Distribution Standard

Building Type Substations and Switching Stations

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Authorisations

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Responsibilities

This document is the responsibility of the Substations Asset Strategy Team, Tasmanian Networks Pty Ltd, ABN 24 167 357 299 (hereafter referred to as "TasNetworks").

Please contact the Asset Strategy Team with any queries related to this standard.

Record of Revisions

Version	Description	Date
1.0	Original issue. Supersedes standard R73554	6/12/2018
2.0	Section 5.6 - Secondary systems revised	20/1/2020
3.0	Section 5.5.2 – Transformer rating table updated Section 5.5.4 – Additional information provided for cables sizing Section 5.6 - Additional information provided for secondary systems Appendix A - Substation standard configurations revised Appendix B - Substation standard equipment details added Appendix C - Substation standard layouts updated Appendix C- Substation standard design drawings included	17/4/2023

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1 Introduction

This Distribution Design Standard for Building Type Substations and Switching Stations contains the approved design requirements and process considerations for the design of building type distribution substations and switching stations that are to be connected to TasNetworks' electrical distribution network.

The application of this design standard applies to both new and existing installations. All new designs must be fully compliant with this standard unless prior approval for non-compliance has been provided by TasNetworks' Asset Strategy Team.

This standard will be periodically updated. It is the responsibility of the user to ensure the latest version of the standard is being used.

1.1 Scope

This standard only applies to building type substations and switching stations supplied at voltages of 22 kV or below.

Building type substations and switching stations are integrated into larger privately owned buildings. The substations are supplied from the distribution network at either 11 kV or 22 kV, comprise high voltage switchgear, one or more transformers, a low voltage switchboard usually provide a low voltage supply to domestic and/or commercial customers at 230/400 volts.

Switching stations are usually installed to provide a dedicated high voltage customer supply. They do not contain transformers.

Historically building type substations have also been of a standalone construction, but this type of construction is no longer undertaken. If a building integrated substation is not required, then it must be a kiosk type construction.

New building substations are required to be connected to and supplied from the existing distribution network. The existing network at the point of connection may comprise underground or overhead infrastructure. The connection to the network must comply with the relevant design standard. References to these standards are provided in Section 1.4.4.

All equipment used must be TasNetworks' approved standard equipment. Variations from the standard equipment must only be used with prior approval from TasNetworks.

1.2 Service conditions

TasNetworks' high voltage distribution network operates at either 22 or 11kV, with the supply originating from either a transmission terminal or zone substation.

Under normal operating conditions the operating voltages on the distribution network feeders may vary between -6% and +10% of their nominal voltage.

The low voltage distribution system supplied from ground mounted substations is nominally a 400/230 V, three phase, 50Hz, four wire CMEN system, to which are connected residential, commercial and industrial customers.

The maximum fault levels of the high voltage and low voltage systems are listed in

Table 1.

Table 1: Distribution network fault levels

Voltage	System	Fault level (kA)	Duration (s)
22 kV	Primary feeder	16	1
11 kV	Primary feeder	16	1
230/400 V	Reticulation, single supply transformer	50	1
230/400 V	Reticulation, multiple supply transformers	100	1

The environmental conditions encountered in Tasmania are defined in Table 2.

Table 2: Environmental conditions encountered in Tasmania.

Environmental condition	Value
Number of days per year of lightning	<20
Altitude	<1500 m
Ambient temperature range	-7ºC to 40ºC
Average outdoor ambient temperature: Minimum Maximum	 0ºC 24ºC
Annual rainfall range	600-2500 mm
Pollution of atmosphere	Normal
Humidity within substation enclosure	Up to 100%
Solar radiation level	Up to 1100 W/m^2 with high ultra violet (UV) content
Maximum wind velocity	210 km/h
Atmospheric, mechanical and chemical impurities	Mild to moderate as per AS/NZS 2312

1.3 Definitions

Table 3: Definitions

Term	Definition
ADMD	After Diversity Maximum Demand is the simultaneous maximum demand of a group of customers divided by the number of customers, expressed in kilovolt amperes.
ALARA	As low as reasonably achievable
ALARP	As low as reasonably practicable
Building substation	A substation within building containing HV switchgear, transformers, an LV switchboard and ancillary equipment.
CBD	Central business district
CMEN	Common multiple earthed neutral system
Earth	A conductor connected to an earthing system.
Earthing system	A conductive network, typically installed below ground for the purposes of providing a path for fault current.
Earth grid	A copper grid installed in the ground below a substation for the purposes of providing a path for fault current.
Easement	A right enjoyed by a party with regard to the land of another party, the exercise of which interferes with normal rights of the owner or occupier of that land.
EMF	Electrical and magnetic field
Isolated substation	A standalone substation that is not part of a larger building.
Integrated substation	A substation installed within a larger privately owned building
Kiosk substation (Padmount)	A ground mounted substation where all the equipment is installed within a single enclosure, usually consisting of the enclosure, high voltage switchgear, transformer(s) and low voltage switchboard. The substation is usually supplied as a complete assembly and is installed or replaced as a unit. The equipment is enclosed in a common weatherproof housing with limited access. Provision is made for replacement of individual components.
NCC	National Construction Code
NCC Class 1	A building classification as defined by the NCC
NCC Class 2	A building classification as defined by the NCC
Switchgear	Electrical equipment used for connecting and disconnecting electrical infrastructure on the network. The term may is often used in reference to switchboards or individual switchboard components e.g. circuit breakers, line switches etc.
Switchboard	An assembly used for the switching and control of electrical circuits. A switchboard would comprise a combination of switches, circuit breakers and secondary protection devices where circuit breakers are installed.
Switching station	A ground mounted installation used for switching high voltage feeders. These installations can be used as HV customer supply points. Switching stations contain high voltage switchgear, but do not contain transformers. Unlike substations they do no and do not provide LV supply to the distribution network.

1.4 Asset Records

TasNetworks' asset records are managed by the Operational Technology group. For the purposes of distribution network design, the following applications are relevant:

- SAP: This is the system used by TasNetworks for the management of its business activities, including asset and works management. The system is used as the master database for asset records.
- NetMaps: A Geographic Information System (GIS) which provides a plan view of the distribution network super imposed on a graphical view of the state. Figure 1 is an example of the typical network plan that it provides.
- Operational schematics: These are schematic drawings of the electrical network providing a more detailed view of the interconnection of the HV distribution network. Figure 2 is an example of typical schematic.
- Single Line Diagram: These are site specific electrical schematics are usually available for both the HV and LV equipment. These schematics are a critical component of a new substation design.

Figure 1: Netmaps view

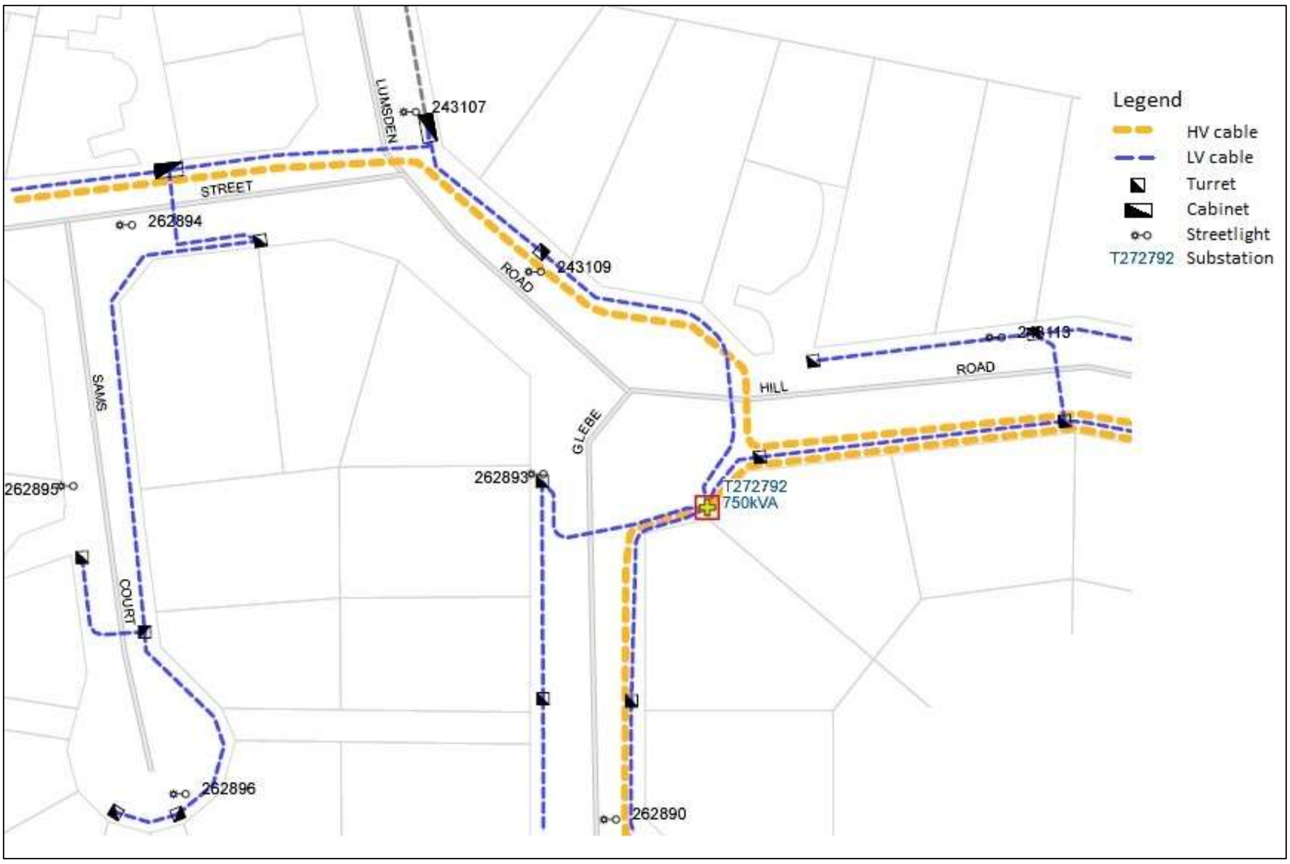
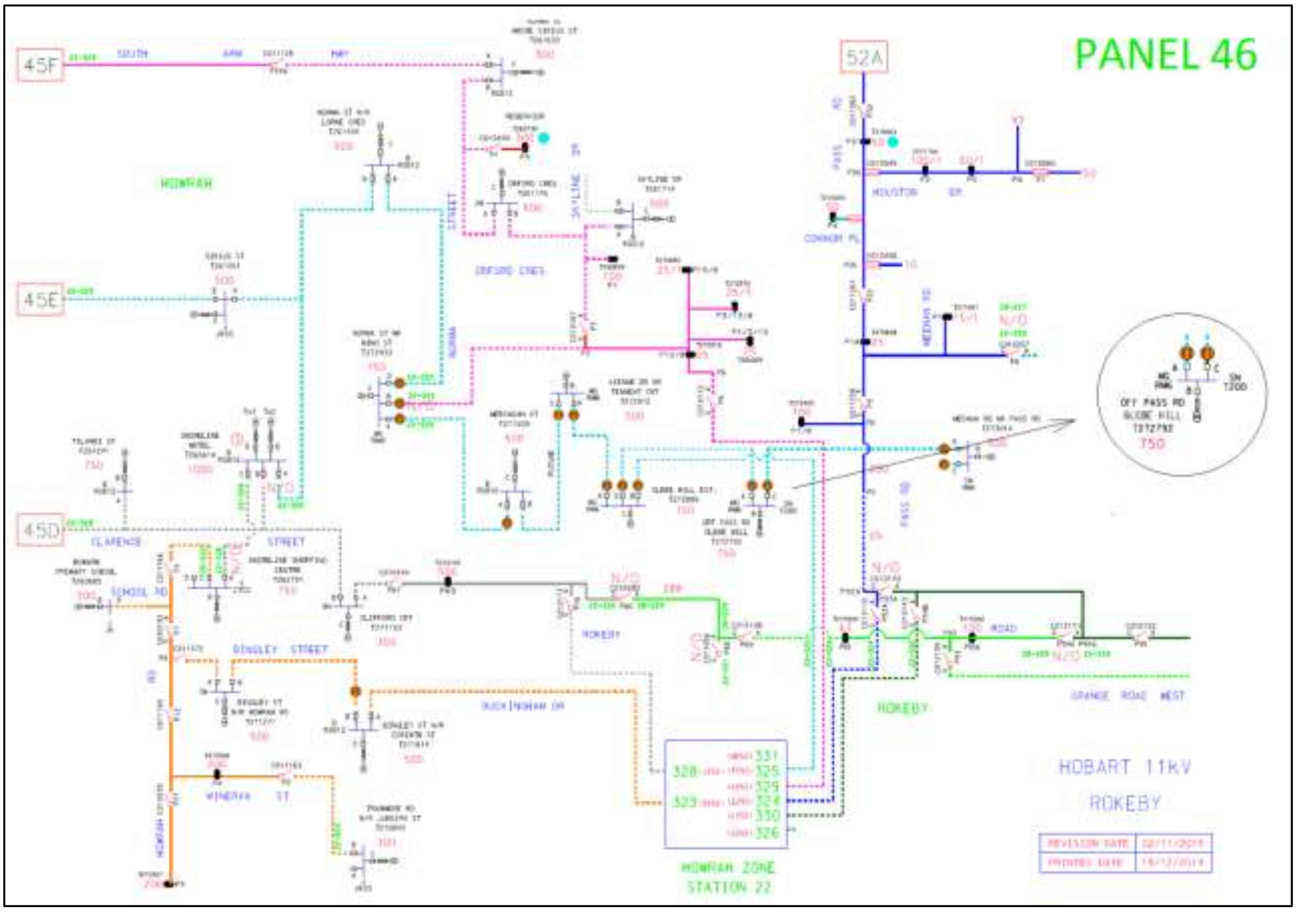


Figure 2: Typical operational schematic



1.5 Acts, regulations and standards

New designs must be fully compliant with all relevant legislative requirements, standards and guidelines. The most up to date regulations and standards must always be used.

The regulations, standards and guidelines listed in the section are relevant to distribution network design and have been provided to assist in undertaking designs. The documents listed in this section are not an exhaustive list and the design must ensure that it is compliant with all relevant regulations and standards.

1.5.1 Acts and regulations

Acts and regulations relevant to distribution network design include:

- Aboriginal Relics Act 1975
- Electricity Supply Industry Act 1995;
- Electricity Supply Industry (Tariff Customers) Regulations 2008;
- Workplace Health and Safety Act 2012
- Workplace Health and Safety Code 2012
- Workplace Health and Safety Regulations 2012
- Occupational Licensing Act 2005
- Environmental Management and Pollution Control Act 1994
- Crown Lands Act 1976
- Crown Lands Regulations 2001
- Environmental Management and Pollution Control (Controlled Waste Tracking) Regulations 2010
- Environmental Management and Pollution Control (Waste Management) Regulations 2010
- Land Use Planning and Approvals Act 1993
- State Policies and Projects Act 1993

- State Policy on Water Quality Management 1997
- Electricity Industry Safety and Administration Act 1997 and Regulations 1999
- Occupational Licensing (Electrical Work) Regulations 2008

For further details on environmental law/regulations, refer to the TasNetworks' Environment & Heritage Design and Construction Standard.

The design must be compliant with the requirements of the Occupational Licensing Code of Practice 2013 (as amended or replaced), which requires compliance with:

- AS 2067 (Substations and high voltage substations)
- AS/NZS 3000 (Wiring Rules)
- AS/NZS 7000 (Overhead line design)

The Code of Practice also requires compliance with any additional obligations imposed by AS 2067, AS/NZS 3000 and AS/NZS 7000 in referring to other Australian Standards and documents.

1.5.2 Applicable Australian and international, standards and guides

<u>General</u>

Document id.	Title
AS 1033.2	High-voltage fuses (for rated voltages exceeding 1000V) - Current-limiting (powder-filled) type.
AS 1284	Electricity metering
AS 1319	Safety signs for the occupational environment
AS 1680.1	Interior and workplace lighting - General principles and recommendations
AS 1680.2.4	Interior lighting - Industrial tasks and processes
AS 1767	Insulating oil for transformers and switchgear
AS 60157.1	Circuit breakers for distribution circuits-up to and including 1000Vac and 1200Vdc
AS 1931	High voltage testing techniques
AS 1939	Degrees of protection provided by enclosures for electrical equipment
AS 2024	High voltage AC switchgear and control gear - Switch-fuse combinations
AS 2067	Substation and high voltage installations exceeding 1 kV ac
AS 2184	Low voltage switchgear and control gear - moulded case circuit breakers for rated voltages up to and including 600 Vac and 250 V dc
AS 2293.1	Emergency escape lighting and exit signs for buildings - System design, installation and operation
AS 2374.7	Guide to loading of oil-immersed transformers
AS 2676.2	Guide to the installation, maintenance, testing and replacement of secondary batteries in buildings - Sealed cells
AS 3000	Electrical Installations Wiring rules
AS 3008	Electrical installations - Selection of cables
AS 3011.2	Electrical installations - Secondary batteries installed in Buildings - Sealed cells
AS 3835	Earth potential rise - Protection of telecommunications network users
AS 3947	Low voltage switchgear and control gear
AS 60044.1	Current transformers - Measurement and protection
AS 60265.2	High voltage AC. switchgear and control gear - Switches and switch-disconnectors for rated voltages above 1 kV and less than 52 kV

AS 60269	Low voltage fuses - Fuses with enclosed fuse links
AS 60076	Power transformers
AS 60479.1	Effects of current on human beings and livestock - General aspects
AS 62271	High voltage switchgear and control gear
ENA EG-0	Power System Earthing Guide
ENA EG1	Substation Earthing Guide
ENA 18-2008	Interim Guideline for the Fire Protection of Electricity Substations
CIGRE 537	Technical Brochure 537, Guide for Transformer Fire Safety practices
IEEE 979	Guide for Substation Fire Protection
IEE837	Standard for Qualifying Permanent Connections Used in Substation Grounding
NFPA 850	Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current converter stations
NUREG 1805	Fire Dynamics Tools (FDT^{s}) – Quantitative Fire Hazard Analysis Methods for the US Nuclear Regulatory Commission Fire Protection Inspection Program

Civil

Document id.	**Title**
AS 1111.1	ISO metric hexagon bolts and screws - Product grade C, bolts
AS 1112	ISO metric hexagon nuts
AS/NZS 1163	Cold-formed structural steel hollow sections
AS 1170.0	Structural design actions - General principles
AS 1170.1	Structural design actions - Permanent, imposed and other design actions
AS 1170.2	Structural design actions - Wind actions
AS 1170.4	Minimum design load on structures - Earthquake Loads
AS 1233	Preferred dimensions in building - Glossary of terms for dimensional coordination
AS 1234	Recommendations for coordinated preferred dimensions in building
AS 1252	High strength steel bolts with associated bolts and washers for structural engineering
AS 1379	Specification and supply of concrete
AS 1554.1	Structural steel welding - welding of steel structures
AS 1580	General Paint Standards
AS 1657	Fixed platforms, walkways, stairways and ladders - Design, construction and installation
AS 1668	The use of ventilation and air-conditioning in building set
AS 1670	Automatic fire detection and alarm systems - System design, installation and commissioning
AS 1682	Fire dampers
AS 1726	Geotechnical site investigations
AS 1905	Components for the protection of openings in fire-resistant walls
AS 1940	The storage and handling of flammable and combustible liquids
AS 2312	Guide to the protection of structural steel against atmospheric

	corrosion by the use of protective coatings
AS 2427	Smoke/heat release vents
AS 2699	Built-in components for masonry construction
AS 2785	Suspended ceilings - Design and installation
AS 2870	Residential slabs and footings - Construction
AS 2941	Fixed fire protection installations - Pumpset systems
AS 3500.3	Plumbing and drainage - Stormwater drainage
AS 3600	SAA concrete structures
AS 3610	Formwork for concrete
AS 3678	Structural steel - Hot-rolled plates, floor plates and slabs
AS 3679.1	Hot-rolled bars and sections
AS 3700	SAA masonry code
AS 3850	Tilt-up concrete construction
AS 4072.1	Components for the protection of openings in fire-resistant separating elements - Service penetration and control joints
AS 4100	Steel structures
AS 4600	Cold-formed steel structures
AS 4671	Steel reinforcing materials

1.5.3 Applicable regulatory standards

Design and construction Related Standards

NCC	National Construction Code Series
	Volume One - Building Code of Australia Class 2 to 9 Buildings
	Volume Two - Building Code of Australia Class 1 and Class 10 Buildings
	Volume Three - Plumbing Code of Australia

1.5.4 TasNetworks standards

Document id.	**Title**
R373312	Distribution Planning Requirements
R678169	Distribution Standard - Building Substations (This standard)
R1598950	Distribution Equipment Standard - High voltage switchgear
R580289	Distribution Equipment Standard - Transformers
R1574901	Distribution Equipment Standard - Low voltage switchboards
R578642	Distribution Equipment Standard – Kiosk Substations
R392089	Distribution Design Standard – Underground System
R391752	Distribution Design Standard – Public Lighting
R2343500	Distribution Protection and Automation Standard
R890310	Private High Voltage Substations Connection Policy
R393981	Drawing Drafting Standard
R393979	Drawing Management Standard
R392685	TasNetworks Environmental Heritage Design and Construction Standard

2 Design framework

A variety of criteria needs to be considered in the design of a substation. The design inputs include meeting stakeholder requirements, compliance with relevant standards and guides, network planning requirements and whole of life cycle management of the installation that would result from the design.

2.1 Design implementation

The design may need to be an iterative process due to the number of design requirements that may be competing with one another. The design should ensure that it assists TasNetworks to achieve a sustainable electrical network by optimal application of technology and ensuring quality of supply. The design should aim to achieve a service life for the substation in excess of fifty years, with a cost effective solution that meets the needs of both the customer and TasNetworks.

2.2 Design methodology

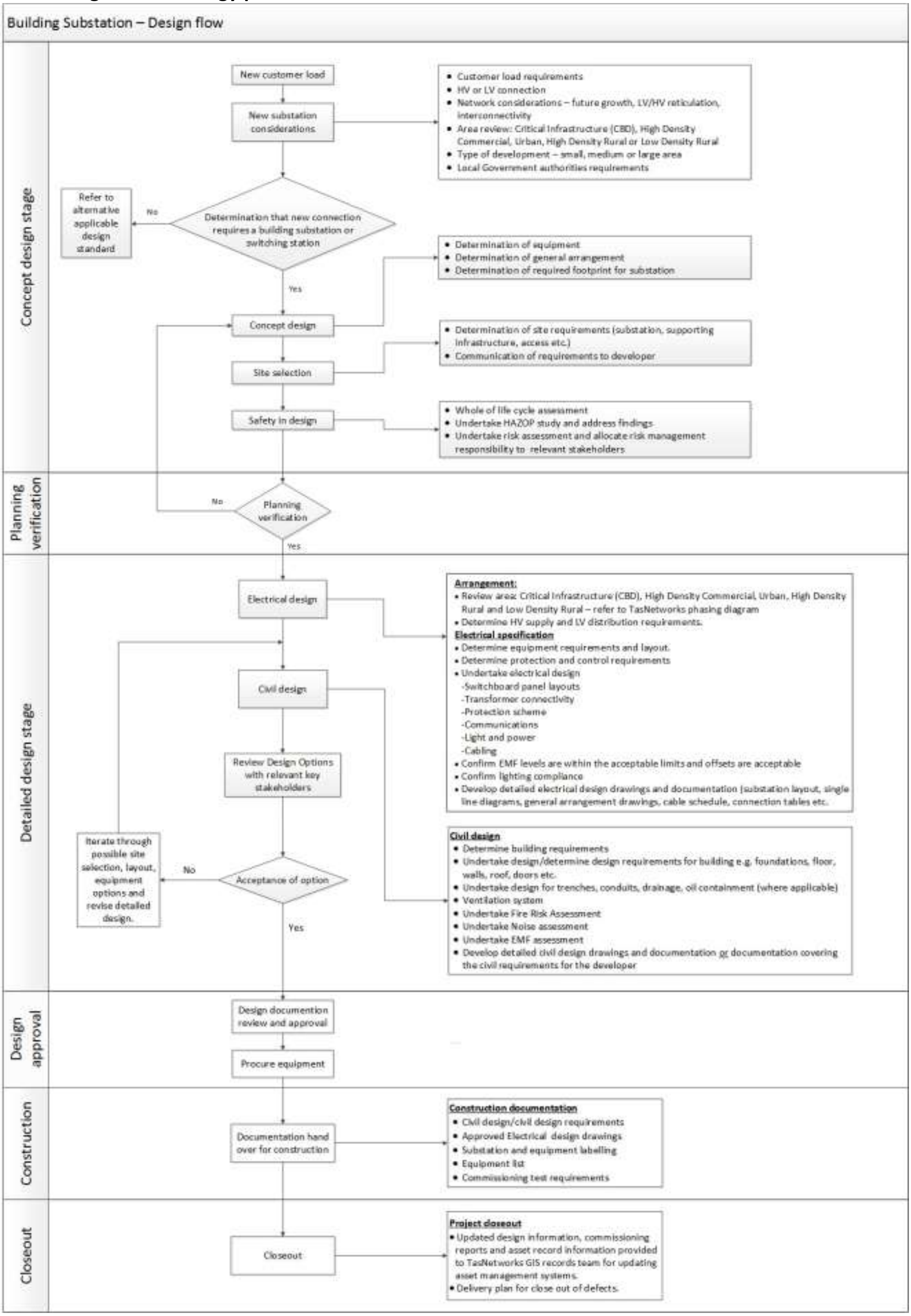
2.2.1 Safety in design

The design must consider and comply with all safety requirements to exercise due diligence in assessing the design, including the requirements under the Work Health and Safety Act 2012. The elements to consider include:

- Early identification of hazards and assessment of risks in the design process, construction phase, operating and maintenance phase and the decommissioning and demolition phases.
- Elimination of identified risks as so far as reasonably practicable or the minimisation of these risks throughout the entire lifecycle of the installation.
- Consultation with stakeholders.
- Communication of the assessment and outcomes through formal documentation.

The safety in design process integrates the above elements into an industry recognised framework, with the focus on early identification of risks and management during the design phase, which usually yields an easier, safer and cheaper outcome to the alternative of managing a situation when the hazards become actual risks. The design must include a safety in design report for each new design, with the detail of the safety in design report proportional to the complexity of the design.

2.2.2 Design methodology process flow



3 Assessment of new connection requirements

3.1 TasNetworks planning requirements

For a new network connection a load demand assessment must be undertaken so that a determination can be made on the options available for connection to the network and ensure alignment with TasNetworks' network planning requirements.

The planning requirements cover the critical elements that need to be considered for the development of the augmentation of the distribution network. These elements include:

- The calculated load demand, with consideration given as necessary to include potential future load requirements for the area, street lighting loading, ADMD (if required) calculations and temporary augmentation of the electrical infrastructure necessary to support both planned and unplanned outages.
- Network capability assessment: Where new loads are in excess of 1000 kVA a detailed assessment of the capability of the upstream network to supply the load must be undertaken. This assessment must include both the HV feeders and the substation at the source of supply.
- Type of load: The design must assess the type of load associated with the new connection to ensure specific requirements are met e.g. loads with a high rate of change (large motors and pumps starting direct on line) versus static loads (commercial and residential).
- Local Government Authority requirements: Councils have varying mandatory requirements relating to electrical infrastructure, which can exceed the requirements of Australian Standards and TasNetworks design standards and planning directives.
- Requirements for specific network areas such as Critical Infrastructure (CBD), High Density Commercial, Urban, High Density Rural and Low Density Rural.

3.2 Customer load requirements

A calculation of the maximum demand of the new development is required to determine whether the electrical network has the capacity to supply the new load or network augmentation is required.

The needs of the new load should be calculated in accordance with AS 3000, in conjunction with TasNetworks' planning standards. For commercial and industrial loads, the customer should provide the value of the new load.

When the actual load requirements are unknown the load demand must be determined by analysing the purpose of the building being developed that the substation will be supplying and its size. Section C3 of AS3000, as detailed in Table 4 provides an example of how this determination can be undertaken.

Table 4: AS 3000, Table C3 - Energy demand method for non-domestic installations

Type of occupancy		Energy demand Range, VA/m^2	Average, VA/m^2
Offices	Light and power	40-60	50
	Air conditioning		
	- cooling	30-40	35
	- reverse cycle	20-30	25
	- zonal reheat	40-60	50
	- variable volume	20	20
Car parks	Open air	0-10	5
	Basement	10-20	15
Retail shops	Light and power	40-100	70
	Air conditioning	20-40	30
Warehouses	Light and power	5-15	10
	Ventilation	5	5
	Special equipment	(use load details)	
Light industrial	Light and power	10-20	15
	Ventilation	10-20	15
	Air conditioning	30-50	40
	Special equipment	(use load details)	
Taverns, licensed clubs	Total	60-100	80
Theatres	Total	60-120	100

In most instances load demands greater than 200 kVA will require the installation of a new network transformer to supply the load. Where the forecast load will be between 100 and 200 kVA the design must include a review the local network and loading to determine if the additional load can be accommodated without the need to install an additional transformer.

3.3 High voltage customer connections

Where a new customer connection is made onto TasNetworks' high voltage network the connection must be in accordance with TasNetworks' Private High Voltage Substation Connection Policy, refer Section 1.4.4.

4 Civil design

Building substations are usually integrated into larger buildings. In these situations TasNetworks does not undertake the design and construction of the building. This work is undertaken by the owner/developer of the building. TasNetworks is responsible for determining the civil requirements for the building and undertaking the electrical design for the substation.

The civil design components that need to be covered in the substation design are:

- Determination of the footprint and floor loading
- Determination of minimum ceiling height
- Determination of access/egress requirements
- Determination of preferred substation location within the building
- Development of detailed civil design for:
  - trenches and conduit entry/exits
  - earthing requirements
  - ventilation system
  - oil containment system (where applicable)
  - determination of waterproofing and drainage requirements
- Fire risk assessment
- Noise assessment
- EMF assessment

Once the civil design requirements have been determined they must be communicated to the building owner/developer for incorporation into the design of the building being constructed.

4.1 Site selection

Building type substations must meet the following criteria:

- Substation must be situated as close as practical to the load. The circuit length of the LV reticulation should not exceed 300 metres.
- Substations should be situated at ground level and have level access.
- Sites must ensure they can provide for easy installation and removal of substation equipment without the need for the use of specialised equipment or work processes.
- The floor within the substation must be level and over one level. The floor level must be at the same level as the ground immediately outside of the access ways to the substation.
- Unrestricted access to the substation for both personnel and vehicles must be available on a 24 hours a day, 7 days a week basis.
- It must be possible to register an unimpeded infrastructure easement over the land that covers the extremities of the substations and its supporting infrastructure e.g. cables and access to the site. An agreement must be obtained with the land owner prior to progressing the detailed design.
- The location for the site must take into consideration future network expansion needs (where applicable).
- The site must be selected to minimise the risk associated from fire, both from the substation or infrastructure external to it.
- Give consideration to significant trees and the protection of associated root zones that may impact upon below ground infrastructure e.g. cable routes.
- Give consideration to potential sea level rise as identified by Local Government Planning Schemes and State modelling in the Coastal Inundation layers available on LIST map.
- Be able to achieve earthing system requirements.
- Have adequate separation from existing underground infrastructure (e.g. gas, water and communication).
- Achieve an adequate level of site security from unauthorised entry and/or vandalism.

- Give consideration to hazards and risks to personnel and the substation from other parties using the site e.g. movement of heavy machinery and vehicle movements in car parks.

A number of possible site options should consider and a compliance/cost trade undertaken so that key stakeholders can review the options and agree on a preferred location.

4.2 Shared facilities

Infrastructure owned by TasNetworks must not be installed in substations with privately owned infrastructure i.e. TasNetworks infrastructure must only be installed in substations dedicated for the use of TasNetworks only.

This included privately owned services infrastructure e.g. ventilation systems water/sewage pipes, power/communications cables must not be installed within the interior of a substation containing TasNetworks' infrastructure.

4.3 Hazardous areas

Substation infrastructure and access routes must not be within an area that is classified as a Hazardous Area as specified in the AS/NZ 3000, sections 1.4.11 and 7.7.

Hazardous areas are defined as areas where flammable or combustible materials are produced, prepared, processed, handled, stored or otherwise exist and may give rise to an explosive atmosphere. The operational and fire separation distances provided in Section 0 are not applicable for these locations.

4.4 Equipment layout and separation

4.4.1 General

The interior layout of the substation must:

- provide a logical and safe arrangement of equipment for access and operational requirements
- provide for the installation and removal of equipment with minimal disruption to other equipment in the substation
- have sufficient space around equipment to both maintain and operate the equipment
- provide a logical arrangement for cable trenching and interconnection of equipment
- allow for the installation of a ventilation system that will adequately cool all the equipment within the substation
- allow for safe access and egress
- meet the requirements of this standard.

A selection of sample substation layouts are provided in Appendix A.

4.4.2 High voltage switchboards

No part of the HV switchboard or its components or equipment is to be closer than 1000 mm to the nearest access doorway or opening. A clear passageway or operating clearance of 1500 mm must be provided in front of the switchboard.

The switchboard must not be located in a position where it would obstruct the removal of equipment from the substation.

Sufficient space must be provided around the switchboard so that it can be removed without the need to remove other structures, equipment or cables not associated with the switchboard that is being removed. Where modular switchgear has been used there must be sufficient space provided on the end of the switchboard so that the switchboard modules can be separated and an individual module removed.

Where a switchboard is placed against a wall, the separation of the rear of the switchboard from the wall must not be less than the distance recommended by the manufacture. The wall behind the switchboard may have projections, such as columns, provided that the minimum clearance is maintained. Normal access to the rear of switchboard must only be possible when the switchboard has front, lateral and rear internal arc fault containment capability i.e. IAC AFLR. Where the separation is greater than 200 mm, but less than 600 mm, barriers and appropriate signage must be installed at the ends of the switchboard to prevent normal access behind it.

The space above and behind the switchboard, must be clear of any ventilation ducts or louvre openings. Light fittings, if mounted on the wall behind the switchboard must be offset with consideration for the need to maintain or replace them.

The switchboard must be positioned over a cable trench that provides sufficient space for the connection and disconnection of cables.

The switchboard must be positioned so that when operational personnel are operating the equipment they are standing on a solid concrete floor and not on trench covers.

4.4.3 Transformers

The positioning of transformers in substations must satisfy the following requirements:

- Transformers must have a clearance of not less than 700 mm from walls, HV and LV switchboards, and doorways. Clearances to other equipment e.g. battery systems may be less than 700 mm on the proviso that sufficient space is still provided to access, operate and maintain the equipment.
- Where multiple transformers are installed they must be separated from each other by at least 1000 mm. All equipment related to the transformers, including connecting cables, cable supports, CTs and CT supports, connection covers etc. must not encroach into the 1000 mm of separation between the transformers.
- For the installation and removal of a transformer no other structures, equipment or cables not related to the transformer must need to be taken out of service or moved to allow for the installation or removal of the transformer. While transformers are being installed or removed, it must be possible to maintain a minimum separation of 300 mm from all other equipment.
- Unless otherwise agreed by TasNetworks, the movement of the transformer to or from the allocated access door or hatch is to be achievable by means of a straight pull route.
- Transformers must not be placed directly under ventilation duct openings or any other overhead openings that might allow water ingress to fall onto the transformer.
- Sufficient clearance is required over the top of each transformer to allow for in-situ maintenance.
- With the exception of fire detection and suppression equipment no equipment or obstructions must be placed above a transformer or designated transformer space.
- In substations where additional capacity may be required at a later stage, additional space must be provided to accommodate the installation of additional or larger transformers.

4.4.4 Low voltage switchboards

A clear passageway or operating clearance of 1500 mm must be provided in front of the switchboard.

Doorways and openings must be at least 1000 mm from the switchboard. Where practical, all ancillary equipment e.g. light and power switchboards, DC systems, fire panels and ventilation systems should also be located at least 700 mm from the ends of the switchboard.

LV switchboards may be placed against external walls, but must be floor mounted and not suspended from walls. Where a switchboard is secured against a wall an assessment must be made on the strength of the wall to ensure it can accommodate the additional loading placed on it by the switchboard.

The switchboard must not be located where it would obstruct equipment removal from the substation.

The space above the low voltage switchboard must be clear of any ventilation duct or louvre opening.

The switchboard must be positioned over a cable trench that provides for connection to the transformer(s) and routing of cables out of the substation.

4.4.5 Cabling

The equipment layout must allow for the installation of cable trenches for subsurface routing of HV and LV power cables, and control cabling. It must allow for cables to be routed as required while maintaining the manufacturer's minimum bending radius for the cable.

Power cables must not be run up walls or overhead. Top entry connection of equipment and overhead cabling must only be done with the approval of TasNetworks. Where approval is given for above ground cabling it must have mechanical protection that meets the requirements of AS 3000.

4.4.6 Ancillary equipment

Ancillary equipment must be installed against internal walls within the substation in a location that is easily accessible. All equipment must be installed against the walls. A clear space of not less than 1500 mm must be provided for in front of equipment panels.

4.5 Substation building

4.5.1 Foundations

The foundations must be designed to accommodate the load of the installation and any additional loads that may be placed on it over its life.

For the life of the installation, without the need for maintenance or remedial work, the foundations must be designed to accommodate:
- local ground conditions
- local environmental conditions
- changes to variations in the ground surrounding the substation
- natural water flows without subsidence or erosion.

Depending on the ground condition an appropriate foundation treatment must be carried out. A polythene damp proof membrane must be installed underneath the floor slab to prevent moisture transfer and to ensure the concrete floor is damp proof. All joints in the membrane must be taped to provide a waterproof barrier.

Where unstable ground or other services cannot be avoided, special footing systems may be required. The footing system may consist of concrete strip footings or piers to an approved foundation level as required.

The area surrounding the substation building immediately under the eaves of the roof (where applicable) must have a concrete pavement sloping away from the building at slope of 1V:50H to prevent water ingress.

