Scope
This manual describes the minimum design and construction requirements for ENERGEX’s Indoor and Outdoor distribution substations.

General
Any proposed deviation from this document must be submitted to ENERGEX in writing with full descriptions and details for approval before it is implemented. Allowance should be made to ensure ENERGEX is provided with sufficient time for full and in-depth consultation and deliberation.

Interpretation
In the event that any user of this manual considers the content uncertain, ambiguous or otherwise in need of interpretation, the user may request ENERGEX to clarify the provision. Should further review be required, the provisions of the previous clause “General” will need to be followed.

Updates & Subscription
When downloaded or printed, this document is uncontrolled. This document is subject to amendment by ENERGEX at any time. Note: Users are responsible for ensuring they are using the latest information.

Disclaimer
This document has been developed using information provided by ENERGEX Construction, Planning and Design staff and as such is suitable for most situations encountered. The requirements of Australian Standards, Building Codes and all other statutory bodies are regarded as the accepted minimum requirements for the establishment of these substations. Where this document exceeds those requirements, this document is to become the accepted minimum.

ENERGEX will not accept any liability for work carried out to a superseded standard. ENERGEX may not accept work carried out that is not in accordance with current standard requirements.

ENERGEX manuals are subject to ongoing review. If conflict exists between manuals, the requirements of the most recent manual are to be adopted.

A proprietary item is any item identified by graphic representation on the drawings, or by naming one or more of the following: manufacturer, supplier, installer, trade name, brand name, catalogue or reference number, and the like. The identification of a proprietary item is a recommendation ONLY. It indicates the required properties of the item, such as the type, quality, appearance, finish, method of construction and performance.

More than one supplier or product is capable of meeting this Specification. An alternative/equivalent item is permissible, provided that it meets the relevant performance criteria and is otherwise of a quality reasonably satisfactory to ENERGEX.

No claim shall arise from any rejection by ENERGEX of an alternative/equivalent item. The acceptance of an alternative/equivalent item shall not be grounds for a variation to cost or time.

When offering an alternative/equivalent item, the Contractor is to provide all available technical information, and any other relevant information requested by ENERGEX. If requested by ENERGEX, the Contractor is to obtain and submit reports on relevant tests by an independent testing authority.

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1 This manual does not apply to padmounted substations. Refer to the Underground Distribution Construction Manual for details of these substations.
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GENERAL

1. Electrical Equipment Usage & Clearance Guidelines

1.1. Transformer Selection

Oil filled transformers must be used for all outdoor substations. Some indoor substations (e.g. most industrial applications) should use oil filled transformers unless ENERGEX or the consumer specifies otherwise.

Dry type transformers should be used for indoor substations located in high rise buildings (residential and commercial) and other major buildings frequented by the public (e.g. Convention/Exhibition centres and major shopping complexes). ENERGEX may also specify dry type transformers for other high fire risk applications. Special care must be taken when selecting dry type transformers to ensure they are not overloaded.

The transformer should be such as to supply the whole of the load by one transformer; however where the maximum demand exceeds 1000kVA, then provision for two transformers and associated switchgear must be allowed.

1.2. Multiple Transformer Installations

To ensure that fault levels are not exceeded, parallel operation of transformers is not permitted. Consumers may require special keying or similar, to prevent inadvertent interconnection of low voltage switchboards (Ref. Standard Network Building Blocks BMS1615).

1.3. Transformer Space & Ventilation Requirements

Substations must provide sufficient space and ventilation to accommodate 1500kVA transformers, ensuring sufficient ventilation is provided for future load, even though smaller units may be initially installed.

Oil filled transformers require an area of 2300 mm long x 1800 mm wide, and dry type transformers require an area of 2300 mm long x 1800 mm wide.

Transformers must be separated from walls, ventilation equipment and other obstructions by a minimum of 900 mm. Transformers must not be directly placed under ventilation duct openings. With the exception of fire damper trip wires (if required), no item of equipment, installation or obstruction is to be placed over a designated transformer space.

Natural ventilation is not adequate for indoor substations. Mechanical ventilation must be provided. Section 6 details ventilation requirements.

As a guide, one general arrangement has been provided for each style of indoor substation. Provided all clearance and access requirements are maintained, other arrangements may be used. An ENERGEX Planning Officer must approve any alternate arrangement. Outdoor substations must be arranged in accordance with the standard layouts provided.

1.4. High Voltage Switchgear Selection

In all cases, it is preferred that standard contract item SF6 Ring Main Units (RMUs) are used, unless otherwise absolutely necessary (e.g. particular unusual retrofit arrangements, which

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1 With the high ambient temperatures experienced in Queensland, dry type transformers should not be loaded in excess of their nameplate rating.
2 Includes LV cable stand and guard.
3 CBD mesh type substation, substation using dry type transformers and SafeLink RMU, substation using oil filled equipment and oil filled RMU’s acceptable to ENERGEX.
preclude standard contract item use and or supply unavailability of standard contract items). SF6 insulated RMU’s shall be used in new installations.

Switchgear used to protect and control dry type transformers must be fitted with shunt trip devices on their associated switch-fuse units. Items which are reasonably acceptable to ENERGEX or current contract items are suitable for this purpose.

For substations installed in the CBD mesh networks, three standard switchboard configurations are available:

- (SC20715) two transformer switchboard (intermediate mesh point);
- (SC20716) three transformer switchboard (intermediate mesh point); and
- (SC20717) three transformer switchboard (mesh point).

All the above switchboards use switch-fuse units to control and protect the transformers, and circuit breakers to control and protect the associated 11 kV feeders. The intermediate mesh point switchboards have two circuit breakers and the mesh point switchboard has three circuit breakers.

These switchboards may be connected together for installations involving multiple transformers. Single 1500Kva transformers may be supplied from a RMU connected between two switchboards (e.g. a seven transformer installation could use 2 x three transformers switchboards with a RMU connected between them).

Planning requirements for customers in CBD mesh networks/high density areas/customers with large loads or HV customers that require a high reliability of supply, must consult with the Asset Manager and Concept Design to confirm protection and switchgear requirements.

High voltage switchgear should be positioned so that its operating side faces away from any associated transformer and must be readily accessible from equipment doors or equipment hatchways. Other equipment, structures or cables, not directly associated with the switchgear must not interfere with its operation and maintenance.

1.5. Low Voltage Switchboards

When required, LV boards / LV isolators are supplied and installed by ENERGEX. An LV board is installed where an LV tie is required to the ENERGEX network. Consumer’s mains are then terminated to the customer side of the LV boards or isolators. The ENERGEX Planning Officer is to advise on the requirements for an LV tie on an individual job basis.

For dry type transformer stations, one LV board may be required to meet network tie or load requirements. For all dry type transformers, LV isolators shall be supplied for each transformer. The consumer will take supply from the load side of the LV isolator. This is to ensure ENERGEX security of the dry type transformer with the trip and alarm on the transformer cubicle.

For transformer station oil filled equipment, on LV board may be required (subject to network tie requirements). For any additional transformers, the consumer normally takes supply directly from the LV bushings. The connections are made using flexible braids and free standing guard, which is supplied and installed by the owner.

For wall mounted switchboards, the substation wall behind the switchboard must not have any protrusions, such as columns or beams, cables or other structures, which will inhibit the safe mounting and operation of the switchboard. A 1500mm clearance must be allowed on the operating side, and no access door or structure should encroach within 900mm.

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4 The shunt trips are connected to the over temperature contacts filled to the dry type transformers and will operate if the transformer’s maximum winding temperature is exceeded.
If the switchboard is free standing over a cable trench, there should be a clear distance of 900mm from the back and sides, and 1500mm on the front or operating side from any structure.

1.6. Clearances in General

To ensure the safety of operators and adequate access for installation and maintenance activities, substations are arranged to achieve the following general clearances:

- 900 mm, between equipment, walls and other obstructions, where personnel must be able to pass through;
- 1500 mm, in front of equipment that must be operated and maintained; and
- 1200 mm, to allow cable bending radii.

For indoor substations, equipment access doorways must provide a clear opening of 2500mm wide x 3100mm high. Personnel access doorways must provide a clear opening of 800mm wide, and increased to 1200mm wide where equipment access is required through this doorway.

For outdoor substations, equipment access gateways must provide a clear opening of 2100mm wide. Personnel access gateways must provide a clear opening of 1200mm wide.

Substation ceilings must provide clear headroom above the floor of at least 3200mm. This height is sufficient for bottom cable entry equipment. If top cable entry equipment is used the clear headroom must be increased to 3750mm.

Cable riser must have internal dimensions no less than 900mm x min 300/max 450mm deep.

Other specific clearances are specified throughout this manual and where specified, take precedence over the figures stated above.

1.7. Miscellaneous Equipment

1.7.1. Battery Chargers

In many CBD applications a 48V battery charger is required to supply protection equipment. It should be located away from the transformer, HV and LV switchgear by a minimum of 900 mm and should be mounted no higher than 1200 mm, above the adjacent floor level. A dedicated circuit from the consumer’s essential building services metered supply, must be used to supply the battery charger.

1.7.2. Battery Charger (HV Customer)

Where HV customers are fed from consumer 11kV switching substations, an 110V 10A modular substation battery charger and DC board shall be installed.

1.7.3. Pilot / Optical Fibre Cables and Cubicles

Pilot / Optical Fibre cables / signalling cables (where present), will be terminated in a pilot / optical fibre cable cubicle. The cubicle should be located away from the transformer, HV and LV switchgear by a minimum of 900 mm from the back and sides, with the front or operating side of the cabinet having clearance of no less than 1500mm.

