

Section 3 describes the layout of the OES document and theses Notes of Guidance, which follow the same format.

OES 36 is split into sections covering:

a) Substation Location and Access – understanding the impact the substation has on its surrounding area. This section should be used by those who have to plan the substation and negotiate the substation location. It includes requirements for personnel and equipment access.
b) Space Requirements and Layouts – typical layouts of a variety of substations which can be used as a guide when allocating space requirements for the substation.
c) Construction – construction and design requirements ensuring the substation is well built to ensure access, operation and maintenance is not compromised. This shall be referred to by the customer and the customer's representatives when constructing and maintaining the substation.
d) Electrical Design – detailing the electrical equipment and the method of construction inside the substation.

Actual construction drawings for the substation will be created by the Network Operator after the location and dimensions of the substation have been determined. They will be based on construction and site drawings provided by the Developer. The Developer shall incorporate the Network Operator's construction requirements into his own drawings.

4 Co-ordination of building programme

Section 4 sets out the importance of making early contact with the appropriate electricity Network Operator sufficiently early in the building works design and construction programme. This is to ensure that there are no unnecessary delays introduced as a result of poor communication or misunderstanding and to avoid any unnecessary costs being incurred through building works not making adequate provision for the substation.

A key issue in urban development is adequate planning for utilities and services and the allocation of land or space that meets the utility provider requirements without later encroachment into space allocated for other purposes.

It is important that Developers liaise with the Network Operator early in the design and construction programme to enable locations and layouts to be agreed and incorporated into building plans, and for site works to be co-ordinated in the programme in a timely manner. This will avoid any structural development that conflicts with, or prevents, development of the substation. Failure to liaise with the Network Operator sufficiently early may potentially result in unnecessary delays in making electricity supplies available to building.

The distribution Network Operator will require a minimum period of six months to obtain the necessary statutory consents and agreements from the first request for a supply of electricity to premises, particularly when a new substation is required. In some cases this may take longer. Where substations are to be sited inside buildings the time required to obtain the site will be reduced and Developers are able to assist in ensuring this part of the process meets their own milestones.

5 Substation Location,Access

Section 5 is about:

a) Ensuring that the substation is built so that essential connection via underground cables can be made between the substation equipment and the local electricity distribution network.
b) Ensuring that 24 hour access is available to maintain and repair the substation equipment.
c) Ensuring safe 24 hour personal access for the Network Operator's authorised staff for immediate system operational needs.

Any electricity substation placed in a building must have at least one of its boundaries on an outside wall of the building. There are of necessity underground cables from the local distribution network that have to be brought into the substation below ground level for connection to equipment. The number of cables will vary depending on site specific circumstances, including the amount of power required by the new building and existing electrical infrastructure in the area.

Also, there must be on-going 24 hour unobstructed vehicular access to the substation doors, to enable the Network Operator to carry out routine and emergency operations without delay.

The substation location and access arrangements must be agreed and confirmed by all concerned parties before construction commences. This is to ensure that future development of the site or surrounding land does not compromise the access provisions described in sections 5.1 and 5.2 of OES 36 and thereby impact on the Network Operator's ability to respond promptly if electricity supplies were lost and operations were required in the substation.

5.1 Personnel Access and Egress

Access to substations by authorised personnel may be required at any time throughout the 24 hour period and substations in buildings must be arranged such that the Network Operator's authorised staff are able to gain access at all times without being delayed at security points or having to rely on building services staff availability for keys.

For reasons of safety, access to high voltage electricity substations has to be restricted to people appointed by the Network Operator as authorised persons under their appropriate safety rules. There can be no compromise to this requirement. In liaison with the Network Operator, Developers must ensure that the building is designed and constructed such that there is no requirement for anyone to enter the substation for the purpose of running or maintaining the building.

Nobody other than persons authorised in writing by the Network Operator may be allowed to hold a key for the substation or enter the substation unless under the direct supervision of such an authorised person.

To ensure these access requirements the Network Operator will either provide door locks that are part of its standard locking system, or arrange to have an external key box fitted at the substation access door where a site specific key is held, secured by the Network Operator's standard lock.

The Network Operator will be responsible for designing the substation so that it has at least one unimpeded means of exit to allow a person to reach the exit door by a suitable route in an emergency. The shape and dimensions of the substation will have to allow for such a design to be prepared. Building owners and occupiers will retain an obligation to ensure that none of their ongoing works, operations or other activities block such emergency exits.

The Developer will be required to specify and install as part of his works the appropriate locks, handles and panic bars to suit the direction of opening required by the Network Operator. For safety reasons, locks will be key only operation from the outside and a hand only from the inside.

5.2 Equipment Access

Access is required directly from a vehicular accessible point at ground level so transformers (the heaviest and largest item in the substation) and other equipment can be placed outside the substation by crane, then winched into final position on temporary skids or wheels. Physically this arrangement has to allow for a delivery vehicle (typically a flat bed vehicle with its own crane) to drive sufficiently close to the substation access to place an item of plant weighing up to 7500kg in a suitable position such that it can then be manoeuvred into the substation using winches.

5.3 Doors and Signs

5.3.1 Doors

For reasons of operational efficiency and safety of personnel, access doors need direct street access or to be accessible using permanent all weather routes. All weather routes need to take into account the severe and sudden flood conditions that can occur in Oman.

Pedestrian access doors must always open outwards allowing panic bars to be installed inside such that an unhindered exit is possible in case of emergency.

Doors shall be located and protected such that they cannot be obstructed by vehicles, equipment, storage, site usage or any other means. The doors must be protected from damage by vehicles either by removable bollards or other effective means.

5.3.2 Signs

The Developer shall affix a prominent notice on the outside of the doors to read:

Danger

THIS AREA MUST BE KEPT CLEAR AT ALL TIMES.

ACCESS TO ELECTRICAL DISTRIBUTION SUBSTATION

خطر

مدخل محطة توزيع كهرباء ـ يجب ترك هذه المنطقة خالية في جميع الأوقات

The exit door shall be clearly labelled "**EMERGENCY EXIT - مخرج طوارئ**" on the inside and be fitted with a panic bar for emergency outward opening.

6 Space Requirements and Layout

Section 6 is about space planning to allocate sufficient floor area for the substations and to ensure safe layouts are created within the substation. Close liaison with the Network Operator will be essential.

The size and shape of the of the substation will be dependent upon the equipment to be installed, which in turn will be largely dependent upon the maximum power requirements (MPR) of the building. It is therefore in the interest of the Developer to be realistic from the outset regarding his maximum power requirements, which are frequently over estimated.

The Network Operator will then consider the additional power demand on the substation, along with its requirements for out-feeds from the substation, for its own network requirements. This will vary on a site by site basis and will take into account, among other things, the existing network configuration and capacity at the location. This will vary on a case by case basis and Developers should not make assumptions based on experience at other locations as this could be misleading and result in additional costs.