4.5.2 Floors

The entire substation floor must be on one level and level. Floor surfaces must be flush and must have a level steel trowelled finish. Floor construction tolerances must comply with AS 3610. Tolerances must also meet equipment manufacture's specifications for floor mounted equipment. The finished floor level must be kept at a minimum of 500 mm above the 1:100 year flood level or as per local council requirements (whichever level is higher).

Floors are to be tamper and vermin proof and of reinforced concrete construction with a minimum slab thickness of 150 mm and have a hard serviceable finish. Floors must be waterproof and must withstand the maximum loads envisaged including a minimum rolling equipment load equal to the heaviest item of equipment. Additives must be supplied to the concrete to produce a non-powdering surface. Measures must be taken to address the vibration issues in the floor especially if an oil containment tank is located underneath the floor slab.

In addition to floors, equipment access areas external to the substation must withstand the maximum loads envisaged. Temporary steel plates may be used to assist in equipment installation.

The concrete floor slab must be designed to have at least two permanent anchor points (in holes) in it for the purposes of skating transformers in an out of the substation. The floor system must be capable of taking the pulling load developed during this skating process.

In general the design of the concrete floor must comply with AS 3600. Steel gratings and steel items must comply with AS 4100. Loadings for the floor must comply with AS/NZS 1170.

The structural design must be suitable for the installation, operation and maintenance of the switchgear installed within the building.

Where oil filled transformers are installed, the use of low level walls for the purposes of oil containment should be avoided as they can impede equipment installation, operation and maintenance and create a hazard for personnel access and escape. To prevent oil escaping, troughs must be located at doorways and inlet ventilators must be mounted 200 mm above floor level.

The floor in front of switchboards extend 1500 mm front the front of the switchboard must be a solid concrete floor. Trenches must not be installed in floors in front of switchboards.

4.5.3 Joints and damp proofing

Construction joints in slabs must be filled with ‘Parchem Stiffjoint’ or an approved equivalent product.

Joints must be sealed with a 10mm x 10mm bead of ‘Bostik Seal ‘N’ Flex’ over a 10mm x 10mm bead of ‘Bostik RTV 936’, with ‘Bostik Patchfix’ epoxy binder applied underneath, or approved equivalent.

Additives to produce a non-powdering floor surface and the use of non-permeable membranes can be used to make the concrete floor damp proof. In order to minimise ingress of moisture all the pipe works penetrating the building floor must be completely encased in the concrete floor and have water stops.

4.5.4 Equipment fixing

All holding down bolts must be hot-dipped galvanized and comply with AS 3600 and AS 4100. Unless a higher grade is required from calculations, the minimum grade of holding down bolt should be 4.6/S. Hilti HKD-S drop in anchor or similar is the preferred anchor for fixing of equipment.

In the case of drilled and placed holding down bolts the minimum gap between the bolt and the hole is 3 mm or as recommended by the manufacturer of the bonding agent. The bonding agent must either be Ramset Chemset Reo 502 or Hilti HIT-RE 500 or equivalent.

Reinforcement must be 50 mm clear of holding down bolts.

The minimum factor of safety for the bond length must be 1.5.

4.5.5 Cable trenches

Cable trenches must be installed in substations so that power cables can run below the floor level. Trenches must be of concrete construction, formed in situ and waterproof.

Trenches must have a minimum width of 600 mm. Trenches may be wider if required for the installation of all the cables. Trenches under HV switchboards must be of sufficient width to allow for the installation and removal of cables. Trenches must have a depth of 1200 mm. Internal corners must be chamfered, with a chamfer of no less than 150 mm. A suitable means must be provided for on the wall of the trench for the anchorage of cables.

Edging must be installed at the top of the trench suitable for supporting the trench covers. Where equipment may need to traverse across trenches the covers must be able to support a wheel load equivalent to 5 tonne equivalent and be complaint with AS/NZS 1170.0 and AS/NZS 1170.1.

All trench covers must be non-flammable and perforated to allow oil to escape into the trench. Each cover must be as a minimum suitable for pedestrian loading. Signage displaying the cover load limit and mass must be provided on each cover. The top of the cable cover when installed must be level with the floor.

A minimum longitudinal slope of 1:60 must be maintained in the cable trench to facilitate free flow of liquids into the sump. Where oil filled transformers are installed the volume of the trench must be not less than 120 per cent of the volume of oil contained within the largest transformer.

A reinforced eye bolt must be installed in the cable trenches to provide an anchor point for pulling cables into the substation.

Cable trenches within substations must be in accordance with drawing D-BS1-0300-SD-001.

4.5.6 Access ramps and steps

The substation floor surface must be on one level for ease of equipment installation, operation and maintenance.

At substation doorways where the internal/external ground levels differ appreciably, landings (preferably external to the substation) with steps and hand rails must be provided to allow safe personnel access and egress.

In the case of main access and equipment doors these landings must also be suitable for equipment handling. The access ramps must be designed for a 6 tonne rolling load. The design of platforms and stairways must comply with AS 1657. Any external metalwork associated with the substation must be bonded to the substation earth mat.

4.5.7 Walls

4.5.7.1 Wall design

Building type substation walls must comply with AS 3600 and AS 3850 for concrete walls and AS 3700 for masonry walls. Design loadings must comply with AS/NZS 1170. The walls must comply with the fire rating requirements specified in this standard and be sufficiently insulated to prevent widely fluctuating temperatures within the substation. Joints in precast concrete walls panels are to be sealed with a fire rated joint filler compatible with wall FRL.

Walls must be vandal, vermin and water proof and have a structural strength of not less than 100 mm thick reinforced concrete. Both internal and external walls must have a hard finish to enable substation equipment to be fixed to the wall.

All external walls are to be waterproof and any seepage, especially at penetrations for conduits must be collected and drained off in an approved manner. Care must be taken to consider the differential settlements at these areas.

Sound proofing must be carried out in accordance with section 4.5.17 of this document.

4.5.7.2 Wall materials

In general, precast concrete wall panels, brick masonry and concrete masonry blocks may be used in compliance with AS 3600, AS 3700 and AS 3850. Sufficient reinforcement must be provided to contain cracks in the walls.

An approved additive must be used in the concrete wall to prevent moisture transfer up the walls from below ground level. Non-absorptive concrete may be used in this case. A plastic moisture barrier must be used with the approval of TasNetworks.

4.5.7.3 Joints and connections

Joints must be provided in masonry walls as required to minimise the extent of cracks. All joints must be sealed to prevent ingress of moisture.

4.5.8 Doorways and doors

Building type substations must have at least one means of access and two means of egress for personnel and at least one means of equipment access via a suitable doorway (preferably) or hatch.

The doors must be spaced well apart (usually located in opposite walls or near opposite corners of the room) and arranged so that the evacuation route complies with the requirements of section 'D' of the Building Code of Australia.

Doorways must be located so that the ground on both sides is at the same level.

Doors must open externally to the outside of the building and are to be protected by bollards or suitable barriers in accordance with clause D1.10 of the Building Code of Australia.

All doors must be installed according to the Building Code of Australia for fire exits relative to the classification of the building and the National Guideline for Prevention of Unauthorised Access to Electricity Infrastructure. External doors are to be fully covered with an external sheet of galvanised steel for weather protection. All doors must meet the fire rating requirements specified in Section 4.7 of this standard.

The door frames must be metal and fitted with three stainless steel butt hinges, and must be powder-coated. Door hardware must be made of 316 grade stainless steel. All doors must be neat in appearance, free from defects and must fit flush in the frames with a waterproof seal. Architraves must be provided for each door. All doors must be equipped with a galvanised steel kick plate approximately 300 mm high located across the bottom of the door on both sides, unless it is finished with galvanised steel on its outside.

The clear opening dimensions of the main access and equipment door must be sufficient to provide ease of access for the largest single item to be installed, including any additional clearance necessary for handling devices such as bi-directional skates and lifting devices. Clearance for handling devices must be no less than 200 mm to the overall height measurement and 300 mm to the overall width of the largest piece of equipment.

The minimum dimensions for the opening of an emergency door must be 1980 mm high by 750 mm wide, as stated in clause 5.5.5 of AS 2067. The emergency escape mechanism fitted to substation doors must be of the horizontal panic bar type (push plate types are not acceptable) preferably fitted with a latch set only (as opposed to vertical rod types).

All doors must be vertically hinged. Sliding and roller doors must not be used.

Fire rated doors must be approved and tagged as per the requirements of AS 1905.1.

The substation must have 24 hour unimpeded access for operation personnel. Access must take into consideration shared sites where third party security systems or alarms may be installed.

The design must also allow for escape of personnel in the case of an emergency. An escape plan must be prepared and stored on site.

Doorways should not be placed in locations where personnel exiting through the door may be placed in a hazardous location. Bollards are to be placed outside doors where there is a risk that personnel stepping out of the door could step onto a road way or there is a risk that the doorway may be blocked e.g. vehicles, bicycles or storage of goods.

Below ground substations must have two 'dedicated' access ways to meet the requirements of clause 5.5.4 of AS 2067.

4.5.9 Windows

Windows must not be installed in substation buildings.

4.5.10 Ventilation and fire dampers

The ventilation for the substation must meet the requirements of Clause 5.5.7 of AS 2067.

The design must ensure that for all the equipment installed in the substation the environmental conditions within the substation at all times, does not degrade the equipment or restrict its performance.

For equipment that relies on cooling to maintain its performance rating e.g. transformers, the design must ensure that the manufacturer's recommended ventilation requirements are achieved.

The ventilation system must have sufficient capacity to adequately cool the largest transformer(s) that the substation has been designed to accommodate, and while all transformers are operating continuously at their maximum rating under worst case environmental conditions.

At the maximum average outdoor ambient temperature, as defined in Table 2, the ambient temperature in the substation must not exceed 35^{o}C while all transformers are operating continuously at their maximum rating.

Separate air inlet and outlet openings must be provided. They shall be located in external walls on opposite sides or in diagonally opposite corners of the substation so that they provide air flow across the transformer radiators. To promote natural flow the air inlet must be located at low level in the external wall and the outlet at a high level. Where necessary, internal or external ventilation ductwork must be used to achieve the desired direction of flow.

Consideration must be given to ensuring the external vents are suitably located and will not be obstructed or introduce unwanted air into the substation e.g. exhaust fumes from cars.

Natural ventilation is preferred. For natural ventilation systems the minimum area of the air inlet and outlet must be not less than 0.3 m^2 per 750 kVA of transformer capacity. The use of internal duct work should not be used for natural ventilation systems.

Where a forced ventilation systems is required to achieve the required ventilation, an automatic fan control system must be used to maintain the temperature within the substations at the required level. The minimum the flow rate must be not less than 0.2 m^3/sec per 750 kVA of transformer capacity.

Where internal or external air ducts are used the capacity of the system must be sufficient to overcome the frictional losses of the ducts and still achieve the required minimum flow rate.

The ventilation system must be fitted with filters on the inlet and outlet openings. The size of the openings must be of sufficient size to ensure any friction loss that occur through the filters do not reduce the air flow down to below the required minimum air flow. Sufficient over capacity must be provided in the size of the filters to ensure that as the filters become contaminated they do not restrict the air flow to the point that the system can no longer provide adequate ventilation.

The external side of all ventilation inlets and outlets must be fitted with weather and tamper proof louvres and vermin proof screens.

For fire protection purposes the design must incorporate FLR 120/120/120 louvre style fire dampers. The fire dampers must be automatically actuated upon detection of smoke.

All substation fire dampers must be fitted with weather and tamper proof louvers and vermin proof screens. Where unfavourable dust conditions exist the ventilation system should also be fitted with filters of an approved type. The fire dampers must be in compliance with AS 1668 and AS 1682.

Where external ducting is used, the fire damper must be installed on the substation wall.

The standard ventilation system design is as per drawing D-BS1-0305-SD-001. If the standard design is used an assessment must be undertaken to ensure that the standard design will provide adequate ventilation and cooling for the equipment within the substation. Where an alternative design is proposed it must receive prior approval by TasNetworks. The design must be submitted with sufficient supporting evidence to demonstrate the alternative design will provide adequate ventilation for the substation.

The substation ventilation system must not form part of the building main ventilation system.

4.5.11 Roofs

4.5.11.1 Types and materials

For substations that require a roof e.g. not fully integrated, a reinforced concrete roof is preferred. A steel sheet roof with a steel trussing may be used with prior approval by TasNetworks.

Steel roofs must be compliant with the compliance with the Building Code of Australia. The minimum roof pitch for steel sheet roofs must be no less than the minimum slope recommended by the manufacturer. All roof sheeting must be fixed with concealed fasteners which do not require the roof sheeting to be penetrated.

There must be no penetrations through the roof. Roofs must be vandal, vermin and weather proof.

Roof materials must comply with the fire rating requirements specified in this standard.

Sufficient insulation must be provided to minimise temperature fluctuations within the substation.

4.5.11.2 Loadings

The design loadings for the roof must be in accordance with AS/NZS 1170.0 and AS/NZS 1170.1.

4.5.11.3 Guttering and down pipes

Where the substation has an external roof storm water guttering and down pipes must be installed in accordance with AS3500.3. The location of the downpipes must be such that they can be connected into storm water system for the site.

External roof guttering must be large enough to minimise blockages and limit the need for routine maintenance.

4.5.12 Ceilings

Building type substation ceilings must comply with the Building Code of Australia and must be designed and constructed to AS/NZS 2785.

The minimum ceiling height must be determined from the overall height of the tallest equipment with additional clearance provided for the installation, operation and maintenance of it, with allowance provided for fittings such as cable trays, ventilation ducts, etc. that may be installed above the equipment. A minimum clearance of 600 mm above the tallest item of equipment is recommended. Ceiling heights must not be less than 2500 mm.

The required door height including clearance for the operating mechanism must also be considered when determining the ceiling height.

Ceiling material must be used to comply with the fire requirements of this standard and the Building Code of Australia.

Sound proofing must be carried out in accordance with section 4.5.17 of this document.

4.5.13 Conduits

Where cables are required to pass through external walls they must be installed in conduits.

The location and depth of the conduits will be dependent on the layout of the substation. The depth of the conduits must be sufficient to ensure the cables outside of the substation can be installed at a compliant depth below ground.

The design must include any additional conduits needed to cater for future expansion of the substation. One additional conduit must be provided as a minimum for each cable type i.e. HV, LV and communications cables.

Following the installation of cables, all conduits must be sealed to prevent the entry or egress of liquids and fire stopped to prevent the spread of fire from the substation.

4.5.14 Drainage

External

Adequate drainage around the substation must be provided to ensure that water is adequately drained away from it and does not pool in the vicinity of it. Where there is the possibility of water flowing against external doorways drains must be installed outside the doorways to direct water away from the substation.

Drains must not introduce uneven surfaces or slope that may become a trip hazard to the operational area at the site.

Site drainage must be designed to ensure that water run off does not negatively impact upon adjacent properties.

Site drainage must consider the implications of water flow into waterways and avoid directing flow into them.

Internal

Where there is the potential for water ingress into the substation there must be a suitable means to collect the water and remove it from the substation. This system must be an automatic one.

Where oil filled transformers are installed within the substation, there must be a means to ensure that no oil can leak out of the substation. Open drains installed in the in front of doorways may be required to achieve this outcome.

4.5.15 Sumps and sump pumps

Where a substation drainage system is required a sump may be connected into the cable trenches and use the trenches for the collection of water. The sump must be at the lowest point in the trench and the trench floor must be sloped with sufficient gradient so that any water ingress into the trenches will drain into the sump.

Sumps must not be placed near or under switchboards, with the preference for sumps to be installed on the opposite side of the room to the HV switchboard. Sumps must not be within 500 mm of a switchboard. If a sump is within 1000 mm of a HV switchboard a vertical barrier must be placed within the trench below the end of the switchboard to prevent moisture rising into the switchboard.

The sump design must be as per D-BS1-0303-SD-001 or D-BS1-0314-SD-001.

The outlet pipe for the system must be connected to the building stormwater. A system must be provided to ensure oil cannot leave the substation through this pipe. The outlet pipe must be at floor level next to the sump. It must not run through substation room around or above other equipment.

4.5.16 Light and power

All light all power circuits shall be supplied from the LV light and power sub-board. They shall be protected by an appropriately rated MCB and 30 mA RCD.

4.5.16.1 General power points

A minimum of two, 230 volt double socket, single phase 10 amp switched power outlets must be installed inside the substation. The outlets must be installed on opposite sides of the substation and in accessible locations.

4.5.16.2 Internal lighting

The average light level in the substation must be no less than 200 lux. The minimum light level must be achieved without the reliance on any other light source.

Interior lighting shall be provided by means of standard 36 watt, 1200 mm fluorescent light fittings complete with diffusers, or an LED equivalent.

Light switches must be installed at all substation entry points. Lights must be fitted at a maximum height 2900 mm above the floor level.

Where the exterior of the substation is outside, exterior lighting is not usually required. Exterior lighting must only be installed if requested by TasNetworks.

Where the substation is accessed through a building e.g. via an internal corridor, a lighting system must be installed outside the substation and be able to be operated by TasNetworks personnel on a 24/7 basis.

4.5.16.3 Emergency lighting and emergency exit signs

The interior of the substation must have an emergency lighting system installed that meets the requirements of AS 2293.1.

The lighting must be normally supplied from the LV light and power sub-board. The backup supply must be provided from batteries installed within the lighting units. The lights must not be powered from the local DC supply.

The emergency lighting system must provide an average minimum light level of 40 lux at floor level.

Emergency exit signs must be placed above doorways. They must be compliant with AS 2293.3.

4.5.16.4 Security lighting

Exterior security lighting is not usually installed at these substations. Security lighting must only be installed if requested by TasNetworks.

Where security lighting is installed, motion sensors must be installed that automatically switch the lights on when movement outside the substation is detected. The lights must also switch off automatically. A means to switch off the lights or by-pass the motion sensor must be provided.

4.5.17 Sound proofing

Sound proofing of the ceiling and walls must be carried out in accordance with the Building Code of Australia. Noise levels must comply with the requirements of the relevant local authority.

The design of the substation must make sure that all noise creating equipment is orientated in a manner which will ensure noise is transmitted away from all sensitive receivers, including residential properties, health facilities, schools, etc.

Penetrations in walls and ceiling must be minimised. Openings must be treated with acoustic louvers to baffle noise generated in the substation.

4.5.18 Building security

The risk of unauthorised entry to the substation must be minimised. There must be no external recesses in the exterior walls that could be used as climbing points.

When fencing is required to improve site security, the design of the fence should prohibit climbing of it.

Intruder alarm and motion detectors may be installed where required by TasNetworks.

Storage rooms must not be installed in the substation unless necessary for the storage of approved equipment.

4.5.19 Paint finish

For all painted surfaces the paint quality must comply with AS 1580. The application of paint must be in accordance with the manufacturer's instructions. An undercoat or primer coat and two finishing coats of paint must be applied to all walls and ceilings as a minimum.

For all internal walls and doors the paint colour must be light cream. Ceilings must be painted white.

Floors must be painted with a suitable flooring paint. The paint colour must be light grey.

External substation walls must be painted in a colour that allows it to blend into the external environment, or it may be painted the same colour as the building that it is installed in.

4.5.20 Vermin control

Substations must be vermin and animal proof. Vermin and animals include cats, rats, possums, snakes, ants, flies, etc.

4.6 Oil containment systems

Where the equipment installed in the substation contains insulating oil and the total oil volume is greater than 1000 litres, an oil containment system must be installed. The system must be compliant with the requirements of AS 2067 and AS 1940.

Where the oil volume is less than 1000 litres, a risk assessment must be undertaken to determine if there is sufficient risk to justify the installation of an oil containment system.

The use of cable stretches for providing oil containments is the preferred solution. Where cable stenches are used, all openings in the trench shall be sealed to prevent oil escaping from substation through cable conduits. Shallow trenches shall be installed across doorways to prevent oil escaping through doorways.

Where the oil containment system comprises a separate oil containment tank the following conditions must be met:

- An indoor flame trap must be installed upstream of the oil containment tank.
- The tank should preferably be located outside the substation, but if there are space limitations at the site the tank may be located inside the substation underneath the floor slab.
- The tank must be easily accessible for draining purposes.
- The volume of the oil containment tank must be sufficient to contain 120 per cent of the volume of oil in the largest transformer to be installed in the substation.
- The inspection cover of the oil containment tank must be able to be opened by one person.

4.7 Fire management

4.7.1 Fire protection

A fire risk assessment must be completed as part of the substation design. The risk assessment must be included as part of the design documentation. Where necessary to manage the fire risk the fire risk mitigation measures must be incorporated into the design. The fire risk assessment and derived protection mechanism(s) must fulfil the requirements of AS 2067.

The fire risk assessment must, as a minimum include the following:

- Likelihood and consequence of fire events
- Underground reticulation such as gas mains
- Environmental sensitivity
- Fire emergency response capability
- The proximity and usage of the adjacent buildings and structures e.g. residential or commercial
- Fire protection mechanisms
- Benefit versus cost analysis.

TasNetworks implements two mechanisms for fire protection. These mechanisms are:

- Passive fire protection: This mechanism seeks to minimise the spread of fire from one delineated zone to another to reduce the overall area at risk of damage. Examples of passive fire protection include, but are not limited to:
  - Providing fire separation distances from the source of the fire
  - Fire separation walls and fire barriers
  - Fire stopping and fire dampers to penetrations within fire barriers
  - Self-closing fire doors to openings in fire separation walls and fire barriers
  - Oil containment/bunding
  - Usage of less flammable insulating transformer fluid.

- Active fire protection: Active protection systems e.g. fire suppression are used when additional protection is required over a passive system. Active systems must not be used as a substitute to passive fire protection.

4.7.2 Fire rating

The fire resistance level (FRL) of the entire substation for structural adequacy/integrity/insulation must be 120 minutes for each i.e. FRL of 120/120/120.

In the event of a fire it is considered that the substation will incur fire and/or smoke damage and repairs to the substation will be necessary, with a complete substation outage a possible result. The arrangement of the local network must look to ensure that in a complete substation outage contingencies are available to provide an alternative means to maintain the network capability and/or customer supply.

This standard does not require the use of firewalls between transformers. Firewalls must only be fitted where critical transformers require additional protection.

Where a fire detection system is installed, the fire detection must be by optical smoke detectors designed and fitted in accordance to part 'E2" of the Building Code of Australia. In the event of smoke detection these alarms must signal the local Fire Panel, communicate an alarm to TasNetworks' Distribution Control Centre and the Tasmanian Fire Service.

4.7.3 Fire suppression

Where fire risks cannot be adequately managed using passive mitigation measures active fire suppression system must also be installed. These systems must comply with the requirements of AS 2067.

TasNetworks' standard suppression system is the Stat-X Aerosol system. The number of suppression units required for the system is dependent on the volume of the substation building. Table 5 provides a guide to the relationship between the volume of the substation and the minimum number of units that should be installed. The designer must ensure that the layout and number of units installed is sufficient to meet the requirements of AS2067.

The use of any other suppression system requires prior approval from TasNetworks.

Table 5: Stat-X fire suppression canister requirements

Protected Room Volume (m^3)		Minimum number of 2500E Stat-X units
Minimum	Maximum	
26	50	2
50	77	3
77	103	4

Smoke and thermal alarms are required to prevent mal operations. These alarms must be connected to a Fire Alarm Control Panel. The Fire Alarm Control Panel must control the Stat-X units to work uniformly alerting TasNetworks' Network Control Centre, the Tasmanian Fire Service and the other occupants of the building.

In the case of the substation located in a shared premise, the Fire Alarm Control Panel must also alert the alarm system of the shared site.

The system must have a means to be isolated when the substation is occupied. There must be local and remote indication of this change of status. If a fire event is detected an audible and visual indication within the substation must be provided, with a short delay prior to system activation occurring.

4.8 Site Identification and Signage

4.8.1 Site Identification

Substations must be affixed with a unique identification plate adjacent to the main entry door of the substation. TasNetworks is responsible for the supply of the identification plate. The site identification plate shall comply with the requirements of Section 6.

The identification plates are approximately 120 x 250 mm, of metal construction and mounted to the substation with tamper proof screws.

4.8.2 Signage

All signage shall be accordance with drawing D-BS1-0302-SD-001.

Safety signage must be installed on all external substation doors. Where fire doors are installed, the signs must be installed on the door with a fastening medium that does not impact on the integrity of the door or installed next to the door.

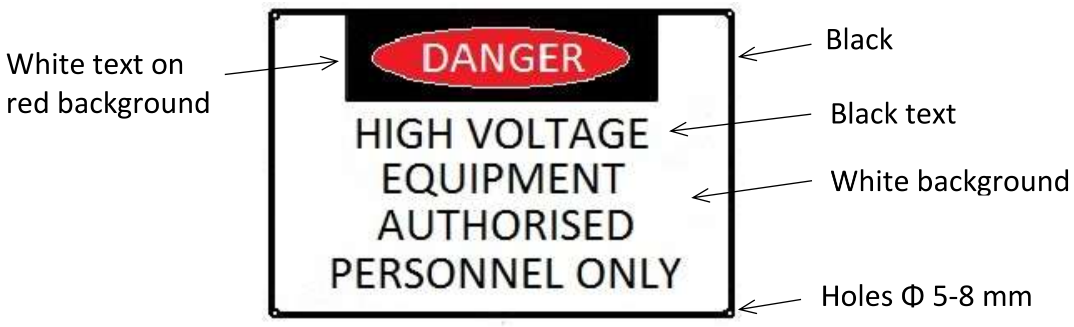
The layout of the signs must be as per

Figure 3. The lettering must not be less than 40 mm in height.

Signs must be compliant with AS 2067, Section 6.9.3 and AS 1319.

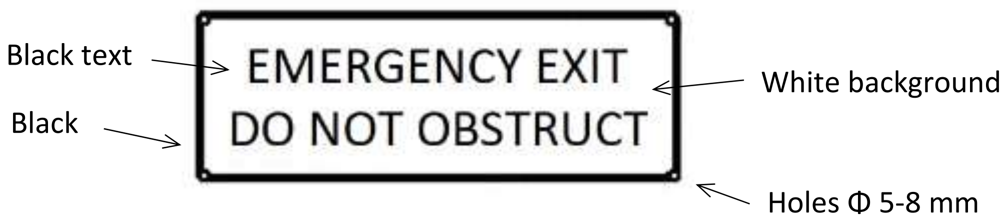
Signs must to be suitable for exterior use and designed to last for the life of the substation.

Figure 3 : High voltage safety sign design



Where emergency exit doors have the potential to be obstructed on their external side a sign shall be installed on the door as per Figure 4. The lettering must not be less than 30 mm in height.

Figure 4 : Emergency exit, Do not obstruct sign.



4.9 Miscellaneous

4.9.1 Access and operational clearance

The substation must have unimpeded access to it for TasNetworks personnel and heavy vehicles. The access must be available on a 24 hours per day, 7 days a week basis.

The access must be sufficient for the installation and removal of the largest piece of equipment installed within the substation.

The ground immediately outside the equipment doors must be a sealed surface and be of sufficient size to act as a hardstand area for the largest item of equipment.

All external door locks must be a TasNetworks approved locking mechanism and use a standard TasNetworks key. The key used must be the appropriate key for the substation type and geographical location of the substation. Padlocks must not be used on external doors.

4.9.2 Confined spaces

There must be no requirement to classify the substation or any part of it as a ‘Confined space’. The assessment criteria for the classification of a confined space must be as per AS 2865.

If an oil containment tank is required and it will be deemed to be a confined space, then its use must receive prior approval from TasNetworks.

Cable trenches must be designed so that they are not confined spaces and only points of restricted access.

Where confined spaces will exist they must be added to TasNetworks’ confined spaces register.

4.9.3 Hazardous materials

If there is a requirement to have hazardous materials on site they must be stored in a suitable storage facility. Material data sheets for all hazardous materials stored on site must be kept on site and stored in the document station.

4.9.4 Vegetation

Vegetation in close proximity to the substation must be kept to a minimum to prevent invasive root systems intruding on the structure. Removal of all large trees in close proximity to the substation must be considered. Such removals may involve obtaining appropriate Council permits.

4.9.5 Document station

A log book station must be installed inside the station. This must consist of a wall mounted A4 document holder and a recording plinth. The document holder must contain the station log book, folded operational drawings and material safety data sheets.

4.9.6 Environmental assessment

An environmental assessment must be completed for the development in accordance with the TasNetworks' Environment and Heritage Design and Construction Standard. The assessment must include as a minimum:

- The risk of environmental harm from potential spillage and leaks of hazardous substances
- Presence of threatened species and habitat or threatened vegetation communities
- Weed presence and associated risks of spread and or management responses required
- Sea level rise – as identified by Local Government Planning Schemes and State modelling in the Coastal Inundation layers available on LIST map
- Erosion risks i.e. are the soils dispersive; is landslip a risk; or are the soils acid sulphate soils. Is there a risk that sediment from the planned works will enter waterways?
- Presence of significant trees and protection of associated root zones
- Presence of Aboriginal Heritage
- Presence of Cultural Heritage

4.9.7 Noise assessment

Transformers within electrical substations generate noise at a nominal frequency of 100 Hz, with higher order harmonics also present. This noise is typically audible and can be intrusive when background noise levels are low e.g. at night.

The design must ensure that noise generated from the substation will not cause a nuisance to external parties. Where necessary, mitigation measures must be put in place to reduce the noise level down to an acceptable level.

Noise mitigation measures must not negatively affect the rating of the substation e.g. reduce the capability of the ventilation system resulting in adequate air flow around transformers.

The designer must ensure compliance to local government authority requirements, Tasmanian Environment Protection Authority, AS 1055.1 and AS 60076.10.

5 Electrical design

The electrical design covers all aspects of the installation that are not part of the building. The electrical design must cover off the following as a minimum:

- Determination of the capacity requirements of substation
- Network and customer supply configurations
- Equipment selection
- Equipment layout
- Equipment ratings
- Secondary systems e.g. protection, monitoring and remote control
- Design and verification of the earthing system, including the determination of testing requirements to confirm compliance with requirements.
- Confirmation that EMF levels are within the acceptable limits

- Lighting requirements
- Confirmation that the ventilation system is complaint and will provide adequate cooling for electrical equipment.
- Equipment labelling
- Development of detailed electrical design drawings and documentation as per Section 7.
- The design documentation must be of sufficient details to demonstrate that it is fit for purpose and compliant with the requirements of this standard. The design will require both engineering drawings and reports.

5.1 Configuration of supply and interconnect ability

The high voltage supply configuration must be the most appropriate based on the neighbouring network to which the substation will be connected. Where a higher level of security is required or the installation is in an area classified as critical infrastructure (CBD) or High Density Commercial, additional requirements may be required. Refer to TasNetworks Planning Requirements document to determine if there may be specific requirements for the network location.

In urban locations, particularly CBD environments additional protection and automation might be necessary. This may be due to the requirements to supply critical customers e.g. hospitals etc. or due to higher regulated security of supply requirements

The additional security may be provided through duplicate high voltage supplies, low voltage reticulation, or a combination of both.

In addition to the normal protection schemes, substations in the Hobart CBD may also require more complex protections systems to minimise supply disruptions when a fault occurs on the high voltage network in these locations.

The standard substation configuration that may be used in building substations are provided in Appendix B. The configurations may be expanded upon, but the configurations, including equipment types used and protection functionality must not be altered.

High voltage circuit breakers must be used for the supply to transformers where:

- the transformers are rated at 1000 kVA or greater
  or
- they can be connected in parallel on their low voltage side.

5.2 Voltage drop calculations

Voltage drop calculations must be determined for all low voltage supply circuits to ensure that under all operating conditions voltage levels are within allowable limits. The voltage tolerance must comply with TasNetworks' Planning Requirements.

For further details on TasNetworks' voltage drop design criteria refer to TasNetworks' standard for underground systems, refer Section 1.4.4.

5.3 Phase sequence

The phase sequence of TasNetworks' electrical network varies across Tasmania. The phase sequence for the point of connection on the network must be correctly determined to ensure the correct phasing on the low voltage distribution board is achieved.

5.4 Electrical and Magnetic Field (EMF)

Substations must be designed so that magnetic fields within and external to the substation are minimised.

The design must consider the effects of EMF and the associated limits for personnel in accordance with ICNIRP, Guidelines for limits exposure to magnetic and electric fields and AS 2067 Appendix D.

The following should be considered in the design to reduce the effects of EMF:

- Increasing the distance for known public areas to sources of EMF where the levels and duration are expected to exceed the acceptable exposure criteria in accordance with ICNIRP.
- Avoiding locating substations close to areas that may contain sensitive electrical equipment.
- Locating heavy current low voltage conductors away from walls and ceilings.
- Avoiding single core HV or LV cable phase arrangements. If single core cables must be installed, then use trefoil arrangement for the cables to increase cancellation effects by reducing distance between the insulated phases within the same circuit.
- Ensuring HV and LV circuits have relatively balanced phases to minimise peak currents and the resulting magnetic fields.
- Avoiding large distances to the HV and LV phases on earth and neutral loops.
- Shielding of EMF sources (least effective method and should be avoided).
- Reducing electrical currents by incorporating energy efficient equipment for large electrical loads.

The design must ensure that metallic items such as concrete reinforcement for the purposes earthing performance do not inadvertently create a source of magnetic fields.

Where EMF shielding is necessary it should be either installed within the walls of the substation or external to it. EMF shielding must only be installed within a substation with prior evaluation and approval by TasNetworks.

5.5 Primary equipment

All equipment used in the substation must be compliant with the relevant TasNetworks standard.

For new substations, the configuration must be must be one of those listed in Appendix A. Where only partial asset replacement or augmentation is occurring the equipment impact shall meet the requirements of Appendix A.

5.5.1 High voltage switchboards

High voltage switchgear installed in substations must comply with the requirements of TasNetworks' high voltage switchgear standard.

The switchgear used may be either extensible or non-extensible. The type of equipment used will be dependent on the functional requirements of the substation.

In substations where two or more transformers are installed the transformers must be supplied and protected by HV circuit breakers.

The standard switchboard arrangements are provided in Appendix A.

5.5.2 Transformers

Transformers installed in substations must comply with the requirements of TasNetworks' transformer standard for distribution substations.

5.5.2.1 Transformer rating

The transformer capacity for the substation must be determined from the criteria listed in section 3.

Transformers must only use passive cooling systems to achieve their design power rating i.e. active cooling systems using fans are not to be used to achieve the power rating of the transformer.

To determine the number and power rating of the transformers required, there may be a need to ascertain the level of supply security required by the customer. If a level of redundancy is required for the supply the use of multiple transformers of smaller capacity may be preferred e.g. 2 x 1000 kVA transformers rather than a single 2000 kVA transformer.

Unless prescribed in the Distribution Planning Requirements, the transformer loading at the time of connection should be no greater than 80 per cent of the transformer power rating. The initial utilisation factor allows for the connection of future customer load to the substation. Refer to TasNetworks Distribution System Design Standard for the specific transformer standard size and the number that must be used for the calculated load.

The standard transformers power and current ratings for use in building stations are provide in tables 7 and 8 for oil and air insulated transformers respectively.

Table 6: Oil insulated transformer ratings

Power rating (kVA)	Primary voltage (HV)		Secondary voltage (LV)	
	Voltage (kV)	Rated current (A)	Voltage (V)	Rated current (A)
500	11	26.2	433	677
	22	13.1		
750	11	39.4	433	1000
	22	19.7		
1000	11	52.5	433	1333
	22	26.2		
1500	11	78.7	433	2000
	22	39.4		

Table 7: Air insulated transformer ratings

Power rating (kVA)	Primary voltage (HV)		Secondary voltage (LV)	
	Voltage (kV)	Rated current (A)	Voltage (V)	Rated current (A)
800	11	42	433	1067
	22	21		
1250	11	65.6	433	1668
	22	32.8		

5.5.2.2 Transformer type

Transformers used in building substations may be conventional oil filled transformers or air insulated transformers. The transformer selection must take into consideration the pros and cons of the different types.

As a standard, oil filled transformers must be used in the first instance. Air insulated transformers shall only be used when an oil filled transformers cannot meet the design requirements. Air insulated transformers may only be used with the approval of TasNetworks' Asset Strategy Team.

Oil filled transformers usually have a greater ability to accommodate loading above their nominal rating over air insulated transformers.

Air insulated transformers have the advantage that an oil containment system is not required, but they do require a more substantial ventilation/cooling system over oil filled transformers. They also have very limited capacity to accommodate overload situations above their design power rating.

5.5.2.3 Voltage set point

The design must determine the most appropriate voltage set point for the transformer to ensure that a compliant supply voltage is achieved under all operating conditions.

5.5.3 Low voltage switchboard

Low voltage switchboards installed in substations must comply with the requirements of TasNetworks' low voltage switchboard standard.

Alternative arrangements must not be used without the prior approval of TasNetworks.

The switchboard configuration and rating must take into consideration future network and customer requirements.

5.5.4 Cables and terminations

5.5.4.1 Minimum requirements

The following requirements are the minimum requirements for cables and their installation:

- Selection of cables and wire must be from AS 3000, AS 3008 and AS 2067.
- Cable and wire colours must be selected using AS 3000 or current industry standards.
- All cables installed within trenches must be installed above the bottom of the trench.
- HV and LV cables must be restrained where appropriate using cable clamps.
- HV cable screens must be terminated to the station earthing system at both ends. Single-core cable screens must be terminated to earth at the HV switchboard end only.
- All external cables and wires must be marked using proprietary marking systems.
- All HV and LV cable terminations must utilise a compression lug and heat shrink kit suitable for the termination. All other minor terminations must have a suitable compression lug or approved period contract termination.
- All control terminals within all switchgear panels must be industry standard slide link terminals to allow isolation during commissioning activities.

Requirements outside this section must be derived from Australian Standards and industry standards:

5.5.4.2 Cable selection

The designer must determine the number of feeders, rating and lengths for both the HV and LV reticulation. TasNetworks' standard HV feeder cable sizes for both 11 and 22 kV are 185 and 240 mm^2 3 core, XLPE insulated, individual copper screened with HDPE sheath.