A typical cabinet should have provision for top or bottom entry of the pilot cables, provision for suitable cable tray or cable ducting should be taken into account, as protection cables should not be run with HV cables. Pilot cables should be run into the substation via a dedicated conduit. Pilot cables entering the substation are regarded as live and therefore appropriate electrical safety rules apply.
1.7.4. Planning Requirements for Optical Fibre Cable Communication Links to C&I Distribution Substations

1.7.4.1. Background

The requirements for communication links to specific C&I substations and the conditions under which communications conduits are to be installed in parallel with new 11kV mains to these substations are pending, following consideration and adoption of the Network Technology Plan.

1.7.4.2. Guideline

This guideline applies to new C&I substations containing relay operated switchgear only, and outlines the preferred options for providing communications bearers to these installations. The lowest cost option, taking into account whole of business costs associated with protection and control requirements, shall be chosen. To aid in selection, the following criteria shall be used:

- If an existing communication link is available and is fit for purpose (e.g. spare pilot wire running past C&I substation), this link is to be utilised as the first preference.

- If there is no suitable existing communication link available, all communication options are to be evaluated and the most cost effective option (which fits the purpose) then selected. Communications options include (but are not limited to): radio link, optical fibre cable, copper pilots and ADSS.

- Where feasible, a spare conduit is to be installed in parallel with the installation of new 11kV cable, associated with C&I substation to cater for future communications requirements. This conduit shall be white, minimum size of 100 mm, LD PVC, and located at the top level kerb side of the conduit bank.

Note: there is no blanket requirement for full remote control functionality of plant associated with relay operated C&I substations, nor remote transmission of temperature alarms associated with all dry type Control System (SACS) at sites which have an existing communication link, or which require communications for protection or control.

The requirements specified will be reviewed after the Network Technology Plan is issued, or when a new specification for C&I switchgear is prepared.

1.7.4.3. Specifics relating to Optical Fibre Cable

The following communication cables shall be installed in conjunction with the establishment of C&I distribution substation projects, to provide for immediate and future communication needs.

<table>
<thead>
<tr>
<th>Mode of Installation</th>
<th>Communication Cable Description</th>
<th>Stock Code Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>With underground Reticulation</td>
<td>Composite optical fibre cable with termite protection comprising 24 single mode fibres and 4 multi mode fibres</td>
<td>17837</td>
</tr>
<tr>
<td>With Overhead Reticulation</td>
<td>All dielectric self supporting (ADSS) overhead optical fibre cable comprising 24 single mode fibres</td>
<td>17826</td>
</tr>
</tbody>
</table>
1.7.4.4. Installation of Optical Fibre Cables in existing conduits

As far as practicable, avoid using empty conduits that will be required in the future for additional HV and LV power cables.

In selecting the most appropriate conduit to use within the footpath electricity alignment or roadway, preference should be given to available conduits in the following order:

- Select those conduits already shared with street lighting and/or pilot/control cables and/or third party optical fibre cables.

  First preference is to be the top level kerb side conduit of the conduit bank, with second preference to be the middle level control cable conduit(s) of the conduit bank.

- If these conduits are filled, use future LV cable space in preference to future HV space, or, install a new conduit of minimum size, 100mm LD PVC white conduit for communication cable.

1.7.4.5. Installation of Optical Fibre Cable in new conduits

Where a new conduit is required to augment an existing conduit bank or to extend a conduit bank to reach a new C&I substation, install a new communications conduit of minimum size, 100 mm LD PVC white conduit, located at the top level kerb side of the conduit bank.

1.7.4.6. Installation of ADSS Optical Fibre Cables at termination poles

The construction drawing 7215-A4 (Section 9, Page 20) of the Overhead Construction Manual, shows the termination arrangement. This drawing is to be amended to show the bending radius of the cable coiled in the No. 8 pit to be 300mm to avoid cable damage. The cable down the pole is to be enclosed in a 50mm white UPVC conduit, stock code 18076. A 300mm minimum radius conduit bend should be used underground at the pole foundation face, to transfer the cable direction towards the pit approximately 1.0m distant from the pole.

1.7.5. SCADA Equipment

SCADA equipment should not be located in any position, where it is likely to be damaged, as a result of equipment being moved within the chamber. Cabinets containing SCADA equipment should have a minimum 1500mm clearance from any energised plant.

2. Earthing

2.1. General

See Section 12 for earthing drawings.

Except for the following cases, an electrode type earthing system must be installed directly under the footprint of each indoor and outdoor substation:

- If a switching station is associated with an upper level substation, the electrode earthing system for both the switching station and the upper level substation is to be laid under the footprint of the switching station chamber.

- If the substation chamber is located near its associated switching station, the electrode earthing system for both the switching station and the substation should be installed under the footprint of the substation.
• If there are exceptional site conditions, ENERGEX may permit/or may require, alternative locations for the electrodes (e.g. remote earthing).

Special earth cable connection arrangements may be required for substation having customer’s electrical protection equipment for the consumer’s mains and main switchboard, additional to the electrical protection in the substation. In these situations, any special arrangements must be agreed on a case by case basis with ENERGEX.

The earth cables from the earthing electrode installation to the chamber, and the earthing electrode installation area, are to be included in the lease and easement documentation for the substation.

2.2. Provisions for the Earthing Electrode System

As mentioned in Section 2.1 Site Selection General, the substation must be located in an area which is free of other building services, except those directly related to the substation. The selected site is required to be stable and clear of any obstructions that could interfere with the installation of any part of the earthing system, including the electrodes. Earthing system electrodes may extend 10m or more into the ground below the substation.

If the substation is located on natural ground, the earthing system is to be installed directly under the floor slab. However, 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. In this case, two groups of cables from the earth grid electrodes are to be brought up through the building structure to the position of the earth bar in the substation (as specified in the next section). Penetration through any waterproof membrane must be resealed.

The earthing electrode system and cables connecting the electrodes are to be installed before any waterproof membranes are laid and before the covering floor slab is constructed. Earth electrodes are to be installed at no less than 3m apart and they must be connected using a cable type earth grid. Cable identification markers are to be installed in the finished surface over the earth grid cable (refer 7525-A4 of UDC Manual).

The earthing system must be protected from damage during construction. Failure to do so will require damage to be repaired to the satisfaction of ENERGEX.

The earthing system is to be a stand alone type, not connected to building reinforcement bars or grading rings. It must also be well clear of building lighting protection systems and should not be connected to the earth bar of any switchboard, other than the earth bar inside the substation.

2.3. Provision for the Installation of Earthing Cables

  2.3.1. Within Substation Rooms

Floor chases must be installed within the floor slabs of substations for the earth cables from substation equipment to the earth electrodes.

  2.3.2. Between Substation Rooms

The earth cables between an upper level substation and its switching station are to be run via a cable riser, which links the two rooms. One earth cable shall be bare and saddled to the unistrut, and one earth cable shall be insulated.

  2.3.3. From the Earth Grid to the Substation Room

If the substation is located on natural ground, the two cables are to enter the substation from a group of electrodes connected to the earth grid.
If the substation is constructed on a suspended floor slab, the two cables from the earth grid are to be brought up through the building structure along separate routes to the earth ring in the substation.

The two earthing cables are to run through two 40mm PVC conduits encased within a structural column. Outer steel pipe or steel hat section are to be used if conduits are surface mounted. The earth cable route is to be marked with cable identification markers along the route.

At the lower end, the conduits are to emerge from the column 300mm above the floor slab under which the earthing system is installed. At the upper end, the conduits are to emerge from the column 100mm above the finished level of the chamber floor slab. The conduits must be straight, except for each end, where bends are to be installed for the sections emerging from the columns. The radius of the bends is to be 305mm. Draw wires are to be installed in both conduits.

All conduits and fittings must be joined with solvent cement, in accordance with manufacturer’s instructions. Conduits and bends must be adequately tied to reinforcing steel in the columns, to prevent separation of the joints during pouring of concrete.

After installation of earthing cables in the conduits and connection to the earthing cables from under the lowest floor slab, the section of exposed earthing cables are to be fitted with a cover not less than 300mm long. Covers are to be formed from a minimum 1.6mm thick galvanised steel sheet. Covers must be readily accessible at all times.

(Refer to Distribution Earthing Manual 03535)

If the substation is not directly above ground, then two 120mm sq copper insulated riser cables shall be provided on separate routes from the basement / ground floor earth grid to the remote substation enclosure. The earth grid is to be located directly under the substation footprint (where practicable), even when substations are located on upper levels of buildings.

3. Environment

3.1. Flood Resilience of Substation

The substation building must be designed to provide flood resilience for the electrical equipment. The general arrangement is shown in Figure 1.

Figure 1 - General Arrangement for Flood Resilience of Electrical Equipment

Electrical equipment, including HV and LV switchgear, transformers and associated control equipment, must be installed above the DFL prescribed by Council.
ENERGEX may allow plant and equipment to be installed in a room below the DFL level provided:

1. The room is water resistance to the DFL level (which includes a designed bunding systems and suitable sump pump scheme for water seepage); and
2. the transformers are completely sealed.

Alternatively the HV switchgear and associated control equipment must be of the submersible type.

### 3.2. Construction and Excavations

Construction of substations or excavation for cable trenches etc, carried out by the builder or ENERGEX will comply with all relevant EPA regulations regarding the prevention of contaminants (e.g. silt, spoil, entering any drain or waterway).

The builder must ensure that the site is left in a clean and tidy condition. The builder is responsible for the correct disposal of contaminants in accordance with local authorities and the EPA. The builder will be held responsible for any relevant claims made be ENERGEX, local authorities and or an Inspector of the EPA, due to an unsuitable clean up prior to hand over of the substation site.

### 3.3. Containment of Contaminants and Water

All ENERGEX substations will have features (e.g. bunding) to contain any oil spill, internally or externally to the substation. Indoor substations and associated chamber are not to have drainage lines connecting them.

The inside (substation chamber side) of each door must have facilities to contain any oil spill, in the form of a removable bung (refer to drawing 7878).

Guidelines for locating Padmount and Ground Transformers with oil volumes above 500L but less than 2000L in sensitive areas refer to (BMS 1607 – Supply and Planning Manual Section 3.2 – clause 3.2.6.1).