Standard layout drawing no.: DWG/OES36/01 sets out a standard layout for a substation containing a single 1000kVA oil filled transformer, one ring main unit and a low voltage feeder pillar. It provides ducts for four Network Operator high voltage cables and eight Network Operator low voltage cables entering / leaving the substation. It also takes into account space requirements for changing the transformer in the event of fault or increased capacity and provides for safe operator exit from operating positions at the ring main unit or LV pillar.

Drawing no.: DWG/OES36/01 applies the same criteria for a substation with a dry type transformer and non-oil switchgear.

Drawings nos.: DWG/OES36/02 and DWG/OES36/03 apply the same criteria on a modular basis to increasing numbers of transformers installed. Variations to these layouts may be acceptable based on location and shape of available space, provided they meet the minimum criteria of the OES and are approved by the Network Operator as acceptable from a safety point of view for connection to his network. In these cases the Developer will have to present his own layout proposals for approval.

Site specific designs must take into account the following requirements:

Equipment shall be located with safety of personnel working in the substation as a priority:

- The high voltage and low voltage switchgear shall be positioned with operator positions as close as practicable to the exit door, with a clear passage at least 750 mm wide from each operator position to the exit door.
- An operating position space of at least 1500 mm from the front of the high voltage and low voltage switchgear shall be allowed for safe operations.

- All other clearances between items of equipment and equipment and walls where there are free standing items of equipment shall be at least 750 mm to allow free air flow and safe replacement of any piece of equipment with the rest of the substation still energised.

The following typical equipment sizes are for guidance only and need to be confirmed with the Network Operator on a site specific basis where standard layouts are not proposed:

- Typical size of 1000kVA oil filled transformer 2000mmx 2000mm
- Typical size of 1000kVA dry type transformer 1400mm x 2300mm
- Typical size of 2000kVA oil filled transformer 2000mmx 2400mm
- Typical size of 2000kVA dry type transformer 1500mmx 2700mm
- Typical size of oil/gas/vacuum ring main unit 800 x 800
- Typical size of low voltage switchboard/fuse board/feeder pillar1500 x 600

As a guide for space planning, these items generally come in a number of groups, each group consisting of transformer, ring main unit and low voltage fuse board, but will vary with individual site circumstances.

7 Construction Requirements

Section 7 is about the construction requirements of the substation and the requirements for incorporating substations into the host building. The principal function of the substation is to accommodate and support the electrical equipment and ensure a safe environment for operational and maintenance staff who work within the substation and the safety of the general public.

7.1 External Appearance

The Network Operator has no specific requirements for the external appearance of the substation provided that otherwise the substation complies in all respects with OES 36, particularly access doors, ventilation requirements (where applicable) and necessary substation labels and danger notices that have to be fixed to external doors.

Developers are advised that they must liaise directly with Municipality building permits departments regarding acceptable external appearance and nothing in the OES 36 or these notes of guidance may be taken as approval of their proposals for external appearance.

7.2 Walls and ceilings

7.2.1 Walls

The walls of the substation are expected to be part of the fabric of the main building and are likely to have been built to higher structural loading requirements than the substation demands. For clarity, the substation walls are to be concrete or solid masonry construction and must have sufficient structural strength to support the weight of any equipment mounted on them, in addition to any structural demands of the building itself. Walls also constitute a key element of

the fire separation requirements set by PACDA and must be built from suitable materials. Concrete and solid masonry will achieve this.

7.2.2 Ceilings

It should not be necessary to suspend cables or other equipment from the substation ceiling. If in exceptional cases this does become necessary the ceiling structure and any load bearing fittings shall be designed for 1.5 times the heaviest item of equipment to be suspended from it in addition to any loads from above.

7.3 Floors

The substation floor, including position of trenches, ducts, cable trays etc. is to be formed in accordance with the Network Operator's drawings and specifications, which will include all layout requirements.

Floor(s) shall be designed to be capable of carrying a load 1.5 times the weight of the heaviest item of substation equipment to be installed on any four points, anywhere in the substation area. The requirement for the weight to be taken on four points allows for a transformer of any dimensions on four casters to be installed in the substation. The 1.5 factor allows for future increase in transformer capacity should this become necessary.

The floor must have a level steel-trowelled finish to prevent any tripping hazard and to permit easy cleaning of any spillages. Walls and Floors must be impervious to any spillage of mineral oil from transformers or switchgear.

If the substation floor is laid on natural or filled ground an appropriate waterproofing membrane is to be placed between the underside of the substation floor and the ground.

Services such as drains, sewers, piping or wiring are not permitted to pass through the substation, the ground below it, access passageways, ventilation ducts or the substation walls, floors or ceilings.

The substation enclosure must be free of encroachments into the floor and trench areas. Columns, beams and walls may occupy certain areas provided they do not conflict with locations for any equipment and their associated clearance requirements. Extra space may be required for the substation in order to cater for any encroachment.

7.4 Weather proofing

The area in which the substation is to be located shall be free from the risk of flooding and storm water damage and any drains provided must be to Omani best practice standards and kept in working order by the Developer. This requirement is expected to present no additional issues for the Developer who will want to keep his building free from floods in any case. Electricity substations have a particular requirement to be kept free from flooding as there can be serious effects due to electrical equipment being submersed and the time to repair and restore electricity supplies will be significant if the substation should suffer flood damage.

The proposal to build any substation must be supported by a flood risk assessment, identifying the likely flood level return period and mitigation measures taken to protect the substation,

which may require level actuated sump pumps to be fitted by the Developer if drainage cannot be demonstrated as adequate.

The siting of the substation with its floor level below the level of the building storm water system is not permissible.

The substation shall be constructed using reliable waterproof materials, waterproof construction methods and site drainage to protect the substation equipment against exposure to dampness and water throughout its life.

All necessary horizontal and vertical damp courses must be provided and the substation room shall have dry wall, floor and ceiling conditions before acceptance for installation of substation equipment.

7.5 Pulling Eyes

The Network Operator may specify that anchors and pulling eyes are required in a substation. This requirement is particularly likely in an indoor substation inside a host building where access for plant delivery is at the minimum requirement and provision has to be made for winching heavy items into position.

Where required, anchors and/or pulling eyes are to be installed in the floor, walls or ceiling in the positions specified by the Network Operator and in a manner to achieve the working load specified.

Normal pulling eye requirements are as follows:

For cables - A single pulling eye cast into the substation floor.

For transformers - One or more pulling eyes cast in, or suitably anchored to, the floor or wall.

Pulling eyes must have a minimum safe working load of 1.5 times the heaviest expected load to allow for future changes and replacement with items of increased capacity and weight.

All anchors and pulling eyes shall be clearly and permanently stamped to indicate safe working load.

Pulling eyes located in floors shall be removable with the floor surface left level to avoid a trip hazard when pulling eyes are removed.

7.6 Cable access, ducts and trenches

7.6.1 Cable Access

Developers must be aware that to provide a route for high and low voltage cables into the substation the OES requires a 2m wide easement across any land not under public control, clear of all construction or other permanent obstruction for the installation and future maintenance of the Network Operator’s underground cables associated with the substation. Developers will be required to grant in perpetuity this easement for a route into the substation which will require access at any time to excavate and divert, maintain or repair the underground cables as required. Developers are advised that it will not be permissible to cover the easement with any permanent structures that could prevent access to the cables.