Where a new substation is being installed within the network or asset replacement of the HV switchboard is occurring, the current rating of all the new sections of HV cable must be equivalent in rating or of a higher rating than the HV feeder cables that they are being connected to.

The HV cable size and number of single phase cables required for connection of the HV switchboard to the transformer is listed in Table 9.

Table 8: HV cable size – HV switchboard to transformer

Power rating (kVA)	Single core cable size Copper or Aluminium (mm^2)	Quantity cables per phase
500 - 2000	95	1

TasNetworks' standard cable sizes for LV reticulation are 185, 240, 300, and 400 mm^2, 4-core XLPE insulated.

Transformer to LV switchboard cables are to be 300 mm^2 single core, copper cables. The number of single phase cables required for the standard transformer sizes to the LV switchboard are listed in Table 9.

Table 9: LV cable size – Transformer to LV switchboard

Power rating (kVA)	Single core cable size (mm^2)	Quantity cables per phase
500	300	1
750	300	2
1000	300	2
1500	300	3

For further details refer to TasNetworks' Distribution Design Standard for Underground System and TasNetworks Planning Requirements.

5.5.4.3 Cable exits to adjacent rooms or buildings

Cables must be fitted into floor culverts and secured with proprietary cable restraining systems e.g. stainless steel or aluminium cable cleats.

Cables exiting the substation to an adjacent building e.g. customer's switch room, must be run in conduit (conforming to AS/NZ 2053) or other proprietary method to allow ease of installation and retrofitting. The method must be compliant with AS 2067.

To prevent fire spreading to adjacent rooms or buildings, all cables which exit the substation to adjacent rooms or buildings must have proprietary fireproof sealing installed around the cables and these cables must be painted with rated intumescent paint to stop fire spreading along the cables. All sealing and paint products must be applied in accordance with the manufacturer's instructions and applied on both sides of the cable exit.

5.6 Secondary systems (Protection, SCADA and DC systems)

To support the operation and monitoring of the primary equipment, the installation of secondary systems and equipment is often required in building substations. These systems usually comprise protection, SCADA (Supervisory Control and Data Acquisition) and DC systems.

The detailed requirements for these systems are defined in the Distribution Protection and Automation Standard (R2343500). All new substations must be fully compliant with the requirements of this standard.

Sections 5.6.1 and 5.6.2 provide a summary of the minimum functionality required for the protection and SCADA systems in the substation.

5.6.1 Protection

The following protection functionality for the equipment must be provided as a minimum:

<u>High voltage switchboards</u>

- The incoming point of supply to the switchboard may be either using a line switch, or a circuit breaker.

  Where circuit breakers are installed at the incoming point of supply, the associated protection scheme shall enable the circuit breaker to clear both over current and earth faults.

  Differential protection schemes (Translay) providing protection for the HV feeder cables, shall only be installed/retained when required. The preference is to not use these schemes due to their reliance on aging pilot cables, which can be in a deteriorated condition.

- Where a switchboard is only supplying a single transformer of less than 1000 kVA, a fuse switch shall be used for the transformer protection.

- Where a switchboard is supplying multiple transformers or a single transformer equal to or greater than 1000 kVA rating, a circuit breaker shall be used for the transformer protection.

  The associated transformer protection scheme shall enable the circuit breaker to clear both over current and earth faults.

  Where switchboards are supplying more than one transformer, a fault detected on the high voltage side of the transformer shall trip both the high voltage transformer circuit breaker and corresponding low voltage circuit breaker.

<u>Low voltage switchboards</u>

- Low voltage switchboard shall be protected by a circuit breaker at every point of supply. The circuit breakers system shall detect, and clear over current events.

- All low voltage distribution circuits emanating from the substation shall be protected by circuit breakers. The circuit breakers system shall detect, and clear over current events.

5.6.2 SCADA

A communication system shall be provided at the substation that can send alarms and signals back to Networks Operations Control Centre. As a minimum, the following alarms shall be configured:

- General alarm (Grouped alarm for loss of ac supply to battery charger, DC under voltage, circuit breaker trip, protection relay fault).

- Fire alarm (Where a fire detection/suppression system is installed).

5.7 Customer connection point

Where a customer is connected to the network at low voltage and they are to be direct connected to the TasNetworks substation, the customer connection point must be the terminals on the downstream side (bottom connection) of the LV circuit breaker in the substation that is used to supply the customer load.

Where a customer is connected to the network at high voltage, the connection arrangement must be in accordance with TasNetworks' Private High Voltage Substation connection policy, reference R377692.

5.8 Energy metering

Energy meters and metering equipment must be part of the customer's installation.

The energy metering system must be in accordance with Chapter 7 of the National Electricity Rules.

Compliance with the Tasmanian Government's metering requirements defined in the Electricity Consumption Metering Safety Requirements (Tasmania), reference DOC/17/85250(V1.0), must also be achieved.

5.9 Earthing

The substation design must include the design of the substation earthing system. The design must be guided by, and compliant with 'Section 8 - Earthing Systems' of AS 2067. The requirements of AS 2067 must be considered the minimum performance based standard for the substation earthing system. Energy Networks Australia (ENA) Power System Earthing Guide, EG-0 may be used as a reference for making risk based assessments using the ALARA (ALARP) principle.

The methodology and engineering processes adopted for deriving the design solution must comply with the guidelines and standards referenced in this section.

The objective of the earthing design, as stated in AS 2067, is to ensure an acceptable safety level of for persons within the zone of influence of the substation's earthing system, with legitimate access in accordance with the risk assessment principles outlined in ENA earthing guide EG-0.

Additional guidance on the design and installation of substation earthing systems can be gained from other published documents such as, but not limited to, ENA EG-1, AS 60479.1 and IEEE 837.

The standards listed in Table 11 should be referred to for guidance for the design of the earthing system. It should be noted that not all of these standards may be relevant to the earthing design being undertaken. The most appropriate standards should be applied to the specific situation.

The earthing system must:

- have a continuous metallic path back to the source of supply for the substation (via cable screens and/or LV neutral) to provide good coupling back to the source of supply.
- be a common bonded HV and LV earthing system.
- have all metallic equipment within the substation bonded to the earthing system.

Table 10: Summary of earthing related standards/guides

Standard	Description	Specific Application	Applicable Scenarios
AS 2067	Substations and high voltage installations exceeding 1 kV ac	Earthing requirements for substation design process (applies to principles outlined in EG0).	All substation earthing systems.
AS/NZS 60479.1	Effects of current on human beings and livestock - General aspects	Earthing requirements for the development of safety limits.	Public and Operator safety limits.
AS/NZS 3000	Low Voltage Installations	Earthing requirements for low voltage installations, with guidance for HV sites.	Customer and private installations.
AS/NZS 3835	Telecommunication Assets	Rules governing earth potential rise and voltage transfer onto telecommunication assets.	Earthing systems near telecommunication pits or exchanges.
AS/NZS 4853	Pipelines	Rules governing earth potential rise and voltage transfer onto pipeline assets.	Earthing systems near conductive metallic pipeline and associated infrastructure.
AS/NZS 1768	Lightning	Guidance and risk management for lightning protection, scope includes the earthing of lightning arrestors.	Earthing of Lightning protection.
ENA EG-0	Power System Earthing Guide, Part 1: Management Principles	This document outlines the entire earthing design process as required by AS 2067.	All earthing systems.
ENA EG-1	Substation Earthing Guide	Further design guidance and specific formulae for modelling an earthing system.	All earthing systems.

5.9.1 Earthing conductors

The specific size of the earth conductor must be determined based on the fault conditions present at the site. Guidance on the conductor sizing calculations can be obtained from ENA EG-1.

A solid copper earthing conductor must be run around the inside perimeter of the substation for the purpose of bonding internal earths to the earthing system. This conductor must be connected to the earthing system in at least two locations. The cross sectional area of the connections to the earthing conductor must not be less than the cross sectional area of the earthing conductor. The earthing conductor must be mounted on the wall at a height of approximately 150 mm from the floor.

Hard Drawn bare stranded copper conductor is preferred for below ground earthing conductors, with insulated Yellow/Green stranded copper conductors preferred for HV earth tail connections within the substation. The minimum size for primary equipment earth tails is 70 mm^2.

5.9.2 Earthing connections

All earth grid and earthing joints must be type tested compression connections. All earth grid and equipment earthing jointing methods should be verified to comply with the intent of IEEE 837. All primary equipment must be suitably fault rated. Test certificates for proprietary items must be provided by the supplier and demonstrate that they are capable of carrying the maximum fault current for all earth fault scenarios and back up clearing times.

Below ground earthing joints must be crimped using Burndy or equivalent earth connections. Heavy duty sealed palm lugs that are suitably fault rated are used for primary equipment connections. They must be hexagonally crimped to the earth conductor. FCI- Hylugs or equivalent must be used.

As minimum HV switchgear and transformers must have two earth connections installed diagonally opposite to each other. All equipment earthing tails and earth tails extending up from the subsurface earthing system must be labelled in accordance with AS/NZS 3000 and AS 2067. The designer must ensure manufacturer’s earthing connections are adequate for the earthing system design.

5.9.3 HV Cable screens

The HV cable screen forms an integral part of TasNetworks’ earthing system design. The metallic screens of cables are designed to provide an effective earth return path for fault current that results from failed equipment.

The HV cable screens must be bonded at both the substation and remote earth point. The remote earth may be a distribution substation or underground to overhead earth electrodes.

The earthing termination at the remote HV asset will be dependent on the infrastructure that it is being connected to. The termination method must be compliant with the applicable TasNetworks standard.

5.9.4 CMEN (Common multiple earthed neutral system)

The substation earthing configuration must be a common multiple earth system where the earths for both the high voltage and low voltage equipment are connected to a common earthing system.

The CMEN system meets the requirements of relevant standards.

5.9.5 Earthing considerations

The earthing system design for the substation will need to consider a range of criteria to ensure that fault currents can be safely dissipated to earth. Existing Australian Standards and best industry practice (in the form of guidelines e.g. ENA EG-0 and EG-1) require a holistic approach to achieve a risk versus cost benefit for the installation.

<u>Public and Operator Safety</u>

The earthing design limits must be initially developed using AS 60479.1. A high level methodology must be developed to derive these limits.

Earthing guideline EG-0 may also be used to determine the limits if determined to be suitable. The analysis should consider a risk versus cost benefit analysis using the principles of contact scenario assessment where there is the likelihood of personal contact with nearby infrastructure during the time of an earth fault at the site. The assessment of what is ‘nearby’ will generally depend on the extent of the earthing system at a site, bonding arrangements, soil resistivity and the fall of potential profile.

There are two scenario categories defined by EG-0 which should be considered. These are:

- Individual risk assessment: The annual risk of fatality for an exposed individual. The risk associated with an individual is usually calculated for a single hypothetical person who is a member of the exposed population. Individual risk assessments do not account for the danger to an exposed population as a whole [EG-0].

- Societal risk assessment: The risk associated with multiple, simultaneous fatalities within an exposed population. When considering the impact on society it is usual to consider the annual impact upon a 'typical segment' of society. Societal risk may be a determining factor in the acceptability of the risk associated with a hazard for areas where many people congregate.

When assessing a site societal risks must be identified. These will exist in heavily populated areas where people congregate on objects such as hand railings or fences.

The development of EG-0 safety limits must be calculated using ENA’s Argon software. The development of these limits must include the benefit of further risk reductions measures and a determination as to whether further improvement of the system is practicable, or the additional cost of mitigation is grossly disproportionate to the risk reduction benefit.

Telecommunication assets
The earthing system design must consider the interaction of telecommunications infrastructure, as both high voltage electrical infrastructure and telecommunication infrastructure often co-exist in close proximity to each other.

The proximity of the earthing system may result in Low Frequency Induction (LFI) and Earth Potential Rise (EPR) in telecommunication equipment during fault conditions on the electricity network. Although these voltage rises are short duration, they may reach hazardous levels. The voltage rise that will appear at the earth under fault conditions is dependent on the earthing design, fault levels and soil resistivity.

The design must determine if there is the potential for voltages to be introduced into the telecommunications network that may be hazardous to users of it. Where a hazardous situation may be exist, mitigation measures must be put in place to either eliminate it. The identification of hazards and minimisation of them must be undertaken in accordance with AS 3835.

Metallic pipe lines
The earthing system design must consider the effects on metallic pipe lines such as, but not limited to, water reticulation and gas pipelines. If new pipes are to be installed then the use of non-conductive pipes in close proximity to the new HV installation is preferred. The requirements in AS 4853 should be followed to develop the appropriate safety limits.

5.9.6 Assessment criteria for compliance

To develop and assess the compliance of the earthing system the site specific information required will include:

- Identification of HV fault locations (sources).
- Phase to earth fault level (zero sequence impedance) in amps.
- Vector or angle information sufficient to recalculate the earth fault level for a given series impedance, and to calculate the X/R ratio.
- Three phase fault level in amps.
- Protection curve settings associated with remote primary protection device (e.g. upstream circuit breaker) for each fault level.

The design must allow for the fault current DC offset and fault current calculations to determine the actual fault level based on the localised system resistance.

The worst case earth fault scenario for the site must be used to complete the earthing study.

5.9.7 Soil resistivity

TasNetworks’ preferred method for measuring soil resistivity is the Wenner four electrode method. Traverse measurements and measurement separation must be selected based on the application purpose i.e. design or development of safety limits and the practicality of testing for the size of the earthing system.

As a minimum for design purposes, two traverses must be performed up to a spacing of 32 metres. The soil resistivity traverse results must account for the characteristic trends of the native soil conditions and any deviations between the traverse results must be clarified by the designer to determine if the measurements are suitable for design purposes. Testing must be undertaken in a location as near as practical to the site and chosen to minimise interference from existing known above/underground metallic infrastructures. Details on the testing methodology can be obtained from ENA EG1.

Site conditions must be recorded at the time of testing including weather conditions, temperature and soil moisture content. Any relevant visual observations of the soil type being tested may also be recorded.

5.9.8 Documentation

The earthing system design must be presented in a detailed package, which is to include layout drawings indicating location of buried conductors, conductor size, insulation surface thickness (if applicable), earth rods and earthing tails to metallic structures. The designer must submit a design report detailing all inputs, assumptions, calculations, graphical model outputs and commission test program.

5.9.9 Continuity testing

The recommended measuring method is the 4-wire Continuity Test method, where the continuity measurement must be referenced to the common HV or LV earth bar for each metallic item within the substation. Alternative testing methods need to be consulted and approved by TasNetworks.

5.9.10 Verification of design

The testing of the earthing system must be carried out by an appropriately qualified and accredited person.

The earth grid installation must be inspected by the designer prior to it being covered up to ensure compliance with the design.

All joints must be tested using a four-wire resistance tester, the test result recorded with a location and photo. If a joint measures higher than the expected calculated value, the joint must be replaced and re-tested.

A commissioning schedule for the HV energisation of the electrical installation must be commissioned in accordance with AS2067-2008. For this installation, it is recommended to perform current injection testing using the off-frequency method to verify the safety of the earthing system.

The remote current injection point should be established based on the interconnection, fault location and soil resistivity at the site under test.

To verify the safety of the installed earthing system in accordance with AS 2067, ENA EG-1, ENA EG-0, the testing should include the following:

- Measurement of earth grid voltage and earth system resistance.
- Measurement of prospective step, touch and hand-to-hand voltages in and around the site and surrounding areas, in accordance with the relevant zone of influence.
- Investigation and measurement of transferred voltages outside the site
- Visual inspection.
- Continuity testing using a 4 wire DC resistance meter.

The installation and commissioning processes must determine the validity and compliance of the design to ensure the earthing safety requirements are met and thus certify compliance. Any non-compliance will be reviewed and mitigated by subsequent coordinated works between the designer and installer.

5.9.11 Stakeholder management

Due to the potential impact to other stakeholders in both the design and construction phase, it is recommended that the earthing design and assessment report is issued to other stakeholders (where applicable), which may include:

- Civil contractors
- Electrical installers
- Telecommunications installers
- Plumbing installers
- Gas installers.

6 Equipment identification

All equipment where a physical change of state may occur during operational activities e.g. circuit breakers, switches and fuses shall have a unique identifier.

Transformers shall also have a unique identifier.

6.1 HV switchboards

6.1.1 Circuit breakers, switches and fuses

High voltage equipment shall be identified with a single capital letter. The first item of equipment shall start with the letter ‘A’. Designation shall be in alphabetical order from left to right. e.g. A, B, C etc.

Equipment shall not be identified as ‘I’ and ‘O’. The next letter, alphabetically shall be used instead.

6.1.2 HV Circuit source/destinations

All high voltage circuits entering or leaving the substation shall have a descriptor that defines their source/destination on the network. Descriptions shall be written in full (where possible) and reference the connection point e.g. site or pole ID.

6.2 Transformers

All transformers shall be individually identified and prefixed with the letters ‘TF’ e.g. TF1, TF2 etc.

6.3 LV switchboards.

6.3.1 Circuit breakers, switches and fuses

Low voltage equipment shall be identified with a single lower case letter. The first item of equipment shall start with the letter ‘a’. Designations shall be in alphabetical order from left to right. e.g. a, b, c etc.

Equipment shall not be identified as ‘i’ and ‘o’. The next letter, alphabetically shall be used instead.

6.3.2 LV Circuit destinations

All low voltage circuits that provide a supply external to the substation shall have a descriptor that defines their destination on the network. Descriptions shall be written in full (where possible) and reference the connection point e.g. site, pole ID.

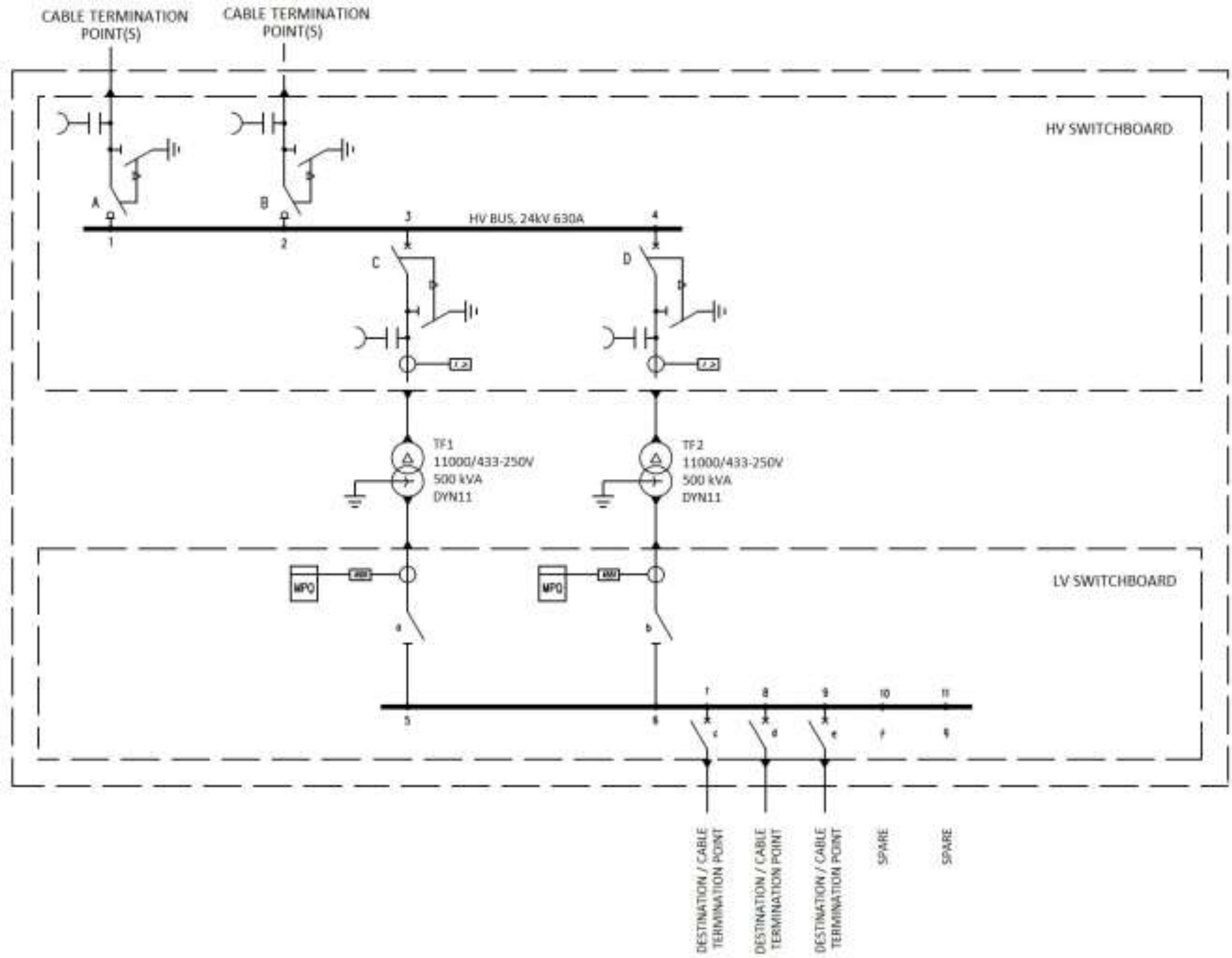
6.4 Secondary equipment.

Where installed, the location and device ids. for all secondary equipment, shall be provided on the one line diagram. The device ids. used shall be in accordance with the Asset Nomenclature Standard.

All secondary equipment identification shall be prefixed with their respective circuit identifiers i.e. ‘A’, ‘B’, ‘C’ etc.

6.5 Example substation schematic

Figure 5: Building substation single line diagram



7 Easements

To ensure TasNetworks' access and management needs are provided for, an Electrical Infrastructure Easement must be registered on the property owner's title. The easement must extend to the extremities of TasNetworks' infrastructure.

If access to the substation requires private land to be traversed, then a right of way must also be registered on the title. This right of way must ensure access is available to TasNetworks personnel on a 24 hour, 7 days a week basis and be suitable for the movement of heavy equipment across it e.g. power transformers and switchgear.

8 Design deliverables

All design deliverables must be legible and comply with TasNetworks' standards for documentation. Documentation must be submitted in electronic form and a hard copy.

8.1 Detailed documents/reports

The designer must ensure that the substation design consists of following documents as a minimum:

- Safety in Design report
- Civil requirements report
- Determination of loading requirements
- HV fault current and associated protection clearance times
- Manufacturer equipment specifications, test reports and ratings
- Fire risk assessment
- Protection study and settings
- Earthing design report
- Voltage drop calculations
- Ventilation system design report
- Evidence of easement on title or electrical infrastructure easement
- Environmental impact assessment or equivalent (if applicable)
- Operation and maintenance manuals for equipment.

8.2 Drawings

The completed design must include all the drawings necessary for the construction and ongoing management of the substation.

The drawings must comply with the format requirements outlined in TasNetworks' Design Drafting Standard. The drawings must be specific to the substation. All drawings shall use TasNetworks' approved distribution substation drawing templates. The symbols used for electrical equipment shall be in accordance with drawing D-806-0001-SD-002 -Distribution Ground Substation HV Switchgear Types.

As a minimum the following drawings must be provided for the design:

- Drawing register with reviewer and approval sign off
- Proposed site and location plan (with dimensions of buildings, relevant structures, access ways, contours and easements)
- Substation building layout (external)
- Detailed civil foundation and structural drawings (as required[1])
- Substation layout (internal)
- Floor detail, including reinforcement and design loading[1]
- General arrangement drawings for all equipment
- Trench arrangements, with cable mounting detail
- Conduit locations
- Oil containment system (if installed)
- Fire systems (if installed)
- Doorways and doors lighting
- Ventilation system

[1] Where the substation is incorporated into a larger building the civil foundation and structure design would normally be undertaken by the developer, with TasNetworks only defining its requirements.

- Metering and Protection One Line Diagram
- AC/DC Schematic diagrams
- Wiring diagrams (one per feeder)
- Cable connection diagram
- Secondary system drawings, including panel layouts and connection tables (if installed)
- Earthing arrangement
- Control and communication (if installed)
- Drawing references for the underground system design
- Detailed underground plan.

Where upgrade/retrofit works are conducted at existing substations or other network infrastructure is altered, the existing drawing shall be revised to include the new devices and associated circuitry added as part of the upgrade/retrofit. Where no such drawings exist, new drawings shall be created for the infrastructure impacted.

8.3 Design check list

Table 11: Design checklist

Design component	Applicable section in standard	Australian Standards/Guide referenced	Drawing/Report reference	Completed/ Actioned Yes/No/NA
Assessment and determination of infrastructure requirements	Section 3	Customer and network requirements. AS 3000		
Site selection	Section 4.1	Customer, network, and statutory requirements. AS 2067		
Equipment selection	Sections 4.4 and 5.5	TasNetworks approved equipment. AS 2067		
Safety in Design sign off	Section 2.2.1	AS 2067		
Detailed civil design review/approval	Section 4	AS 2067		
Detailed electrical design review/approval	Section 5 Primary 5.1 – 5.5, 5.8 and 5.9 Secondary 5.6, 5.7 Earthing 5.11	AS 2067		
Design options cost versus benefit sign off. Stakeholder consultation/approval				
Documentation hand over for construction				

Appendix A - Substation standard configuration schematics

Figure 6: Substation configurations - Single HV feeder supply, with supply via line switch

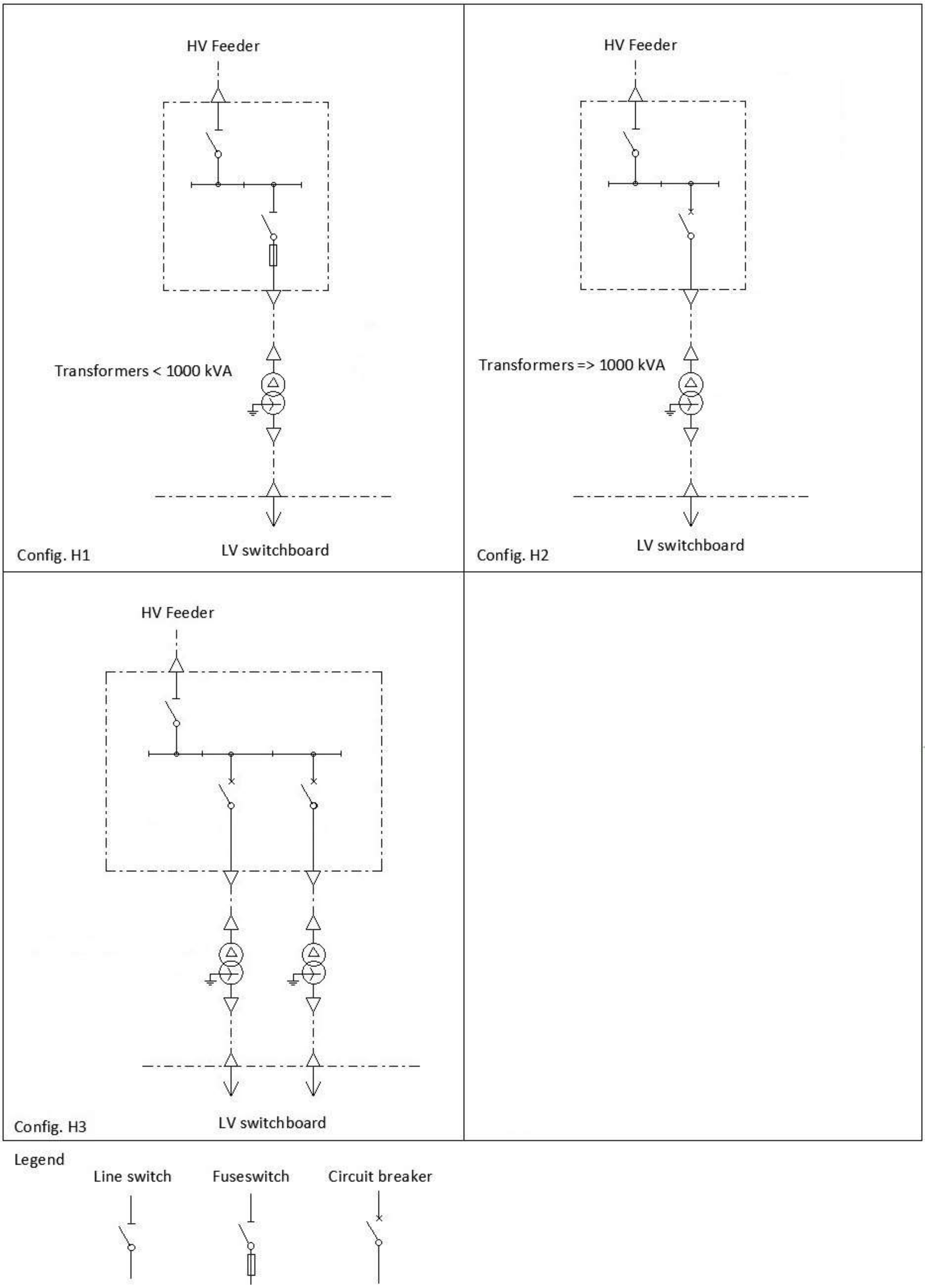


Figure 7: Substation configurations - Dual HV feeder supply, with supply via line switches

Transformers < 1000kVA **Transformers ≥ 1000kVA**

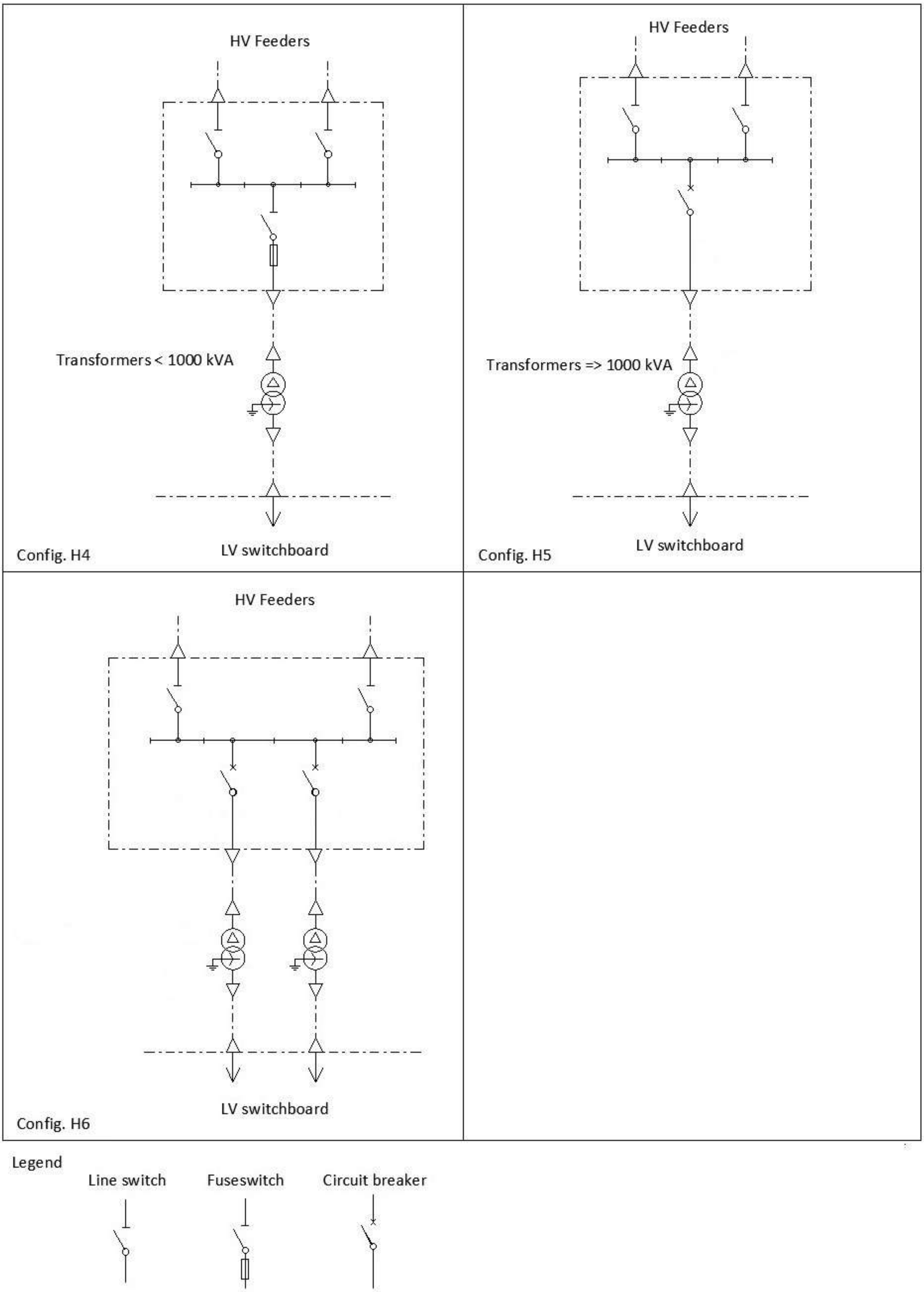


Figure 8: Substation configurations - Dual HV feeder supply, with circuit breaker protection

Transformers < 1000kVA **Transformers ≥ 1000kVA**

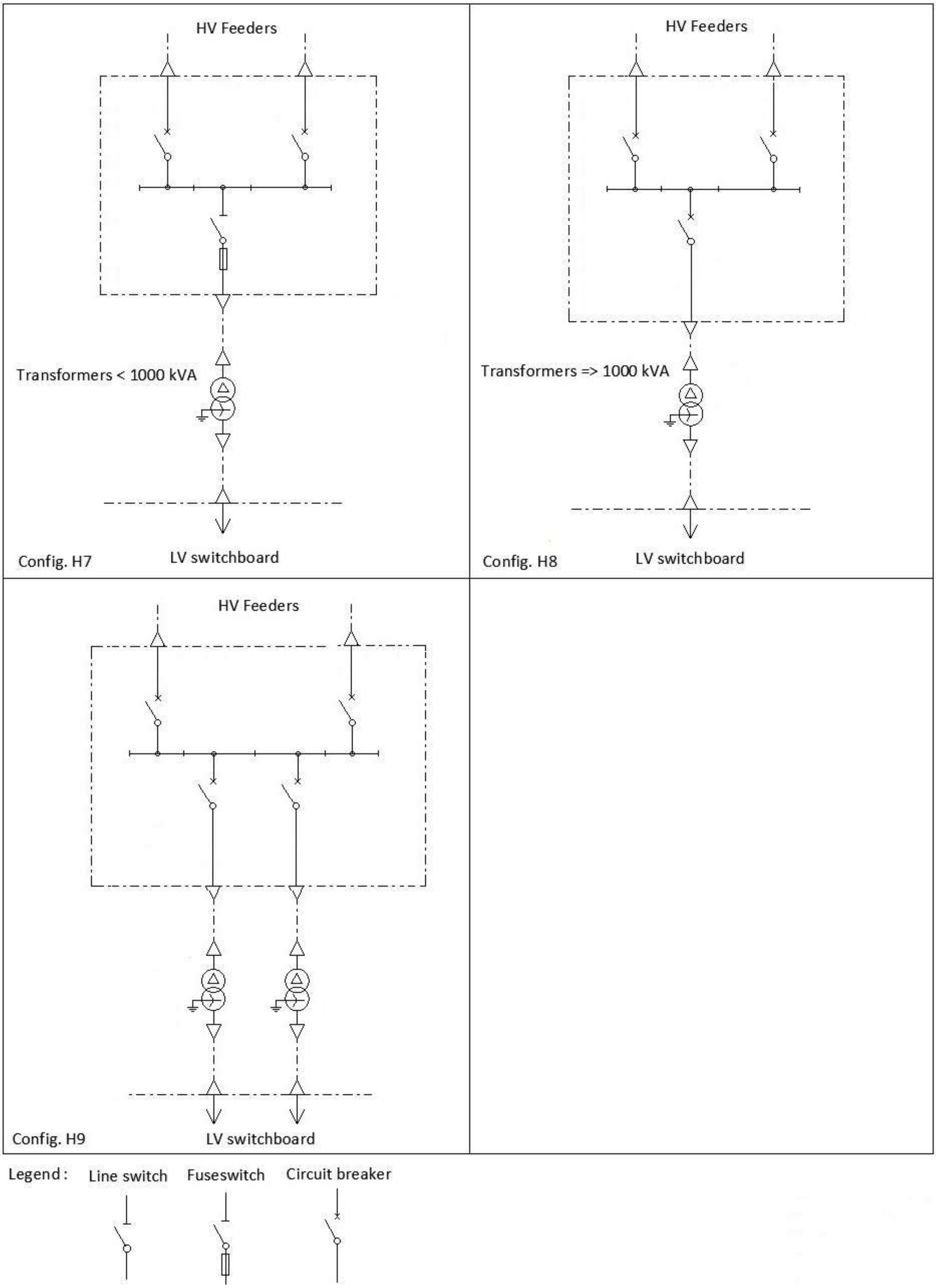


Figure 9: Substation configurations – Triple HV feeder supply with circuit breaker protection