All external conduits terminating in a substation chamber are to be sealed, after the cable installation, against the ingress and egress of contaminants and water (refer to drawing 7882).

### 3.4. Other Environmental Constraints

#### 3.4.1. Noise

Selected substation sites should address (if required), the noise restriction requirements of the EPA, local authorities or any other relevant authorities. Noise restricting devices may be used, providing they comply with the building requirements and do not restrict any substation operations.

#### 3.4.2. EMF

In areas where building occupancy above or around the substation are likely to involve normal office accommodation or living accommodation, measures shall be taken by the developer to ensure magnetic field levels from substation equipment (especially nearby low voltage cabling), do not interfere with office functions or raise occupant concern.

A level of around one microtesla (while significantly below national public exposure standards), is recommended as a target level for continually occupied office areas in new buildings, consistent with effective operation of digital equipment and a precautionary approach to increased magnetic fields and unknown health effects.
Note: The Queensland Department of Public Works now has a standard magnetic field measurement protocol, which takes mitigation action where measured magnetic fields in existing buildings exceed five microtesla.

2009: Guidelines for the Management of 50Hz Magnetic Fields in office buildings owned and managed by the Queensland Department of Public Works.

Further reference: -

Electric and Magnetic Fields: Further information on magnetic fields is contained in the Australian Radiation Protection and Nuclear Safety Agency (ARPANASA) website www.arpansa.gov.au.

3.4.3. SF6 Guidelines


Policies and procedures have been developed to ensure industries best practices are met for the installation, maintenance and disposal of SF6 gas to ensure responsible and sustainable environmental management.
OUTDOOR TYPE SUBSTATIONS

4. Site Selection

4.1. General

An ENERGEX Planning Officer must approve the selected site before detailed work can proceed.

To select a site suitable for the establishment of a substation, the following general requirements must be taken into account:

- The substation enclosure housing the switchgear must be as close as possible to ground level or property boundary, and positioned with doors opening to the outside of the building. Unimpeded access must be maintained at all times.

- No approval will be giving to other positions (such as within a building) without the approval and negotiation of ENERGEX’s Asset Manager.

- The substation (including any ground beneath the substation) must be located in an area free of other building services except those directly relating to the substation or otherwise specified by ENERGEX.

- The selected site is required to be stable, and also be clear of any obstruction which could interfere with the installation of any part of the earthing system electrodes. These may extend up to 10 metres into the ground below the substation.

- The selected substation site must be above the Defined Flood Level (DFL), as prescribed by Council, with the floor of the substation a minimum of 75mm above the DFL.

Substations and their associated access routes must not be within an area, which is:

- classified as a hazardous area as defined in AS3000;

- deemed to be a confined space according to Part 15 of the WH&S Regulation 1997;

- likely to be used for such purposes or in such a manner that would significantly increase the risk of fire or cause access difficulties; or

- utilised as a possible storage or collection area for combustible or dangerous material or goods.

Sites that may restrict future development of the premises should be avoided, as relocation of the substation and associated electrical equipment would be extremely costly to the owner of the premises. In addition, future development of the premises must not encroach upon the agreed access route of the substation or other clearances indicated by this document.
5. Access

5.1. General

This section covers the requirements for equipment and personnel access.

Unimpeded access to all ENERGEX substations must be maintained 24 hours, 7 days a week. Substations must be provided with direct street access or be accessible using permanent all weather routes. Access points must be located where they will not be obstructed by vehicles, equipment, site usage or any other impediments. Access through areas that are deemed dangerous to personnel (such as areas patrolled by guard dogs) is unacceptable.

Bollards are to be placed outside access gates where there is a risk of personnel stepping onto roadways or there is a risk of the gate being blocked by such things as vehicles (including bicycles) or the storage of goods being delivered or awaiting collection. Each gate is to be fitted with appropriate safety signs, as indicated by AS3000 and as per ENERGEX requirements.

Entry into any substation by unauthorised personnel is not allowed. Doors and gates must be fitted with suitable key operated locks, as approved by ENERGEX. [(Series 234 Padlocks for outdoor type and 201 Night Latch or 570 Cylinder for indoor substation doors) where (“Outside: opened by key D-handle always rigid. Inside: opened by handle at all times”)]

5.1.1. Personnel

Personnel access gates must swing outwards and provide a minimum clear opening 1200mm wide. This wider gate provides access for personnel, as well as access for smaller equipment items.

Personnel access gates are used for normal entry and exit from substations. All substations must be provided with two separate personnel access gates. The second personnel gates may not be required, if the equipment access gate is suitably located with the provision for personnel access, at the discretion of ENERGEX.

These gates are also used to facilitate rapid escape in the event of a fire or explosion. For this reason, personnel access gates should be located diagonally opposite where possible.

Unrestricted access, without notice, by ENERGEX personnel to the substation or switching station must be available at all times. The requirement must be included in any immediate or future building security arrangements. The imposing of restrictions to substation personnel access, such as the obtaining of approval or arranging access through the building owner, tenant, building security (‘off or on site’) or other source, is not acceptable.

5.1.2. Equipment

Large pieces of equipment such as transformers (up to 6 tonnes) require a mobile crane (up to 25 tonnes) and a heavy truck for movement to and from the substation. As such, an all-weather access roadway suitable for use by these vehicles is required from the street to the substation. These access routes must have a maximum slope of no greater than 1:12.

Attention should be given to the transformer access route, as the maximum slope for a typical mobile crane can be no greater than 1:8.

A transformer handling area and room for vehicle manoeuvring must be allowed for, adjacent to the substation. The transformer handling area should be so that all the substation’s transformers can be stored there at any time. The grade/slope of the handling area should not exceed 1:20.
Equipment access gates are to provide a minimum clear opening of 2100mm. These gates can swing inward or outward, however inwards swinging gates must be positioned so that the minimum clearances around equipment are maintained when the gates are in the fully open position.

Suitable headroom is required along the route of passage of the vehicles and in the equipment handling area and vehicle manoeuvring room, so that operation of the crane is not impeded. The headroom required is no less than 5.5m for structures on a level access route. Where the access route for the crane is on sloping ground and / or where there are humps or dips in the access route, the headroom for structures must be increased as necessary, to compensate for the position of the crane. Each case will need to be determined to the satisfaction of ENERGEX’s Planning Officer.

To allow the delivery of plant, the width of the access route should be wide enough to accommodate a large crane or truck and should be increased on bends and in the manoeuvring area near the substation equipment access gate.

The above clearance requirements must be achieved after completion of building surface treatments, including cladding of overhead structures and paving of the access route.

Any reinstatement necessary in the event of damage to concrete slab, paving tiles or road surfaces, doors etc., is the responsibility of the owner of the property.

5.1.3. Mains

An easement clear of all constructions may be required for the installation and the future maintenance of ENERGEX mains associated with the substation. The minimum width is required to be 2m for cables, or the width of construction of a cable pit and duct system. No structure may be erected or levels altered within the easement, without permission from ENERGEX. Other services may cross the easement, provided ENERGEX is satisfied that the mains will not be affected.

When a switching station is used in conjunction with remote transformers, the associated 11kV mains must be run between the equipment using conduits / cable tray, or in the case of an upper level substation, via a cable riser.

Protection wiring (if required), is not permitted in low or high voltage cables chases, ducting or conduits.

6. Construction

6.1. General Construction Information

6.1.1. General

Building work must suit the general building construction and ENERGEX’s requirements, in accordance with local building regulations. Standard substation signs and danger boards will be supplied and installed by ENERGEX. The substation must be constructed above the Defined Flood Level (DFL), with the floor a minimum of 75mm above the DFL. Reinforced concrete floor slabs must be designed to support the loads, indicated on ENERGEX’s accompanying drawings. No services other than ENERGEX’s or those serving their installation are to be contained in, pass through or pass under (if located on solid ground) the site.

6.1.2. Enclosure

Outdoor enclosures must be constructed in accordance with drawings 7852-A4, 7853-A4, 7854-A4 and 7855-A4.
The upper 500mm of the enclosure must consist of strained, galvanised, barbed wire spaced 150mm apart or some other suitable anti-climbing device, as approved by ENERGEX.

All gates must be fully clad (and fitted with anti-climbing device) to the same height as the rest of the enclosure. All gates must be pad lockable (refer to drawing 7871-A4). Unless otherwise approved by ENERGEX, the personnel access gate shall not be located in the same wall as the equipment access gate.

Note: Do not earth fences or gates.

6.1.3. Cable Trenches

Cable trench dimensions must be as indicated on ENERGEX's accompanying drawings. Cable trenches must have 150mm minimum walls and floor, with flush fitting covers set in 50mm wide rebates. These rebates are to support any steelwork and should be set so that a trip hazard is not created.

Cable trenches must be suitably drained to local council requirements and relevant EPA regulations (refer to section 8) and covered. Outdoor substation trenches must be covered using galvanised "Hot Dip checker plate" steel covers (refer to drawing 7873 for further detail). All trench covers shall be supplied and installed by the customer, before commissioning of the substations.

Cable holes through covers will be cut by ENERGEX as required. Trench covers must be flush fitting with the surrounding floor. Junctions in trenches require a 300mm radius above the floor of the trench, to prevent cable damage during installation.

Cable pulling eyes will be supplied by ENERGEX and installed by the customer, in locations specified by ENERGEX. Cable pulling eyes must be tied to the reinforcing steel in the concrete pour.

Cables trenches and floor chases can be at various depths, providing that sufficient depth has been allowed for the bending radius of any cable. If cable trenches or floor chases of various depths are linked, they must allow for smooth transition of cabling providing ramps.

The inside surfaces of all pits and floor chases are to be smooth and free of protrusions and any angles must be well rounded and smooth. When a 'T' intersection cable trench is constructed, a 300 mm x 300 mm truncated corner under the floor slab is required (refer to drawing 7884-A4).