7.6.2 Cable Ducts

The Developer shall install ducts in accordance with OES 2 and any additional requirements of the Network Operator from the substation enclosure to 150mm beyond the property boundary. Bends shall have a minimum-bending radius of 1800mm to cater for all cable sizes. All ducts shall be of material conforming to the requirements of OES 2 and the applicable Network Operator's Standards. The minimum number of ducts to be installed is four for high voltage cables and eight for low voltage cables.

7.6.3 Cables inside substations

Inside the substation the cables are required to be connected to the substation equipment and follow a route between the point of entry and the equipment that does not create any hazard to operators inside the substation. Suitably supported busbar ducts may also be used on low voltage connections of higher current ratings.

Cables inside the substation may either be routed to substation equipment via trenches or suitably supported on walls and across floors.

Where cable trenches are used in substations trench walls must be able to support transformer loads applied to the substation floor within 300 mm of the cable trench. Trenches must be watertight and must not be connected to the outside drainage system.

Where cables are routed above floor level suitable trays or other supports shall be used. Where this is the case, the cables and their supports shall be designed not to create any tripping hazard in the substation and must avoid crossing egress routes from operating positions.

7.6.4 Cable Trench Covers

Trench covers manufactured of glass reinforced plastic (GRP) or other suitable material shall be provided and installed on all trenches. These covers must be constructed to support pedestrian traffic. Trench covers must be divided into sections weighing not more than 20kg. Suitable materials will be of non-conductive material, and the weight limit permits removal and replacement by one person without causing any electrical hazard.

Trench covers shall be flush with the surrounding floor level and fitted to ensure negligible sideways movement, a 75mm recess at the trench lip is expected to achieve this.

7.7 Oil Containment

"Where oil filled equipment is to be installed provision shall be made within the substation to contain any oil spillage in the unlikely event of a transformer or switchgear tank failure. Items of plant may be individually or collectively bunded to contain spillage." This is a requirement of the OES to prevent mineral insulating oil becoming a pollutant into drains, water courses or the ground beneath the substation. It is becoming less frequent to install oil filled equipment as modern designs of switchgear and transformers do not use oil as an insulating medium. However, there are still designs available using oil and these may have to be used in certain

circumstances. The containment for oil spillage must be adequate in area and position to catch the majority of oil in the case of failure and sufficient in volume to cater for 110% of the capacity of the largest oil containing item in each bunded area.

7.8 Fire protection

The requirements regarding fire prevention and for suppression are PACDA requirements. The requirement to provide three hour fire separation is to ensure that different sections of the building are compartmentalised as far as fire is concerned, and that a fire in any location will be retained there for the minimum period stated allowing PACDA time to respond and control the fire to prevent further spread. To assist this, where flammable materials are used or installed PACDA require fire suppression systems of an approved (by PACDA) type to be installed (see Section 7.8.1 below)

PACDA must be informed of the intention to build a substation inside a building and have the opportunity to give final approval to the design before the substation is commissioned.

Developers are advised to seek advice from PACDA early in their building programme to avoid any delays or abortive works.

7.8.1 Additional precautions when oil filled equipment is installed

In a substation, flammable material generally means electrical insulating oil. If any item of equipment filled with insulating oil is to be installed, Public Authority for Civil Defence and Ambulance requirements also call for a fire suppression system to be fitted.

In this case the designs shall demonstrate that the substation is capable of being sealed to the necessary level to ensure the fire quenching gases of fire suppression systems will be contained in the substation for a period sufficient to extinguish the fire. Segregated air conditioning systems or forced ventilation with fire dampers must be fitted if a cooling system is required in the substation. Provision shall be made for safe inspection and maintenance of each fire detection, alarm and extinguishing system installed.

7.9 Noise

The OES requires that the substation design shall comply with the requirements of Ministerial Decision 79/94 (Issuing regulations for noise pollution control in public environment issuing regulations for noise pollution control in public environment).

This Ministerial Decision is mandatory and must be observed but also it is the minimum standard expected.

Developers may wish to take into account that transformers emit a constant low-pitched hum and further consideration must be given to the residential occupancy of the building and proximity of residential buildings when planning substation locations to avoid public nuisance complaints. Developers should be aware that if the noise level does comply with Ministerial Decision 79/94 then the Network Operator is unlikely to be able to take any further steps and that any objections from residents or building users may be expected to rest with Developers.

7.10 Ventilation

Substations are to be designed with suitable ventilation in order to dissipate heat losses from the electrical equipment and to ensure that the maximum ambient temperature of the substation does not rise above 50^{o}C with all transformers operating at 100% rating. Transformers and other electrical equipment in the substation are designed for a maximum working temperature of 50^{o}C.

In addition to the base requirements specified in the OES Developers are required to provide calculations for each substation individually based on substation size, equipment installed, building construction and other site specific parameters to determine if natural ventilation is possible or forced ventilation is required.

7.10.1 Natural Ventilation

Natural ventilation by means of vermin and weatherproof louvered vents, directly to outside air shall normally be provided. Vents shall be positioned to provide maximum ventilation to the transformer but not create additional fire risk external to the louvres.

7.10.2 Forced Ventilation

The Network Operator will be responsible for any forced ventilation system. The system, comprising fans, ducting, inlet/outlet vents and control systems may be required to be designed, supplied and installed by the Developer.

Forced ventilation systems shall be designed so that the inlet air is drawn through the circulation fan and then blown over the transformers and not the other way around. The outlet shall be ducted independently and directly to open air with sufficient separation between outlet and inlet vents to prevent recirculation.

Fans must be installed inside the substation and all wiring contained within the substation.

All vents should be kept clear of pedestrian areas and must be located to prevent entry of noxious gases such as vehicle exhausts or other pollutants.

Designs must be submitted to the Network Operator for approval who may also require to check for adequate air flow before final approval.

All vents are to be fitted with fire dampers.

Overpressure control flaps on ventilation systems shall stop overpressure less than 10kPa venting out through ventilation. Ventilation systems shall be designed to resist/contain these pressures.

Substation ventilation ducts shall not contain any other services, give access to other portions of the host building or form part of the ventilation system for the host building.

8 Electrical Design

Section 8 of OES 36 covers electrical design issues which are fully under the control of the Network Operator but on which the Developer will need to liaise during the design and construction phase. The Section is to ensure that the Network Operator is provided with a substation, which can be safely operated and provides safe supplies of electricity to the building and the distribution network.

8.1 Interface points / customers equipment

No customer-owned equipment is allowed in the Network Operator's substation as for safety reasons access cannot be granted for maintenance. Hence, provision for metering, the customer's main switchgear and distribution board must be accommodated in adjacent rooms.

The connection between the Network Operator's equipment and the customer's main switchgear has to be supplied by the Developer to a specification approved by the Network Operator. Developers should seek guidance from the Network Operator on the specification required at a location before commencing installation.