Transformers < 1000kVA **Transformers ≥ 1000kVA**

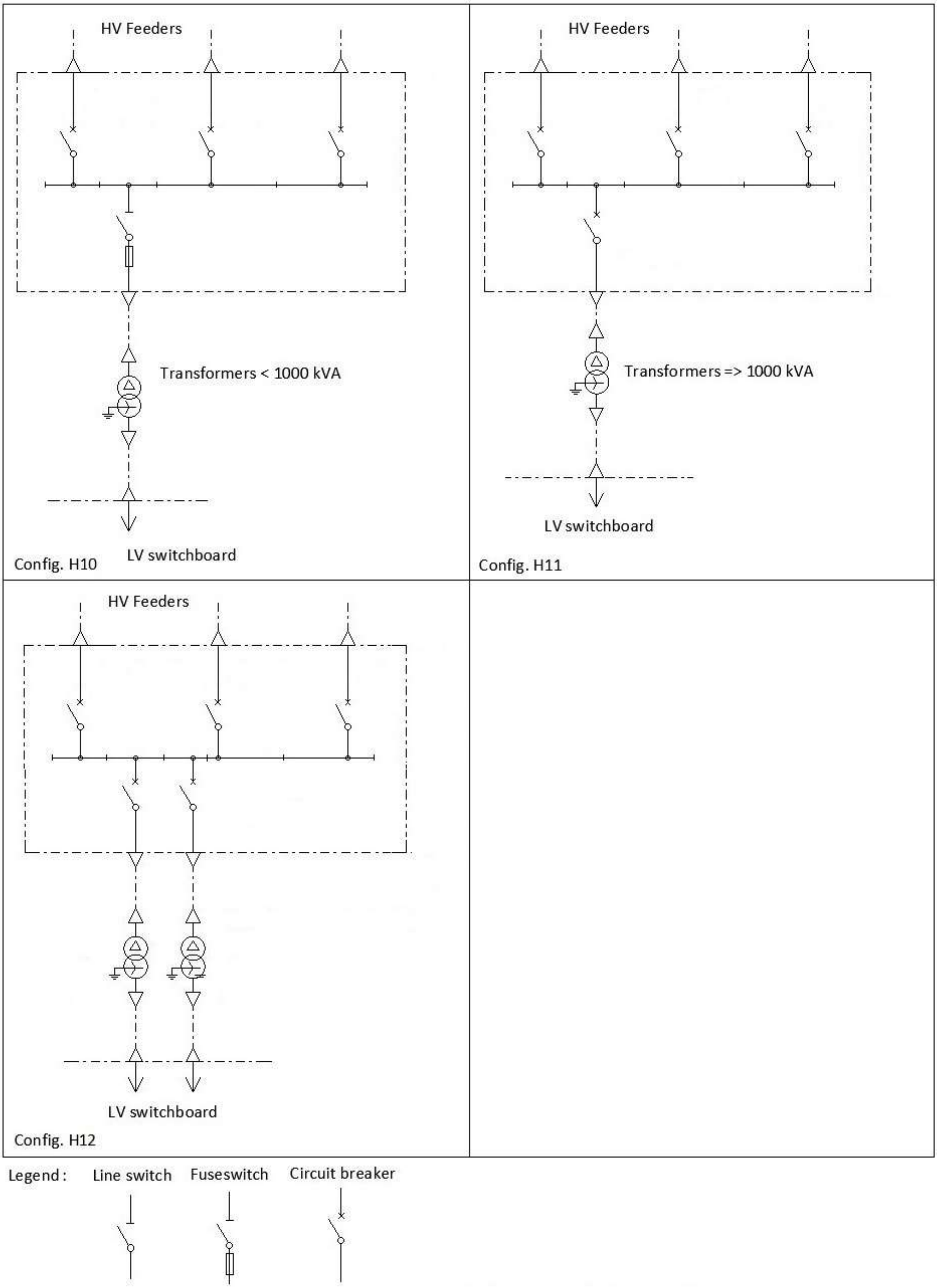
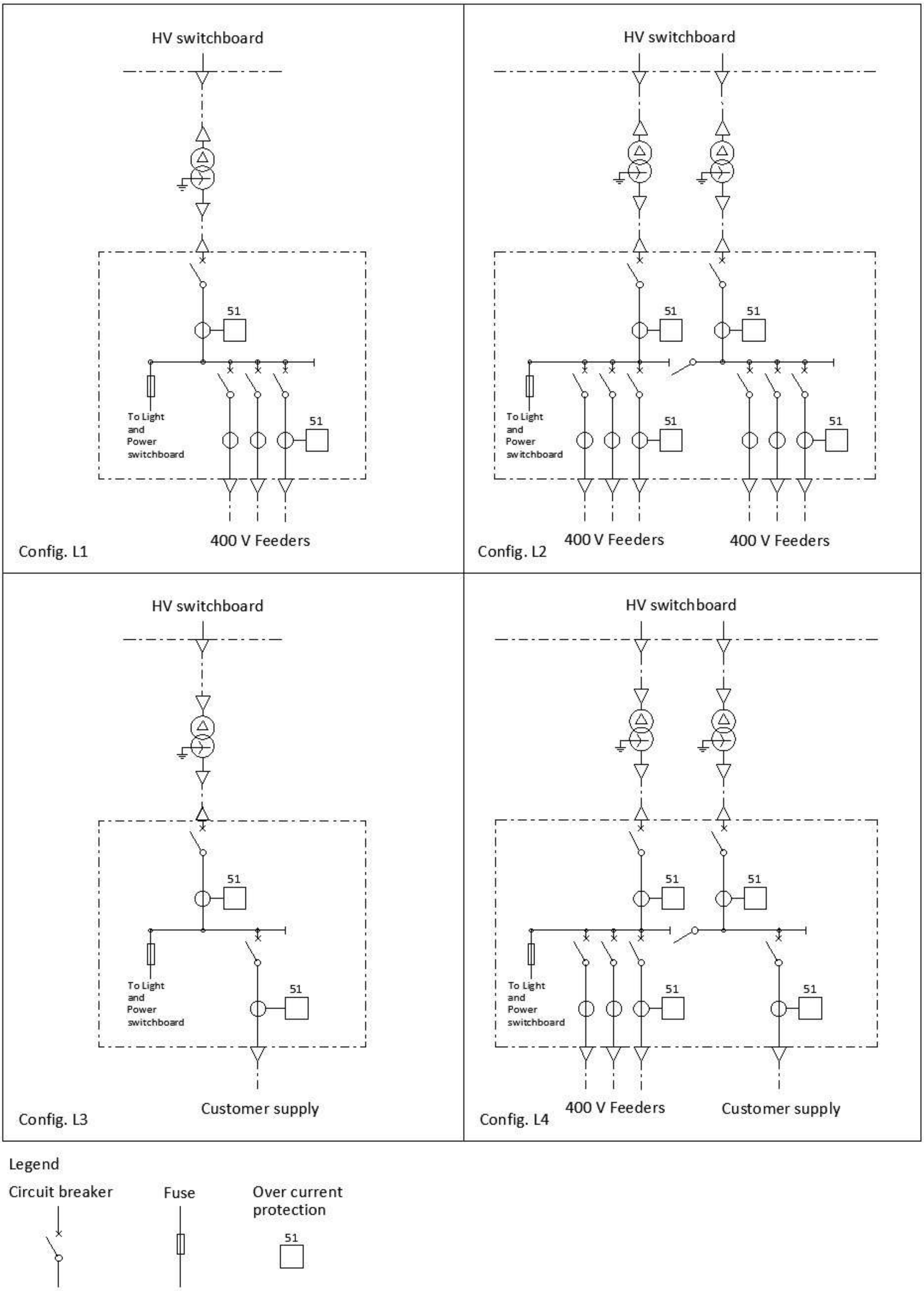


Figure 10: Substation configurations - Low voltage schematics



Appendix B – Standard equipment

Only the equipment listed in this section shall be used in building substations.

8.4 HV Switchboards

The following tables provide the details for the standard switchboard components and also the bill of material numbers the complete switchboard assemblies.

Table 12: HV switchboard components

HV Switchboards item	Manufacturer and type	Makers Id.	Makers drawing set	SAP material number
Switch	ABB SafePLus	C	D-809-0040-MD-001	990568
Switch fuse	ABB SafePLus	F	D-809-0041-MD-001	990569
Vacuum CB – with ABB relay	ABB SafePLus	V	D-809-0044-MD-001	990571
Vacuum CB – without relay	ABB SafePLus	Sv	D-809-0043-MD-001	990573
Bus tie	ABB SafePLus	SvBr	D-809-0042-MD-001	990570
Cable riser	ABB SafePLus	D	D-809-0045-MD-001	990572
RMU – 2-Way	ABB SafePLus	CV	D-809-0046-MD-001	990574
RMU – 3-Way	ABB SafePLus	CVC	D-809-0047-MD-001	990575
RMU – 4-Way	ABB SafePLus	CVC	D-809-0048-MD-001	990576

The BOM (Bill of material) numbers listed in Table 13are for the complete HV switchboard and the components required to install them e.g. mounting frame, unistrust, cables clamps etc.

Table 13: HV switchboard configurations – Incoming feeders with Line switch

HV Switchboards	Configuration	Total assembled width (mm)	BOM number
1 Feeder, 1 transformer less than 1000 kVA	C - F	750	730057
1 Feeder, 1 transformer 1000 kVA or greater	C – V[1]	750	730058
1 Feeder, 2 transformer	C – V – V[1]	1129	730059
2 Feeder, 1 transformer less than 1000 kVA	C - C - F	1129	730066
2 Feeder, 1 transformer 1000 kVA or greater	C - C – V[1]	1129	730067
2 Feeder, 2 transformer	C – C - V - V	1508	730068
3 Feeder, 1 transformer less than 1000 kVA	C – C – C - F	1508	730078
3 Feeder, 1 transformer 1000 kVA or greater	C – C – C - V	1508	730079
3 Feeder, 2 transformer	C – C - C – V - V	1887	730080

Note 1: This is a modular switchboard, not an RMU.

Table 14: HV switchboard configurations – Incoming feeders with circuit breaker (No translay)

HV Switchboards	Configuration	Total assembled width (mm)	BOM number
1 Feeder, 1 transformer less than 1000 kVA	V - F	750	730060
1 Feeder, 1 transformer 1000 kVA or greater	V - V	750	730061
1 Feeder, 2 transformer	V – V - V	1129	730062
2 Feeder, 1 transformer less than 1000 kV	V – V - F	1129	730070
2 Feeder, 1 transformer 1000 kVA or greater	V - V - V	1129	730071
2 Feeder, 2 transformer	V – V – V - V	1508	730072
2 Feeder, 3 transformer	V – V – V – V - V	1887	730073
3 Feeder, 1 transformer less than 1000 kVA	V – V – V - F	1508	730082
3 Feeder, 1 transformer 1000 kVA or greater	V – V – V - V	1508	730083
3 Feeder, 2 transformer	V – V – V – V - V	1887	730084
3 Feeder, 3 transformer	V – V – V – V – V - V	2266	730085

Table 15: HV switchboard configurations – Incoming feeders with circuit breaker (Translay)

HV Switchboards	Configuration	Total assembled width (mm)	BOM number
1 Feeder , 1 transformer less than 1000 kVA	Sv - F	750	730063
1 Feeder, 1 transformer 1000 kVA or greater	Sv - V	750	730064
1 Feeder, 2 transformer	Sv – V - V	1129	730065
2 Feeder, 1 transformer less than 1000 kV	Sv – Sv - F	1129	730074
2 Feeder, 1 transformer 1000 kVA or greater	Sv – Sv - V	1129	730075
2 Feeder, 2 transformer	Sv - Sv - V - V	1508	730076
3 Feeder, 1 transformer less than 1000 kVA	Sv – Sv - Sv - F	1508	730082
3 Feeder, 1 transformer 1000 kVA or greater	Sv – Sv - Sv - V	1508	730083
3 Feeder, 2 transformer	Sv – Sv - Sv – V - V	1887	730084
3 Feeder, 3 transformer	Sv – Sv - Sv – V – V - V	2266	730085

8.5 Transformers

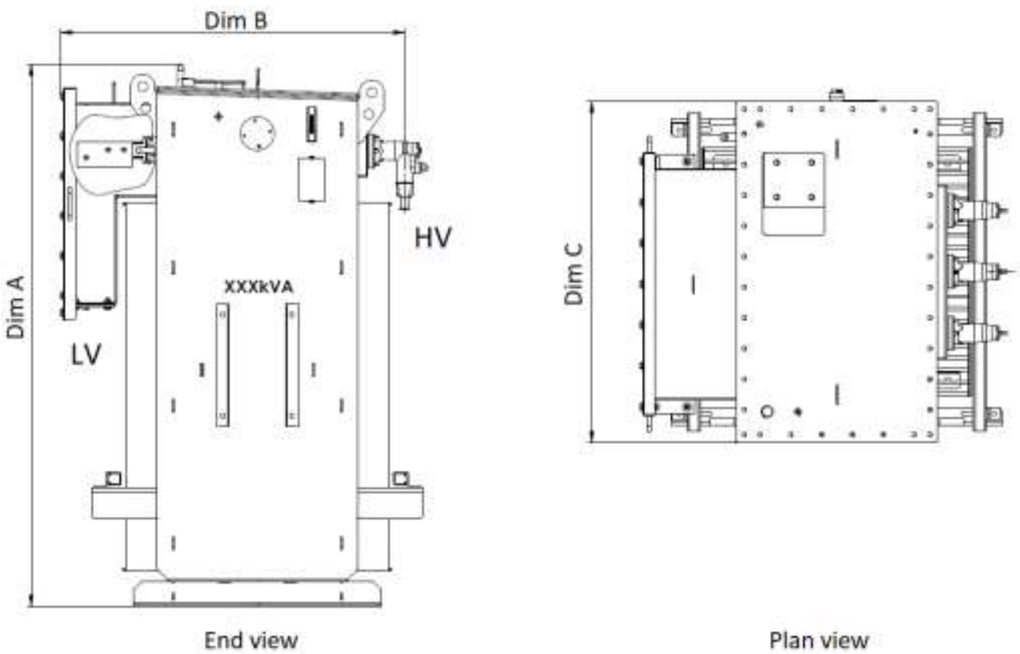
All transformers have a 'Type A' plug connection on the HV side for connecting to the HV cables.

Table 16: Standard transformers

Power rating (kVA)	Voltage (kV)	SAP Material part number	Manuf.	Manufacturer part number	Description
500	11	427835	Tyree	500M4IT	T/FORMER, 500kVA 11/433, GM, interface A
	22	427839	Tyree	500M5IT	T/FORMER, 500kVA 22/433, GM, Interface A
750	11	427843	Tyree	750M4IT	T/FORMER, 750kVA 11/433, GM, Interface A
	22	427847	Tyree	750M5IT	T/FORMER, 750kVA 22/433, GM, Interface A
1000	11	427851	Tyree	1000M4IT	T/FORMER, 1000kVA 11/433, GM, Interface A
	22	427855	Tyree	1000M5IT	T/FORMER, 1000kVA 22/433, GM, Interface A
1500	11	427859	Tyree	1500M4IT	T/FORMER, 1500kVA 11/433, GM, Interface A
	22	427863	Tyree	1500M5IT	T/FORMER, 1500kVA 22/433, GM, Interface A

Table 17: Transformer dimensions

Power rating (kVA)	Voltage (kV)	Dim A (mm)	Dim B (mm)	Dim C (mm)	Mass (kg)
500	11 / 22	< 1850	< 1140	< 1200	< 2250
750	11 / 22	< 1850	< 1230	< 1550	< 3240
1000	11 / 22	< 2250	< 1230	< 1670	< 3950
1500	11 / 22	< 2250	< 1485	< 1800	< 5200



Further details of the transformers are provided on drawing D-0809-0038-MD-001.

The BOM (Bill of material) numbers listed in Table 18 are for transformers and the components required to install them e.g. unistrust, cables clamps etc.

Table 18: Transformer configurations

Transformers	Voltage (kV)	BOM number	BOM Description
1 x 500 kVA	11	730033	BS T/FORMER Tyree 1x500kVA 11kV
1 x 750 kVA		730034	BS T/FORMER Tyree 1x750kVA 11kV
1 x 1000 kVA		730035	BS T/FORMER Tyree 1x1000kVA 11kV
1 x 1500 kVA		730036	BS T/FORMER Tyree 1x1500kVA 11kV
2 x 500 kVA		730037	BS T/FORMER Tyree 2x500kVA 11kV
2 x 750 kVA		730038	BS T/FORMER Tyree 2x750kVA 11kV
2 x 1000 kVA		730039	BS T/FORMER Tyree 2x1000kVA 11kV
2 x 1500 kVA		730040	BS T/FORMER Tyree 2x1500kVA 11kV
3 x 500 kVA		730041	BS T/FORMER Tyree 3x500kVA 11kV
3 x 750 kVA		730042	BS T/FORMER Tyree 3x750kVA 11kV
3 x 1000 kVA		730043	BS T/FORMER Tyree 3x1000kVA 11kV
3 x 1500 kVA		730044	BS T/FORMER Tyree 3x1500kVA 11kV
1 x 500 kVA	22	730045	BS T/FORMER Tyree 1x500kVA 22kV
1 x 750 kVA		730046	BS T/FORMER Tyree 1x750kVA 22kV
1 x 1000 kVA		730047	BS T/FORMER Tyree 1x1000kVA 22kV
1 x 1500 kVA		730048	BS T/FORMER Tyree 1x1500kVA 22kV
2 x 500 kVA		730049	BS T/FORMER Tyree 2x500kVA 22kV
2 x 750 kVA		730050	BS T/FORMER Tyree 2x750kVA 22kV
2 x 1000 kVA		730051	BS T/FORMER Tyree 2x1000kVA 22kV
2 x 1500 kVA		730052	BS T/FORMER Tyree 2x1500kVA 22kV
3 x 500 kVA		730053	BS T/FORMER Tyree 3x500kVA 22kV
3 x 750 kVA		730054	BS T/FORMER Tyree 3x750kVA 22kV
3 x 1000 kVA		730055	BS T/FORMER Tyree 3x1000kVA 22kV
3 x 1500 kVA		730056	BS T/FORMER Tyree 3x1500kVA 22kV

8.6 LV Switchboards

Four standard LV switchboard arrangements have been developed for use in the substations. These arrangements are suitable for use in substations with either a one or two transformers.

Table 19: Standard LV switchboard arrangements

LV Switchboards	Manufacturer	Type	Width (mm)
Single transformer switchboard (Non extendable)	Bartech	Type 1	1968
Single transformer switchboard (Extendable)	Bartech	Type 2	2544
Two transformer switchboard (with bus-tie)	Bartech	Type 3	4464
Two transformer switchboard (Type 3 without bus-tie)	Bartech	Type 4	3312

Further detail for this equipment is provided in Appendix C, Section C4.

Alternative switchboard arrangements may be used in the substations, but the individual panels and equipment installed in them, must be those previously approved for use by TasNetworks under the supply contract.

Table 21 lists the materials identification numbers for the standard switchboard components.

Table 20: LV switchboard components

2000 - 2500A ACB Tier				
Bus Rating	**1250 A**		**2500 A**	
Fault Rating	**50 kA**	**80 kA**	**50 kA**	**80 kA**
2000A MasterPact	-	-	990462	990480
2500A MasterPact	-	-	990463	990481

800 - 1600A ACB Tier				
Bus Rating	**1250 A**		**2500 A**	
Fault Rating	**50 kA**	**80 kA**	**50 kA**	**80 kA**
800A Compact NS	990454	990472	990464	990482
1000A Compact NS	990455	990473	990465	990483
1250A Compact NS	990456	990474	990466	990484
1600A Compact NS	-	-	990467	990485
1250A MasterPact	990453	990471	990460	990478
1600A MasterPact	-	-	990461	990479

Distributor and Bus Tiers				
Bus Rating	**1250 A**		**2500 A**	
Fault Rating	**50 kA**	**80 kA**	**50 kA**	**80 kA**
Distributor Tier	990458	990476	990469	990487
But Tie 1250A Isolator	990457	990475	-	-
But Tie 2500A Isolator	-	-	990468	990486
Riser Tier	990459	990477	990470	990488

Distributor Tier Circuit Breakers				
Bus Rating	**1250 A**		**2500 A**	
Fault Rating	**50 kA**	**80 kA**	**50 kA**	**80 kA**
630A Compact NSX	990489	990493	990489	990493
800A Compact NS*	990490	990494	990490	990494
1000A Compact NS*	990491	990495	990491	990495
1250A Compact NS*	990492	990496	990492	990496

* Bottom slot only.

Appendix C – Standard substation and equipment drawings

The substation designs in this section meet the requirements of the standard.

Standard substation layout designs have been developed for the following substation types:

- Single transformer - 3 x HV feeders, natural ventilation.
- Two transformer - 2 x HV feeders, natural ventilation.
- Two transformer - 2 x HV feeders, forced ventilation.
- Switching station - 3 x HV feeders and 1 x Customer circuit breaker.

Alternative substation layouts may be used provided they meet requirements of this standard.

C1 – Substation and switching station layouts

Drawing id.	Title
D-BS1-0325-GA-001	Building Type Substation, Single Transformer, Natural ventilation, Plan view.
D-BS1-0325-SI-002	Building Type Substation, Single Transformer, Natural ventilation, Elevations - Sheet 1.
D-BS1-0325-SI-003	Building Type Substation, Single Transformer, Natural ventilation, Elevations - Sheet 2.
D-BS1-0310-GA-001	Building substation, Sample Layout, Two transformer, Natural ventilation, Plan view.
D-BS1-0310-SI-002	Building substation, Sample Layout, Two transformer, Natural ventilation, Elevations - Sheet 1
D-BS1-0310-SI-003	Building substation, Sample Layout, Two transformer, Natural ventilation, Elevations - Sheet 2
D-BS1-0311-GA-001	Building substation, Sample Layout, Two transformer, Forced ventilation, Plan view.
D-BS1-0311-SI-002	Building substation, Sample Layout, Two transformer, Forced ventilation, Elevations - Sheet 1
D-BS1-0311-SI-003	Building substation, Sample Layout, Two transformer, Forced ventilation, Elevations - Sheet 2
D-BS1-0320-GA-001	Building type switching station, Sample layout, Plan view
D-BS1-0320-SI-002	Building type switching station, Sample layout, Elevations - Sheet 1
D-BS1-0320-SI-003	Building type switching station, Sample layout, Elevations - Sheet 2

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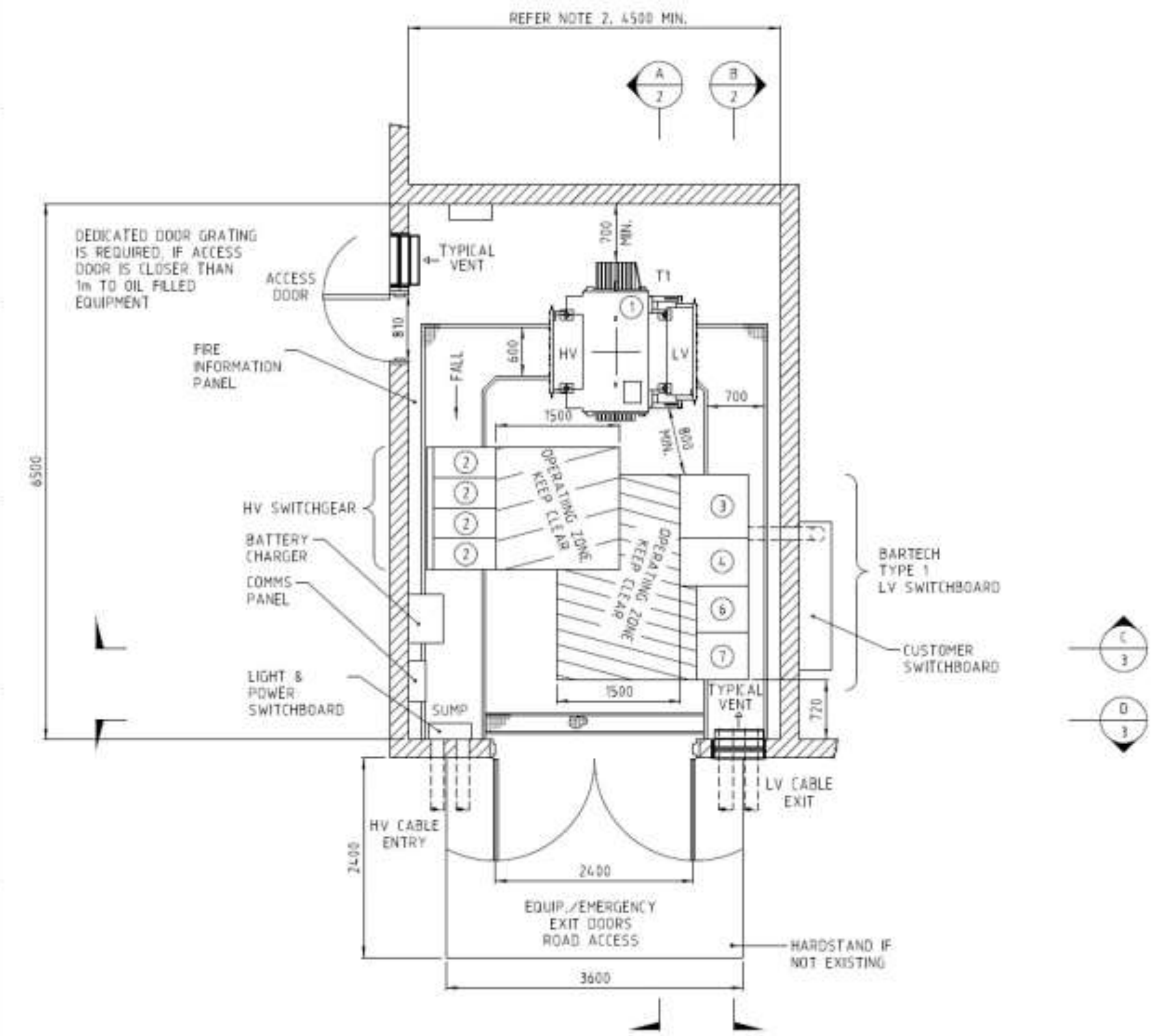

TYPICAL PLAN VIEW OF DUAL FRONTAGE SUBSTATION
WITH ONE 750 kVA TRANSFORMER
NATURAL VENTILATION ARRANGEMENT

ITEM	QTY	PLANT
1	1	TRANSFORMER (750kVA SHOWN)
2	4	HV CIRCUIT BREAKER
3	1	LV CIRCUIT BREAKER - TRANSFORMER
4	1	LV CIRCUIT BREAKER - CUSTOMER
5	-	-
6	4	LV CIRCUIT BREAKERS - STREET SUPPLIES
7	1	CABLE RISER
8	2	VENT WITH SMOKE & FIRE DAMPERS
9	-	-

NOTES
1. NATURAL VENTILATION ARRANGEMENT ONLY SUITABLE WHEN EXTERNAL VENTING AVAILABLE.
2. BUILDING SIZE TO BE DETERMINED FROM EQUIPMENT DIMENSIONS.

REFERENCE DRAWINGS
D-BS1-0300-SD-001 CABLE TRENCH
D-BS1-0301-SD-001 FIRE RATED DOOR DETAILS
D-BS1-0302-SD-001 SIGNAGE
D-BS1-0304-SD-001 CABLE TRENCH GRATING
D-BS1-0304-SD-002 CABLE TRENCH GRATING SUPPORT DETAIL
D-BS1-0305-SD-001 VENTILATION
D-BS1-0325-SD-002 BUILDING SUB SINGLE TRANSFORMER NATURAL VENTILATION ELEVATIONS
D-BS1-0325-SD-003 BUILDING SUB SINGLE TRANSFORMER NATURAL VENTILATION ELEVATIONS
D-BS1-0315-SD-001 HV SWITCHBOARD (ABB SAFEPLUS) GENERAL ARRANGEMENT
D-BS1-0315-SD-002 HV SWITCHBOARD (ABB SAFEPLUS) SUPPORT FRAME
D-BS1-0316-SD-001 LV SWITCHBOARD (BARTECH TYPE 3) GENERAL ARRANGEMENT

ALTERATIONS — ORIGINAL ISSUE

TasNetworks

DRAWN	M.WESTBURY
DESIGNED BY	M.WESTBURY
CHECKED BY	S.HALL
APPROVED BY	M.EMMETT
DATE APPROVED	31/MAR/2023

TITLE
BUILDING SUBSTATION
SINGLE TRANSFORMER
NATURAL VENTILATION
PLAN VIEW

SCALE 1:75
A4

D - BS1 - 0325 - GA - 001

REVISION A

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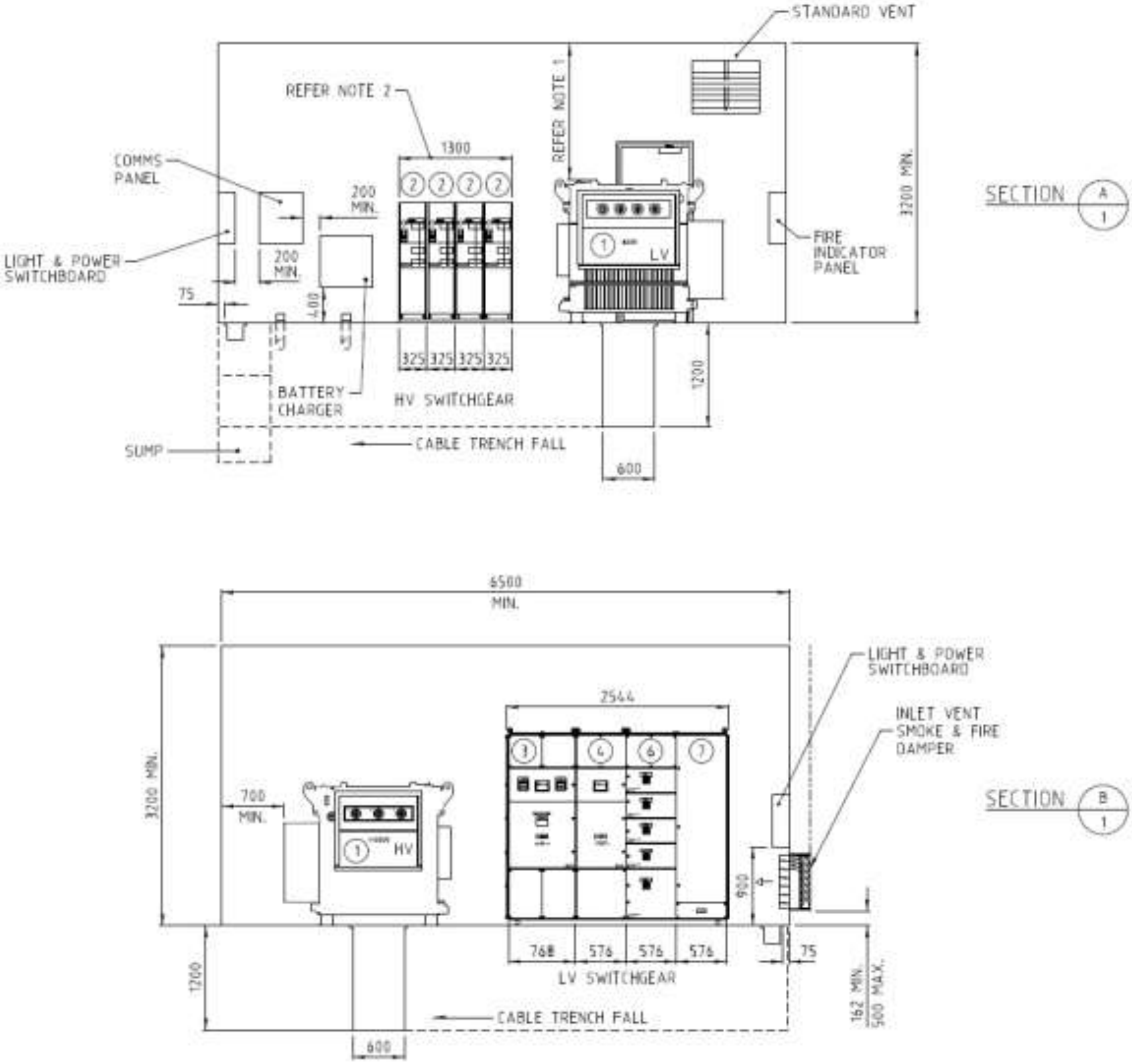


REFERENCE DRAWINGS
D-BS1-0300-SD-001 CABLE TRENCH
D-BS1-0301-SD-001 FIRE RATED DOOR DETAILS
D-BS1-0302-SD-001 SIGNAGE
D-BS1-0304-SD-001 CABLE TRENCH GRATING
D-BS1-0304-SD-002 CABLE TRENCH GRATING SUPPORT DETAIL
D-BS1-0305-SD-001 VENTILATION
D-BS1-0325-SD-001 BUILDING SUB SINGLE TRANSFORMER NATURAL VENTILATION GA
D-BS1-0325-SD-003 BUILDING SUB SINGLE TRANSFORMER NATURAL VENTILATION ELEVATIONS
D-BS1-0315-SD-001 HV SWITCHBOARD (ABB SAFEPLUS) GENERAL ARRANGEMENT
D-BS1-0315-SD-002 HV SWITCHBOARD (ABB SAFEPLUS) SUPPORT FRAME
D-BS1-0316-SD-001 LV SWITCHBOARD (BARTECH TYPE 3) GENERAL ARRANGEMENT

NOTES
1. MINIMUM CLEARANCE BETWEEN CEILING & EQUIPMENT 1600mm.
2. PROTECTION SECONDARY WIRING COMPARTMENT (AS REQ'D).

REFER TO SHEET 1 FOR EQUIPMENT LIST

ALTERATIONS: ORIGINAL ISSUE

TasNetworks

DRAWN	H.WESTBURY
DESIGNED BY	H.WESTBURY
CHECKED BY	D.HALL
APPROVED BY	M.EMMETT
DATE APPROVED	11/MAR/2023

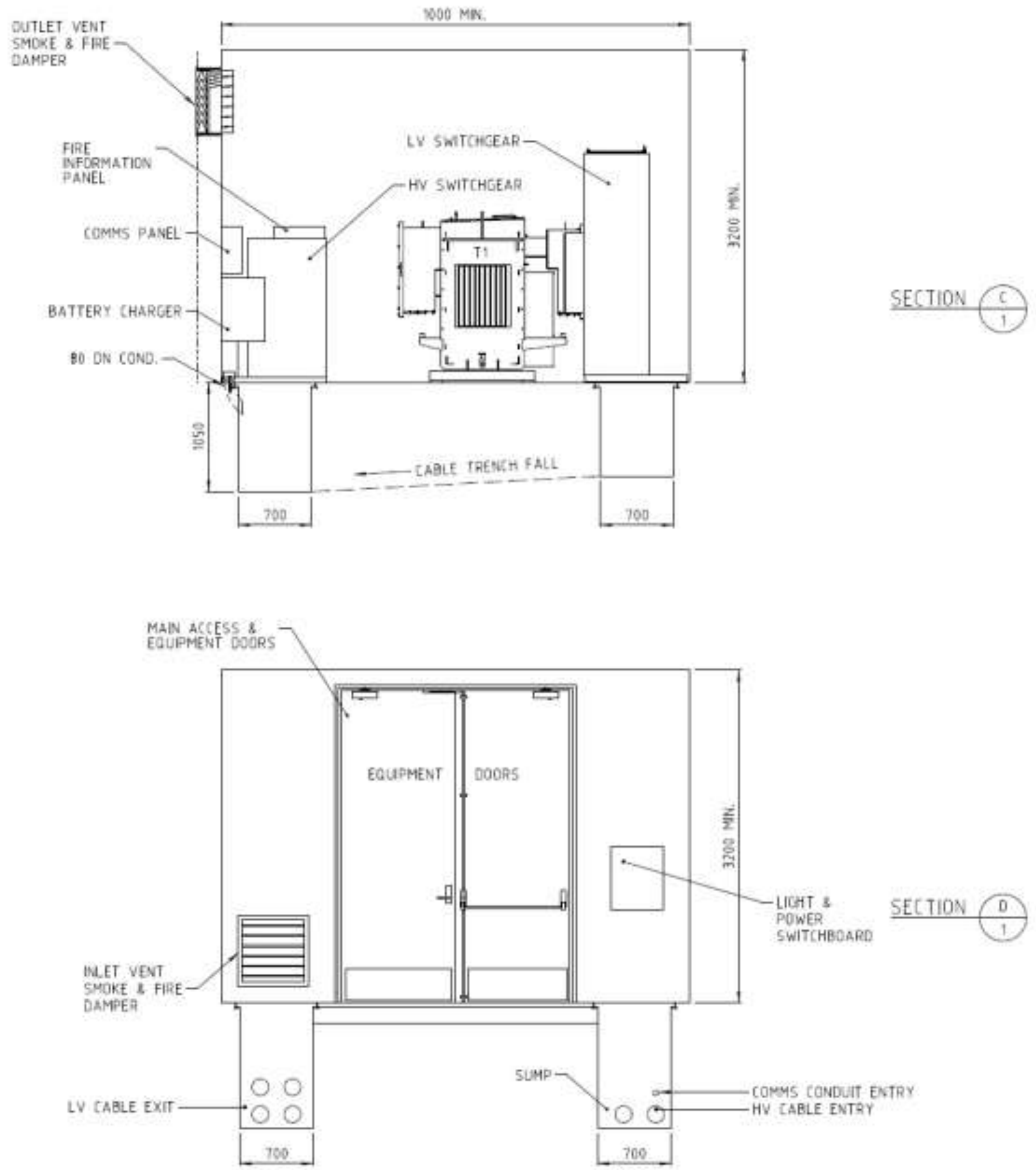
TITLE: BUILDING SUBSTATION SINGLE TRANSFORMER NATURAL VENTILATION ELEVATIONS

SCALE 1:75

A4

D - BS1 - 0325 - SI - 002

REVISION B



NOTES
1. NATURAL VENTILATION ARRANGEMENT ONLY SUITABLE WHEN EXTERNAL VENTING AVAILABLE.
2. BUILDING SIZE TO BE DETERMINED FROM EQUIPMENT DIMENSIONS.