6.1.4. Floor Chase and Earth Pocket Covers

Floor chases must be finished with cement grouting, after ENERGEX has installed the earthing system. For earth pockets outside substations, all earth pocket covers will be constructed from 6mm thick steel floor plate however, if it is likely that heavy equipment may be rolled over them, a 10mm steel plate should be used. Covers must be free of burrs and sharp edges and are to be finished in an inorganic zinc paint (to provide a non-slip surface).

6.1.5. Steelwork

The customer must supply and install any steelwork bolted in for support of trench covers across tee trenches, on nominated positions by ENERGEX. This steelwork is to be a minimum of 100 x 50 x 9.3 kg channel or 100 x 75 x 10 unequal angle. All steelwork must be hot dipped galvanised. Steelwork to support equipment (e.g. dry type transformers, ring main units and metering units) will be supplied by ENERGEX.
6.1.6. Low Voltage Cable Stands

Where the customer terminates their mains directly on the transformer terminals, the customer will be responsible for providing and installing the associated LV cable stand\(^5\). Tinned flexible braid connectors must be supplied by the consumer and used for the connection of the consumer’s mains to the LV terminals of the transformer.

The consumers mains are to be connected using stainless steel bolts greased with anti-seize compound, which is acceptable to ENERGEX, and must be supported clear of the transformer on a suitable cable support, supplied and installed by the consumer. A guard must also be supplied and fitted by the consumer to protect the LV terminals of the transformer. The guard must have removable 3mm plastic inspection cover marked “Danger Live Cables behind for means of testing purposes only. Any removal/replacement of this guard should be done deenergised”. An example of this guard is located with the general construction drawings (refer to drawing 7889-A4). When a low voltage switchboard is installed, ENERGEX will supply the LV cable stand for the associated transformer.

6.1.7. Transformer Hauling Eyes / Floor Anchors

Transformer hauling eyes / floor anchors must be installed when crane access is limited.

When hauling eyes / floor anchors are required, ENERGEX will supply them. The customer must install the hauling eyes / floor anchors, flush with the floor, in the positions specified by ENERGEX.

6.1.8. Conduits

All conduits and associated fittings must comply with the requirements of AS/NZS 2053. The following types of conduit may be used:

- Rigid UPVC – Light Duty (minimum); and
- Fibre Reinforced Concrete – Light Duty (minimum)

Note: ‘Corflo’ type conduits or equivalents, including ‘sandwich construction’ conduits, are not permitted

Conduits must be 125mm or 150mm, as specified by ENERGEX and must be supplied and installed by the customer. All joints must be solvent welded. A 2.5mm plastic coated steel draw wire or 6mm black polypropylene rope must be left in each conduit. Conduits must be securely sealed by the consumer in an approved ENERGEX manner (e.g. pipe stoppers, nylon expanding plugs) to seal against ingress or dirt, vermin and water. ENERGEX will provide a basic level of water sealing in conduits after cable installation, but as it is the responsibility of the consumer to prevent ingress of water into the building. The customer should undertake additional measures to seal conduits and wall penetrations.

To prevent cable damage during installation, conduit entries to cable trenches must be bell mouthed and conduits entering pits or substation chambers must have their edges pencil rounded.

Where conduits change direction, sweeping bends of no less than 1830mm radius should be used. Elbows must not be used and under no circumstances are conduits to be bent to achieve the bending radius. For conduits installed within a customer’s property, any deviations along the conduit route must not exceed 90 degrees in total. Deviations greater than 90 degrees and cable lengths greater than 100m will generally require the installation of cable pits.

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\(^5\) LV cable stands are not required for dry type transformers.
Conduits for mains entry and exit to the substation must project 150mm past the boundary line of the building and are to be socket ended. These conduits are to terminate at a depth set by ENERGEX.

For conduit runs to a basement or low level indoor substations, where the RL at the start of the run (e.g. the footpath) is higher than the RL where the cables enter the substation room, a separate 2 hour fire rated “water trap” chamber with suitable drainage must be provided. The enclosure is to have an area no smaller than 1m x 1m. The incoming conduits are to terminate into this chamber, with cables only passing through the chamber to enter into the substation room. The cables exiting the water trap and / or entering the cable penetration into the substation room are to be filled with waterproof sealant after the cables have been installed. Unused conduits must be securely sealed by the consumer in an approved ENERGEX manner (e.g. pipe stoppers, nylon expanding plugs) to prevent the ingress of dirt and water. ENERGEX will provide a basic level of water sealing after cable installation, noting that it is the responsibility of the developer/consumer to prevent ingress of water into the building. Drainage of the water trap chamber is to be used as per Section 6.1.9.

6.1.9. Building below potential water table

In situations where the substation (or any associated chamber, pit or conduit) is below the level to which the surrounding water table may rise under any condition, both the call cavity and the under floor area of the substation and associated chamber, must be gravity drained to a suitable discharge point or to a collection well.

In some instances, an oil separation tank may be required. The tank must be external to the substation and any associated chambers, and have a reliable automatic discharge pumping system. The pumping system must be installed to the appropriate Australian Standard and the wiring and control system is to be supplied from the building essential services. An appropriate label is to be fixed to a substation wall, indicating the presence of the pumping system and the source of the power to the pump.

The substation floor must be designed to withstand any hydrostatic pressure to which it may be subject to if the pumping system fails. Particular attention must be paid to the incorporation of waterproofing membranes. If at any stage in the life of the substation chamber it is found that flooding is occurring, the building owner will have to supply and fit a pump and any other water stopping features deemed necessary by ENERGEX. The owner is responsible for the repair of any leaks from the ceiling.
INDOOR TYPE SUBSTATIONS

7. Site Selection

7.1. General

An ENERGEX Planning Officer must approve the selected site, before detailed work can proceed.

To select a site suitable for the establishment of a substation, the following general requirements must be taken into account:

- The substation enclosure housing the switchgear must be as close as possible to ground level or property boundary, and positioned with doors opening to the outside of the building. Unimpeded access must be maintained at all times.

- No approval will be giving to other positions (such as within a building) without the approval and negotiation of ENERGEX’s Asset Manager.

- The substation (including any ground beneath the substation) must be located in an area free of other building services, except those directly relating to the substation or otherwise specified by ENERGEX.

- The selected site is required to be stable and clear of any obstruction, which could interfere with the installation of any part of the earthing system, electrodes of which may extend up to 10m into the ground, below the substation.

- The selected substation site must be above the Defined Flood Level (DFL), as prescribed by Council, with the floor of the substation a minimum of 75mm above the DFL.

- Extra attention should be given to the encroachment of any column or beam into an indoor type substation, its associated passageways and ventilation ducts, so that equipment clearance guidelines in this manual are not reduced.

Substations and their associated access routes must not be, within an area, which is:

- classified as a hazardous area as defined in AS3000;

- deemed to be a confined space according to Part 15 of the WH&S Regulation 1997;

- likely to be used for such purposes or in such a manner that would significantly increase the risk of fire or cause access difficulties; or

- utilised as a possible storage or collection area for combustible or dangerous material or goods.

Sites that may restrict future development of the premises should be avoided, as relocation of the substation and associated electrical equipment would be extremely costly to the owner of the premises. In addition, future development of the premises must not encroach upon the agreed access route of the substation or other clearances indicated by this document.

7.2. Indoor Substations

7.2.1. General

Indoor substations are normally contained within buildings but may be constructed as free standing enclosures.
Substations must comply with the following requirements, which vary according to the height of the substation above ground level.

7.2.2. Surface Substations

Surface substations should be located at ground level, although they may be located up to 2m above ground level, providing all of the transformer(s) access doors are at the same level.

These substations must be located fronting a public street or an all weather heavy duty access roadway capable of withstanding loads applied by vehicles transporting equipment to and from the substation. Access for all equipment and personnel must be through doors in the external wall or walls, as described in following sections. Surface substations shall be provided with a trench for the installation of bottom cable entry equipment.

This type of substation within a building must have at least one frontage in an external wall of the building, which faces an open, uncovered, unenclosed, outer area acceptable to ENERGEX. Locations in external walls, which face inner areas such as areas where access is or may be restricted, courtyard type areas or enclosed, partly enclosed or covered areas, are not acceptable.

7.2.3. Elevated Substations

In some special situations, where there are not technically viable alternatives, elevated substation may be permitted, where the floor level is up to 6m above the adjacent street or roadway level. The builder / owner must provide and maintain plant handling facilities to the satisfaction of ENERGEX. Elevated substations may be provided with a cable trench for the installation of bottom entry equipment, where appropriate. A suitable sign is to be placed inside and outside the substation, reminding the owner of their responsibility for building maintenance.

7.2.4. Basement Substations

This type of substation is located below ground level. In the case of a multi-level basement, the chamber substation is to be located on the first useable level below ground, provided the room is above the Defined Flood Level (DFL) prescribed by Council with the floor of the substation a minimum of 75mm above the DFL.

Access for equipment may be through hatchways. Personnel access must be through doors in the external wall or walls. Basement substations shall be provided with a cable trench for the installation of bottom cable entry equipment.

Conduits for cable entry to the substation may enter the substation room through a penetration in a wall, below the substation ceiling. This penetration must be adjacent to a side wall. The side wall is to be fitted with a vertically mounted cable ladder, so that the bending radius of the cable, from the penetration to the cable ladder, is not less than 1830mm. The cable trench is to be extended to the base of the cable ladder.

Basement substations must not be located where the access is off (or through) storage areas or similar facilities not acceptable to ENERGEX.

Equipment access via a ramp is acceptable, subject to the conditions stated in section 3.1.2 'Equipment'.

7.2.5. Upper Level Substations

This type of substation is located above ground level (usually in high rise buildings) where the elevation of the substation is so that it does not meet the equipment and personnel access requirements for a surface substation. Extra consideration should be
given to the location chosen for this type of substation, due to the nature of the equipment and personnel access requirements.