The Network Operator will connect or supervise the connection of the customer's distribution board to the supply point on the low voltage board or the low voltage terminals of the transformer, depending upon the electrical protection and isolation system adopted at the site. These cables will become the property of the Network Operator and the equipment ownership boundary will be the incoming connections to the customer's main switch(es). This is to be specified in the customer connection agreement.

The Network Operator and the Developer shall each satisfy themselves that the requirements of OES - 4 clause 2.8 are complied with regarding isolation and protection of their own sections of the installation.

A particular area that requires liaison and agreement between the Developer and the Network Operator is the following requirement in the OES

"Where no protection exists between the Network Operator's transformer LV terminals & the Developer's main switch: -

(i) The Developer shall provide a main switch with access covers to all chambers that can be locked to prevent access to any live equipment on the supply side of the outgoing terminals (load side) of the main switch.

(ii) The Network Operator shall apply locks to the locking points of all chambers for danger of death notices to be displayed on the locked equipment chambers.

To prevent excessive, potentially damaging and dangerous current flows through the customer's network the Network Operator shall ensure that where there is more than one point of supply to the same premises there shall be no means of making a parallel connection between them through any part of the customer's network."

Distribution transformers with ratings above 2000kVA are to be installed only following a site-specific study addressing low voltage side short circuit levels, connections, switchgear, fuse gear and protection arrangements, which has been approved by the Network Operator.

The Network Operator will specify the lighting and power requirements for the substation including emergency lighting requirements. Under the connection agreement terms of supply the Network Operator may ask the Developer to supply and install these requirements.

These are essential safety requirements that demand close co-operation between Developer and Network Operator.

8.2 Earthing

The purpose of earthing is to ensure that potentially dangerous voltages cannot become present on metal work in substations and to enable protective systems to detect excess current in the event of a fault developing and then operate to disconnect electricity supplies. This is a key safety feature.

The earthing requirements when a substation is installed inside a building are exactly the same as for a substation situated outdoors or in its own free standing building.

A buried earthing electrode system in accordance with OES 4 and meeting the Oman Distribution Code requirements has to be installed.

The key issue is for Developers of buildings containing a substation to liaise closely with the Network Operator during construction as the earthing installation will need to be installed, inspected and tested during the building works, and before it is covered.

The earthing installation requirements will have a large dependency on soil conditions at the site and this will require measurements to be taken at various stages during the installation of the earthing conductors.

Depending upon soil conditions and hence the extent of the earthing system required, earthing system electrodes may extend ten metres or more into the ground below the substation. If the substation is constructed on a suspended floor slab, the earthing system is to be installed at the lowest level of building excavation directly below the substation footprint.

The standard requires that the substation is constructed on a stable foundation which bears on soil or the basement structure of the host building. Where the foundation bears on soil, the soil must be clear of any obstruction or rubble, which could interfere with the installation of the earthing electrode system through the substation floor.

The Network Operator’s approved drawings will indicate the earthing system to be used, including the expected location and the number of electrodes to achieve the designed earthing resistance values. Until the earthing systems are installed and measurements taken the values cannot be confirmed and, in some cases, additional electrodes may need to be installed outside the substation area to achieve satisfactory earth resistance values. Developers should request an earthing drawing from the Network Operator early in the building programme to ensure construction is not delayed.

The entire earthing system installation shall be approved by the Network Operator prior to being covered. The Developer must give sufficient notice to indicate when this work can be carried out.

The Developer shall ensure that the earthing system connections are brought through the floor into the substation.

All exposed metal work within the substation shall be electrically bonded to the earthing system. This includes metal doors and frames and reinforcing metalwork in the floor. All earthing connections will have a minimum cross sectional area of 70mm^2 copper. This ensures that all items of conducting material in the substation are kept at the same electrical potential and will not pose any danger to people inside the substation (and outside in the case or metal doors and frames, louvres and vents to the outside).

If any part of the substation building cannot be adequately bonded to earth, it must be constructed from a suitable insulating material.

The Developer shall provide a connection point to the floor reinforcing at a convenient location as advised by the Network Operator's representative.

The Network Operator will determine whether combined or segregated high and low voltage earthing systems are to be used. Based on earth resistance measurements that are taken, this cannot be determined for certain in advance of works beginning.

8.3 Combined HV and LV earthing

Wherever possible Network Operators will opt for a combined earthing system enabling a single earthing grid to be installed providing earth connections for high and low voltage systems. This is the preferred earthing arrangement as it is simpler to install, test and maintain but is dependent on the soil conditions enabling a combined resistance to earth not exceeding 1 ohm being achieved.

The soil conditions found in Oman may make it difficult to obtain low value earth resistance readings

The earthing system has to be capable of being tested stand-alone, i.e. not connected to the earth bar of any switchboard other than the earth bar inside the substation and not connected to the host building's reinforcing bars with the exception of reinforcing in the floor and walls of the substation enclosure itself which must be electrically separated from the remainder of the host building. This enables the integrity of the earth connection to be tested before any other connection is made to it that could lead to spurious test results.

The substation must be separated by at least 5m from the host building's lightning protection earth connection.

The earth cable size shall be a minimum of 70mm^2 copper to give low resistance to earth fault currents and adequate short term rating for the currents that might flow.

8.4 Segregated HV and LV earthing

Where the resistance to earth of 1 ohm cannot be achieved, separate HV and LV earthing systems each having a resistance to earth of not more than 10 ohms will have to be installed. In this case, the LV neutral earthing system must be insulated and separated electrically by a distance of at least 3m from the HV substation earthing system (bonded metal doors, exposed metal, reinforcement, HV cable screen earth, etc). This will require the low voltage neutral point earthing connection to be insulated through the area where the substation high voltage earthing grid is installed to an independent earthing system, separated, as stated by the minimum of 3 metres. This is to prevent earth rod zones overlapping and transferring voltages from one to another.

The HV and the LV earthing systems must be separated by at least 5m from the host building's lightning protection earth connection.

8.5 Electric and Magnetic Fields (EMFs)

EMFs are now a widely discussed phenomenon, and occupiers of buildings will want to be sure that they are not taking unnecessary risks. On behalf of the power sector in Oman AER has undertaken tests at distribution substations and the results showed that EMF levels were well below the maximum exposure levels recommended by ICNIRP. The OES requires that "The substation shall be designed such that EMF levels remain within the ICNIRP maximum recommended exposure levels at the substation boundary".

The typical substation layouts associated with this standard achieve ICNIRP requirements with current equipment specifications purchased by Network Operators.

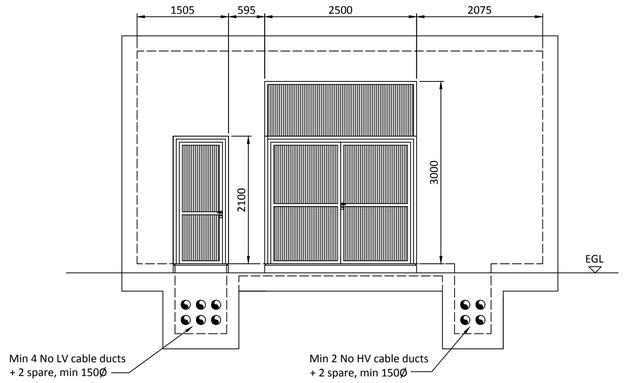
Developers can ensure that they do everything possible to keep EMF levels below the ICNIRP guidelines for all new substations by allocating adequate space for the substation and working with Network Operators to keep substation equipment close to the centre of the substation, allowing plenty of space between substation equipment and substation boundaries, and by installing only compact designs of switchgear in switchrooms under their control.