REFERENCE DRAWINGS
D-BS1-0300-SD-001 CABLE TRENCH
D-BS1-0301-SD-001 FIRE RATED DOOR DETAILS
D-BS1-0304-SD-001 CABLE TRENCH GRATING
D-BS1-0304-SD-002 CABLE TRENCH GRATING SUPPORT DETAIL
D-BS1-0305-SD-001 VENTILATION
D-BS1-0325-SD-001 BUILDING SUB SINGLE TRANSFORMER NATURAL VENTILATION GA
D-BS1-0325-SD-002 BUILDING SUB SINGLE TRANSFORMER NATURAL VENTILATION ELEVATIONS
D-BS1-0315-SD-001 HV SWITCHBOARD (ABB SAFEPLUS) GENERAL ARRANGEMENT
D-BS1-0315-SD-002 HV SWITCHBOARD (ABB SAFEPLUS) SUPPORT FRAME
D-BS1-0316-SD-001 LV SWITCHBOARD (BARTECH TYPE 3) GENERAL ARRANGEMENT

REFER TO SHEET 1 FOR EQUIPMENT LIST

ALTERATIONS
ORIGINAL ISSUE

TasNetworks

DRAWN	H.WESTBURY
DESIGNED BY	H.WESTBURY
CHECKED BY	S.BALL
APPROVED BY	M.EMMETT
DATE APPROVED	31/MAR/2023

TITLE
BUILDING SUBSTATION
SINGLE TRANSFORMER
NATURAL VENTILATION
ELEVATIONS

SCALE 1:75

A4

D - BS1 - 0325 - SI - 003

REVISION A

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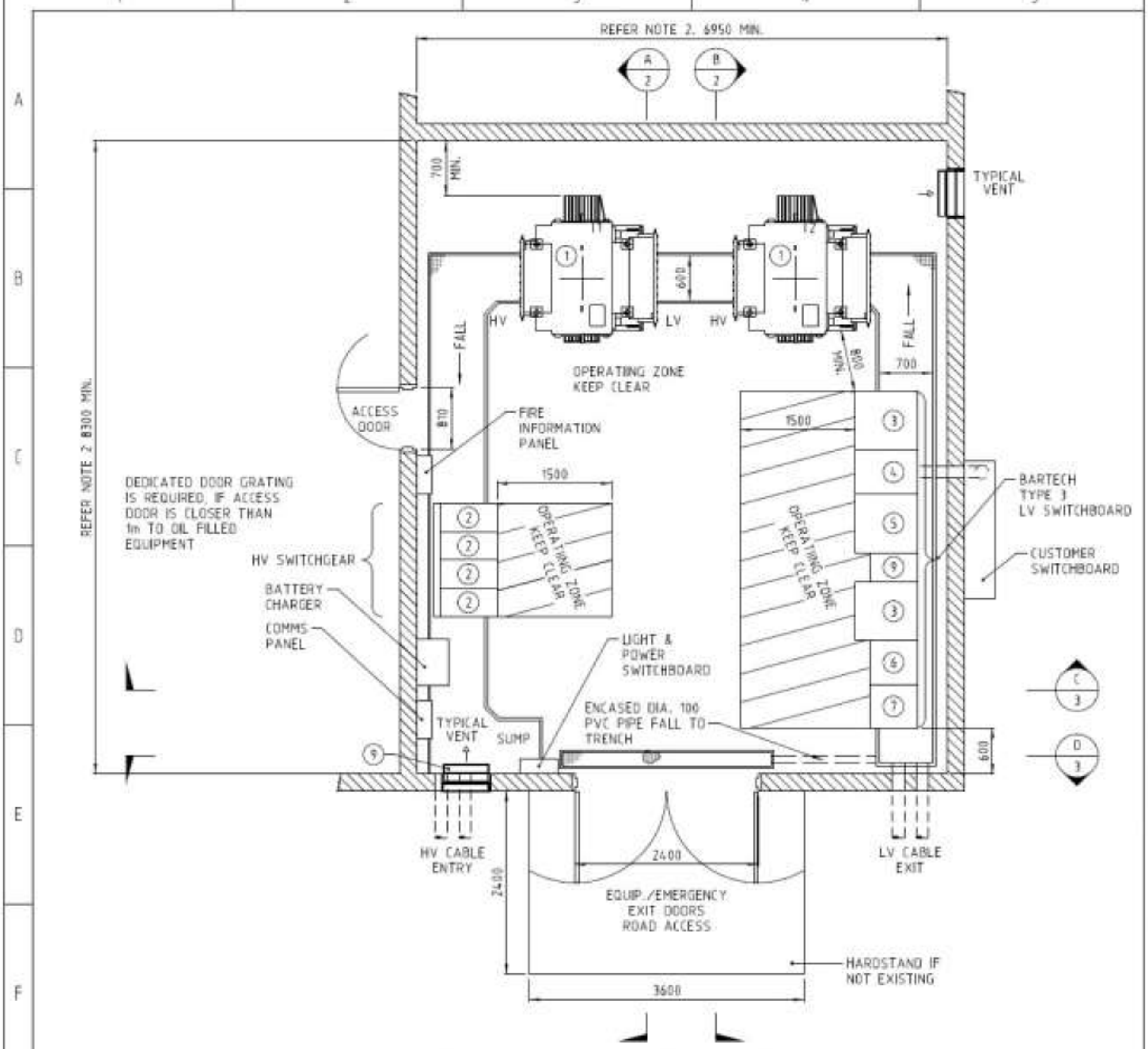

TYPICAL PLAN VIEW OF DUAL FRONTAGE SUBSTATION
WITH TWO 750 kVA TRANSFORMERS
NATURAL VENTILATION ARRANGEMENT

ITEM	QTY	PLANT
1	2	TRANSFORMER (750kVA)
2	3	HV CIRCUIT BREAKER
3	2	LV CIRCUIT BREAKER - TRANSFORMER
4	1	LV CIRCUIT BREAKER - CUSTOMER
5	1	LV BUS SECTIONALISER
6	4	LV CIRCUIT BREAKERS - STREET SUPPLIES
7	1	CABLE RISER
8	2	VENT WITH SMOKE & FIRE DAMPERS
9	1	BUS RISER

NOTES
1. NATURAL VENTILATION ARRANGEMENT ONLY SUITABLE WHEN EXTERNAL VENTING AVAILABLE.
2. BUILDING SIZE TO BE DETERMINED FROM EQUIPMENT DIMENSIONS.

REFERENCE DRAWINGS
D-BS1-0300-SD-001 CABLE TRENCH
D-BS1-0301-SD-001 FIRE RATED DOOR DETAILS
D-BS1-0302-SD-001 SIGNAGE
D-BS1-0304-SD-001 CABLE TRENCH GRATING
D-BS1-0304-SD-002 CABLE TRENCH GRATING SUPPORT DETAIL
D-BS1-0305-SD-001 VENTILATION
D-BS1-0310-SD-002 BUILDING SUB SAMPLE TWO TRANSFORMER NATURAL VENTILATION ELEVATIONS
D-BS1-0310-SD-003 BUILDING SUB SAMPLE TWO TRANSFORMER NATURAL VENTILATION ELEVATIONS
D-BS1-0315-SD-001 HV SWITCHBOARD (ABB SAFEPLUS) GENERAL ARRANGEMENT
D-BS1-0315-SD-002 HV SWITCHBOARD (ABB SAFEPLUS) SUPPORT FRAME
D-BS1-0316-SD-001 LV SWITCHBOARD (BARTECH TYPE 3) GENERAL ARRANGEMENT

ALTERATIONS
ORIGINAL ISSUE
DRAWING UPDATED FROM RED-LINE MARK-UP PROVIDED BY G.HALL
REV B

TasNetworks

DRAWN	CS PRO SOLUTIONS
DESIGNED BY	CS PRO SOLUTIONS
CHECKED BY	CS PRO SOLUTIONS
APPROVED BY	G. HALL
DATE APPROVED	24/11/2016

TITLE
BUILDING SUBSTATION - SAMPLE LAYOUT
TWO TRANSFORMER
NATURAL VENTILATION
PLAN VIEW

SCALE 1:75
A4
D - BS1 - 0310 - GA - 001
REVISION B

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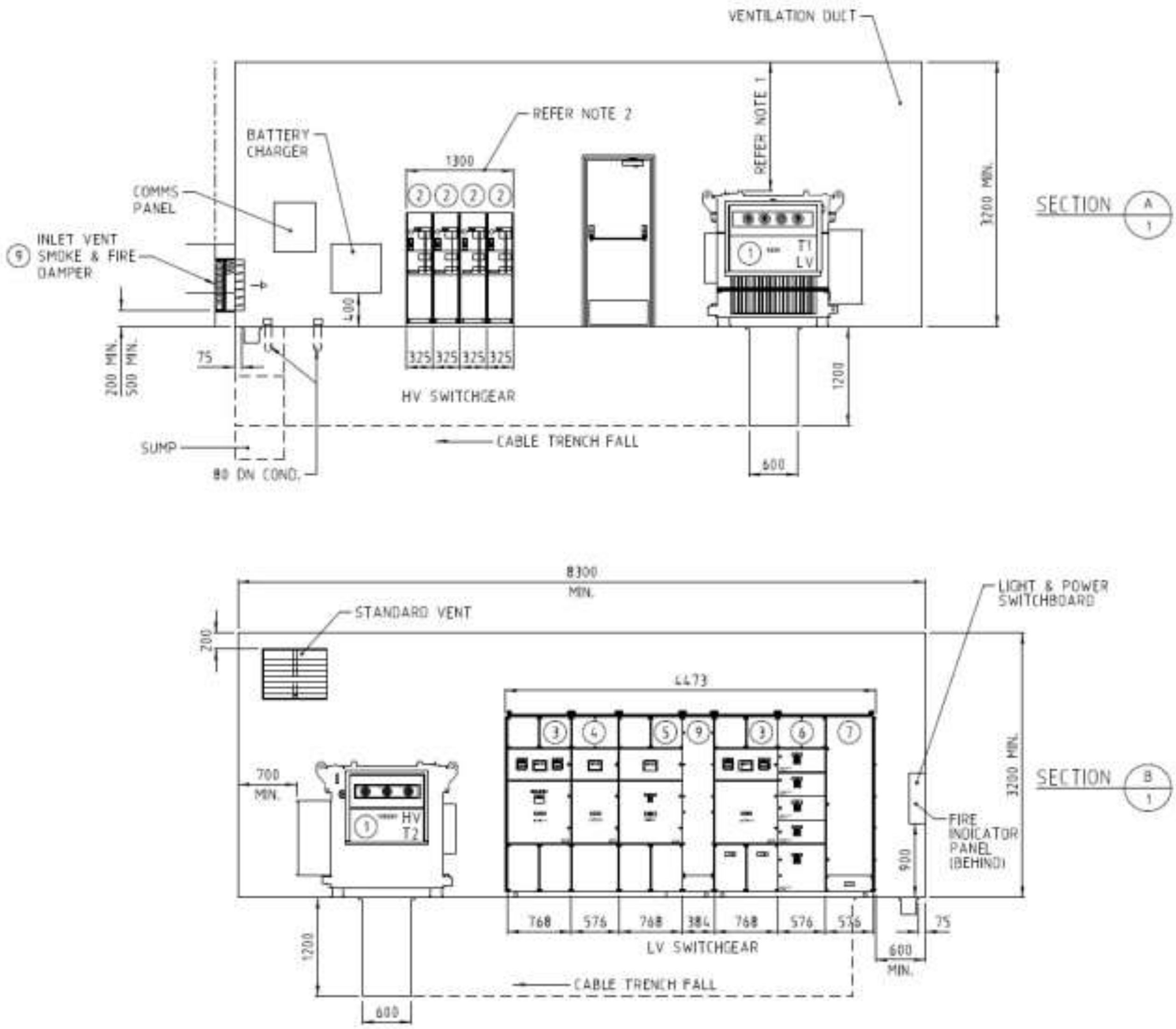

REFERENCE DRAWINGS
D-BS1-0300-SD-001 CABLE TRENCH
D-BS1-0301-SD-001 FIRE RATED DOOR DETAILS
D-BS1-0302-SD-001 SIGNAGE
D-BS1-0304-SD-001 CABLE TRENCH GRATING
D-BS1-0304-SD-002 CABLE TRENCH GRATING SUPPORT DETAIL
D-BS1-0305-SD-001 VENTILATION
D-BS1-0310-SD-001 BUILDING SUB SAMPLE TWO TRANSFORMER NATURAL VENTILATION GA
D-BS1-0310-SD-003 BUILDING SUB SAMPLE TWO TRANSFORMER NATURAL VENTILATION ELEVATIONS
D-BS1-0315-SD-001 HV SWITCHBOARD (ABB SAFEPLUS) GENERAL ARRANGEMENT
D-BS1-0315-SD-002 HV SWITCHBOARD (ABB SAFEPLUS) SUPPORT FRAME
D-BS1-0316-SD-001 LV SWITCHBOARD (BARTECH TYPE 3) GENERAL ARRANGEMENT

NOTES
1. MINIMUM CLEARANCE BETWEEN CEILING & EQUIPMENT 1600mm.
2. PROTECTION SECONDARY WIRING COMPARTMENT (AS REQ'D).

REFER TO SHEET 1 FOR EQUIPMENT LIST

ALTERATIONS
ORIGINAL ISSUE
DRAWING UPDATED FROM RED-LINE MARK-UP PROVIDED BY G.HALL
REV B

TasNetworks

DRAWN	CS PRO-SOLUTIONS
DESIGNED BY	CS PRO-SOLUTIONS
CHECKED BY	CS PRO-SOLUTIONS
APPROVED BY	G.HALL
DATE APPROVED	24/11/2016

TITLE
BUILDING SUBSTATION – SAMPLE LAYOUT
TWO TRANSFORMER
NATURAL VENTILATION
ELEVATIONS

SCALE 1:75
A4
D – BS1 – 0310 – SI – 002
REVISION B

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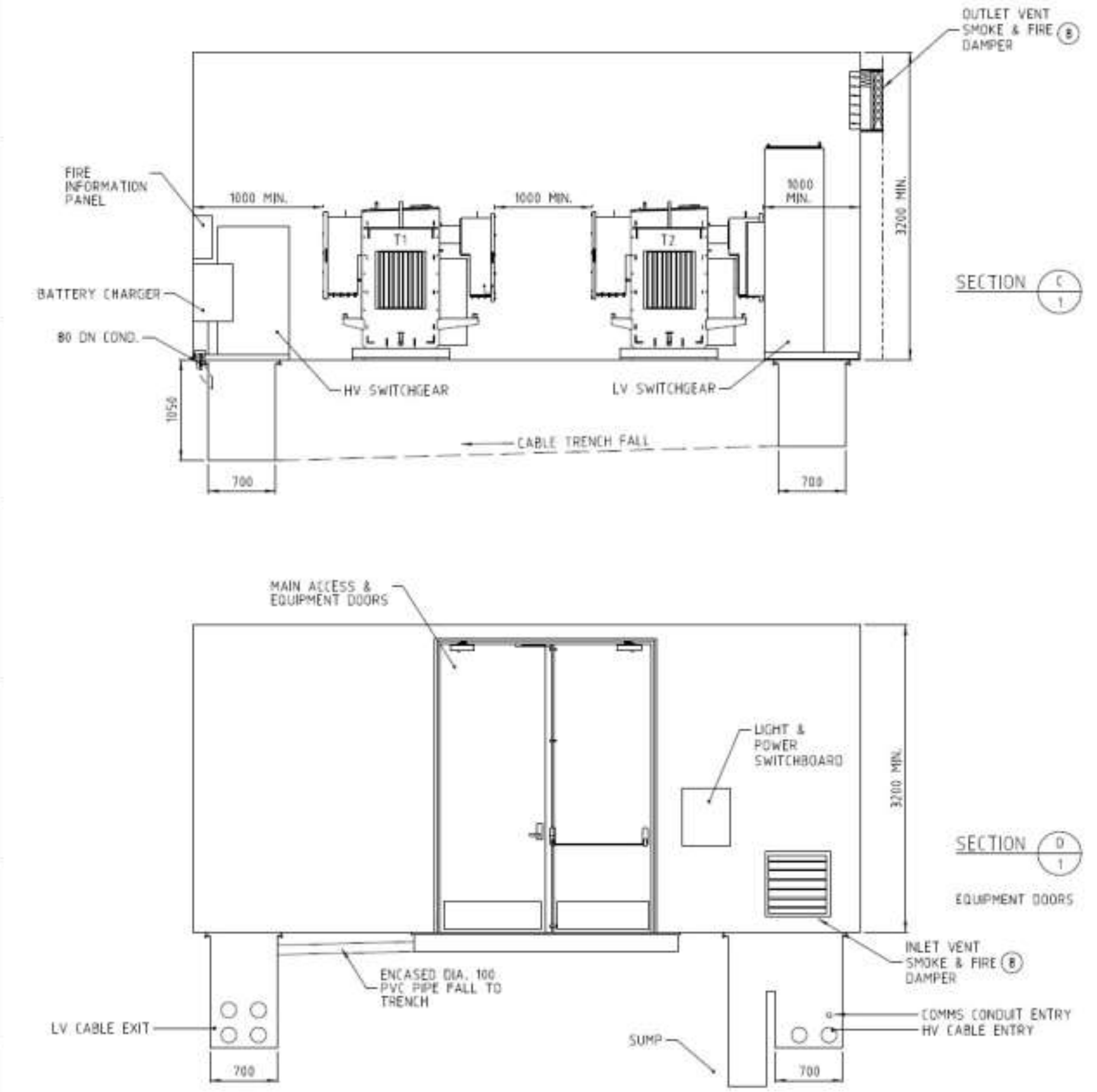

NOTES
1. NATURAL VENTILATION ARRANGEMENT ONLY SUITABLE WHEN EXTERNAL VENTING AVAILABLE.
2. BUILDING SIZE TO BE DETERMINED FROM EQUIPMENT DIMENSIONS.

REFERENCE DRAWINGS
D-BS1-0300-SD-001 CABLE TRENCH
D-BS1-0301-SD-001 FIRE RATED DOOR DETAILS
D-BS1-0304-SD-001 CABLE TRENCH GRATING
D-BS1-0304-SD-002 CABLE TRENCH GRATING SUPPORT DETAIL
D-BS1-0305-SD-001 VENTILATION
D-BS1-0310-SD-001 BUILDING SUB SAMPLE TWO TRANSFORMER NATURAL VENTILATION GA
D-BS1-0310-SD-002 BUILDING SUB SAMPLE TWO TRANSFORMER NATURAL VENTILATION ELEVATIONS
D-BS1-0315-SD-001 HV SWITCHBOARD (ABB SAFEPLUS) GENERAL ARRANGEMENT
D-BS1-0315-SD-002 HV SWITCHBOARD (ABB SAFEPLUS) SUPPORT FRAME
D-BS1-0316-SD-001 LV SWITCHBOARD (BARTECH TYPE 3) GENERAL ARRANGEMENT

REFER TO SHEET 1 FOR EQUIPMENT LIST

ALTERATIONS		
ORIGINAL ISSUE		

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DRAWN	H.WESTBURY
DESIGNED BY	G.HALL
CHECKED BY	M.MORRISS
APPROVED BY	M.EMMETT
DATE APPROVED	19/JUL/2022

TITLE BUILDING SUBSTATION – SAMPLE LAYOUT
TWO TRANSFORMER
NATURAL VENTILATION
ELEVATIONS

SCALE 1:75

A4

D – BS1 – 0310 – SD – 003

REVISION B

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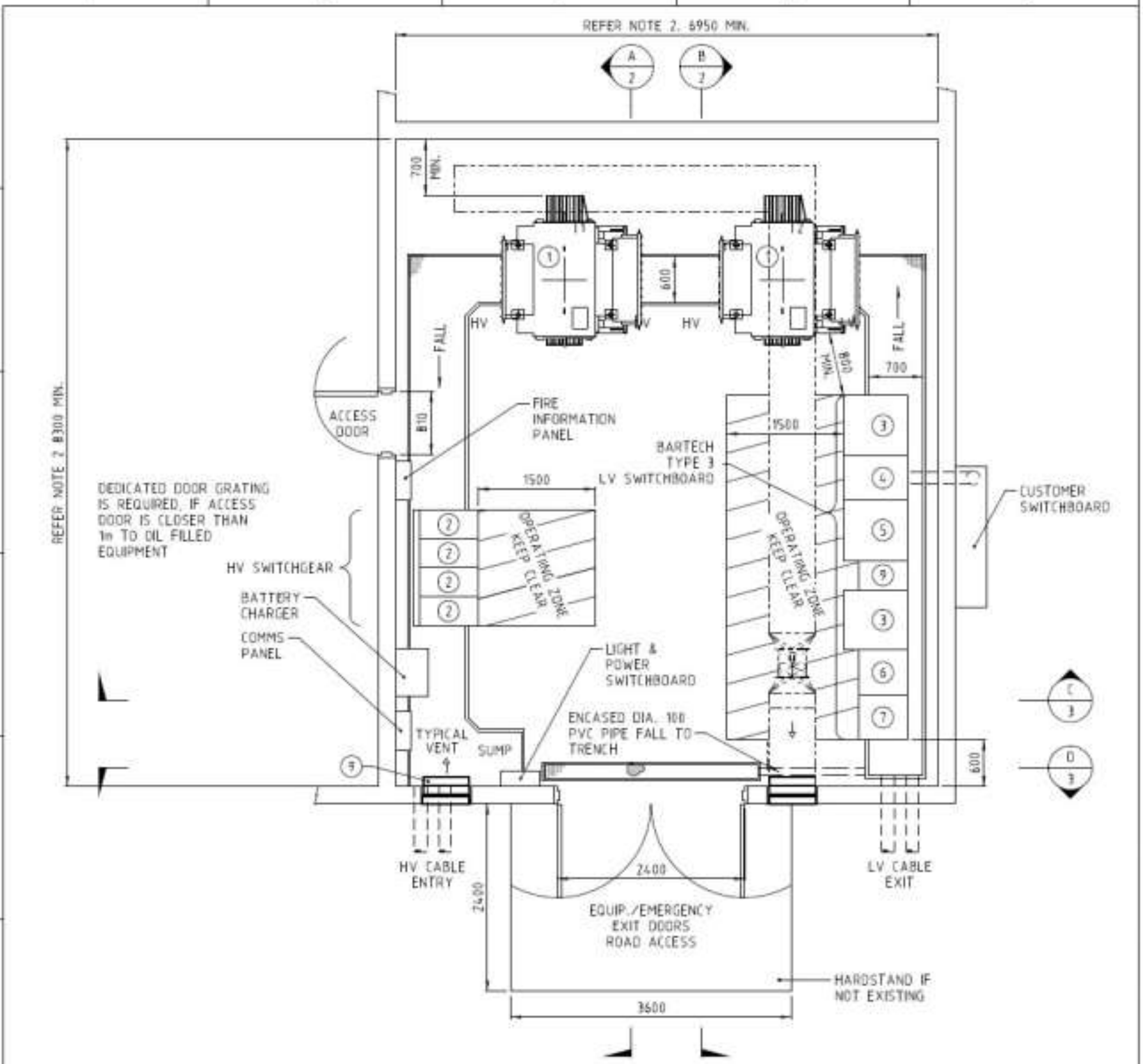

TYPICAL PLAN VIEW OF DUAL FRONTAGE SUBSTATION
WITH TWO 750 kVA TRANSFORMERS
NATURAL VENTILATION ARRANGEMENT

NOTES
1. FORCED VENTILATION ARRANGEMENT NOT TO BE USED WHEN NATURAL VENTING POSSIBLE.
2. BUILDING SIZE TO BE DETERMINED FROM EQUIPMENT DIMENSIONS.

REFERENCE DRAWINGS
D-BS1-0300-SD-001 CABLE TRENCH
D-BS1-0301-SD-001 FIRE RATED DOOR DETAILS
D-BS1-0302-SD-001 SIGNAGE
D-BS1-0304-SD-001 CABLE TRENCH GRATING
D-BS1-0304-SD-002 CABLE TRENCH GRATING SUPPORT DETAIL
D-BS1-0305-SD-001 VENTILATION
D-BS1-0311-SD-002 BUILDING SUB SAMPLE TWO TRANSFORMER FORCED VENTILATION ELEVATIONS
D-BS1-0311-SD-003 BUILDING SUB SAMPLE TWO TRANSFORMER FORCED VENTILATION ELEVATIONS
D-BS1-0315-SD-001 HV SWITCHBOARD (ABB SAFEPLUS) GENERAL ARRANGEMENT
D-BS1-0315-SD-002 HV SWITCHBOARD (ABB SAFEPLUS) SUPPORT FRAME
D-BS1-0316-SD-001 LV SWITCHBOARD (BARTECH TYPE 3) GENERAL ARRANGEMENT

ITEM	QTY	PLANT
1	2	TRANSFORMER (750kVA)
2	3	HV CIRCUIT BREAKER
3	2	LV CIRCUIT BREAKER - TRANSFORMER
4	1	LV CIRCUIT BREAKER - CUSTOMER
5	1	LV BUS SECTIONALISER
6	4	LV CIRCUIT BREAKERS - STREET SUPPLIES
7	1	CABLE RISER
8	2	VENT WITH SMOKE & FIRE DAMPERS
9	1	BUS RISER

ALTERATIONS

REV		
-	ORIGINAL ISSUE	
B	DRAWING UPDATED FROM RED-LINE MARK-UP PROVIDED BY G.HALL	

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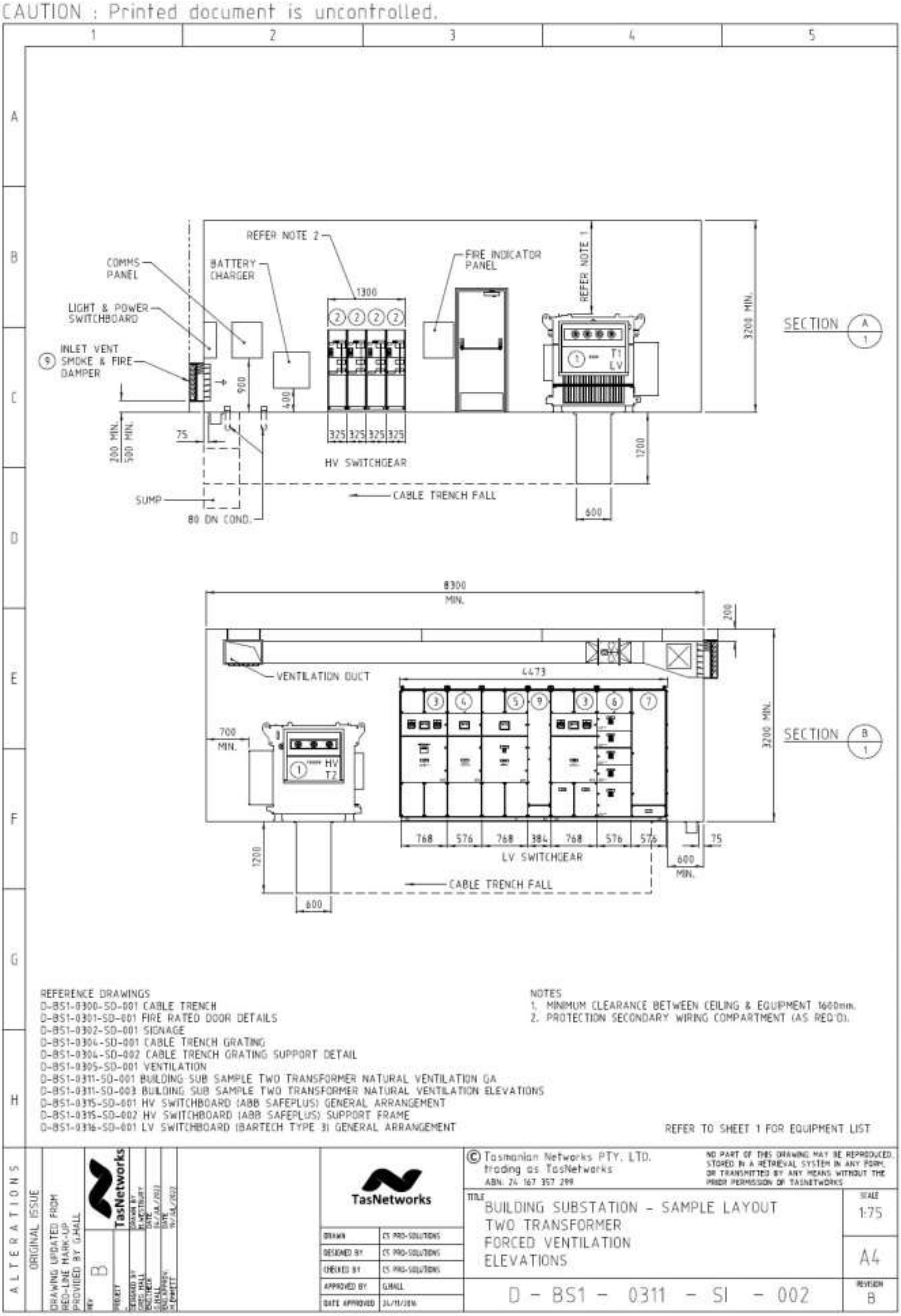
DESIGNED BY	CS PRO SOLUTIONS
CHECKED BY	CS PRO SOLUTIONS
APPROVED BY	G. HALL
DATE APPROVED	24/11/2016

TITLE
BUILDING SUBSTATION - SAMPLE LAYOUT
TWO TRANSFORMER
FORCED VENTILATION
PLAN VIEW

SCALE 1:75
A4

D - BS1 - 0311 - GA - 001

REVISION B


CAUTION : Printed document is uncontrolled.
REFER NOTE 2
COMMS PANEL
BATTERY CHARGER
FIRE INDICATOR PANEL
REFER NOTE 1
LIGHT & POWER SWITCHBOARD
INLET VENT SMOKE & FIRE DAMPER
HV SWITCHGEAR
CABLE TRENCH FALL
SUMP
80 DN COND.
SECTION A 1
VENTILATION DUCT
LV SWITCHGEAR
SECTION B 1
REFERENCE DRAWINGS
D-BS1-0300-SD-001 CABLE TRENCH
D-BS1-0301-SD-001 FIRE RATED DOOR DETAILS
D-BS1-0302-SD-001 SIGNAGE
D-BS1-0304-SD-001 CABLE TRENCH GRATING
D-BS1-0304-SD-002 CABLE TRENCH GRATING SUPPORT DETAIL
D-BS1-0305-SD-001 VENTILATION
D-BS1-0311-SD-001 BUILDING SUB SAMPLE TWO TRANSFORMER NATURAL VENTILATION GA
D-BS1-0311-SD-003 BUILDING SUB SAMPLE TWO TRANSFORMER NATURAL VENTILATION ELEVATIONS
D-BS1-0315-SD-001 HV SWITCHBOARD (ABB SAFEPLUS) GENERAL ARRANGEMENT
D-BS1-0315-SD-002 HV SWITCHBOARD (ABB SAFEPLUS) SUPPORT FRAME
D-BS1-0316-SD-001 LV SWITCHBOARD (BARTECH TYPE 3) GENERAL ARRANGEMENT
NOTES
1. MINIMUM CLEARANCE BETWEEN CEILING & EQUIPMENT 1600mm.
2. PROTECTION SECONDARY WIRING COMPARTMENT (AS REQ'D).
REFER TO SHEET 1 FOR EQUIPMENT LIST
ALTERATIONS
ORIGINAL ISSUE
DRAWING UPDATED FROM RED-LINE MARK-UP PROVIDED BY G.HALL
B
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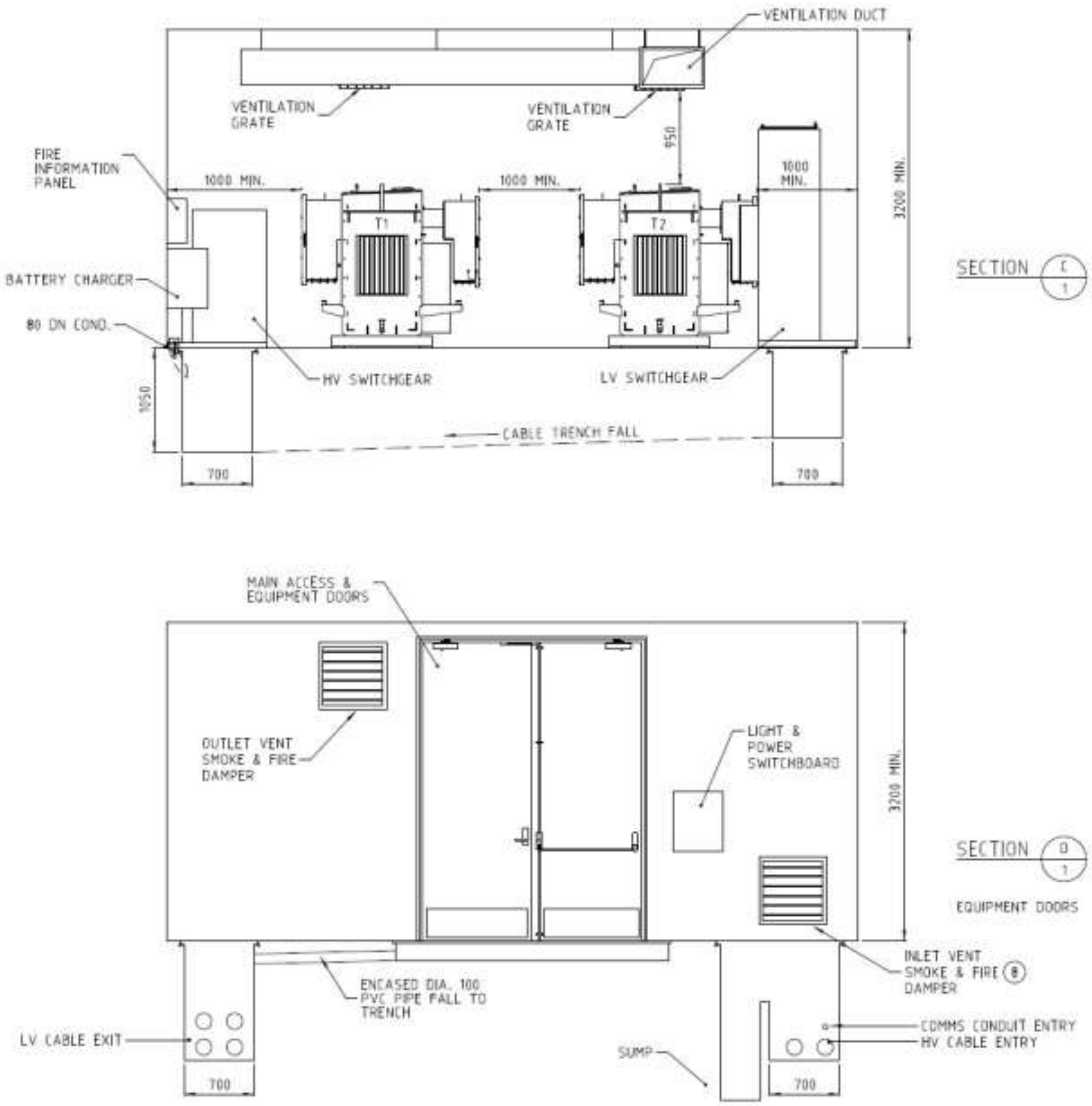
TITLE
BUILDING SUBSTATION - SAMPLE LAYOUT
TWO TRANSFORMER
FORCED VENTILATION
ELEVATIONS
SCALE 1:75
A4
DRAWN CS PRO-SOLUTIONS
DESIGNED BY CS PRO-SOLUTIONS
CHECKED BY CS PRO-SOLUTIONS
APPROVED BY G.HALL
DATE APPROVED 24/11/2016
D - BS1 - 0311 - SI - 002
REVISION B



NOTES
1. NATURAL VENTILATION ARRANGEMENT ONLY SUITABLE WHEN EXTERNAL VENTING AVAILABLE.
2. BUILDING SIZE TO BE DETERMINED FROM EQUIPMENT DIMENSIONS.

REFERENCE DRAWINGS
D-BS1-0300-SD-001 CABLE TRENCH
D-BS1-0301-SD-001 FIRE RATED DOOR DETAILS
D-BS1-0304-SD-001 CABLE TRENCH GRATING
D-BS1-0304-SD-002 CABLE TRENCH GRATING SUPPORT DETAIL
D-BS1-0305-SD-001 VENTILATION
D-BS1-0311-SD-001 BUILDING SUB SAMPLE TWO TRANSFORMER FORCED VENTILATION GA
D-BS1-0311-SD-002 BUILDING SUB SAMPLE TWO TRANSFORMER FORCED VENTILATION ELEVATIONS
D-BS1-0315-SD-001 HV SWITCHBOARD (ABB SAFEPLUS) GENERAL ARRANGEMENT
D-BS1-0315-SD-002 HV SWITCHBOARD (ABB SAFEPLUS) SUPPORT FRAME
D-BS1-0316-SD-001 LV SWITCHBOARD (BARTECH TYPE 3) GENERAL ARRANGEMENT

REFER TO SHEET 1 FOR EQUIPMENT LIST

ALTERATIONS
ORIGINAL ISSUE

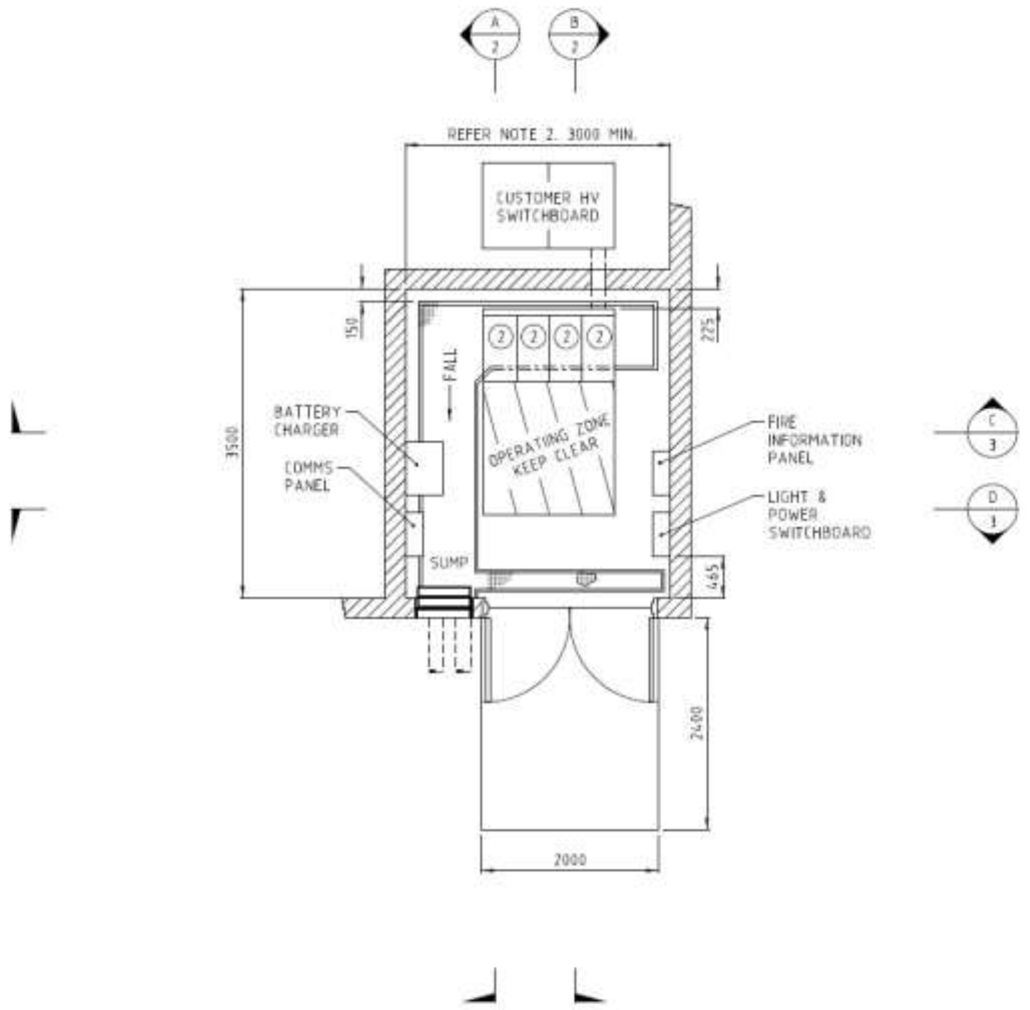
TasNetworks

DRAWN	H.WESTBURY
DESIGNED BY	G.HALL
CHECKED BY	N.MORRIS
APPROVED BY	M.EMMETT
DATE APPROVED	19/JUL/2022

TITLE
BUILDING SUBSTATION - SAMPLE LAYOUT
TWO TRANSFORMER
FORCED VENTILATION
ELEVATIONS

SCALE 1:75
A4
REVISION B

D - BS1 - 0311 - SI - 003



TYPICAL PLAN VIEW OF SWITCHING STATION
NATURAL VENTILATION ARRANGEMENT

NOTES
1. NATURAL VENTILATION ARRANGEMENT ONLY SUITABLE WHEN EXTERNAL VENTING AVAILABLE.
2. BUILDING SIZE TO BE DETERMINED FROM EQUIPMENT DIMENSIONS.