Upper level substations are normally used to accommodate distribution transformers and are installed in conjunction with switching stations.

7.2.6. Switching Stations

A switching station is a type of substation that does not contain any transformers; it only houses high voltage switchgear and other ancillary equipment\(^6\). Where a LV feed is required to the outside network, ensure that a transformer and LV distribution board is housed in the switching room. The associated transformers can be located in the same building, closer to the load centres in other substation rooms. Control and earth cables are to be installed between substation rooms.

Typical examples include:

- High rise buildings – switching station on lower / street level, transformers located on upper floors.
- Large factories – switching station on street frontage, transformers near LV switchboards.

Unless specified otherwise by this standard, the requirements for switching stations are similar to the requirements for indoor substations. Switching substations shall be provided with a cable trench for the installation of bottom cable entry equipment.

7.2.7. Metering Chambers

ENERGEX may agree to supply some customers at high voltage\(^7\). In these situations, a metering chamber may be required to accommodate the associated HV metering unit(s). Unless specified otherwise by this standard, the requirements for metering chambers are similar to the requirements for indoor substations.

8. Access

8.1. General

This section is applicable to all types of indoor substations, that is; surface, elevated, basement, upper level, switching stations and HV metering chambers. Unimpeded access to all ENERGEX substations must be maintained 24 hours a day, 7 days a week.

Bollards are to be placed outside doors, when there is a risk of personnel stepping onto roadways when using them or there is a risk of the door being blocked by such things as vehicles (including bicycles) or the storage of goods being delivered or awaiting collection.

Each door must be fitted with appropriate safety signs, as indicated by AS3000 and as per ENERGEX requirements.

Doors must swing in their own frames using heavy duty non-corroding metal hinges.

8.2. Personnel Access

Indoor substations require two dedicated personnel access doorways.

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\(^6\) Battery chargers, pilot wire cubicles and SCADA equipment.

\(^7\) Supply at high voltage is generally not available in the Brisbane CBD.
Note: Where it is not practical to provide diagonally opposite personnel access doors, appropriately positioned equipment access doors may be used instead, provided they are made lockable from the outside and are fitted with micro-switches to operate a local twin / single ballast light above the door (refer to section 7.1).

Personnel access doors must open outwards and provide a minimum clear opening 800mm wide.

These doors are also used to facilitate rapid escape in the event of a fire or explosion and must be fitted with an emergency escape panic bar. For this reason, personnel access doors should be located diagonally opposite, where possible.

Each door is to be fitted with a lock body 3572 series storeroom locking latch or similar, and fitted with oval cylinder available from ENERGEX stores to suit 570 cylinders or similar. It is required to be operated by key from the outside with the outside handle always being rigid, and with level handle or similar on the inside. The latch must be fitted so that there is no less than 10mm engagement of the latch bolt into the striker plate, when the door is in the closed position. The latch must have no less than 65mm back set. Each door is also to be fitted with a push plate and 200mm D handle on the outside of the door.

8.2.1. Upper level substations

Personnel access to an upper level substation is obtained from within the customer’s building. A right-of-way is therefore required from a convenient lift or stairway to the access doors. Access using fire stairs or a part of the building that may be tenanted is unacceptable.

8.2.2. Basement Substations

Personnel access is achieved using dedicated access points directly from the street level to the substation level.

Note: Where two or more substations are located adjacent to each other, it is not acceptable for any of the access doors, hatches or passageways to be shared between substations. Each substation must stand alone and have two access arrangements.

Personnel Hatchways

Personnel hatchways are no longer permitted

Personnel doors with stairs

Stairways must be large enough to allow for the passage of personnel and minor equipment. They must be no less than 1200mm wide and fitted with appropriate handrails. Headroom must be a minimum of 2200mm.

Stairways and passageways must be provided with lighting. Access doors should be fitted with micro-switches to automatically activate the stairway and / or passageway lighting (refer to section 7.1 for details).

8.2.3. Switching stations and metering chambers

Depending on their location, the personnel access requirements for these rooms are the same as those for surface or basement substations.

Equipment access doors are used during the installation and removal of major plant items such as transformers, HV switchboards and ring main units. They may also be utilised for substation ventilation and as such, are louvered.

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8 An equipment access door may already be in a position to serve the purpose of a personnel access door.
Substations must have sufficient equipment access doors to allow the installation and removal of each major plant item, without having to interfere with the other major plant items in the room.

It is preferable that the doors swing outwards to allow ready evacuation should the need arise. If inwards swinging doors are essential, then provision to maintain the minimum clearances around the substation equipment when the doors are in the fully open position must be provided, as is the provision for emergency evacuation of the substation. The developer must provide full details of how such egress is to be effected.

When outward swinging, the doors must swing to 180 degrees if sufficient manoeuvring space is available in front of the substation.

One door leaf must be secured in position with a shooting bolt at the top and bottom of each panel (refer to drawing 7874-A4). The top bolt is to have its shoot extended so that it is capable of operation without the use of a ladder (maximum of 2000mm from floor). Both bolts are to achieve a minimum of 25mm penetration into the sockets and shoots are to be machined to allow easy socket entry. Shooting bolts are to be of heavy duty non-corroding metal.

The other door leaf must be fitted with a lock body 3572 series locking latch or similar and fitted with oval cylinder available from ENERGEX stores to suit 570 cylinders or similar, operated by key from the outside where the handle is always rigid and a lever handle or similar on the inside.

Each door is to be fitted with D handles on both sides (refer to drawings 7874 and 7876 for further details – located in section 14).

8.2.4. Upper level substations

Access for small items of equipment can generally be undertaken using a goods lift; however, heavy items of equipment, such as transformers and switchboards, are required to be lifted up into the substation by an appropriate crane. This crane may be a mobile type, if the substation is within reach of the equipment handling area at street level, and road closure is easy to effect. However, if the substation is higher in the building, a permanent lifting device will be required. This may be a suitable strengthened building maintenance crane, a dedicated plant room lifting device or a dedicated substation lifting device as approved by ENERGEX.

Padmount transformers are not permitted on upper levels of buildings or under buildings or overhangs.

Access for equipment into the substation may be via doors or hatches (similar to those required for a basement substation).

8.2.5. Basement Substations

Equipment may enter and leave the substation via a dedicated equipment hatch. The equipment hatch must provide a clear opening of 2500mm x 3000mm and must be fitted with a retractable / removable safety guard (refer to drawing 7880-A4). ENERGEX should be consulted before construction, as room sizes may have to be increased to allow for the hatch cover. Where possible, locate the access hatch outside the substation room.

The centre of the hatch is to be within 5.2m of an all weather access roadway, which is suitable for heavy duty vehicles. If this requirement cannot be met, a permanent lifting device of a suitable capacity is to be provided for transportation of heavy equipment from the truck unloading area to the hatch. To allow crane access, a clearance of at least 600mm is required around all sides of the hatch. If the hatch is to be located within the substation room, the hatch is to be positioned so that there is a minimum clearance of 600mm to any wall or obstruction and there is no need to move any piece of
equipment, cables or cable ladders to gain full accessibility for any piece of heavy equipment.

The hatch should be positioned so that no equipment is placed directly underneath during normal operation. Where equipment which is being moved, must be turned within the access chamber, adequate clearance must be provided from walls and other pieces of equipment, cables and ladders etc.

The hatch cover is to be of a type approved by ENERGEX and must be designed and installed to allow for any surface finishing material and waterproofing. Surface finish and waterproofing of the hatch cover and surrounding area, must be so that removal and replacement of the hatch cover does not result in damage to either the surface finish of the hatch cover or surrounding areas. Hatch covers must comply with Australian Standards AS3996.

The hatch cover outlines must be clearly delineated in the surrounding surface finish. ENERGEX will seal the hatch cover in place after the final installation of equipment and at any time the hatch is required. An adjacent on site space must be provided for the temporary storage of the hatch cover, clear of the street and pedestrian thoroughfares. The area above the hatchway must be clear of other equipment.

A retractable/removable hatch safety guard is to be installed immediately below the hatch. The retractable hatch safety guard is to be operated by a hand winch, fixed to a basement wall adjacent to the hatch and approximately 1.2m above the floor level. Where the hatch is exposed to weather, and is installed within the substation room, the safety guard shall be weather proof and self draining.

Anchor points must be provided on opposite sides and adjacent to floor openings, at a minimum height of two metres. The anchors may be set into walls. If wall anchors are not practicable, then a suitable structure will be required.

8.2.6. Equipment

Large pieces of equipment such as transformers (up to 6 tonnes) require a mobile crane (up to 25 tonnes) and a heavy truck for movement to and from the substation. As such an all-weather access roadway suitable for use by these vehicles is required from the street to the substation. These access routes must have a maximum slope of no greater than 1:12.

Attention should be given to the transformer access route, as the maximum slope for a typical mobile crane can be no greater than 1:8.

A transformer handling area and room for vehicle manoeuvring must be allowed for, adjacent to the substation. The transformer handling area should be so that all the substation’s transformers can be stored there at any time. The grade/slope of the handling area should not exceed 1:20.

In the case of movement of Dry Type Transformers either by winch cables or skates, the maximum grade/slope must not exceed 1:200.

Equipment access doors are to provide a minimum clear opening of 3100mm. These doors should swing outward preferably. If inwards swinging doors are provided these must be positioned so that the minimum clearances around equipment are maintained when the doors are in the fully open position, and due regard for the provision for emergency evacuation of the substation must be taken, with the developer providing full details of how such egress is to be effected.

Suitable headroom is required along the route of passage of the vehicles and in the equipment handling area and vehicle manoeuvring room, so that operation of the crane is not impeded. The headroom required is no less than 5.5m for structures on a level access route. Where the access route for the crane is on sloping ground and/or where there are humps or dips in the access route, the headroom or structures must be
increased as necessary, to compensate for the position of the crane. Each case will need to be determined to the satisfaction of ENERGEX's Planning Officer.