While substation EMF levels will be well within ICNIRP limits at the boundaries if the above advice is taken Developers may further reassure occupants of their building by placing residential parts of the buildings away from the substation where this is practicable.

Additional EMF shielding is unlikely to be necessary in any situation but if Developers wish to add EMF shielding they may appoint an approved EMF consultant to provide advice and determine the extent of any additional shielding.

The Network Operator will have to approve any shielding proposed for installation inside the substation.

This drawing is to be read in conjunction with Document OES36 - Distribution Substations Inside Buildings



Elevation 1

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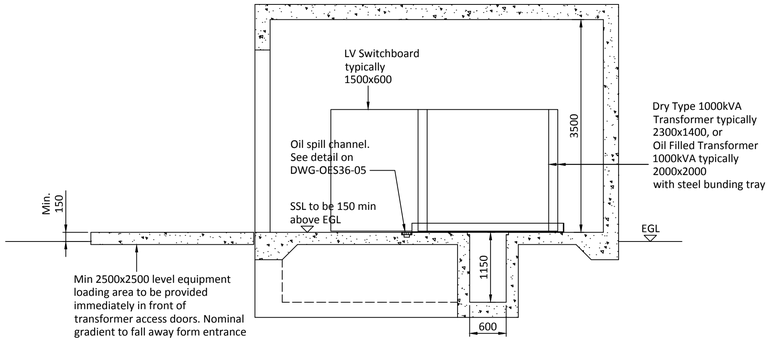
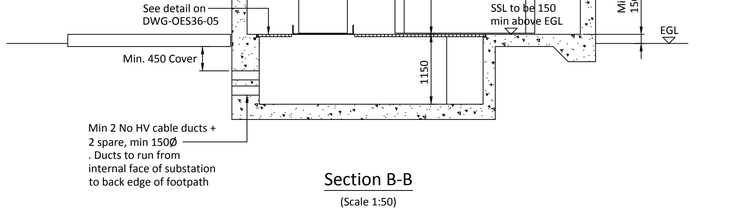


Section C-C

(Scale 1:50)

Plan (Type 1a)

(Scale 1:50)



Section B-B

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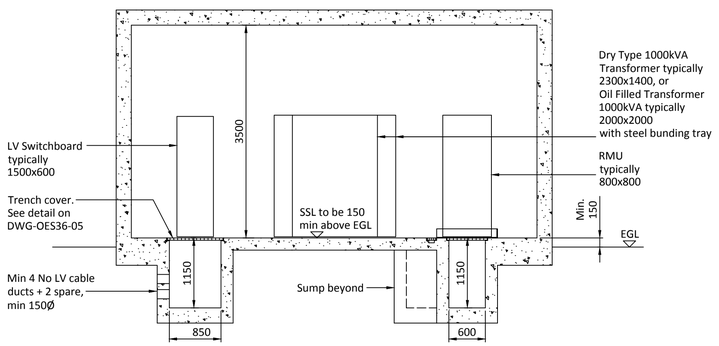


Section A-A

(Scale 1:50)

A1

GENERAL NOTES

DO NOT SCALE.

1. This drawing is to be read in conjunction with all other relevant drawings and OES-36 Standard - Distribution Substations Inside Buildings.
2. All dimensions are in millimetres unless otherwise stated.
3. All specialist items to be used in accordance with the manufacturers recommendations.
4. Temporary protection shall be provided to prevent water penetration into any existing structures during the works.
5. The running of heating, gas, telecoms, water and other services through or under the substation area will not be permitted.

FOUNDATIONS, CONCRETE AND REINFORCEMENT

1. All foundations, concrete and reinforcement shall be designed to sustain plant and site specific loadings.

DUCTS

1. The number of ducts and duct entry positions are to be determined by the Developer in consultation with the Distribution Network Owner (DNO).

FLOOR SLAB

1. All floor slabs shall be designed to sustain plant and site specific loadings.
2. All reinforcement to have sufficient minimum concrete cover to reinforcement so as to provide 3 hour fire rating.

ROOF SLAB

1. All roof slabs shall be designed to sustain plant and site specific loadings.
2. All reinforcement to have sufficient minimum concrete cover to reinforcement so as to provide 3 hour fire rating.
3. No services or drainage from above shall be permitted to pass through the roof slab into the substation area.

WALLS

1. All walls to be designed to sustain plant and site specific loadings.
2. All reinforcement to have sufficient minimum concrete cover to reinforcement so as to provide 3 hour fire rating.

DOORS

1. All doors to be designed for site specific door opening dimensions and loadings. Typically steel louvred doors with powder coat painted finish, panic bar and and padlock.
2. Mastic pointing to frame surrounds externally.

VENTILATION LOUVRES

1. Louvres to be steel construction with powder coated paint finish. Louvres to be fitted in external doors or walls.
2. Mastic pointing to frame surrounds externally.

FINISHES

1. Floor to receive 2 coats of grey concrete floor paint.
2. Walls and ceiling to receive 2 coats of white emulsion paint for dust sealing.
3. Doors and louvres to be powder coat painted.

Drawing abbreviations

SSL - Structural Slab Level.
EGL - External Ground Level.
RSA - Rolled Steel Angle
GRP - Glass Reinforced Plastic

DESCRIPTION	REV	DATE	CHKD	APPR
Clearances around equipment increased.	E	25.03.15	KAN	KGP

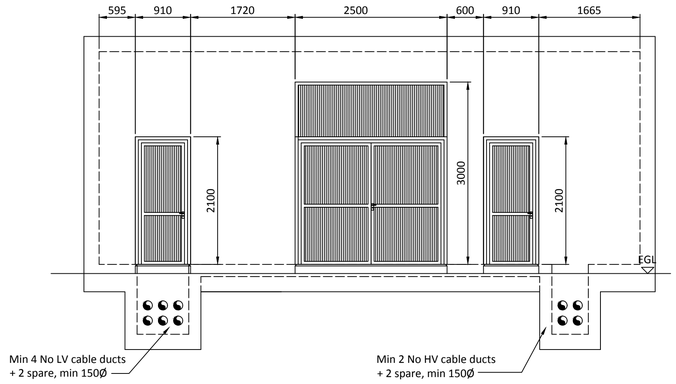
SULTANATE OF OMAN

STATUS	Information
PROJECT	Sultanate of Oman Distribution Sub-Stations Inside Buildings
DRAWING TITLE	Typical Type 1a Substation GA Sections & Elevations

DRAWN	JM	DATE	04/03/2013
CHECKED	KAN	SCALE	AS SHOWN @ A1
APPROVED	KGP		

DRAWING NUMBER	REVISION
DWG/OES36/01	E

This drawing is to be read in conjunction with Document OES36 - Distribution Substations Inside Buildings