REFERENCE DRAWINGS
D-BS1-0300-SD-001 CABLE TRENCH
D-BS1-0301-SD-001 FIRE RATED DOOR DETAILS
D-BS1-0302-SD-001 SIGNAGE
D-BS1-0304-SD-001 CABLE TRENCH GRATING
D-BS1-0304-SD-002 CABLE TRENCH GRATING SUPPORT DETAIL
D-BS1-0305-SD-001 VENTILATION
D-BS1-0320-SD-002 BUILDING SWITCHING STATION NATURAL VENTILATION ELEVATIONS
D-BS1-0320-SD-003 BUILDING SWITCHING STATION NATURAL VENTILATION ELEVATIONS
D-BS1-0315-SD-001 HV SWITCHBOARD (ABB SAFEPLUS) GENERAL ARRANGEMENT
D-BS1-0315-SD-002 HV SWITCHBOARD (ABB SAFEPLUS) SUPPORT FRAME

ALTERATIONS: ORIGINAL ISSUE

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DRAWN	H.WESTBURY
DESIGNED BY	H.WESTBURY
CHECKED BY	C.HALL
APPROVED BY	M.EMMETT
DATE APPROVED	12-AUG-2022

TITLE: BUILDING SUBSTATION SINGLE TRANSFORMER NATURAL VENTILATION PLAN VIEW

SCALE 1:75

A4

D - BS1 - 0320 - GA - 001

REVISION A

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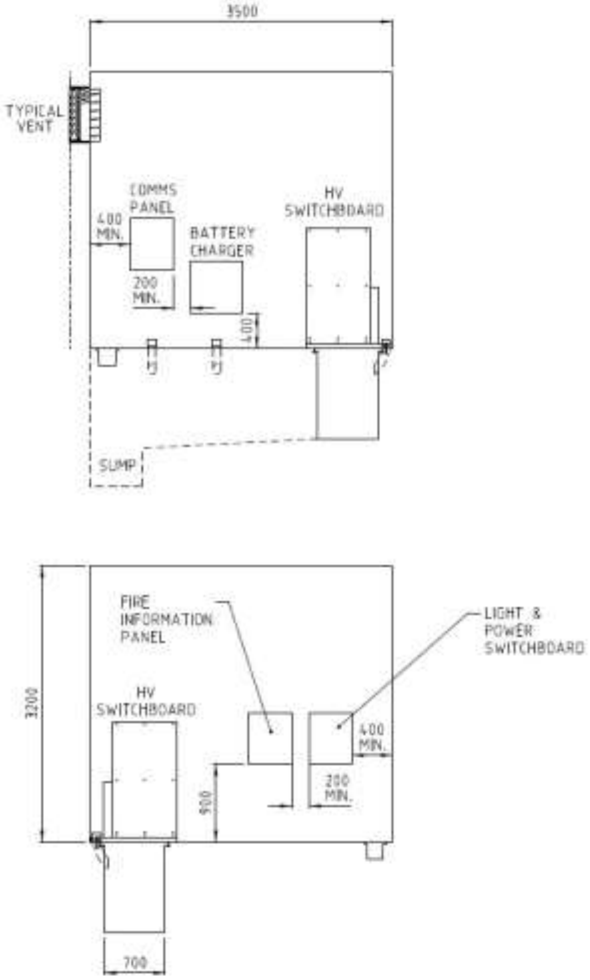

TYPICAL ELEVATIONS OF SWITCHING STATION
NATURAL VENTILATION ARRANGEMENT

NOTES
1. NATURAL VENTILATION ARRANGEMENT ONLY SUITABLE WHEN EXTERNAL VENTING AVAILABLE.
2. BUILDING SIZE TO BE DETERMINED FROM EQUIPMENT DIMENSIONS.

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D-BS1-0301-SD-001 FIRE RATED DOOR DETAILS
D-BS1-0302-SD-001 SIGNAGE
D-BS1-0304-SD-001 CABLE TRENCH GRATING
D-BS1-0304-SD-002 CABLE TRENCH GRATING SUPPORT DETAIL
D-BS1-0305-SD-001 VENTILATION
D-BS1-0320-SD-001 BUILDING SWITCHING STATION NATURAL VENTILATION GA
D-BS1-0320-SD-003 BUILDING SWITCHING STATION NATURAL VENTILATION ELEVATIONS
D-BS1-0315-SD-001 HV SWITCHBOARD (ABB SAFEPLUS) GENERAL ARRANGEMENT
D-BS1-0315-SD-002 HV SWITCHBOARD (ABB SAFEPLUS) SUPPORT FRAME

EMF/PDF CREATION DATE 19/JUL/2022

ALTERATIONS: ORIGINAL ISSUE

TasNetworks

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DESIGNED BY	H.WESTBURY
CHECKED BY	G.HALL
APPROVED BY	M.EMMETT
DATE APPROVED	12-AUG-2022

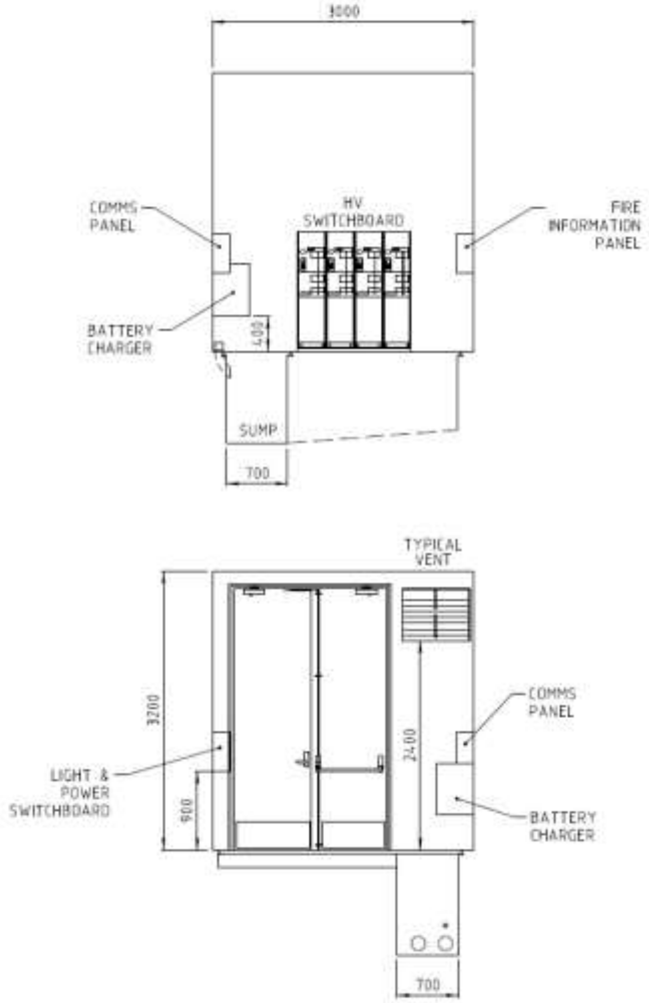
TITLE BUILDING SWITCHING STATION NATURAL VENTILATION SIDE ELEVATIONS
-

SCALE 1:75

A4

D - BS1 - 0320 - SI - 002

REVISION A



TYPICAL ELEVATIONS OF SWITCHING STATION
NATURAL VENTILATION ARRANGEMENT

NOTES
1. NATURAL VENTILATION ARRANGEMENT ONLY SUITABLE WHEN EXTERNAL VENTING AVAILABLE.
2. BUILDING SIZE TO BE DETERMINED FROM EQUIPMENT DIMENSIONS.

REFERENCE DRAWINGS
D-BS1-0300-SD-001 CABLE TRENCH
D-BS1-0301-SD-001 FIRE RATED DOOR DETAILS
D-BS1-0302-SD-001 SIGNAGE
D-BS1-0304-SD-001 CABLE TRENCH GRATING
D-BS1-0304-SD-002 CABLE TRENCH GRATING SUPPORT DETAIL
D-BS1-0305-SD-001 VENTILATION
D-BS1-0320-SD-001 BUILDING SWITCHING STATION NATURAL VENTILATION GA
D-BS1-0320-SD-002 BUILDING SWITCHING STATION NATURAL VENTILATION ELEVATIONS
D-BS1-0315-SD-001 HV SWITCHBOARD (ABB SAFEPLUS) GENERAL ARRANGEMENT
D-BS1-0315-SD-002 HV SWITCHBOARD (ABB SAFEPLUS) SUPPORT FRAME

ALTERATIONS
ORIGINAL ISSUE

TasNetworks

DRAWN	M.WESTBURY
DESIGNED BY	M.WESTBURY
CHECKED BY	C.HALL
APPROVED BY	M.EMMETT
DATE APPROVED	12-AUG-2021

TITLE
BUILDING SWITCHING STATION
NATURAL VENTILATION
END ELEVATIONS
-

SCALE 1:75

A4

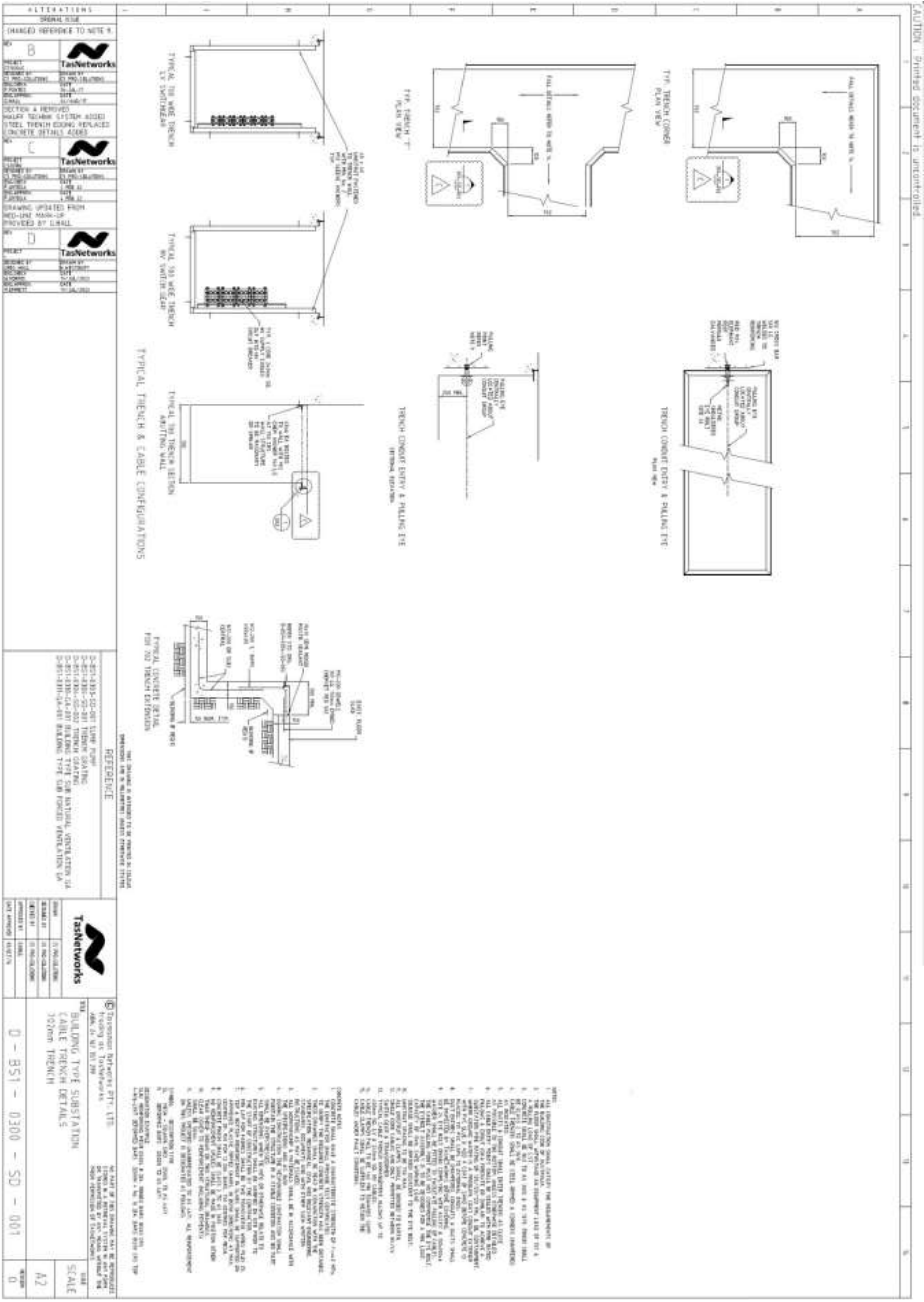
D - BS1 - 0320 - GA - 003

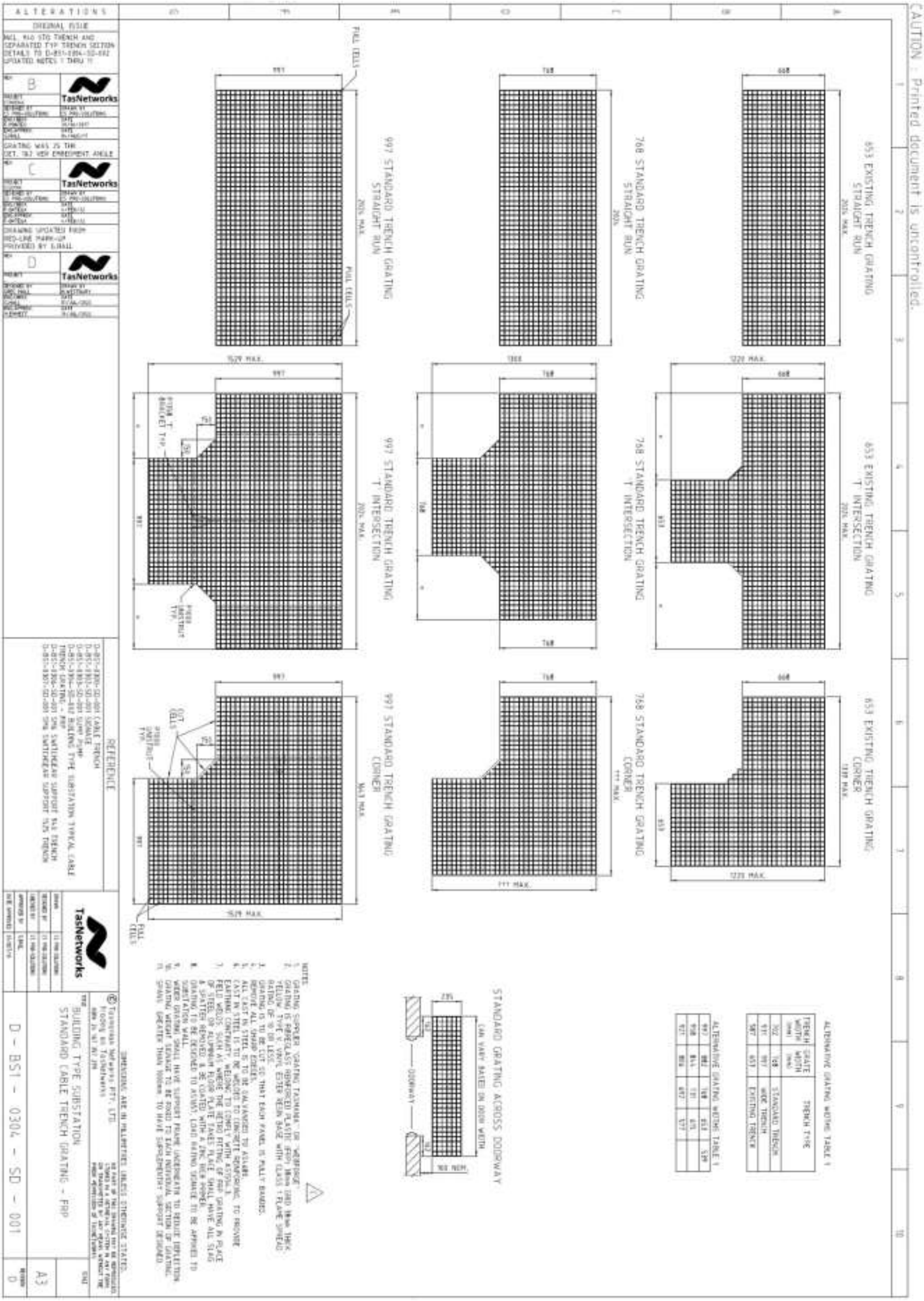
REVISION A

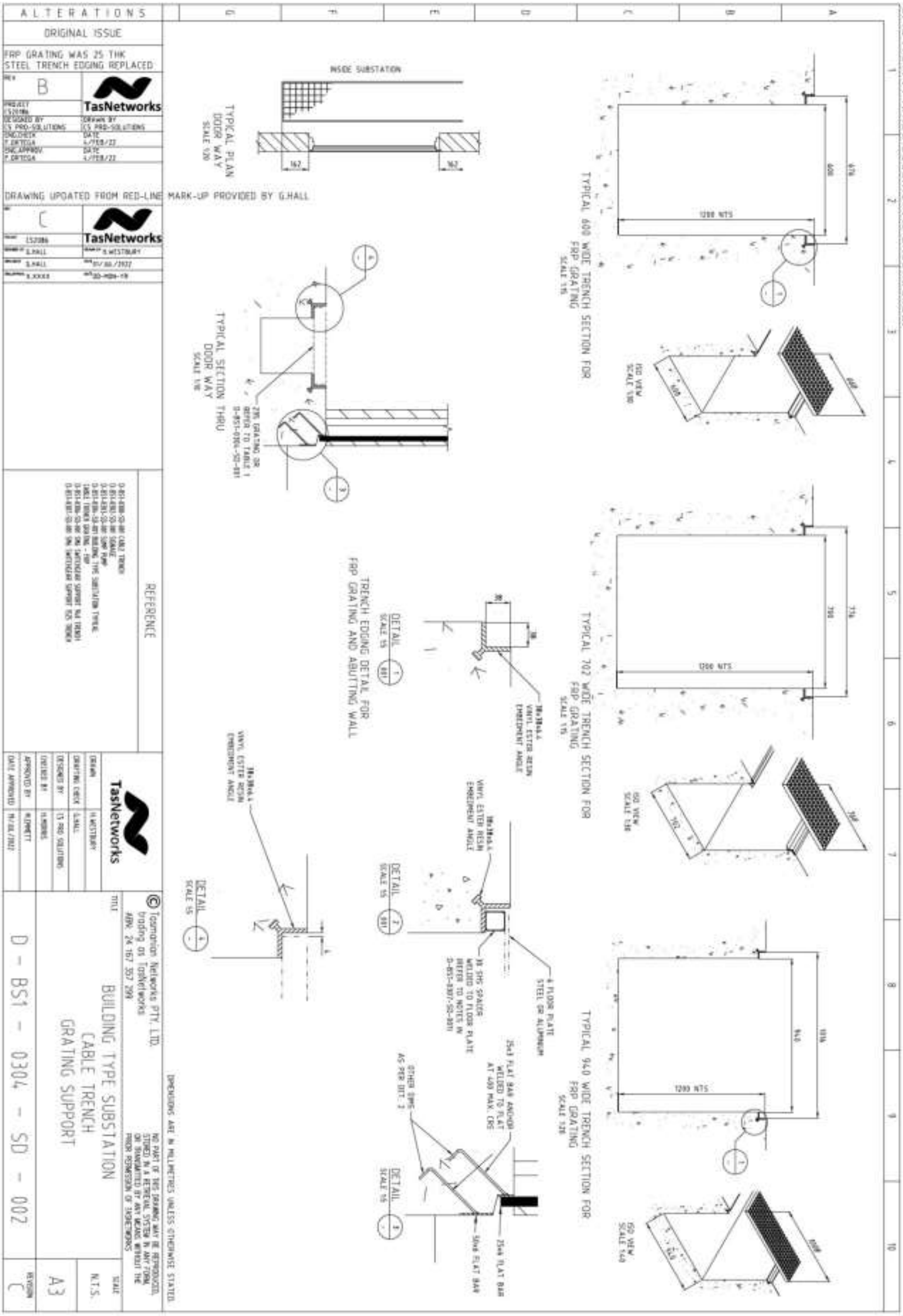
EMF/PDF CREATION DATE 19/JUL/2022

C2 – Substation components

Drawing id.	Title
D-BS1-0300-SD-001	Cable trench details
D-BS1-0304-SD-001	Typical cable trench grating - Grating
D-BS1-0304-SD-002	Typical cable trench grating – Trench section views
D-BS1-0301-SD-001	Fire rated door details
D-BS1-0302-SD-001	Building type substations, Typical signage details
D-BS1-0303-SD-001	Typical sump pump and DC schematic (Substation not containing oil)
D-BS1-0314-SD-001	Typical sump pump and DC schematic (Substation containing oil)
D-BS1-0305-SD-001	Ventilation and fire dampers
D-BS1-0318-SD-001	Earth connection details (Bonding and connections in foundations


CAUTION: Printed document is uncontrolled
TYPICAL TRENCH & CABLE CONFIGURATIONS
TRENCH CONDUIT ENTRY & PULLING EYE
REFERENCE
BUILDING TYPE SUBSTATION
CABLE TRENCH DETAILS
300mm TRENCH
D - BS1 - 0300 - SD - 001
A2
SCALE


CAUTION : Printed document is uncontrolled.
997 STANDARD TRENCH GRATING STRAIGHT RUN
768 STANDARD TRENCH GRATING STRAIGHT RUN
653 EXISTING TRENCH GRATING STRAIGHT RUN
997 STANDARD TRENCH GRATING 'T' INTERSECTION
768 STANDARD TRENCH GRATING 'T' INTERSECTION
653 EXISTING TRENCH GRATING 'T' INTERSECTION
997 STANDARD TRENCH GRATING CORNER
768 STANDARD TRENCH GRATING CORNER
653 EXISTING TRENCH GRATING CORNER
STANDARD GRATING ACROSS DOORWAY
ALTERNATIVE GRATING WIDTHS TABLE 1
REFERENCE
NOTES:
TasNetworks
BUILDING TYPE SUBSTATION
STANDARD CABLE TRENCH GRATING - FRP
D - BS1 - 0304 - SD - 001
A3



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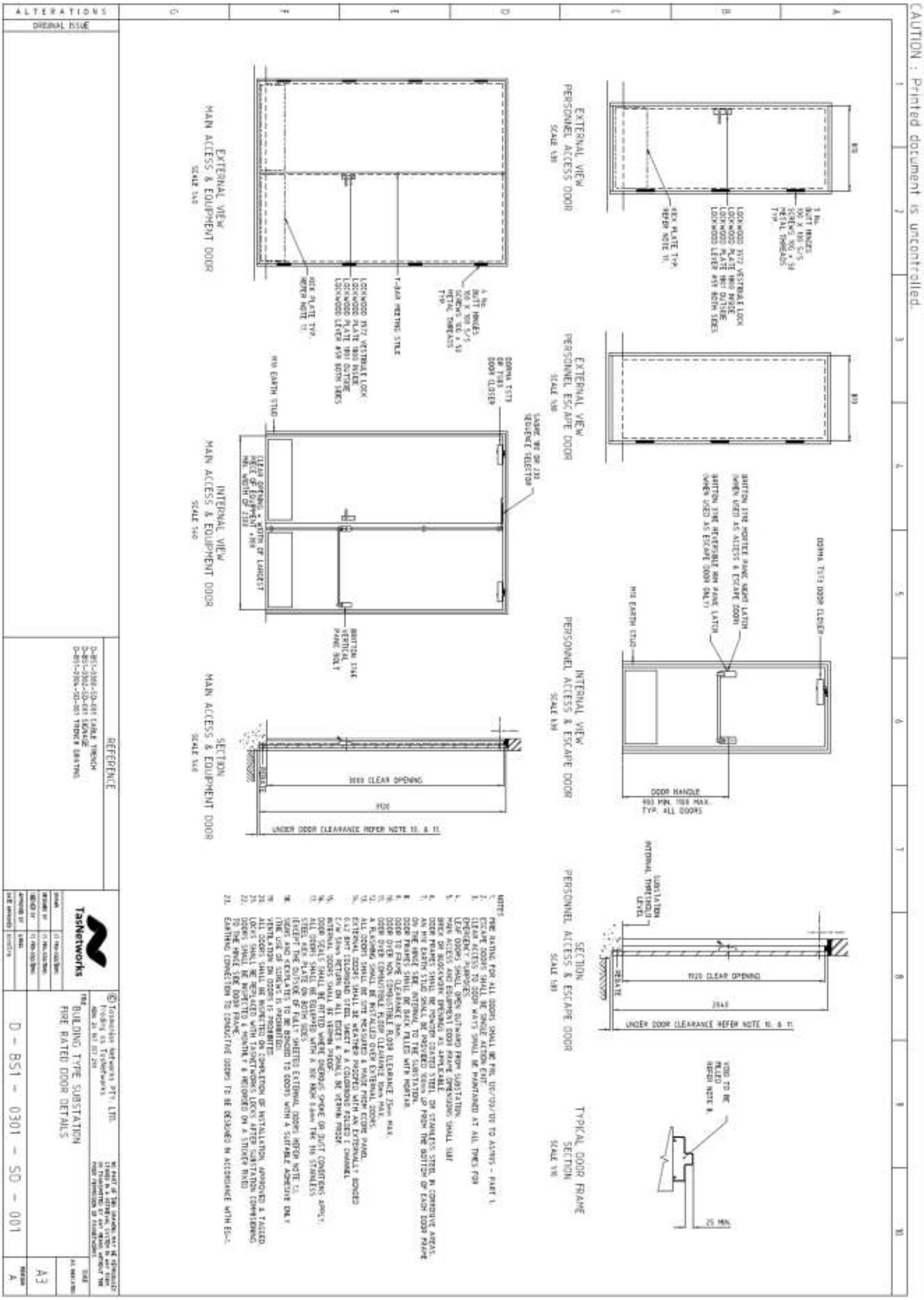
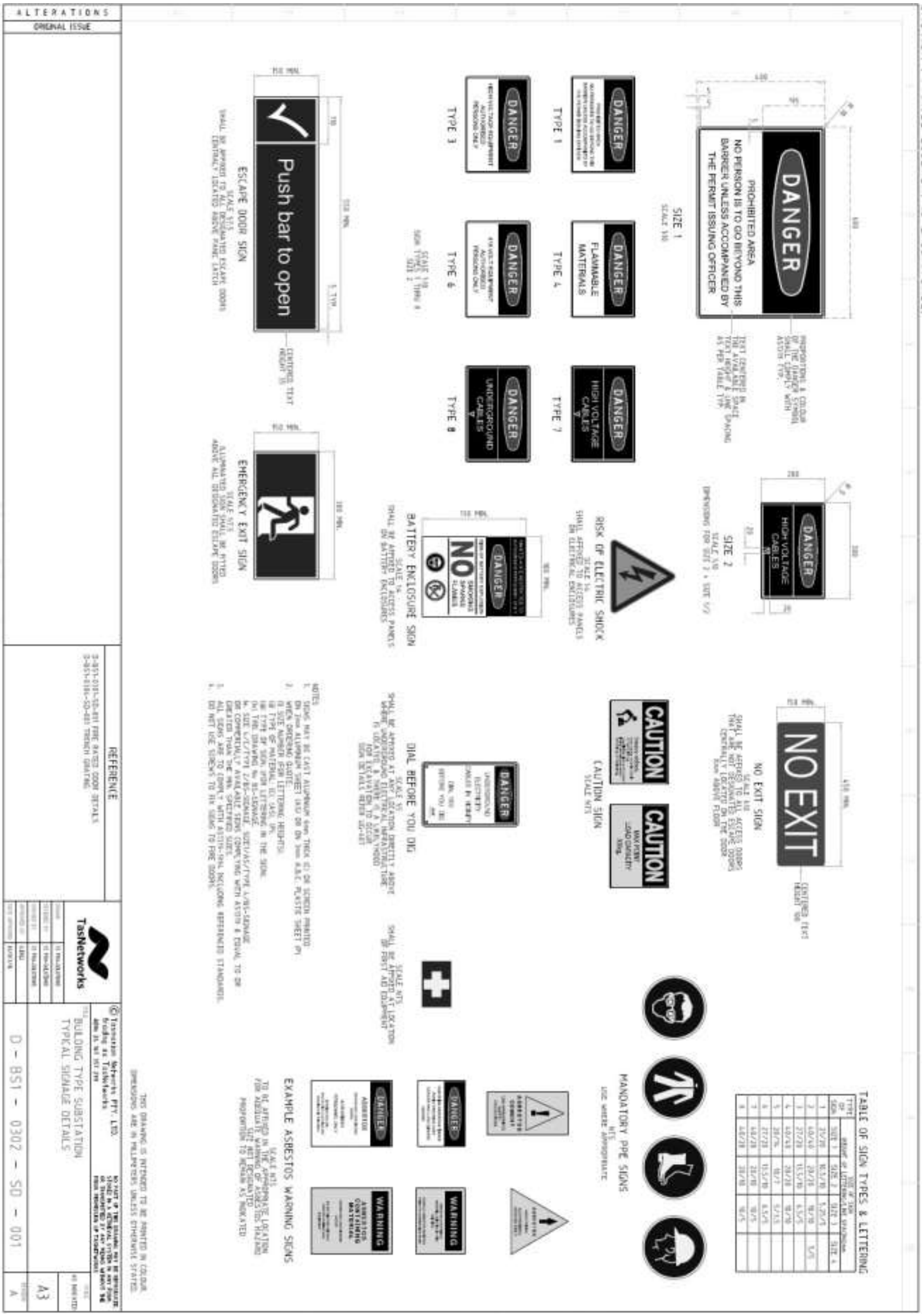

CAUTION : Printed document is uncontrolled.
ALTERATIONS
ORIGINAL ISSUE
REFERENCE
EXTERNAL VIEW PERSONNEL ACCESS DOOR
EXTERNAL VIEW PERSONNEL ESCAPE DOOR
INTERNAL VIEW PERSONNEL ACCESS & ESCAPE DOOR
SECTION PERSONNEL ACCESS & ESCAPE DOOR
TYPICAL DOOR FRAME SECTION
EXTERNAL VIEW MAIN ACCESS & EQUIPMENT DOOR
INTERNAL VIEW MAIN ACCESS & EQUIPMENT DOOR
SECTION MAIN ACCESS & EQUIPMENT DOOR
NOTES
TasNetworks
BUILDING TYPE SUBSTATION
FIRE RATED DOOR DETAILS
D - BS1 - 0301 - SD - 001
A3