To allow the delivery of plant, the width of the access route should be wide enough to accommodate a large crane or truck and should be increased on bends and in the manoeuvring area near the substation equipment access gate.

The above clearance requirements must be achieved after completion of building surface treatments; including cladding of overhead structures and paving of the access route.

Any reinstatement necessary in the event of damage to the concrete slab, paving tiles or road surfaces, doors etc is the responsibility of the owner of the property.

8.3. Multiple Feeder Application requiring Relay Protection

8.3.1. General

When the circuit breakers and switching stations are fed by multiple feeders requiring relay protection, approval must be obtained from Network Asset Management Planning Group Planners to ensure correct application of 11 kV switchgear.

8.4. HV Commercial & Industrial Substation

Refer to Network Building Blocks (BMS1615/Section 4.6.5).

For typical example of Major Customer Substation (Refer to Section 10, Dwg 17771-A3 Sh 1&2)

9 Construction of Indoor Substations

9.1 General

Building work must suit the general building construction and ENERGEX’s requirements, in accordance with local building regulations. Standard substation signs and danger boards will be supplied and installed by ENERGEX. The substation must be constructed above the Defined Flood Level (DFL), with the floor a minimum of 75mm above the DFL. Reinforced concrete floor slabs must be designed to support the loads indicated on ENERGEX’s accompanying drawings. No services other than ENERGEX’s or those serving their installation are to be contained in, pass through or pass under (if located on solid ground) the site.

The construction must provide a chamber that is dry and completely isolated from the remainder of the building by walls, floor, ceiling and doors giving at least a two hour fire barrier. The substation and associated chamber construction must prevent the entry of birds and vermin. All necessary vertical and horizontal damp proof courses must be provided, and the chambers must not impair the effectiveness of waterproofing and fire rating of the chambers. Walls, ceiling and floors, which depend on their thickness and/or the incorporation of an admixture for waterproofing, are not acceptable. Walls must be provided by a drained cavity of at least 50mm, while floors and ceilings must have an appropriate membrane applied to effect waterproofing.

Walls, floor and ceiling of chambers must be designed to adequately support any load likely to be superimposed thereon. No buildings services, other than those approved by ENERGEX must be contained in or pass through the site, or other services pass under the site if located on solid ground.

Attention is to be given to the encroachment of any column or beam into the substation chamber or its associated access passageways and ventilation ducts, so that the clearance outlined in this document are not reduced.

9.1.1 Walls
The walls of the substation and associated chambers must be constructed of light coloured solid clay bricks not less than 230mm thick, solid concrete blocks or pre-case reinforced concrete of not less than 190mm. Mortar joints must be iron jointed, to ensure a smooth fair finished wall surface, which is free of mortar protrusions.

All substation walls below ground level built against natural excavation or where a retaining wall is used to retain natural excavation, a drained cavity not less than 50mm is to be formed on the outside of the substation wall. Sole reliance of a waterproofing membrane in these situations is not acceptable. Any cavity constructed in conjunction with a substation or associated chamber, is to extend below the level of the lowest pit in the substation chamber and be drained to a point free of surcharge. Walls are to be so designed that they withstand any loads imposed on them by the substation and/or the building structure. Any penetration in the walls is to be sealed, to prevent the ingress of water.

Reinforced concrete columns are permitted in the substation chamber, however any column incorporated into the walls is to be positioned so that it is flush with the interior of the substation wall. The joints where brick walls abut a column are to be so that the fire rating and waterproofing of the wall is not impaired.

The areas surrounding any pulling eyes (which maybe attached to a wall), are to be suitably reinforced, so that the use of the pulling aye does not cause damage to the wall.

Where expansion of control joints are incorporated in any substation wall, these features must have a fire rating and waterproofing equivalent to the substation chamber.

### 9.1.2 Floor

The floor of the substation and any associated chamber is to be designed by a practising structural engineer and be capable to carry the loads of substation equipment, together with any loads imposed by the building.

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. Differences in floor levels between the substation chamber, associated chambers and the outside access areas, must be as outlined in Section 3 Access. Provision is to be incorporated in the floor slab, for any floor hauling eyes/anchors or recesses. Floor slab construction must take into account the depths of pits and floor chases, so that the headroom of the substation chamber is not decreased.

The floor of the substation room housing dry type transformers, much be sealed with a concrete sealer to minimise dust.

**Note:** The construction method for the floor slab must provide for a minimum concrete encasement of 150mm for any conduit, which is located in any void between the finished substation floor slab and a structural slab.

Reference should also be made to Section 5 Earthing in regard to floor slabs. A buried electrode system is required to be installed in the ground directly under the substation floor or in the case of suspended floor, at the lowest level of excavation directly below the footprint of the substation.

### 9.1.3 Ceiling

The ceiling slab of the substation and any associated chamber is to be designed by a practising structural engineer and be capable of carrying the loads likely to be imposed thereon. It must be of a fire rating, not less than the remainder of the substation chamber and must incorporate any required waterproofing membrane. The concrete formwork finish must be Class 2 or better. If the ceiling is not plain reinforced concrete but incorporated ribbed steel formwork left permanently in place or exposed steel
beams, then the exposed steel will have to be sprayed to achieve a fire rating not less than the remainder of the substation chamber.

When the slab forming the ceiling is of prestressed or post-tensioned construction, then the wire strands forming the tensioning and any anchor mechanism must be fully protected to achieve a fire rating comparable to the remainder of the substation chamber.

The ceiling slab should be positioned to give headroom of not less than 3.2m. The position of any beams in the ceiling should be so that the 3.2m headroom is maintained. The preferred minimum ceiling height for Top entry Indoor type substation is 3.75m and Bottom entry is 3.2m.

9.1.4 Painting

Internal walls and doors of the substation and associated chambers are to be painted firstly with a coat of acrylic based filler/sealer, then painted by the builder to BS 381C No. 384 “Light Straw” or similar.

The ceiling is to be completed with gloss/semi gloss ceiling white.

All exposed non-galvanised metal must be primed with an appropriate etch primer and finished in two (2) coat of grey paint, either enamel or acrylic based. External doors can be finished in colours to suit the building décor. Louvers can be finished in colours to suit the building décor, however if they are to be left in natural aluminium they must be finished with a grade A coating of clear anodising, followed by a coat of clear methacrylate lacquer or equivalent.

9.1.5 Cable Risers

Cable risers must be positioned so that personnel access is not impeded by the need to remove plant and equipment.

The cable riser must be vertical construction; no bends, corners etc are permitted. Harness points for electrical workers are required and should be located 1.5m above floor level and below the ceiling/floor slab above (ie 2 per floor). Refer ENERGEX Planning.

A standard sized cable riser of 900mm x min 300 (max 450mm), is sufficient for up to 4 x 11kV cables, control cables and 2 earthing cables.

Full access to cables is to be provided at all times. To achieve this, the cable riser is to be provided with full width doors, on each floor, for the full height of the riser. The height of the cable risers can be divided into multiple door panels provided the fire ratings are not reduced at panel joints and any frames between the panels do not impede access to the cables. The doors are to provide a 2 hour fire rating and should be arranged to provide full access when they are fully opened. It is preferable to have 180 degree swing on these doors. Doorways are to be fitted with a removable safety chain barrier across the doorway on the inside of the cable riser.

If the width of the riser is covered by a single door, it is to be provided with a series of latch bolt (or similar), with oval cylinder operated by a key from the outside. The latch must be fitted so that there is no less than 10mm engagement of the latch bolt into the striker plate when the door is in the closed position. The latch must have no less than 65mm back set.

If the width of the riser is covered by a double door, one door leaf is to be provided with a series latch bolt (or similar), with oval cylinder operated by a key from the outside. The latch must be fitted so that there is no less than 10mm engagement of the latch bolt into the striker plate when the door is in the closed position. The latch must have no less than 65mm back set. The other door leaf is to be secured in position with a shooting bolt at the top and bottom of the panel. The top bolt is to have its shoot extended, so that it is capable of operation without the use of a ladder. Both bolts are
to achieve a minimum of 25mm penetration into the sockets and shoots are to be machined, to allow easy socket entry. Shooting bolts are to be of a heavy duty non-corroding metal. Each door leaf is to swing on its frame, using heavy duty non-corroding metal hinges.

A minimum clear area of 1.5m is required in front of the cable riser doors.

When the cable riser extends above, a false ceiling access to this area is to be achieved by locked fire rated doors, as previously described. A section of the false ceiling is to be readily removable to allow access and a clear space of 1.5m measured from the outside of the doors, is to be available. Building services are not to be run in this clear zone.

Cables in the riser are to be secured using cable cleats spaced at a minimum of 1m intervals. Cable cleats should be fixed using non-ferrous nuts and bolts, to prevent localised heating or eddy currents.

9.1.6 Cable Tray and Support Brackets

Cable tray should be installed so that clearances set out in this manual are not encroached. All brackets should be 600mm centres. Refer to drawing 7879 A4 for further detail.

A stabilising bar must be fitted to cable support brackets and fixed to an end wall to stop the brackets twisting during cable pulls. All cable tray and cable support brackets must be earthed by 70mm cable.

10 Ventilation

10.1 General Information

To ensure adequate cooling of transformers, mechanical ventilation of any indoor ENERGEX substation requires a forced ventilation system. The ventilation system must be designed to operate with positive pressure and to dissipate heat emitted from transformers during normal operation. While cooling inflow may only be required during times of peak load or high temperatures, it is required that positive airflow is maintained at all times to prevent the ingress of contaminants.