Elevation 1

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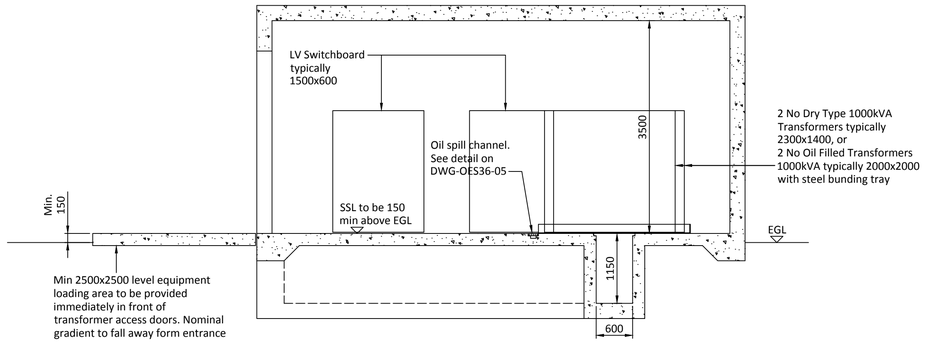

Section C-C

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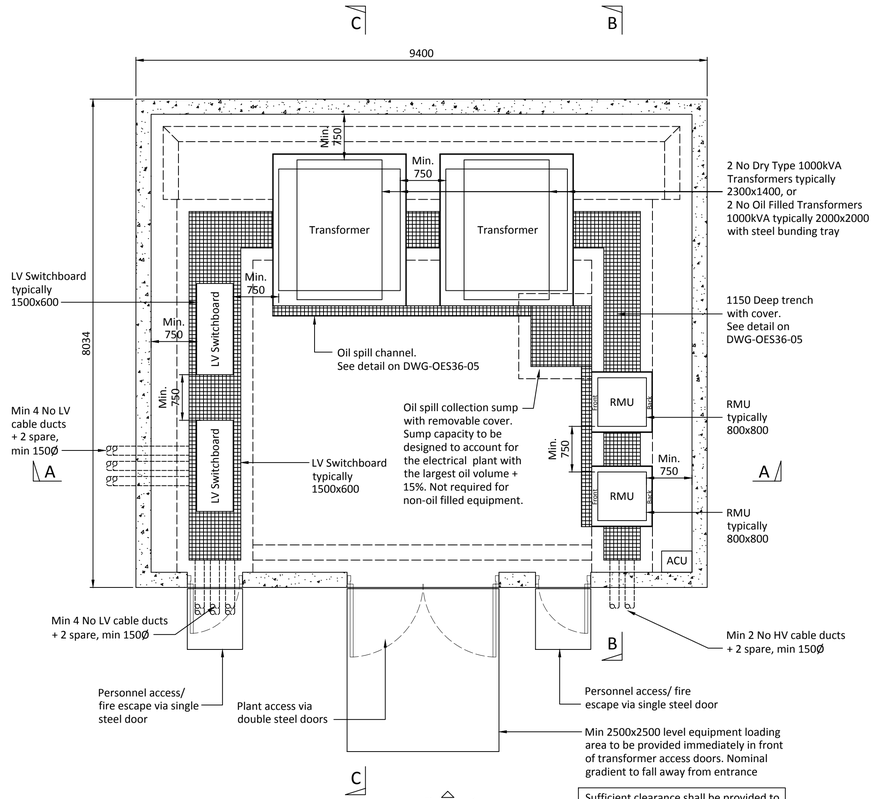
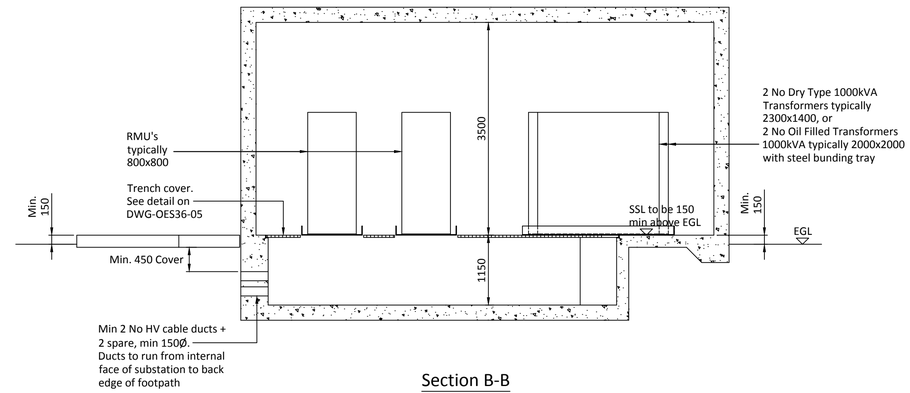


Sufficient clearance shall be provided to allow both doors to open 180° without being impeded.

Plan

(Scale 1:50)



Section B-B

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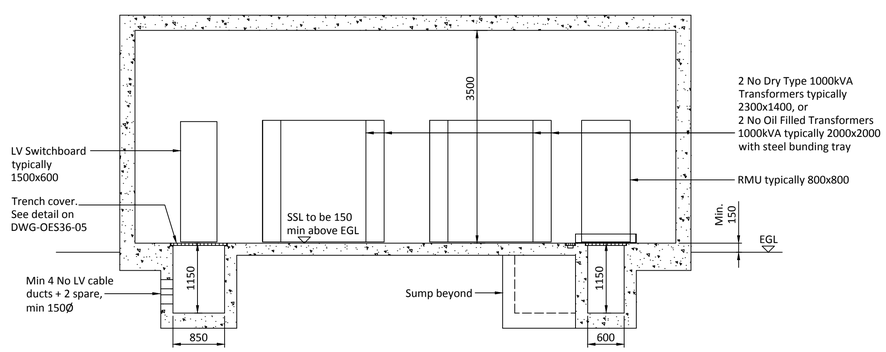

Section A-A

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A1

GENERAL NOTES

DO NOT SCALE.

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2. All dimensions are in millimetres unless otherwise stated.
3. All specialist items to be used in accordance with the manufacturers recommendations.
4. Temporary protection shall be provided to prevent water penetration into any existing structures during the works.
5. The running of heating, gas, telecoms, water and other services through or under the substation area will not be permitted.

FOUNDATIONS, CONCRETE AND REINFORCEMENT

1. All foundations, concrete and reinforcement shall be designed to sustain plant and site specific loadings.

DUCTS

1. The number of ducts and duct entry positions are to be determined by the Developer in consultation with the Distribution Network Owner (DNO).

FLOOR SLAB

1. All floor slabs shall be designed to sustain plant and site specific loadings.
2. All reinforcement to have sufficient minimum concrete cover to reinforcement so as to provide 3 hour fire rating.

ROOF SLAB

1. All roof slabs shall be designed to sustain plant and site specific loadings.
2. All reinforcement to have sufficient minimum concrete cover to reinforcement so as to provide 3 hour fire rating.
3. No services or drainage from above shall be permitted to pass through the roof slab into the substation area.