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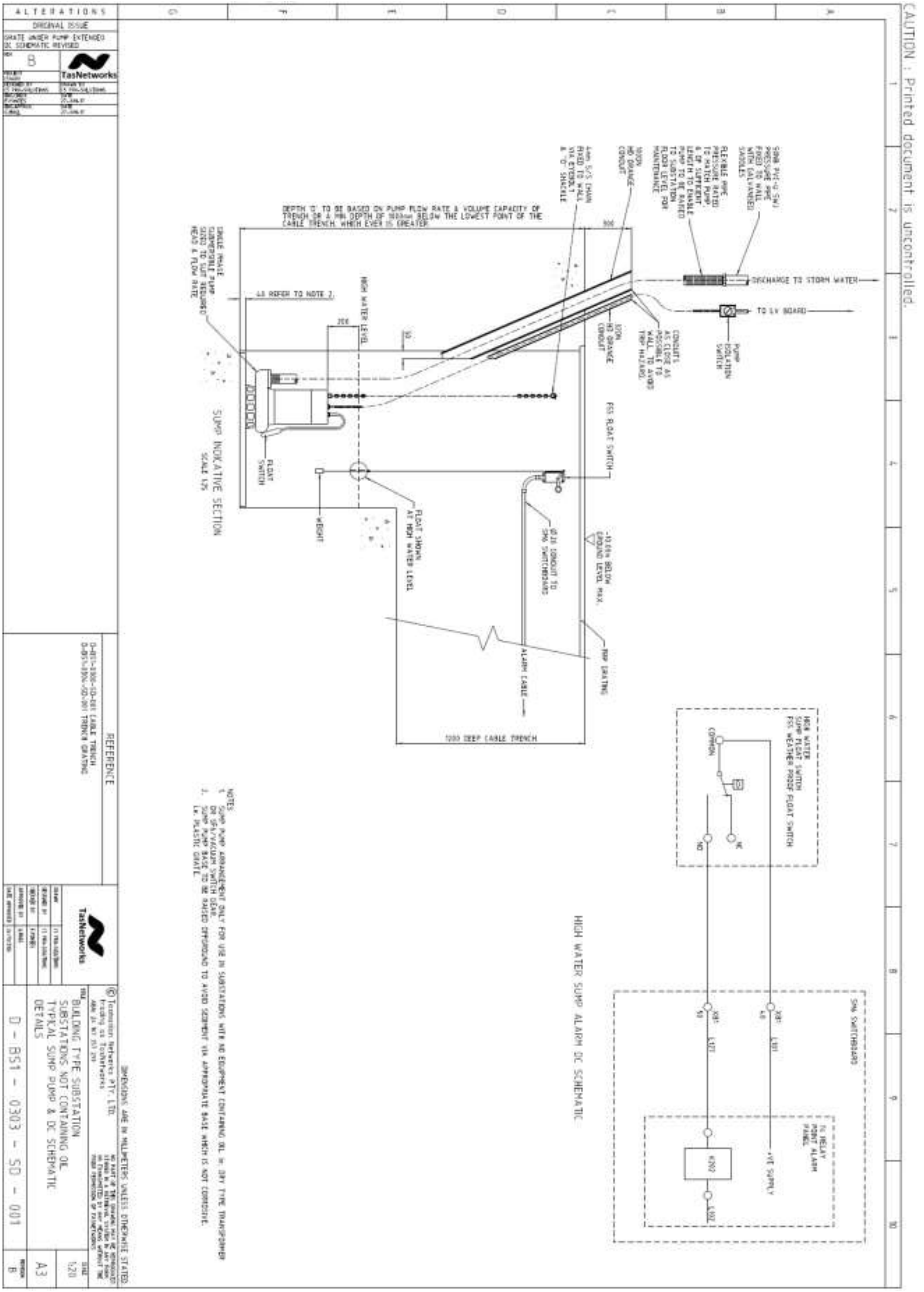
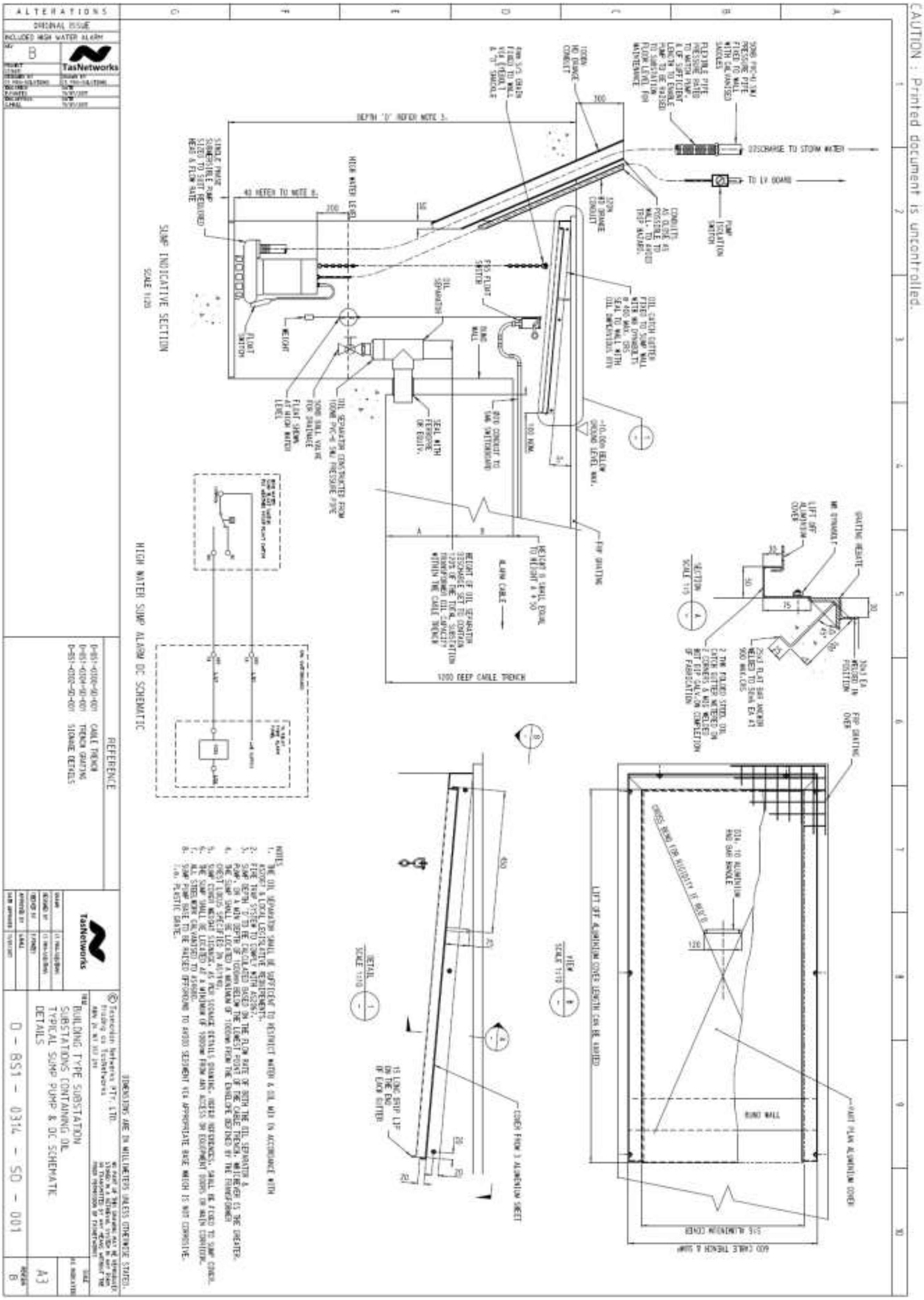
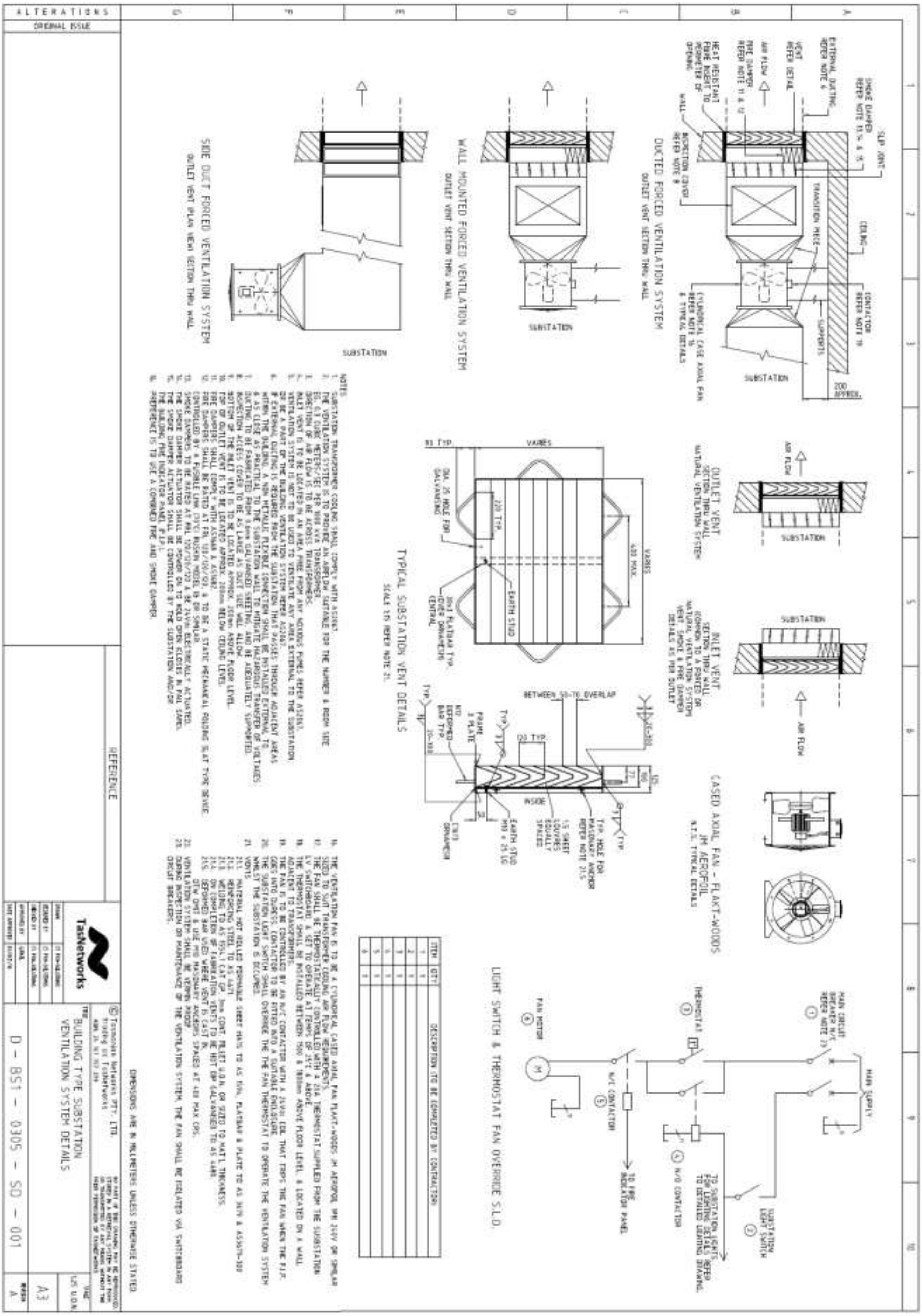
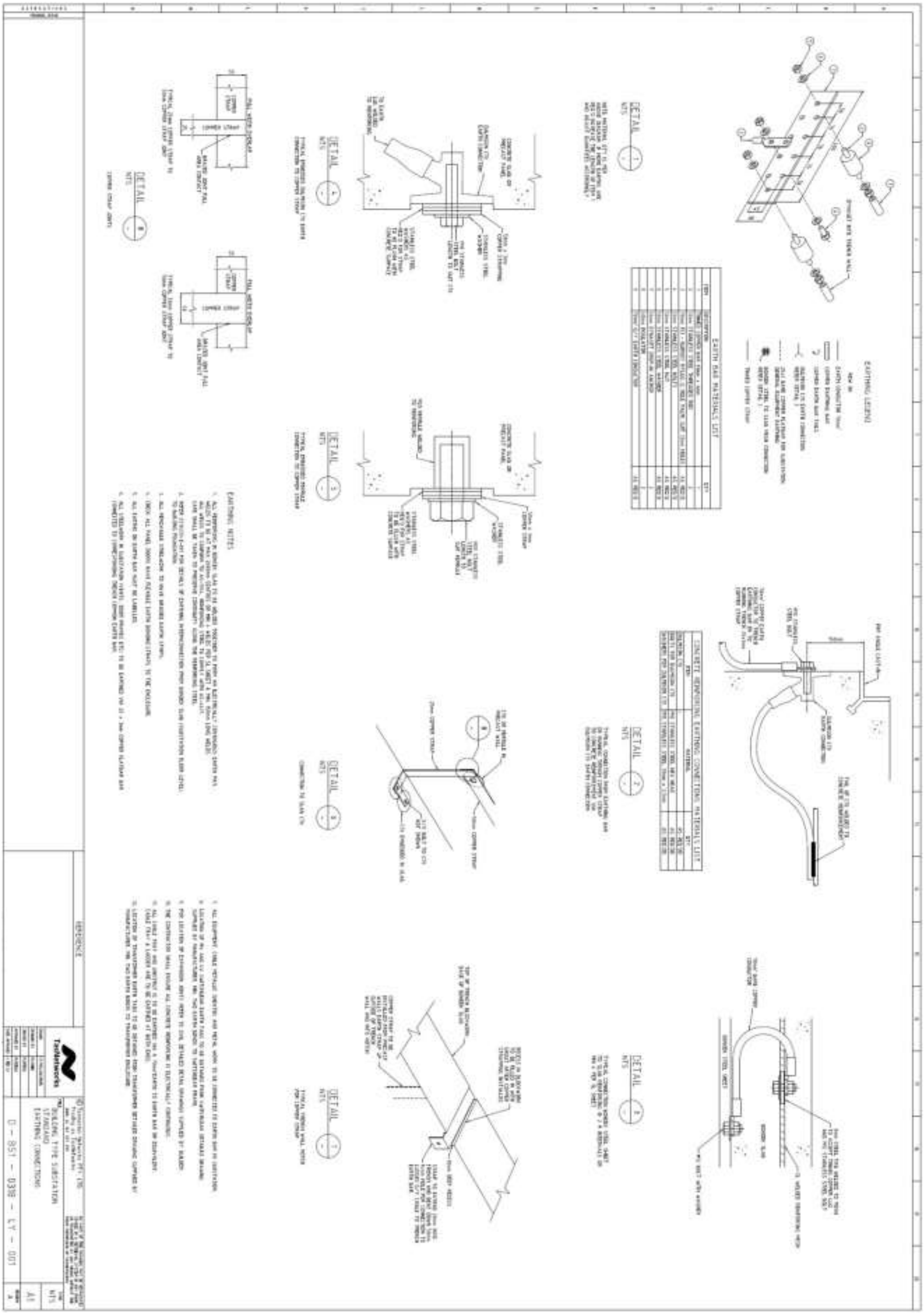

CAUTION : Printed document is uncontrolled.
ALTERATIONS
ORIGINAL ISSUE
TasNetworks
DISCHARGE TO STORM WATER
TO LV BOARD
SUMP INDICATIVE SECTION
SCALE 1:25
1200 DEEP CABLE TRENCH
ALARM CABLE
FRP GRATING
FSS FLOAT SWITCH
FLOAT SWITCH
WEIGHT
HIGH WATER LEVEL
REFERENCE
NOTES
HIGH WATER SUMP ALARM DC SCHEMATIC
HIGH WATER SUMP FLOAT SWITCH
FSS WEATHER PROOF FLOAT SWITCH
COMMON
NO
NC
SMA SWITCHBOARD
DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE STATED
BUILDING TYPE SUBSTATION
SUBSTATIONS NOT CONTAINING OIL
TYPICAL SUMP PUMP & DC SCHEMATIC
DETAILS
D - BS1 - 0303 - SD - 001
A3
1:20
B


CAUTION : Printed document is uncontrolled.
SUMP INDICATIVE SECTION
HIGH WATER SUMP ALARM DC SCHEMATIC
REFERENCE
1200 DEEP CABLE TRENCH
DISCHARGE TO STORM WATER
BUILDING TYPE SUBSTATION
SUBSTATIONS CONTAINING OIL
TYPICAL SUMP PUMP & DC SCHEMATIC
DETAILS
D - BS1 - 0314 - SD - 001
TasNetworks



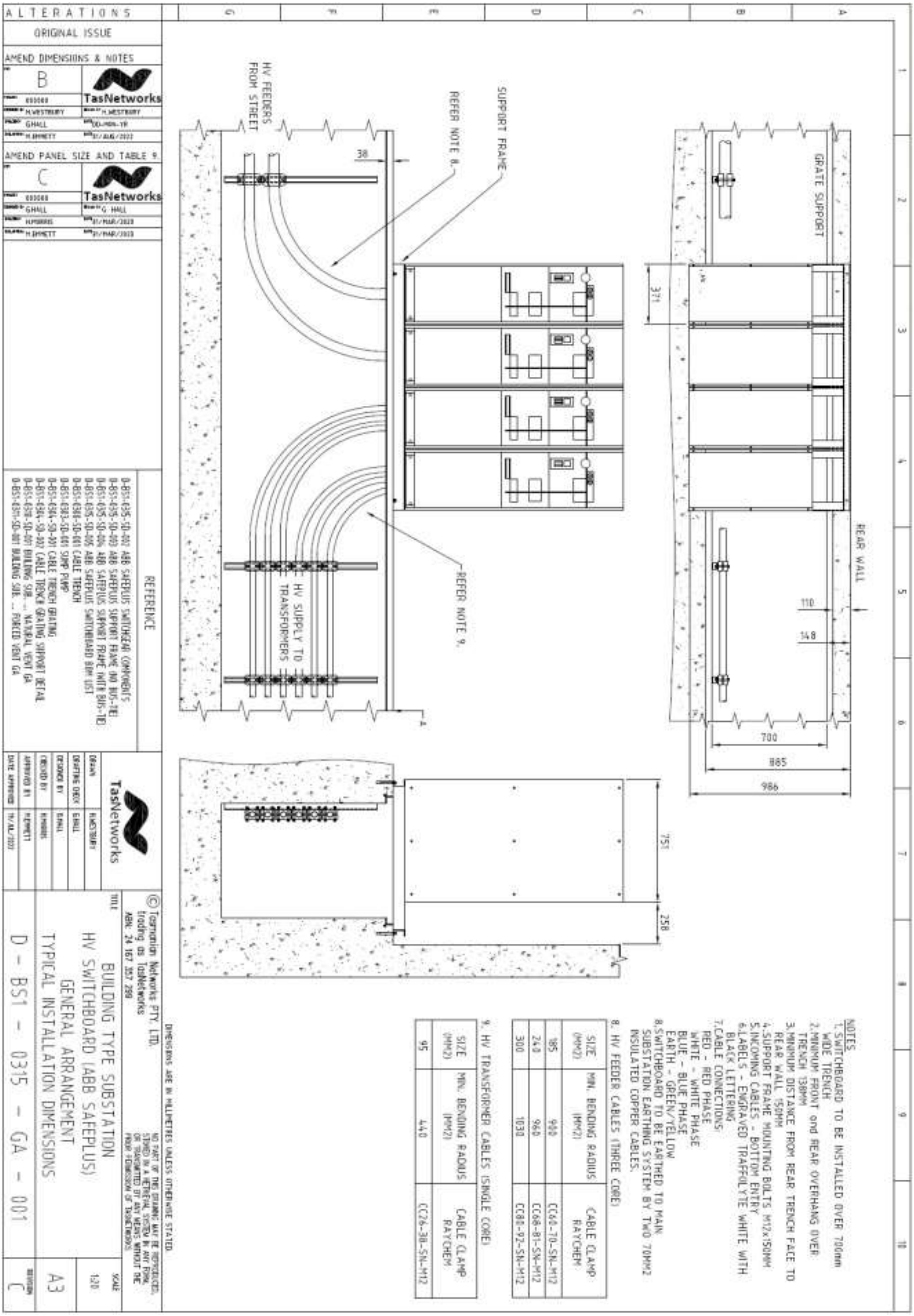
ALTERATIONS
ORIGINAL ISSUE
REFERENCE
DUCTED FORCED VENTILATION SYSTEM
WALL MOUNTED FORCED VENTILATION SYSTEM
SIDE DUCT FORCED VENTILATION SYSTEM
TYPICAL SUBSTATION VENT DETAILS
CASED AXIAL FAN - FLAKT-WOODS JM AEROFOIL
LIGHT SWITCH & THERMOSTAT FAN OVERRIDE S.L.D.
SUBSTATION
TasNetworks
BUILDING TYPE SUBSTATION VENTILATION SYSTEM DETAILS
D - BS1 - 0305 - SD - 001
A3



C3 - HV switchboards

These standard designs are designed for the use of ABB Safeplus HV switchgear.

Drawing id.	**Title**
D-BS1-0315-SD-001	ABB HV switchboard GA over trench
D-BS1-0315-SD-002	ABB Safeplus switchboard components
D-BS1-0315-SD-003	ABB Safeplus switchboard mounting frame (no bus-tie)
D-BS1-0315-SD-004	ABB Safeplus switchboard mounting frame (with bus-tie)
D-BS1-0315-SD-005	ABB Safeplus switchboard configurations, bill of materials.



REAR WALL
GRATE SUPPORT
SUPPORT FRAME
REFER NOTE 8.
REFER NOTE 9.
HV SUPPLY TO TRANSFORMERS
HV FEEDERS FROM STREET
NOTES
1. SWITCHBOARD TO BE INSTALLED OVER 700mm WIDE TRENCH
2. MINIMUM FRONT and REAR OVERHANG OVER TRENCH 138MM
3. MINIMUM DISTANCE FROM REAR TRENCH FACE TO REAR WALL 150MM
4. SUPPORT FRAME MOUNTING BOLTS M12x150MM
5. INCOMING CABLES - BOTTOM ENTRY
6. LABELS - ENGRAVED TRAFFOLYTE WHITE WITH BLACK LETTERING
7. CABLE CONNECTIONS:
RED - RED PHASE
WHITE - WHITE PHASE
BLUE - BLUE PHASE
EARTH - GREEN/YELLOW
8. SWITCHBOARD TO BE EARTHED TO MAIN SUBSTATION EARTHING SYSTEM BY TWO 70MM2 INSULATED COPPER CABLES.
8. HV FEEDER CABLES (THREE CORE)
SIZE (MM2) | MIN. BENDING RADIUS (MM2) | CABLE CLAMP RAYCHEM
185 | 900 | CC60-70-SN-M12
240 | 960 | CC68-81-SN-M12
300 | 1030 | CC80-92-SN-M12
9. HV TRANSFORMER CABLES (SINGLE CORE)
SIZE (MM2) | MIN. BENDING RADIUS (MM2) | CABLE CLAMP RAYCHEM
95 | 440 | CC26-38-SN-M12
DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE STATED.
ALTERATIONS
ORIGINAL ISSUE
AMEND DIMENSIONS & NOTES
AMEND PANEL SIZE AND TABLE 9.
REFERENCE
D-BS1-0315-SD-002 ABB SAFEPLUS SWITCHGEAR COMPONENTS
D-BS1-0315-SD-003 ABB SAFEPLUS SUPPORT FRAME (NO BUS-TIE)
D-BS1-0315-SD-004 ABB SAFEPLUS SUPPORT FRAME (WITH BUS-TIE)
D-BS1-0315-SD-005 ABB SAFEPLUS SWITCHBOARD BOM LIST
D-BS1-0300-SD-001 CABLE TRENCH
D-BS1-0303-SD-001 SUMP PUMP
D-BS1-0304-SD-001 CABLE TRENCH GRATING
D-BS1-0304-SD-002 CABLE TRENCH GRATING SUPPORT DETAIL
D-BS1-0310-SD-001 BUILDING SUB. ... NATURAL VENT GA
D-BS1-0311-SD-001 BUILDING SUB. ... FORCED VENT GA
TasNetworks
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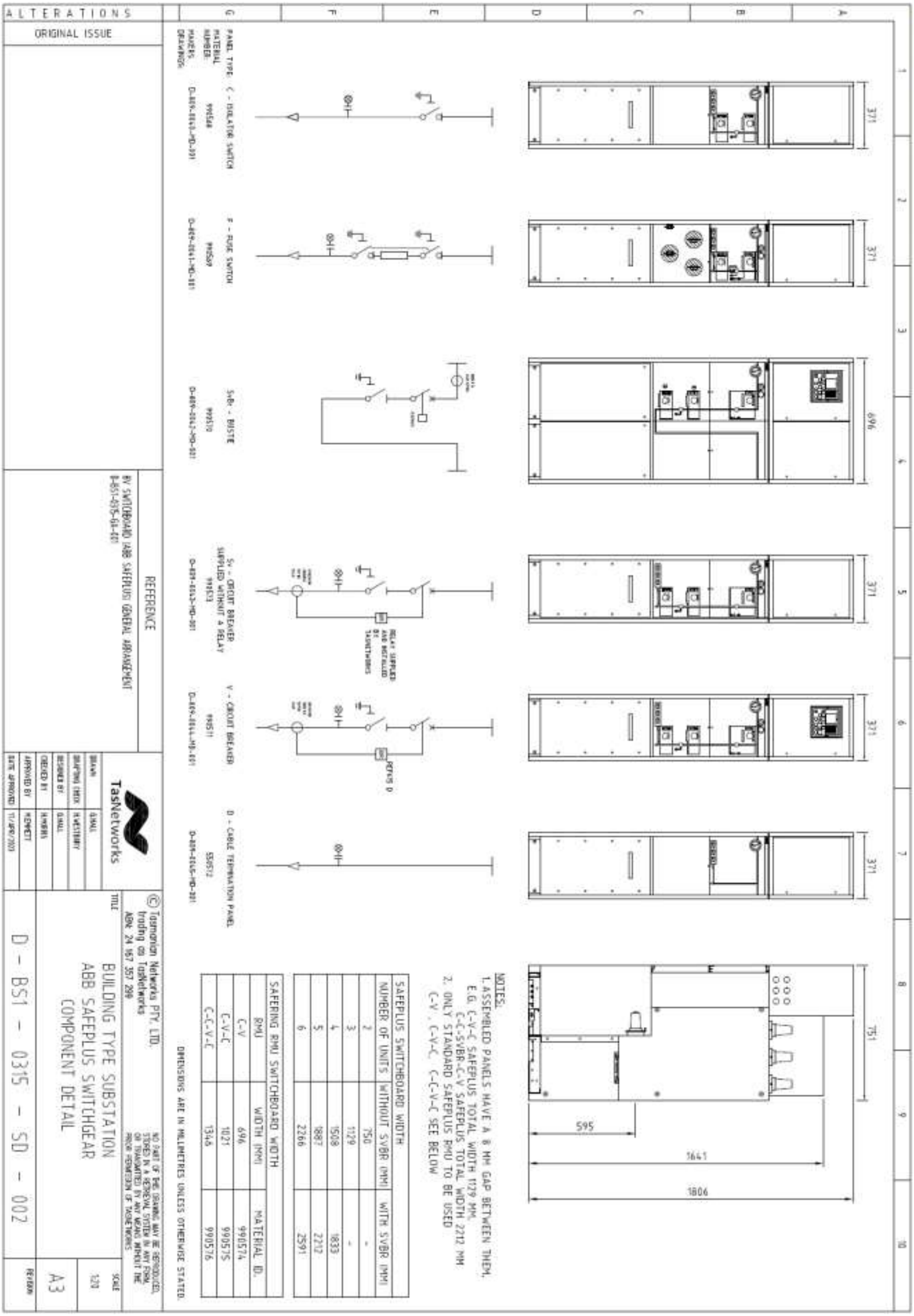
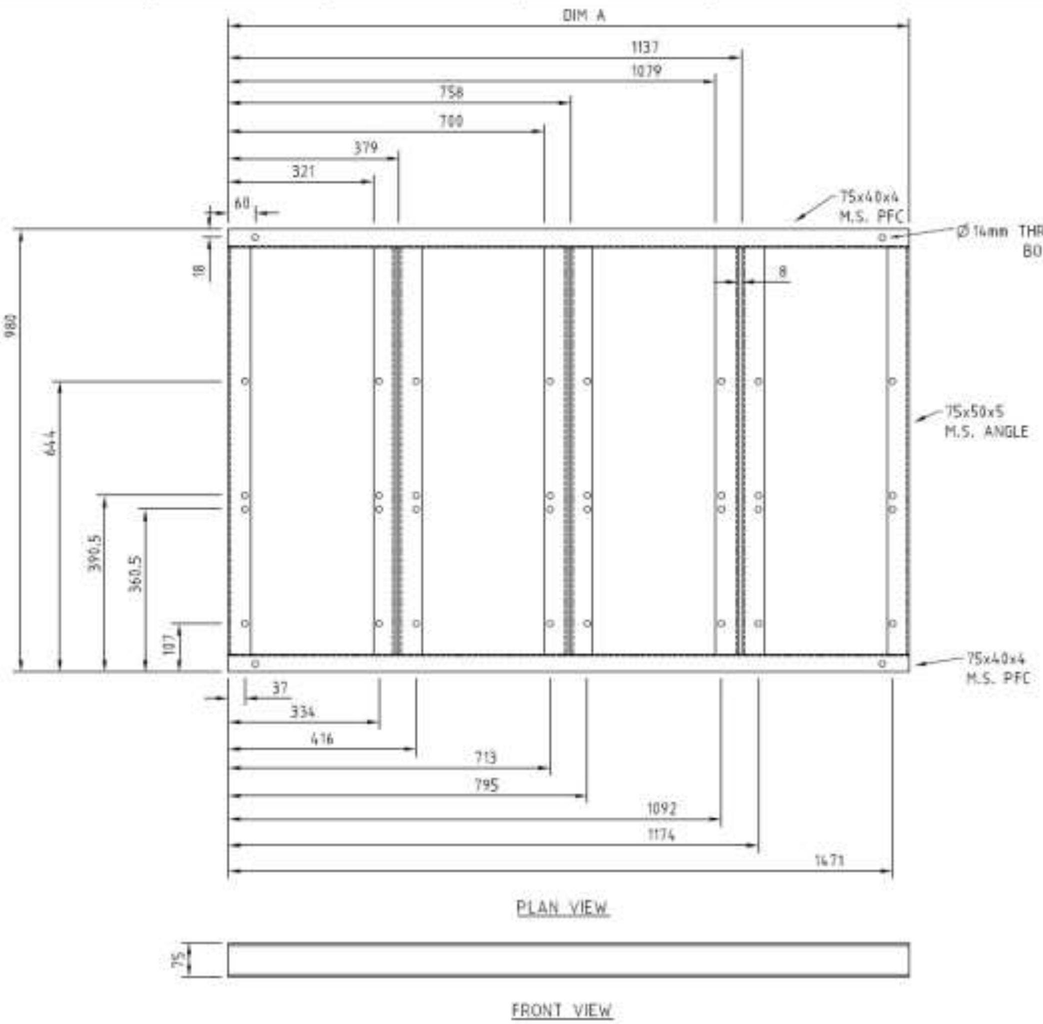
BUILDING TYPE SUBSTATION
HV SWITCHBOARD (ABB SAFEPLUS)
GENERAL ARRANGEMENT
TYPICAL INSTALLATION DIMENSIONS
SCALE 1:20
A3
D - BS1 - 0315 - GA - 001
REVISION C

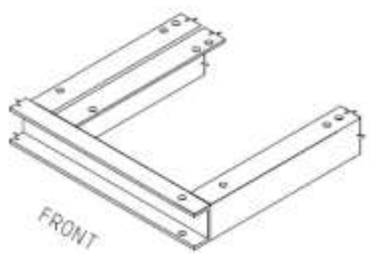

ALTERATIONS
ORIGINAL ISSUE
REFERENCE
TasNetworks
BUILDING TYPE SUBSTATION
ABB SAFEPLUS SWITCHGEAR
COMPONENT DETAIL
D - BS1 - 0315 - SD - 002
A3
NOTES:
1. ASSEMBLED PANELS HAVE A 8 MM GAP BETWEEN THEM.
E.G. C-V-C SAFEPLUS TOTAL WIDTH 1129 MM.
C-C-SVBR-C-V SAFEPLUS TOTAL WIDTH 2212 MM
2. ONLY STANDARD SAFEPLUS RMU TO BE USED
C-V, C-V-C, C-C-V-C SEE BELOW
SAFEPLUS SWITCHBOARD WIDTH
NUMBER OF UNITS
WITHOUT SVBR (MM)
WITH SVBR (MM)
SAFERING RMU SWITCHBOARD WIDTH
RMU
WIDTH (MM)
MATERIAL ID.
DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE STATED.
C - ISOLATOR SWITCH
F - FUSE SWITCH
SvBr - BUSTIE
V - CIRCUIT BREAKER
D - CABLE TERMINATION PANEL
371
696
751
595
1641
1806



NOTES:
1. SUPPORT FRAME FOR USE WITH ABB SAFEPLUS MODULAR SWITCHGEAR ONLY.
2. FRAME NOT SUITABLE FOR SWITCHBOARDS WITH A BUS-TIE
3. ALL JOINTS TO BE WELDED.
4. TOP AND BOTTOM SURFACES TO BE FLAT WITH NO RAISED WELDS PRESENT.
5. COMPLETED FRAME TO BE HOT DIP GALVANISED.

FRAME LENGTH AND WEIGHT

SWITCHBOARD SIZE	DIM A (MM)	WEIGHT (KG)
2 - WAY	750	28
3 - WAY	1129	41
4 - WAY	1508	54
5 - WAY	1887	66
6 - WAY	2266	79



DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE STATED.

ALTERATIONS
ORIGINAL ISSUE

REFERENCE
D-BS1-0315-SD-001 ABB HV SWITCHBOARD GA
D-BS1-0315-SD-002 ABB SAFEPLUS COMPONENTS
D-BS1-0315-SD-004 ABB SAFEPLUS SUPPORT FRAME (WITH BUS-TIE)
D-BS1-0315-SD-005 ABB SAFEPLUS BILL OF MATERIALS

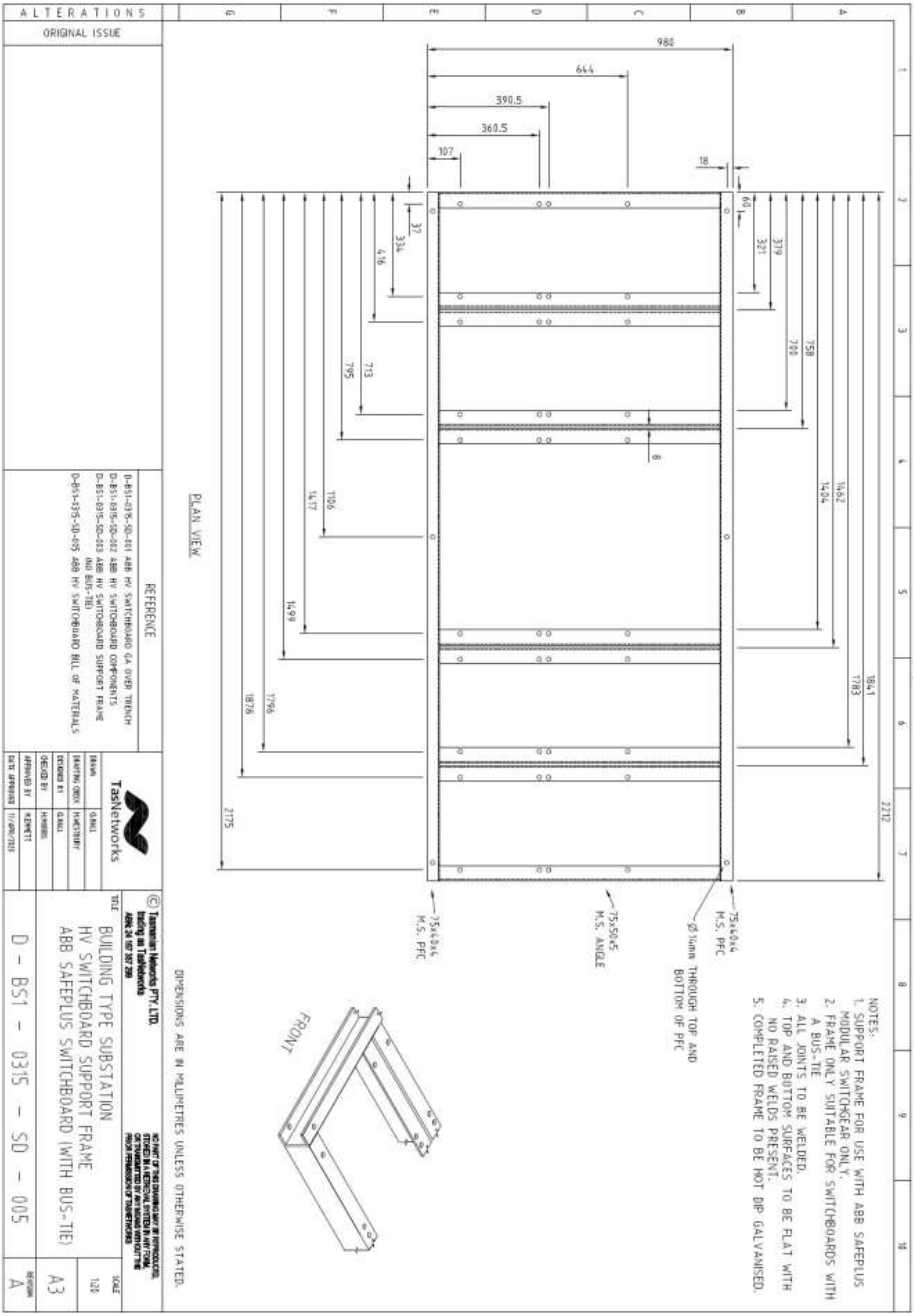
TasNetworks

DRAWN	G.HALL
DRAFTING CHECK	H.WESTBURY
DESIGNED BY	G.HALL
CHECKED BY	H.MORRIS
APPROVED BY	M.EMMETT
DATE APPROVED	11/APR/2023

TITLE
BUILDING TYPE SUBSTATION
HV SWITCHBOARD SUPPORT FRAME (NO BUS TIE)
ABB SAFEPLUS SWITCHBOARD

SCALE 1:20
A3
REVISION

D - BS1 - 0315 - SD - 003


ALTERATIONS
ORIGINAL ISSUE
REFERENCE
D-BS1-0315-SD-001 ABB HV SWITCHBOARD GA OVER TRENCH
D-BS1-0315-SD-002 ABB HV SWITCHBOARD COMPONENTS
D-BS1-0315-SD-003 ABB HV SWITCHBOARD SUPPORT FRAME (NO BUS-TIE)
D-BS1-0315-SD-005 ABB HV SWITCHBOARD BILL OF MATERIALS
PLAN VIEW
FRONT
75x40x4 M.S. PFC
75x50x5 M.S. ANGLE
Ø 14mm THROUGH TOP AND BOTTOM OF PFC
NOTES:
1. SUPPORT FRAME FOR USE WITH ABB SAFEPLUS MODULAR SWITCHGEAR ONLY.
2. FRAME ONLY SUITABLE FOR SWITCHBOARDS WITH A BUS-TIE
3. ALL JOINTS TO BE WELDED.
4. TOP AND BOTTOM SURFACES TO BE FLAT WITH NO RAISED WELDS PRESENT.
5. COMPLETED FRAME TO BE HOT DIP GALVANISED.
DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE STATED.
TasNetworks
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TITLE
BUILDING TYPE SUBSTATION
HV SWITCHBOARD SUPPORT FRAME
ABB SAFEPLUS SWITCHBOARD (WITH BUS-TIE)
D - BS1 - 0315 - SD - 005
SCALE 1:20
A3
REVISION A