10.2 Fans

Cooling fans are to have low tip speeds and be either continually running or thermostatically controlled. Where thermostatically controlled fans are used, an “On/Off/Auto” switch shall be mounted inside the substation room. The sound pressure level of fans is not to exceed recommendations of the Australian Building Code and in accordance to the Environmental Act, which recommends noise produced must be less than 3DB above ambient level, as measured as the receiver. To ensure ease of access for maintenance, fans must be mounted outside the substation room and not over equipment, while allowing easy access via a ladder.

10.3 Fan Settings

For thermostatically controlled fans, ventilation fan control is to be set to operate at 28°C ambient air temperature and cut out at 24°C. Temperature sensors are to be located inside the substation room, up high on the wall housing the outlet vents, and positioned so that they are able to detect the temperature of the outgoing airflow.

10.4 Positive Pressure

To ensure positive pressure, it is acceptable for a smaller fan to be fitted, allowing positive pressure to be maintained whenever cooling airflow is not required. In all cases, the pressure being maintained must be high enough to prevent the ingress of dust and chemical fumes through openings in the room. At least one fan capable of maintaining positive pressure in the substation room should be active at all times, to prevent the ingress of dust and
contamination. Where this fan is installed as part of a separate system, the quality of inlet air for this fan is subject to the same requirements as external vents used to supply cooling air. In situations where filters are required for cooling fans, the air supplied by this fan must also be filtered.

10.5 Air Source Requirements

The nominated air source for incoming air is to be fresh outside air and external inlet vents are to be located away from all substantial known heat sources, including substation outlet vents. It is desirable that external outlet vents are open to fresh air, but may be vented to indoor areas such as carparks, provided that sufficient airflow is available to safely remove hot and potentially smoke-filled air from the structure. Outlet vents must not terminate in areas where heat or smoke dissipation will cause inconvenience or are subject to fire risk. Areas such as those under awnings, under carpark ramps or adjacent to foyers or lobbies, are to be avoided. Where it is impossible or impractical to directly vent outlet air from the substation room, ducting must be provided to redirect the air to a suitable location.

Incoming air must be filtered.

Where the air source used is likely to contain corrosive or conductive substances, such as cement dust, salt deposits or coal dust, the incoming air must be filtered. This may only be a requirement during building works while the sub is being built and/or immediately after substation commissioning and ongoing building works on nearby sites, or may be required on a permanent basis, depending on the location of and environment of the building.

10.6 Cooling Requirements

The airflow should be blown into the substation near the floor and exhausted from the top of the room. Where possible, a dedicated inlet should be provided for each transformer, so that air will be blown across/through the transformer. Where this is not possible, shared ventilation may be acceptable, provided that vanes are fitted to direct the airflow from a single duct across multiple transformers. The flow of fresh air into the substation room is to be 1330 Litres/second per transformer, and the inlet and outlet cross-sections must be designed so that the flow speed of the cooling air remains below 1.5m/s.

10.7 Ventilation and Ducting

10.7.1 General Requirements

All air ducts should be a minimum length possible, and bends in the ducting and changes in cross-sectional area should be limited. The aspect ratio of all ventilation ducts, inlets and outlets shall be kept as close as possible to 1:1 and shall in no case exceed 4:1. Including the effects of filters where fitted, the overall impedance of the ducting system must be less than 250Pa. Ducts of over 10m in length must be approved in writing by an ENERGEX Officer, to ensure their compliance with this requirement. Conditional approvals may be granted, which allows the design to proceed, subject to specific changes being made to the submitted design.

All unfiltered external vents and duct endings are to be fitted with louvers, which are to be covered with vermin-proof screens.

It is preferred that external inlet and outlet ducts or vents are located on different sides of the building. The distance between any part of the termination openings for inlet and outlet ducts is to be not less than 6m, measured in a direct line in free air or around wall faces. The level of the bottom of the outlet opening is to be at least 1.2m above the top of the inlet opening.

The bottom edge of any duct opening is to be no less than 3m above any area where pedestrian traffic can be anticipated. If this is not practicable, the height of the bottom of the opening can be reduced to 2.3m, providing upward deflecting guide vanes are fitted to the outside of weatherproof louvers.
Efforts must be undertaken to ensure that rain or moisture is prevented from being sucked into the substation. As a guide, this may mean that airspeed through external air intakes should not exceed 2.5m/s and carefully considering design requirements where upward deflecting guide vanes are fitted.

Ducts should not be located anywhere that there is a reasonable possibility that the openings could become fully or partially blocked, or otherwise rendered unsuitable or ineffective by future development.

Louvered door or panel type ventilation is not acceptable in situations where heavy pedestrian traffic occurs, such as in shopping centres, at bus stops or in the CBD. In these situations, ventilation of the substation chamber requires ducting to a suitable venting location.

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

Where a concrete plenum is to form part of the ventilation system, the inside concrete surfaces are to be sealed with a concrete sealer and ensure that all water shall be diverted away from the area at all times.

10.7.2 Inlet Ventilation

Where possible, the ventilation ducting system shall be installed on the outside of the substation room. If this is not practical, ducting can be installed inside the substation, however the room size may have to increase to comply with appropriate clearances set out in this manual. Transformers must be located as close as possible to the ventilation louvers/inlets, after taking into account the required clearance of 900mm. For dry type transformers, there must be 100mm clearance between the bottom of the ventilation duct and the floor, to ensure efficient airflow up through the enclosure and the cores of the transformer, while minimising the risk of blowing dust and other contaminants into the transformer.

Where a concrete plenum is to form part of the ventilation system, the inside concrete surfaces are to be sealed with a concrete sealer, so that concrete contaminants are reduced for dry type transformers.

10.7.3 Outlet Ventilation

The preferred outlet ventilation method for indoor substations is through the use of large open vents to allow hot air to escape the substation room. These vents are to be as high as possible on the substation wall to allow the escape of hot exhaust air. Substation outlet vents must be provided on the opposite wall to inlet vents. As circulation paths are to be kept as short as possible, it is desirable that an outlet vent is located directly opposite each inlet vent within the substation, although this may not always be possible.

Upper level chambers are generally located on the outside face of the building, due to ease of heavy equipment access. In the case of these substations, the outside wall is to be fully louvered, where possible, to form a single large air outlet.

Where outlet ducting is required, this ducting must comply with the requirements of a standard outlet vent, in that the substation outlet vent shall be located as described above, and the cross-sectional area of the duct shall be at least equal to the area of the substation outlet vent. The external outlet vent shall be located as high as practical to allow for good ventilation through convective flow, and must also have a cross-sectional area at least equal to that of the substation outlet vent. Where this is difficult to achieve, it may be a requirement that extraction fans be installed.

10.8 Fire Damper
A fire damper is to be fitted to all inlet duct openings at the substation end and to the outlet duct opening in the case of suburban type substations. In the case of CBD type substations, the outlet damper is to be part of the fan unit. Where dampers project into the substation chamber, they must be provided with guards sufficient to provide protection from personal injury. Such guards must not impair the operation of the damper or reduce the required equipment clearance limits stated in this manual.

Dampers must be connected to a mechanically operated tripping system that holds open against a spring during normal operation. The tripping mechanism must be activated by fire in the substation chamber and be arranged so that moving parts do not fall onto live equipment.

10.9 Wiring

The ventilation system must be fed from the Fire Essential Section of the Main Switch Board. This is to ensure that power to the fan system is continually available from the building’s essential services. It should be ensured that the fans can be electrically isolated from the Main Switch Board, to safely allow for maintenance on fans and filters without disabling other essential electrical systems.

10.10 Approval

Mechanical ventilation of any ENERGEX substation is to be designed and approved by a Mechanical Engineer who is a Registered Professional Engineer of Queensland and the certification forwarded to ENERGEX Planning before installation.

10.11 Maintenance

Upon hand over control to ENERGEX of the substation, the ventilation system is the responsibility of the building owner.

Filters to inlet and outlet vents and grills must be periodically cleaned, and access requirements should be considered during design. Fans should regularly be inspected to ensure operation and shall be replaced as soon as possible if found to have failed, and suitable alternative measure/s put in place until the fan/s have been replaced and are operational. Any maintenance work that will result in a reduction of airflow to the substation room shall not be planned between the hours of 11.00am and 3.00pm during summer months.

Where air filtering is required, it is the responsibility of the building owner that the filters be regularly checked, so as to ensure that adequate airflow can be maintained and where necessary, filters be replaced.

10.12 Related Drawings

See Section 11 for Ventilation drawing 7900-A4.
11 Substation Light and Power

11.1 General

The substation light and power system is installed and maintained by the customer at no cost to ENERGEX.

Lighting of the substation and associated chambers must be fluorescent and provide a minimum of 110lux throughout the entire room. Light fittings must be positioned, so that damage is avoided and the fittings do not interfere with doors, hatchways, cables and other associated substation equipment. Light fittings must be wall mounted or ceiling mounted and must not be located over HV switches, transformers, LV switchboards, protection panels (if required) or other equipment. Hanging light fittings with chain supports or similar are permitted when cable trays obscure light from ceiling mounted lights and must not be located over HV switches, transformers, LV switchboards, protection panels (if required) or other equipment. Minimum mounting height is to be no lower than the bottom of the cable tray.

The opening of any personal access door or equipment hatchway must automatically activate substation lighting. Micro-switches should be fitted for this purpose.

In addition to the micro-switches, heavy duty light switches are to be installed adjacent to each personnel access door or equipment hatchway.

Micro-switches are to be fitted to access doors for lighting in passageways leading to substations. ENERGEX to fit sign “Access to ENERGEX Substation” to door.

Light and power circuits must be wired in accordance with AS 3000. This applies to all indoor substations that accommodate GT, RMU or switchgear. Supply to the sub-board shall be taken from the customer’s metered supply at the main switchboard and shall be connected through the essential building services main switch (where provided).

11.2 CBD Mesh Substations

Supply must be taken from the customer’s metered supply and be connected through the essential building services main switch (where provided). The cable to the sub-board must be 900mm in excess, to allow for ENERGEX to install a change over switch (if required).