WALLS

1. All walls to be designed to sustain plant and site specific loadings.
2. All reinforcement to have sufficient minimum concrete cover to reinforcement so as to provide 3 hour fire rating.

DOORS

1. All doors to be designed for site specific door opening dimensions and loadings. Typically steel louvred doors with powder coat painted finish, panic bar and and padlock.
2. Mastic pointing to frame surrounds externally.

VENTILATION LOUVRES

1. Louvres to be steel construction with powder coated paint finish. Louvres to be fitted in external doors or walls.
2. Mastic pointing to frame surrounds externally.

FINISHES

1. Floor to receive 2 coats of grey concrete floor paint.
2. Walls and ceiling to receive 2 coats of white emulsion paint for dust sealing.
3. Doors and louvres to be powder coat painted.

Drawing abbreviations

SSL - Structural Slab Level.
EGL - External Ground Level.
RSA - Rolled Steel Angle
GRP - Glass Reinforced Plastic

DESCRIPTION	REV	DATE	CHKD	APPR
Clearances around equipment increased.	E	25.03.15	KAN	KGP

SULTANATE OF OMAN

STATUS
Information

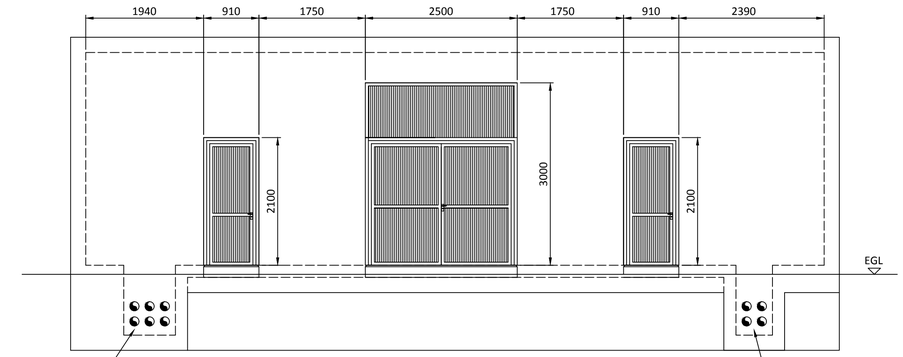
PROJECT
Sultanate of Oman
Distribution Sub-Stations Inside Buidlings

DRAWING TITLE
Typical Type 1b Substation GA
Sections & Elevations

DRAWN	JM	DATE	04/03/2013
CHECKED	KAN	SCALE	AS SHOWN @ A1
APPROVED	KGP		

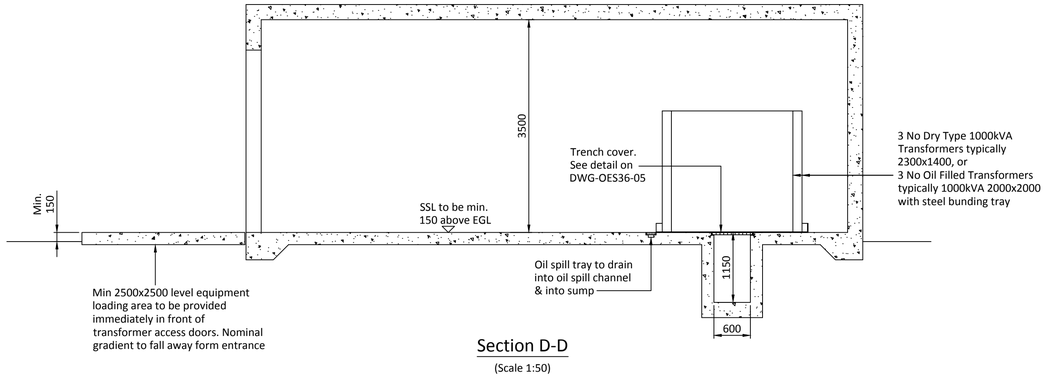
DRAWING NUMBER: DWG-OES36-02
REVISION: E

This drawing is to be read in conjunction with Document OES36 - Distribution Substations Inside Buildings



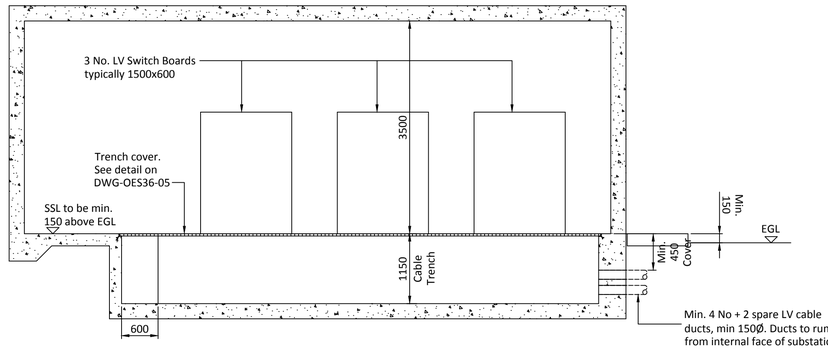
Elevation 1

(Scale 1:50)



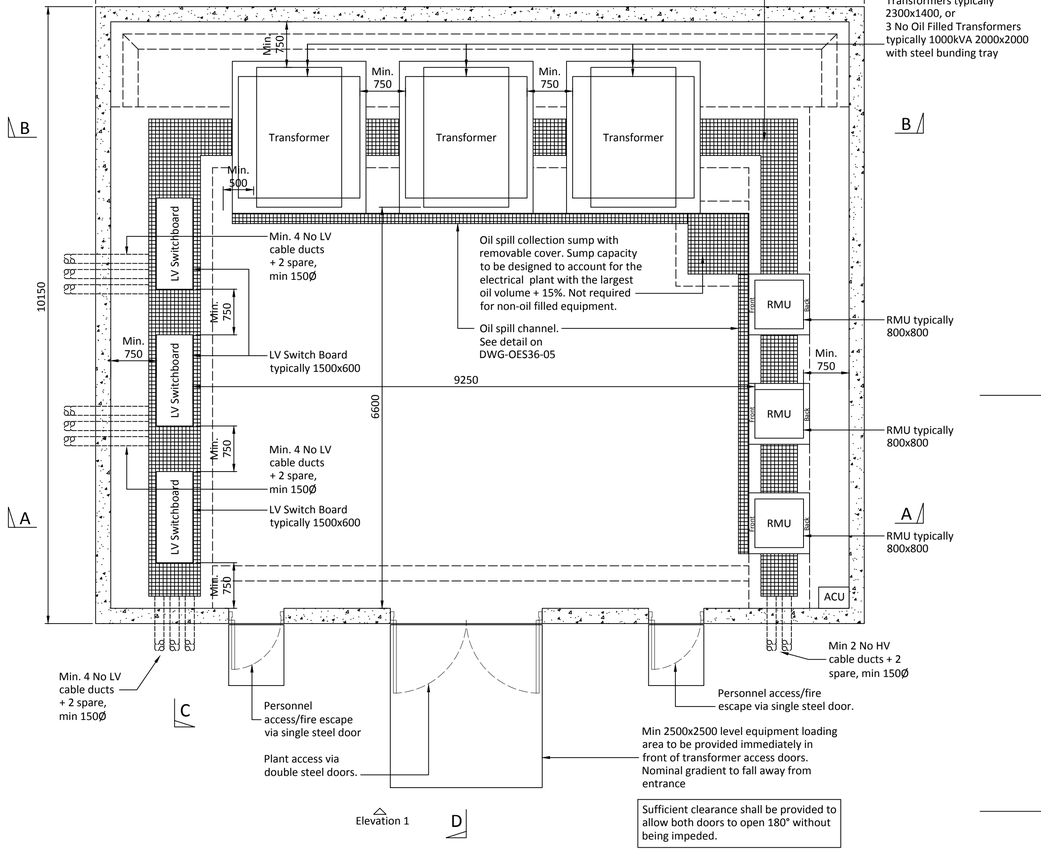
Section D-D

(Scale 1:50)