The battery charger is to be supplied from a separate dedicated circuit from the customer’s metered supply.

Where requested, the LV sub-board must be mounted 1500mm above the floor and consist of the following circuits:

- 1 x 3 phase – 30A supply – to a 5 pin 30A outlet mounted 1200mm above the floor below the board
- 1 x 3 phase – substation ventilation fan/s if required
- 1 x 1 phase – substation lighting
- 1 x 1 phase substation GPO
- 1 x 1 phase – 10A battery charger supply permanently connected – to a 10A outlet mounted 1200mm above the floor and below the sub-board

Note: All GPOs must be protected by an RCD
12 Fire Protection

The fire rating and protection system must be completed and certified by the appropriate authority, before the substation will be energised. This certification should be forwarded to ENERGEX. Fire protection and detection systems, installed by the builder inside any substation, are subject to final approval by ENERGEX.

Fire detectors fitted in indoor type substations should be dry head type only. Under no circumstances, should water be discharged within the substation area.

Where CO2, BTH or BCF are installed by the builder, a “SHUT OFF” value is to be installed for use while ENERGEX operating and maintenance personnel are inside. Substations and their associated ventilation shafts, cable entries and cable risers etc are to comply with a 2 hour fire rating and should have suitable fire rated doors and mechanically operated fire damper systems.

Dampers must be connected to a mechanically operated tripping system that holds them open during normal operation. The trip must be operated by fire in the chamber and be arranged that moving parts do not fall near or on live equipment. If the substation is top entry, then tripping mechanism is to be positioned under the cable ladder.

Fire barriers are to be fitted in the cable risers on each floor, through which the riser passes and rated to match the 2 hour substation requirements. The fire barriers are to be readily removable and any supporting framework should not interfere with the cables or decrease the cable riser access sizes.

All cables and or busbar openings into the substation are to be sealed after installation, so that the completed installation has an equivalent fire rating to the substation walls. The sealant must be suitable for any fire rating applications and installed according to any relevant Australian Standards.

For HV feeder cables requiring a fire rating, the installation of cables on cable trays with removable fire rated covers is not acceptable. In these cases, the cables must be installed in 2 hour fire rated conduits or conduits within a 2 hour fire rated enclosure.

Fire extinguishers are no longer installed in indoor substations. When carrying out works within C&I substation, appropriate fire extinguishers must be carried by work crews while on site.
### 13. TYPICAL SUBSTATION ARRANGEMENT

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OUTDOOR ENCLOSURES
Typical Enclosure Layout for
1 & 2 Outdoor Type RMU’s
7852-A4

Not to Scale
OUTDOOR ENCLOSURES

Typical Enclosure Layout for 2 Transformers & 2 RMU's

7853-A4
PLAN

40NB pvc conduit for metering cables

See NOTE 3

900x600x400
Metering Box supplied by ENERGEX and installed in wall/fence by builder.

See NOTE 3

Equipment access gates, 2100mm clear opening
See NOTE 4.

Alternative positions for personnel and light equipment
and light equipment access gate.
See NOTE 4.

4 Electrical conduits

Reinforced concrete slab across cable trench.
Floor anchor

6 Earthpockets with chases. Refer to dwg 7919-A4 for detail.

NOTES:
1. Customer to take supply from load side of metering unit.
2. 900H x 600W x 400D Revenue metering enclosure to be installed in wall/fence by builder.
   Contact ENERGEX OPERATIONS for wired meter panel and wiring drawings
3. Meter box to be earthed to substation earth when meter box is part of substation wall.
   Earth Mat Gradient 1 in 1000 x 1000mm
4. Reinforced concrete landing slab

OUTDOOR ENCLOSURES
Typical Enclosure Layout for
1 Transformer and 1 RMU &
1 HV Metering Unit & 1 RMU

7855-A4
NOTE 1
The crosshatched area shown on the plan is to be excavated to a depth of 1200. When the 11kV cable has been installed by ENERGEX then the excavation shall be backfilled with sand or lean, compacted and skin with 50 thick of 116 ratio weak mix concrete by the owner of the premises.
NOTE:
Where enclosures are located adjacent to buildings (or other structures that reduce security) the following conditions will apply:

(A) A roof should be constructed over the enclosure and the site treated as an indoor type, OR

(B)

1. Windows above the substation must be fixed closed.
2. No services including down pipes to pass through the substation area.
3. Where windows cannot be fixed closed, a mesh frame will be constructed over the enclosure.

The size of the Galvanised mesh frame will be a maximum width of 2.4m and fitted with 4 lifting lugs for removal. The frame will be located 2.5m above the equipment floor. The mesh will be able to carry the weight of 100kg point load at centre.
R.C. slab across cable trench. Maximum load 250kgs at centre.

Alternative personnel access

4. Loose steel supports for equipment.

Electrical conduits.

PLAN

Earth Mat Gradient Ring 1000 x 1000mm connected to Meter Box. 900x600x400 Metering Box supplied by ENERGEX and installed in wall/fence by builder.

40NB pvc conduit for metering cables

See NOTE 3

Operating Side

Clear opening

Reinforced concrete loading slab

6 Earth packets with floor chases. Refer dwg 7919-A4 for detail. Equipment and personnel access doors

Ceiling

SECTION

Cable pulling eye

NOTES:
1. Customer to take supply from load side of metering unit.
2. 900H x 600W x 400D Revenue metering enclosure to be installed in wall/fence by builder.
   Contact ENERGEX METERING OPERATIONS for prewired meter panel and wiring drawings.
3. Meter box to be earthed to substation earth when meter box is part of substation wall.
4. Metering Cables not sheathed nor earthed.
R.C. slab across cable trench
Maximum load 250kgs at centre

Alternative personnel access

4 Loose steel supports for Equipment

40NB pvc conduit for metering cables

MU

RMU

Operating Side

PLAN

Electrical conduits:

6 Earth pockets with floor chases. Refer dwg 7919-A4 for detail.

Equipment and personnel access doors

Ceiling

900x600x400

Metering Box supplied by ENERGEX and installed on wall by builder.

NOTES:
1. Customer to take supply from load side of metering unit.
2. 900H x 600W x 400D Revenue metering enclosure to be installed in wall/fence by builder.
   Contact ENERGEX METERING OPERATIONS for prewired meter panel and wiring drawings.
3. Meter box to be earthed to Customer MEN or Seperate Earth Spike.
4. Meter Box mounted outside of room.
5. Metering Cables not sheathed nor earthed.
Notes.
1. For details of the trench under transformers, refer to 7930-A4-Sh.2.
2. (a) In some circumstances LV board may not be required.
   (b) LV board may be located against wall when Energex intake cable DO NOT enter sub through the same wall.
   Refer section 1.4 for detail & confirm with Energex planning officer.
3. Ventilation duct openings to be 100 from floor. Extraction fans to be installed on opposite side of room when ventilating louvers are not used.
4. This door may not be required if an equipment access door for bottom entry equipment — 3200 mm.
   is suitably located and can also serve as a personnel access door.
5. Ceiling height for top entry equipment — 3750 mm.
6. Field Test to test controller in Temperature settings & commission.
7. LV isolators (Dwg 7940-A4) shall be used with Dry Type Transformers in CBD & high rise buildings.
   (Refer to section 1.4.)

Indoor Substation
Typical Layout - Minimum Clearances
Satelink (CFCF) RMU, 2 x Dry Type
Transformers & LV Switchboard
LV Isolator

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Notes:
1. For details of the trench under transformers, refer to 7830-A4-Sh.2
2. (a) In some circumstances LV board may not be required.
(b) LV board may be located against wall when Energex intake cable DO NOT enter sub through the same wall.
   Refer section 1.4 for detail & confirm with Energex planning officer.
3. Ventilation duct openings to be 100 from floor. Extraction fans to be installed on opposite side of room when ventilating louvers are not used.
4. This door may not be required if an equipment access door is suitably located and can also serve as a personnel access door.
5. Ceiling height for top entry equipment = 3750 mm, for bottom entry equipment = 3200 mm.
6. Field Test to test controller in temperature settings & commission.
7. LV isolators (Dwg. 7940-A4) shall be used with dry type transformers in CBG & high rise buildings (Refer section 1.4).

Indoor Substation
Typical Layout - Minimum Clearances
Safeplus HV Switchgear, 2 x Dry Type Transformers & LV Switchboard
LV Isolator
Notes:
1. For details of the trench under transformers, refer to 7881-A4
2. (a) In some circumstances LV board may not be required.
   (b) LV board may be located against wall when Energey intake cable DO NOT enter sub through the same wall.
   Refer section 1.4 for detail & confirm with Energey planning officer.
3. (a) Ventilation duct openings to be 100 from floor. Extraction fans be installed on opposite side of room
    when ventilating louvers are not used. (b) If ventilation duct is greater than 300, room size must be increased to maintain 900mm clearance to transformer.
4. This door may not be required if an equipment access door is suitably located and can also serve as a personnel access door.
5. Ceiling height for top entry equipment - 3750 mm, for bottom entry equipment - 3200 mm.
Personnel and equipment access door with reinforced concrete landing slab

Reinforced concrete loading slab

Two equipment access doors

Electrical conduits

RP Boundary

FOOTPATH

Alternative personnel and equipment access door

Reinforced concrete slab across cable trench
Maximum load 25t at centre

Earth pockets with chases

PLAN
(Not To Scale)

TYPICAL CABLE LADDER
USE UNISTRUT CHANNEL
(Not To Scale)

Footpath Level

Cable ladder

Cables

1000

SIDE ELEVATION
Scale 1:125

NOTES:
1. For further substation detail and dimensions refer to B426-A4
General Indoor Substation in Basement
Remote from Footpath
8773-A4

NOTES:
1. For further substation detail and dimensions refer to 8426-A4.
2. Minimum width of the cable rest must be 600mm. For multiple transformer stations cable rest to be 1000mm wide.