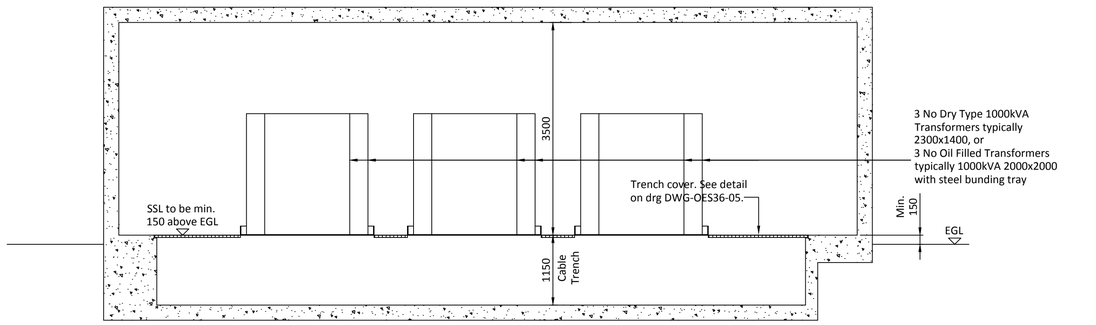
Section C-C

(Scale 1:50)



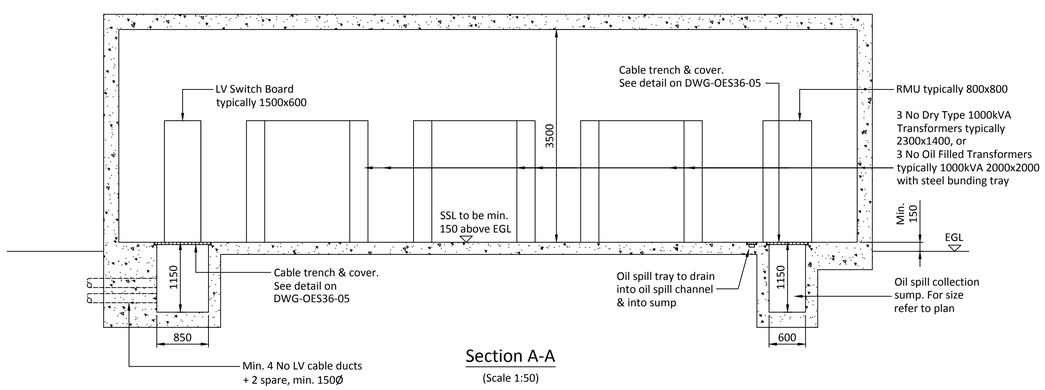
Plan

(Scale 1:50)



Section B-B

(Scale 1:50)



Section A-A

(Scale 1:50)

A1

GENERAL NOTES

DO NOT SCALE.

1. This drawing is to be read in conjunction with all other relevant drawings and OES-36 Standard - Distribution Substations Inside Buildings.
2. All dimensions are in millimetres unless otherwise stated.
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GRP - Glass Reinforced Plastic

DESCRIPTION	REV	DATE	CHKD	APPR
Clearances around equipment increased.	E	25.03.15	KAN	KGP

SULTANATE OF OMAN

STATUS: Information

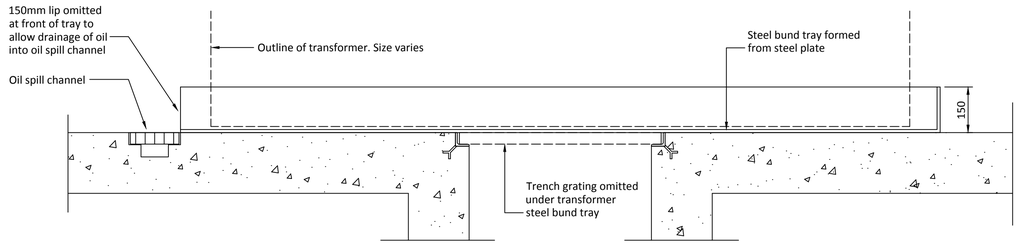
PROJECT: Sultanate of Oman
Distribution Sub-Stations Inside Buildings

DRAWING TITLE: Typical Type 1c Substation GA
Sections & Elevations

DRAWN	JD	DATE	04/03/2013
CHECKED	KAN	SCALE	AS SHOWN @ A1
APPROVED	KGP		

DRAWING NUMBER	REVISION
DWG-OES36-03	E

This drawing is to be read in conjunction with Document OES36 - Distribution Substations Inside Buildings

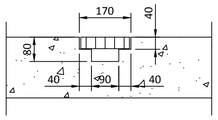


Indicative Steel Bund Tray Detail

(Scale 1:10)

Form oil spill channel in floor slab to support 38mm deep x 160 wide moulded open type GRP grating trench cover with gritted surface.

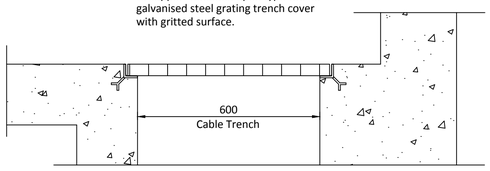
Ensure that the oil spillage channel runs into the oil spill collection sump to divert any oil spillages into it.



Indicative Oil Spill Channel Detail

(Scale 1:10)

RSA mild steel angle kerb supports with welded tangs for casting into concrete slab, galvanised finish. Angles to support moulded open type GRP or galvanised steel grating trench cover with gritted surface.



Indicative Cable Trench Grating Detail

(Scale 1:10)

A1

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DESCRIPTION	REV	DATE	CHKD	APPR
Clearences around equipment increased.	C	25.03.15	KAN	KGP

SULTANATE OF OMAN

STATUS: Information

PROJECT: Sultanate of Oman
Distribution Sub-Stations Inside Buildings

DRAWING TITLE: Typical Substation Details

DRAWN	JM	DATE	11/03/2013
CHECKED	KAN	SCALE	AS SHOWN @ A1
APPROVED	KGP		

DRAWING NUMBER: DWG-OES36-04

REVISION: C