		Switchboard						Mounting frame									Unistrut				Cable clamps			
BOM Id	BOM name	Feeders	Material Id.	Qty	Transformers	Material Id	Qty	Frame	Qty	Frame mounting bolts (M12 dynabolt)	Qty	Swbd mounting bolts (M12x40)	Qty	Washers (12mm)	Qty	Unistrut	Quantity at 6000mm	Bolts (M12 dynabolt)	Qty	3 core	Qty	3 x single core	Qty
730057	BS ABB Safeplus 1xC+1xF	1 x Line switch	990568	1	1 x Fuse switch	990569	1	730090	1	75223	4	75223	8	65615	20	129358	1	75223	6	242854	1	242850	6
730058	BS ABB Safeplus 1xC+1xV	1 x Line switch	990568	1	1 x Circuit breaker (with REF615 relay installed)	990571	1	730090	1	75223	4	75223	8	65615	20	129358	1	75223	6	242854	1	242850	6
730059	BS ABB Safeplus 1xC+2xV	1 x Line switch	990568	1	2 x Circuit breaker (with REF615 relay installed)	990571	2	730091	1	75223	6	75223	12	65615	30	129358	1	75223	6	242854	1	242850	12
730060	BS ABB Safeplus 1xV+1xF	1 x Circuit breaker (with REF615 relay installed)	990571	1	1 x Fuse switch	990569	1	730090	1	75223	4	75223	8	65615	20	129358	1	75223	6	242854	1	242850	6
730061	BS ABB Safeplus 1xV+1xV	1 x Circuit breaker (with REF615 relay installed)	990571	1	1 x Circuit breaker (with REF615 relay installed)	990571	1	730090	1	75223	4	75223	8	65615	20	129358	1	75223	6	242854	1	242850	6
730062	BS ABB Safeplus 1xV+2xV	1 x Circuit breaker (with REF615 relay installed)	990571	1	2 x Circuit breaker (with REF615 relay installed)	990571	2	730091	1	75223	6	75223	12	65615	30	129358	1	75223	6	242854	1	242850	12
730063	BS ABB Safeplus 1xSv+1xF	1 x Circuit breaker (no relay installed)	990573	1	1 x Fuse switch	990569	1	730090	1	75223	4	75223	8	65615	20	129358	1	75223	6	242854	1	242850	6
730064	BS ABB Safeplus 1xSv+1xV	1 x Circuit breaker (no relay installed)	990573	1	1 x Circuit breaker (with REF615 relay installed)	990571	1	730090	1	75223	4	75223	8	65615	20	129358	1	75223	6	242854	1	242850	6
730065	BS ABB Safeplus 1xSv+2xV	1 x Circuit breaker (no relay installed)	990573	1	2 x Circuit breaker (with REF615 relay installed)	990571	2	730091	1	75223	6	75223	12	65615	30	129358	1	75223	6	242854	1	242850	12
730066	BS ABB Safeplus 2xC+1xF	2 x Line switches	990568	2	1 x Fuse switch	990569	1	730091	1	75223	4	75223	12	65615	28	129358	1	75223	6	242854	2	242850	6
730067	BS ABB Safeplus 2xC+1xV	2 x Line switches	990568	2	1 x Circuit breaker (with REF615 relay installed)	990571	1	730091	1	75223	4	75223	12	65615	28	129358	1	75223	6	242854	2	242850	6
730068	BS ABB Safeplus 2xC+2xV	2 x Line switches	990568	2	2 x Circuit breaker (with REF615 relay installed)	990571	2	730092	1	75223	6	75223	16	65615	38	129358	1	75223	6	242854	2	242850	12
730069	BS ABB Safeplus 2xC+3xV	2 x Line switches	990568	2	3 x Circuit breaker (with REF615 relay installed)	990571	3	730093	1	75223	8	75223	20	65615	48	129358	1	75223	8	242854	2	242850	15
730070	BS ABB Safeplus 2xV+1xF	2 x Circuit breakers (with REF615 relay installed)	990571	2	1 x Fuse switch	990569	1	730091	1	75223	4	75223	12	65615	28	129358	1	75223	6	242854	2	242850	6
730071	BS ABB Safeplus 2xV+1xV	2 x Circuit breakers (with REF615 relay installed)	990571	2	1 x Circuit breaker (with REF615 relay installed)	990571	1	730091	1	75223	4	75223	12	65615	28	129358	1	75223	6	242854	2	242850	6
730072	BS ABB Safeplus 2xV+2xV	2 x Circuit breakers (with REF615 relay installed)	990571	2	2 x Circuit breaker (with REF615 relay installed)	990571	2	730092	1	75223	6	75223	16	65615	38	129358	1	75223	6	242854	2	242850	12
730073	BS ABB Safeplus 2xV+3xV	2 x Circuit breakers (with REF615 relay installed)	990571	2	3 x Circuit breaker (with REF615 relay installed)	990571	3	730093	1	75223	8	75223	20	65615	48	129358	1	75223	8	242854	2	242850	15
730074	BS ABB Safeplus 2xSv+1xF	2 x Circuit breakers (no relay installed)	990573	2	1 x Fuse switch	990569	1	730091	1	75223	4	75223	12	65615	28	129358	1	75223	6	242854	2	242850	6
730075	BS ABB Safeplus 2xSv+1xV	2 x Circuit breakers (no relay installed)	990573	2	1 x Circuit breaker (with REF615 relay installed)	990571	1	730091	1	75223	4	75223	12	65615	28	129358	1	75223	6	242854	2	242850	6
730076	BS ABB Safeplus 2xSv+2xV	2 x Circuit breakers (no relay installed)	990573	2	2 x Circuit breaker (with REF615 relay installed)	990571	2	730092	1	75223	6	75223	16	65615	38	129358	1	75223	6	242854	2	242850	12
730077	BS ABB Safeplus 2xSv+3xV	2 x Circuit breakers (no relay installed)	990573	2	3 x Circuit breaker (with REF615 relay installed)	990571	3	730093	1	75223	8	75223	20	65615	48	129358	1	75223	8	242854	2	242850	15
730078	BS ABB Safeplus 3xC+1xF	3 x Line switches	990568	3	1 x Fuse switch	990569	1	730092	1	75223	4	75223	16	65615	36	129358	1	75223	10	242854	4	242850	6
730079	BS ABB Safeplus 3xC+1xV	3 x Line switches	990568	3	1 x Circuit breaker (with REF615 relay installed)	990571	1	730092	1	75223	4	75223	16	65615	36	129358	1	75223	10	242854	4	242850	6
730080	BS ABB Safeplus 3xC+2xV	3 x Line switches	990568	3	2 x Circuit breaker (with REF615 relay installed)	990571	2	730093	1	75223	6	75223	20	65615	46	129358	1	75223	10	242854	4	242850	12
730081	BS ABB Safeplus 3xC+3xV	3 x Line switches	990568	3	3 x Circuit breaker (with REF615 relay installed)	990571	3	730094	1	75223	8	75223	24	65615	56	129358	1	75223	12	242854	4	242850	15
730082	BS ABB Safeplus 3xV+1xF	3 x Circuit breakers (with REF615 relay installed)	990571	3	1 x Fuse switch	990569	1	730092	1	75223	4	75223	16	65615	36	129358	1	75223	10	242854	4	242850	6
730083	BS ABB Safeplus 3xV+1xV	3 x Circuit breakers (with REF615 relay installed)	990571	3	1 x Circuit breaker (with REF615 relay installed)	990571	1	730092	1	75223	4	75223	16	65615	36	129358	1	75223	10	242854	4	242850	6
730084	BS ABB Safeplus 3xV+2xV	3 x Circuit breakers (with REF615 relay installed)	990571	3	2 x Circuit breaker (with REF615 relay installed)	990571	2	730093	1	75223	6	75223	20	65615	46	129358	1	75223	10	242854	4	242850	12
730085	BS ABB Safeplus 3xV+3xV	3 x Circuit breakers (with REF615 relay installed)	990571	3	3 x Circuit breaker (with REF615 relay installed)	990571	3	730094	1	75223	8	75223	24	65615	56	129358	1	75223	12	242854	4	242850	15
730086	BS ABB Safeplus 3xSv+1xF	3 x Circuit breakers (no relay installed)	990573	3	1 x Fuse switch	990569	1	730092	1	75223	4	75223	16	65615	36	129358	1	75223	10	242854	4	242850	6
730087	BS ABB Safeplus 3xSv+1xV	3 x Circuit breakers (no relay installed)	990573	3	1 x Circuit breaker (with REF615 relay installed)	990571	1	730092	1	75223	4	75223	16	65615	36	129358	1	75223	10	242854	4	242850	6
730088	BS ABB Safeplus 3xSv+2xV	3 x Circuit breakers (no relay installed)	990573	3	2 x Circuit breaker (with REF615 relay installed)	990571	2	730093	1	75223	6	75223	20	65615	46	129358	1	75223	10	242854	4	242850	12
730089	BS ABB Safeplus 3xSv+3xV	3 x Circuit breakers (no relay installed)	990573	3	3 x Circuit breaker (with REF615 relay installed)	990571	3	730094	1	75223	8	75223	24	65615	56	129358	1	75223	12	242854	4	242850	15

DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE STATED.

ALTERATIONS

ORIGINAL ISSUE

REFERENCE

D-BS1-0315-GA-001 ABB SAFEPLUS GENERAL ARRANGEMENT
D-BS1-0315-SD-002 ABB SAFEPLUS COMPONENT DETAIL
D-BS1-0315-SD-004 HV SW/BRD (ABB SAFEPLUS) SUPPORT FRAME
D-BS1-0303-SD-001 CABLE TRENCH
D-BS1-0303-SD-001 SUMP PUMP
D-BS1-0304-SD-001 CABLE TRENCH GRATING
D-BS1-0304-SD-002 CABLE TRENCH GRATING SUPPORT DETAIL
D-BS1-0318-SD-001 BUILDING SUB. ... NATURAL VENT GA
D-BS1-0319-SD-001 BUILDING SUB. ... FORCED VENT GA

TasNetworks

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DRAFTING CHECK	H.WESTBURY
DESIGNED BY	E.HALL
CHECKED BY	H.HARRIS
APPROVED BY	H.EMMETT
DATE APPROVED	17/APR/2023

TITLE

BUILDING TYPE SUBSTATION
HV SWITCHBOARD (ABB SAFEPLUS)
BILL OF MATERIALS FOR SWITCHBOARDS

SCALE NTS

A3

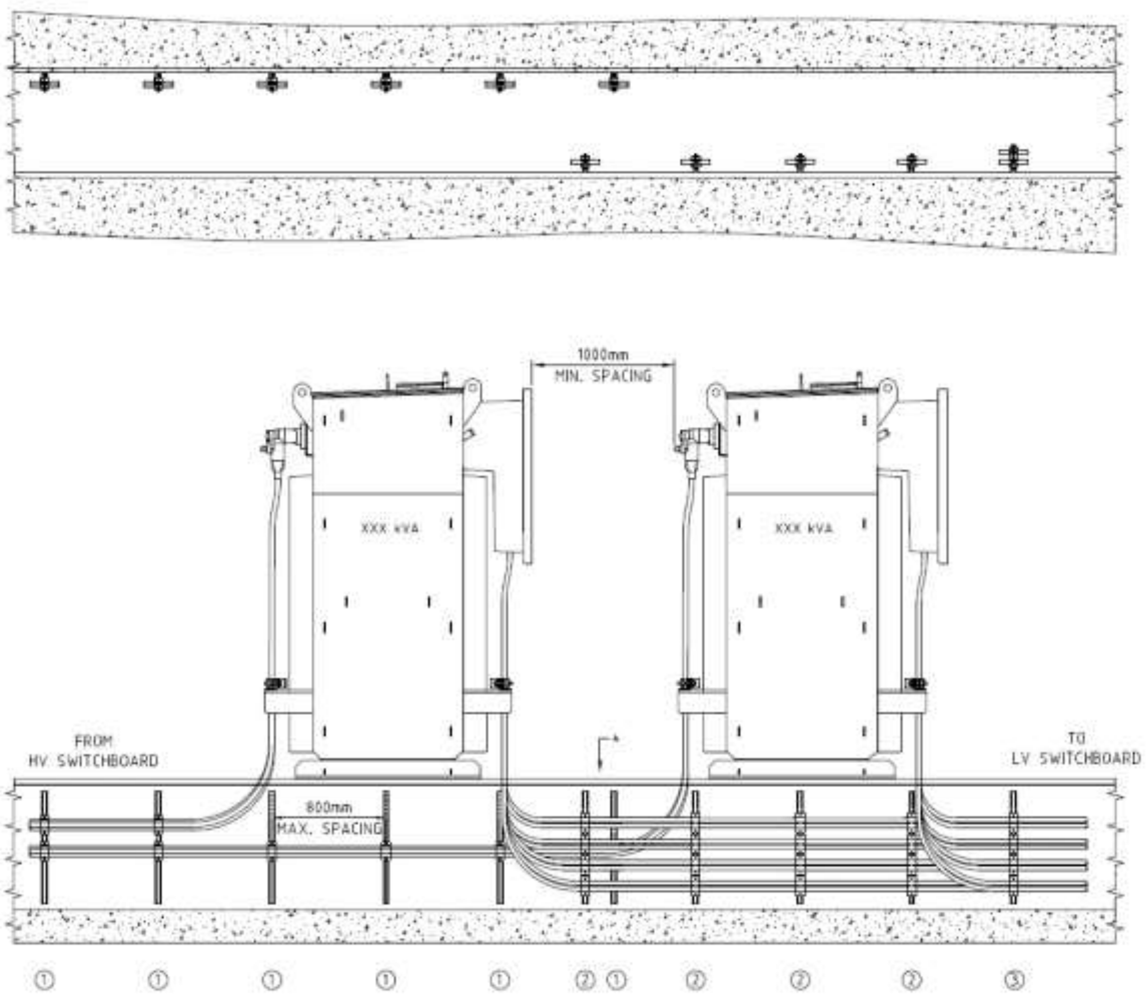
REVISION

D - BS1 - 0315 - SD - 003

C5 - Transformers

The standard substation layout drawing is designed for the use of Tyree transformers.

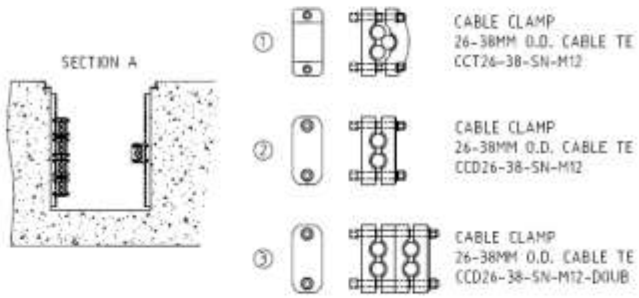
Drawing Id.	Title
D-BS1-0317-SD-001	Transformer (Tyree), General arrangement, Typical installation
D-809-0038-MD-001	Tyree transformer 500 -1500 kVA, 11/22 kV



NOTES:
1. DRAWING FOR INSTALLATION OVER 700mm WIDE TRENCH.
2. REFER DRAWING D-0809-0038-MD-001 FOR TRANSFORMER DIMENSIONS.
3. LV CABLES FROM TRANSFORMER TO BE SINGLE CORE CABLES OF MIMIMUM SIZE 300 MM2.
500kVA TRANSFORMERS - ONE CABLE PER PHASE.
750, 1000 and 1500kVA TRANSFORMERS - TWO CABLES PER PHASE.
4. EACH TRANSFORMERS TO BE BONDED TO THE SUBSTATION EARTHING SYSTEM BY TWO INSULATED 70MM2 CABLES.
6. CABLE IDENTIFICATION: RED PHASE - RED
WHITE PHASE - WHITE
BLUE PHASE - BLUE
NEUTRAL - BLACK
EARTH - GREEN/YELLOW

TRANSFORMER (TYREE) BILL OF MATERIALS

TRANSFORMER	B.O.M. TRANSFORMER ONLY		B.O.M. TRANSFORMER WITH UNISTRUT AND MOUNTS	
	11 kV	22 kV	11 kV	22 kV
500 kVA x 1	427835	427839	73033	73045
500 kVA x 2			73034	73046
500 kVA x 3			73035	73047
750 kVA x 1	427843	427847	73036	73048
750 kVA x 2			73037	73049
750 kVA x 3			73038	73050
1000 kVA x 1	427851	427855	73039	73051
1000 kVA x 2			73040	73052
1000 kVA x 3			73041	73053
1500 kVA x 1	427859	427863	73042	73054
1500 kVA x 2			73043	73055
1500 kVA x 3			73044	73056



DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE STATED.

ALTERATIONS: ORIGINAL ISSUE

REFERENCE
D-0809-0038-MD-001 TYREE TRANSFORMERS 500-1500 kVA
D-BS1-0304-SD-001 CABLE TRENCH GRATING - FRP
D-BS1-0304-SD-001 CABLE TRENCH GRATING - SUPPORT DETAIL

TasNetworks

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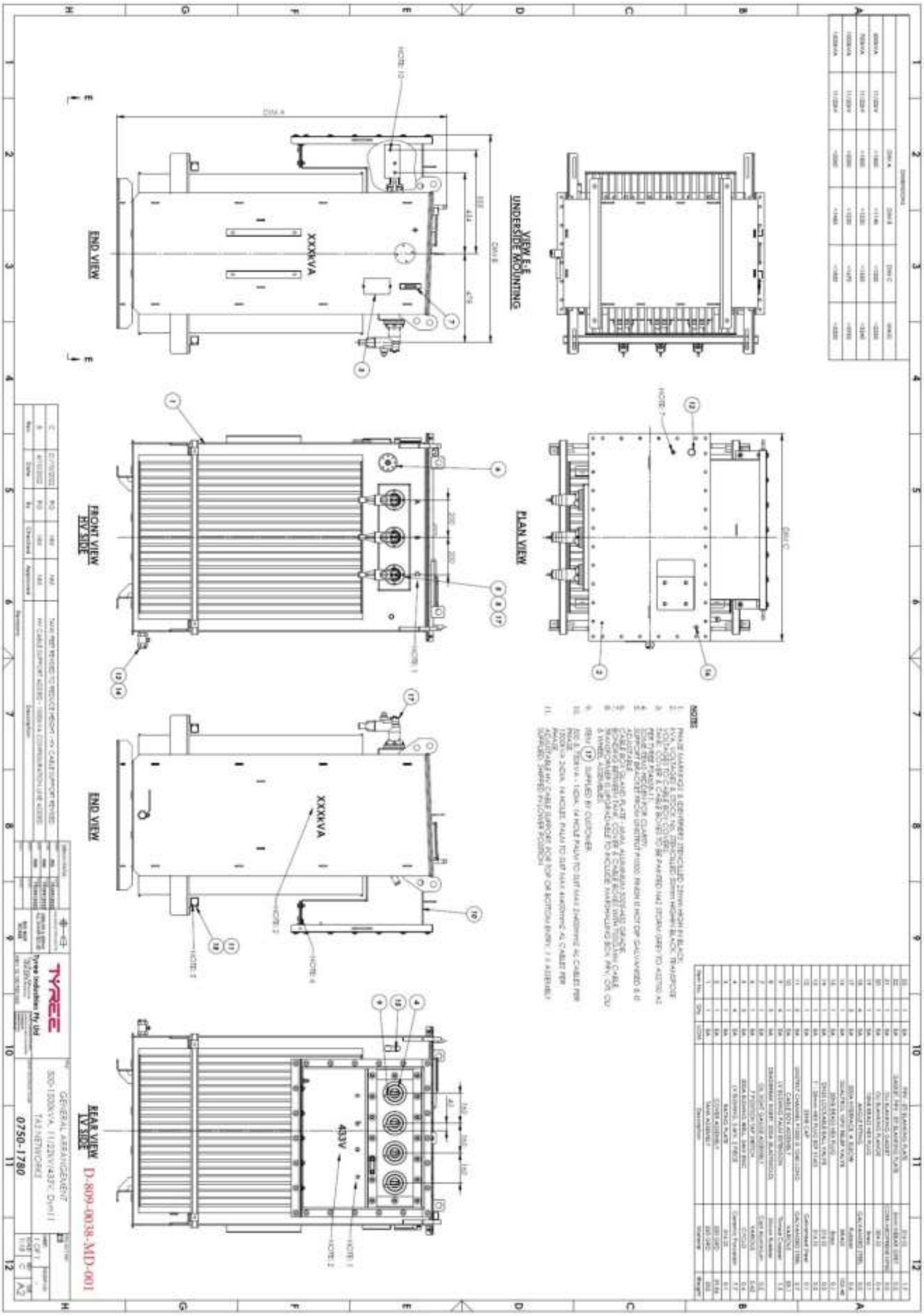
CHECKED BY	B.HARRIS
APPROVED BY	M.EMMETT
DATE APPROVED	17/APR/2023

TITLE: BUILDING TYPE SUBSTATION
TWO TRANSFORMERS (TYREE)
GENERAL ARRANGEMENT
TYPICAL INSTALLATION DIMENSIONS

SCALE: 1:20
A3
REVISION

D - BS1 - 0317 - SD - 001



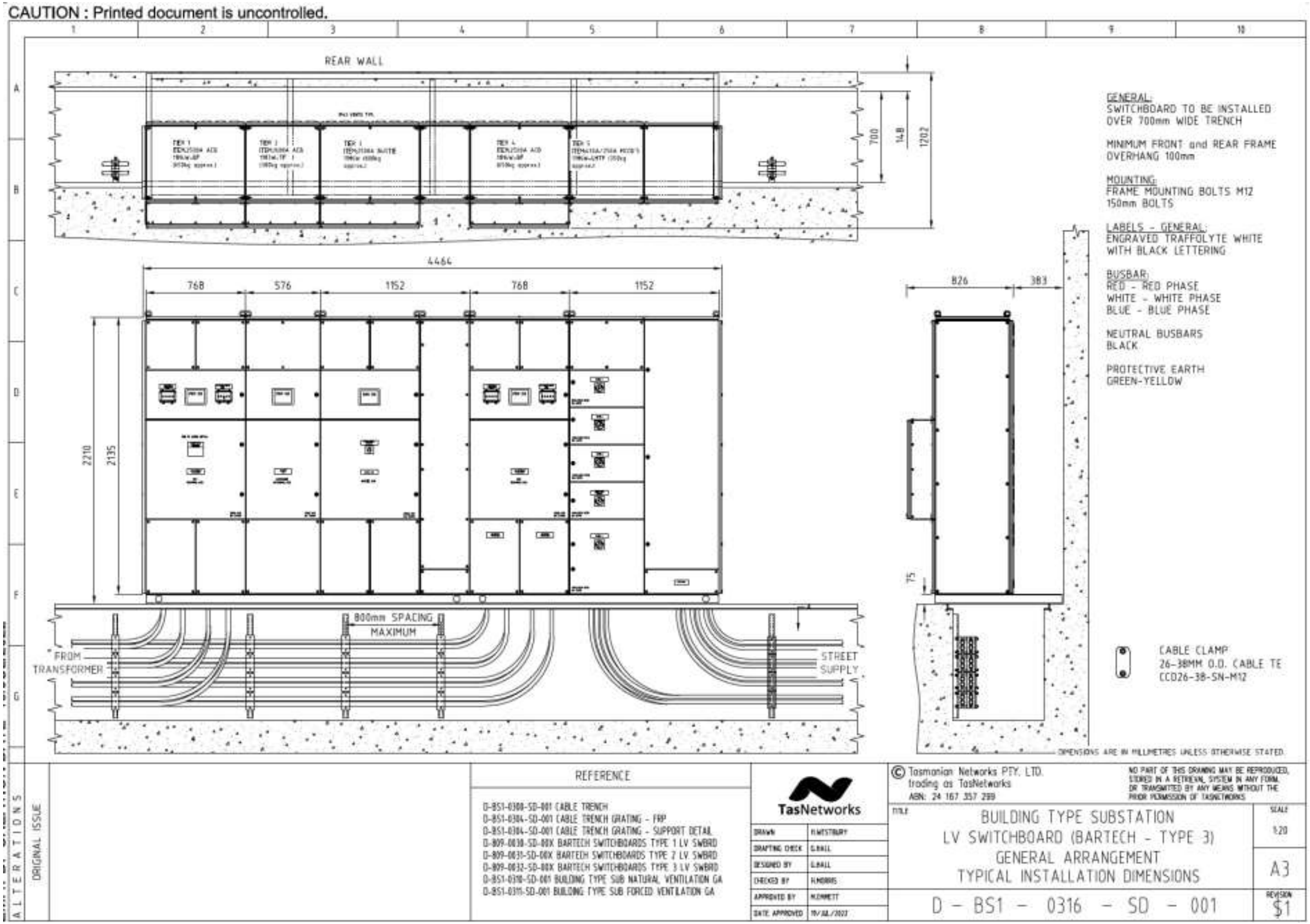
C4 - LV switchboards

The following LV switchboard standard designs use a Bartech LV switchboard.

The LV switchboard may be either one of the standard assemblies i.e. Type 1, 2 or 3, or built up from the individual panel assemblies.

Manufacture Type	Type Description
Type 1	Single transformer with street supplies (With option for small customer circuit breaker.
Type 2	Single transformer with customer circuit breaker and street supplies.
Type 3	Two transformer with customer circuit breaker, bus-tie and street supplies.

Drawing id.	Title
D-BS1- 0316-SD-001	LV switchboard general arrangement
D-BS1- 0316-SD-002	Bartech LV switchboard components
D-BS1- 0316-SD-003	Bartech LV switchboard configurations, bill of materials
D-809-0030-SD-001	Bartech switchboards Type 1 LV Swbrd - SLD
D-809-0030-SD-002	Bartech switchboards Type 1 LV Swbrd – Control schematic
D-809-0030-SD-003	Bartech switchboards Type 1 LV Swbrd – GA Plan and front external
D-809-0030-SD-004	Bartech switchboards Type 1 LV Swbrd - GA Front external
D-809-0030-SD-005	Bartech switchboards Type 1 LV Swbrd - GA Front internal
D-809-0030-SD-006	Bartech switchboards Type 1 LV Swbrd - GA Materials list
D-809-0031-SD-001	Bartech switchboards Type 2 LV Swbrd - SLD
D-809-0031-SD-002	Bartech switchboards Type 2 LV Swbrd – Control schematic
D-809-0031-SD-003	Bartech switchboards Type 2 LV Swbrd – GA Plan and front external
D-809-0031-SD-004	Bartech switchboards Type 2 LV Swbrd - GA Front external
D-809-0031-SD-005	Bartech switchboards Type 2 LV Swbrd - GA Front internal
D-809-0031-SD-006	Bartech switchboards Type 2 LV Swbrd - GA Materials list
D-809-0032-SD-001	Bartech switchboards Type 3 LV Swbrd - SLD
D-809-0032-SD-002	Bartech switchboards Type 3 LV Swbrd – Control schematic
D-809-0032-SD-003	Bartech switchboards Type 3 LV Swbrd – GA Plan and front external
D-809-0032-SD-004	Bartech switchboards Type 3 LV Swbrd - GA Front internal
D-809-0032-SD-005	Bartech switchboards Type 3 LV Swbrd - GA Materials list


CAUTION : Printed document is uncontrolled.
REAR WALL
700
148
1202
4464
768
576
1152
768
1152
2210
2135
826
383
75
800mm SPACING MAXIMUM
FROM TRANSFORMER
STREET SUPPLY
GENERAL:
SWITCHBOARD TO BE INSTALLED OVER 700mm WIDE TRENCH
MINIMUM FRONT and REAR FRAME OVERHANG 100mm
MOUNTING:
FRAME MOUNTING BOLTS M12
150mm BOLTS
LABELS - GENERAL:
ENGRAVED TRAFFOLYTE WHITE WITH BLACK LETTERING
BUSBAR:
RED - RED PHASE
WHITE - WHITE PHASE
BLUE - BLUE PHASE
NEUTRAL BUSBARS
BLACK
PROTECTIVE EARTH
GREEN-YELLOW
CABLE CLAMP
26-38MM O.D. CABLE TE
CCD26-38-SN-M12
DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE STATED
ALTERATIONS
ORIGINAL ISSUE
REFERENCE
D-BS1-0308-SD-001 CABLE TRENCH
D-BS1-0304-SD-001 CABLE TRENCH GRATING - FRP
D-BS1-0304-SD-001 CABLE TRENCH GRATING - SUPPORT DETAIL
D-B09-0030-SD-00X BARTECH SWITCHBOARDS TYPE 1 LV SWBRD
D-B09-0031-SD-00X BARTECH SWITCHBOARDS TYPE 2 LV SWBRD
D-B09-0032-SD-00X BARTECH SWITCHBOARDS TYPE 3 LV SWBRD
D-BS1-0310-SD-001 BUILDING TYPE SUB NATURAL VENTILATION GA
D-BS1-0311-SD-001 BUILDING TYPE SUB FORCED VENTILATION GA
TasNetworks
DRAWN
DRAFTING CHECK
DESIGNED BY
CHECKED BY
APPROVED BY
DATE APPROVED
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ABN: 24 167 357 299
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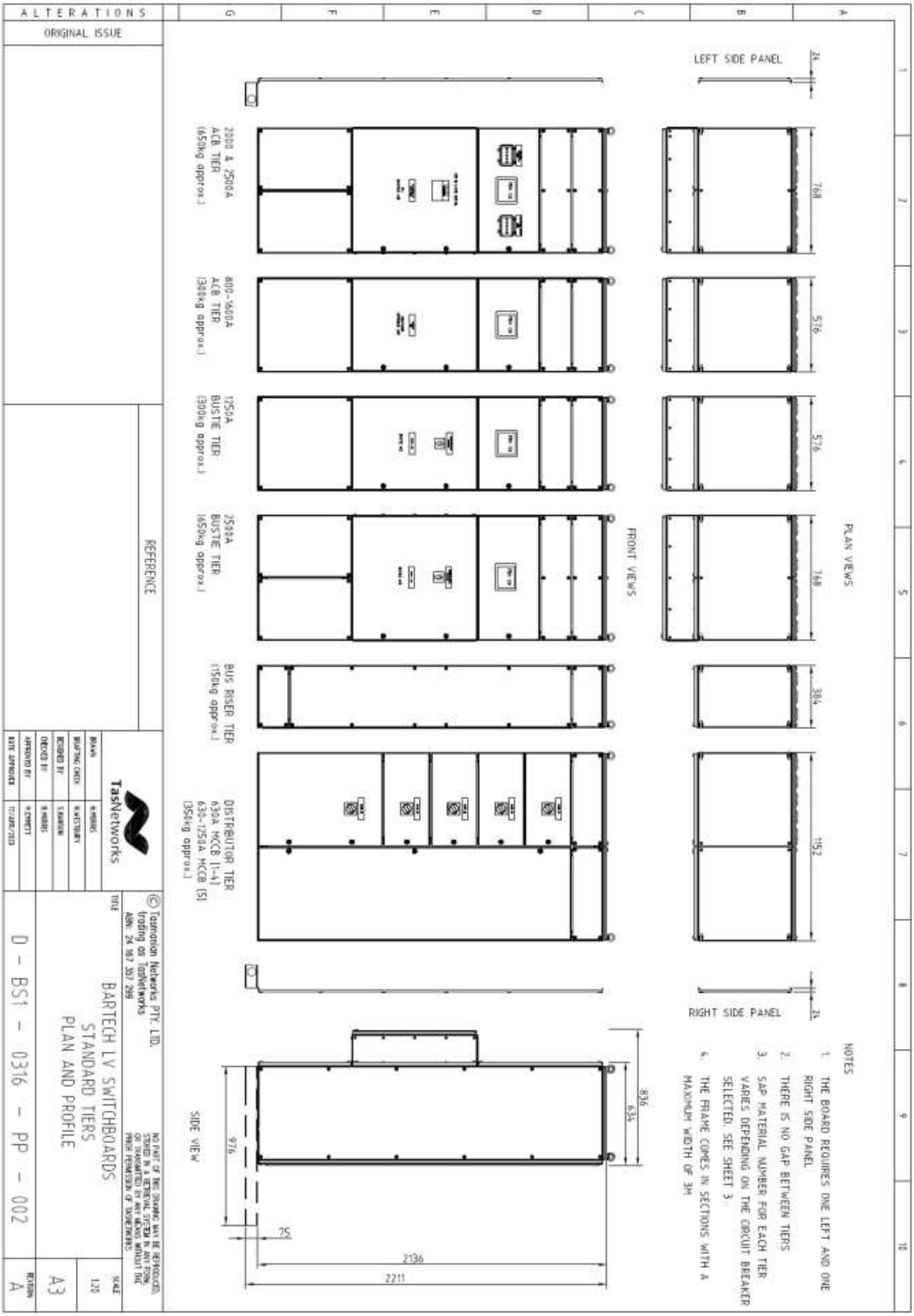
TITLE
BUILDING TYPE SUBSTATION
LV SWITCHBOARD (BARTECH - TYPE 3)
GENERAL ARRANGEMENT
TYPICAL INSTALLATION DIMENSIONS
SCALE
1:20
A3
D - BS1 - 0316 - SD - 001
REVISION
$1


ALTERATIONS
ORIGINAL ISSUE
REFERENCE
LEFT SIDE PANEL
RIGHT SIDE PANEL
PLAN VIEWS
FRONT VIEWS
SIDE VIEW
2000 & 2500A ACB TIER (650kg approx.)
800-1600A ACB TIER (300kg approx.)
1250A BUSTIE TIER (300kg approx.)
2500A BUSTIE TIER (650kg approx.)
BUS RISER TIER (150kg approx.)
DISTRIBUTOR TIER 630A MCCB (1-4) 630-1250A MCCB (5) (350kg approx.)
768
576
576
768
384
1152
24
836
634
976
75
2136
2211
NOTES
1. THE BOARD REQUIRES ONE LEFT AND ONE RIGHT SIDE PANEL
2. THERE IS NO GAP BETWEEN TIERS
3. SAP MATERIAL NUMBER FOR EACH TIER VARIES DEPENDING ON THE CIRCUIT BREAKER SELECTED. SEE SHEET 3
4. THE FRAME COMES IN SECTIONS WITH A MAXIMUM WIDTH OF 3M
TasNetworks
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TITLE
BARTECH LV SWITCHBOARDS
STANDARD TIERS
PLAN AND PROFILE
D - BS1 - 0316 - PP - 002
A3
1:20
SCALE
REVISION
A

BARTECH LV SWITCHBOARD STANDARD TIERS MATERIALS LIST

2000-2500A ACB TIER				
BUS RATING	1250 A		2500 A	
FAULT RATING	50 kA	80 kA	50 kA	80 kA
2000A MASTERPACT	-	-	990462	990480
2500A MASTERPACT	-	-	990463	990481

800-1600A ACB TIER				
BUS RATING	1250 A		2500 A	
FAULT RATING	50 kA	80 kA	50 kA	80 kA
800A COMPACT NS	990454	990472	990464	990482
1000A COMPACT NS	990455	990473	990465	990483
1250A COMPACT NS	990456	990474	990466	990484
1600A COMPACT NS	-	-	990467	990485
1250A MASTERPACT	990453	990471	990460	990478
1600A MASTERPACT	-	-	990461	990479

DISTRIBUTOR AND BUS TIERS				
BUS RATING	1250 A		2500 A	
FAULT RATING	50 kA	80 kA	50 kA	80 kA
DISTRIBUTOR TIER	990458	990476	990469	990487
BUS TIE 1250A ISOLATOR	990457	990475	-	-
BUS TIE 2500A ISOLATOR	-	-	990468	990486
RISER TIER	990459	990477	990470	990488

DISTRIBUTOR TIER CIRCUIT BREAKERS				
BUS RATING	1250 A		2500 A	
FAULT RATING	50 kA	80 kA	50 kA	80 kA
630A COMPACT NSX	990489	990493	990489	990493
800A COMPACT NS	990490	990494	990490	990494
1000A COMPACT NS	990491	990495	990491	990495
1250A COMPACT NS	990492	990496	990492	990496

NOTES

1. ALL BOARDS REQUIRE A 63 AMP HRC FUSE FOR LIGHT AND POWER - FITTED TO THE BUS BAR.
   MATERIAL NUMBER: 990467
2. MATERIAL NUMBERS ARE DEPENDANT ON THE BUS RATING AND FAULT RATING.
3. MATERIAL NUMBERS ARE THE SAME FOR SAP AND WASP DESIGN TOOL.
4. THE LEFT AND RIGHT SIDE END PANELS ARE INCLUDED WITH COMPLETE SWITCHBOARD.
5. THE BOARD FRAME IS INCLUDED WITH THE COMPLETE SWITCHBOARD.
6. A DISTRIBUTOR CIRCUIT BREAKER MUST BE ADDED FOR EACH SLOT IT IS REQUIRED IN.
7. ONLY THE LOWEST SLOT OF THE DISTRIBUTOR TIER CAN HAVE A COMPACT NS CIRCUIT BREAKER INSTALLED IN IT.

ALTERATIONS

ORIGINAL ISSUE

REFERENCE

TasNetworks

DRAWN	H.MORRIS
DRAFTING CHECK	H.WESTBURY
DESIGNED BY	G.HALL
CHECKED BY	H.MORRIS
APPROVED BY	M.EMMETT
DATE APPROVED	17/APR/2019

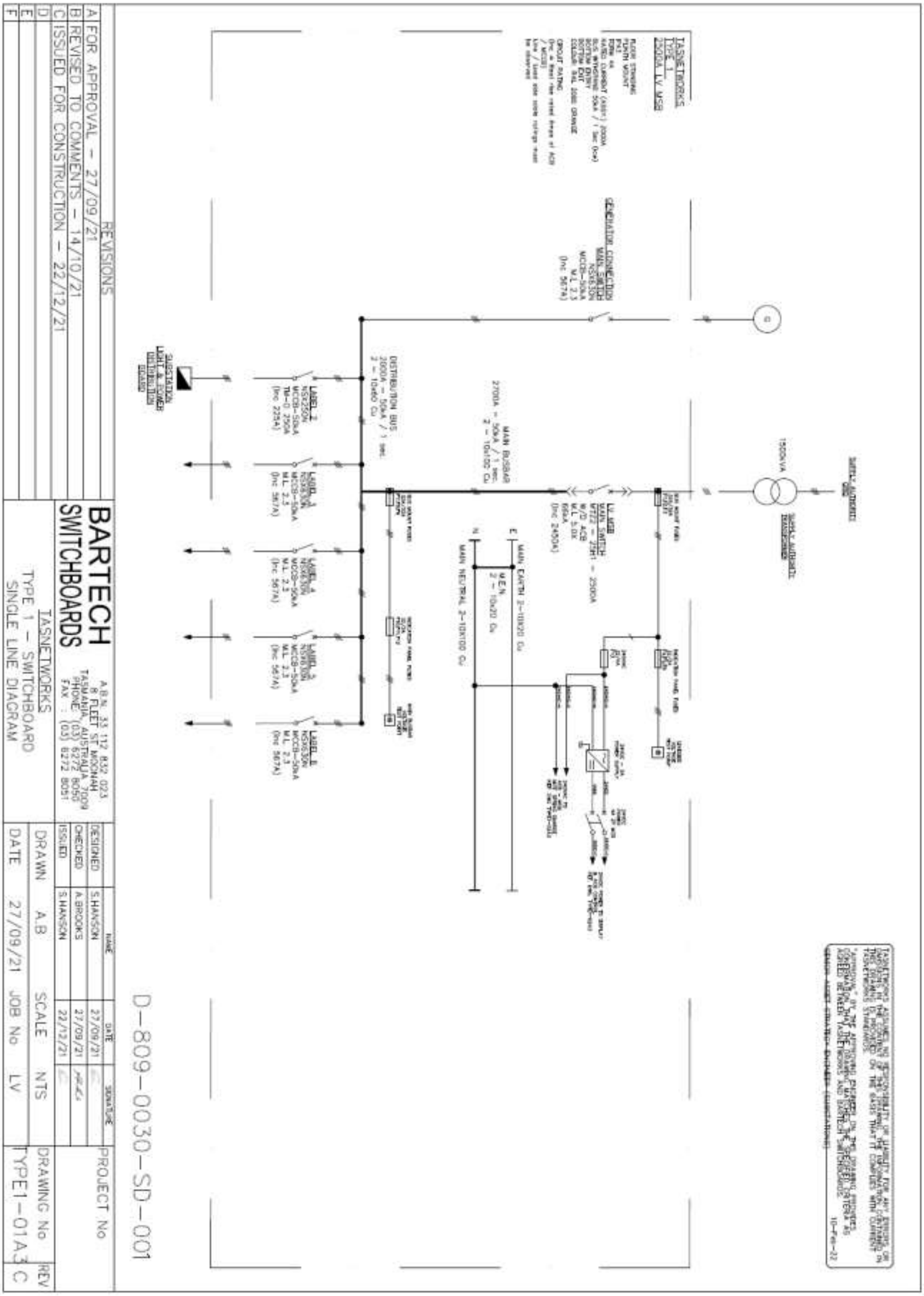
TITLE: BARTECH LV SWITCHBOARDS STANDARD TIERS MATERIALS LIST

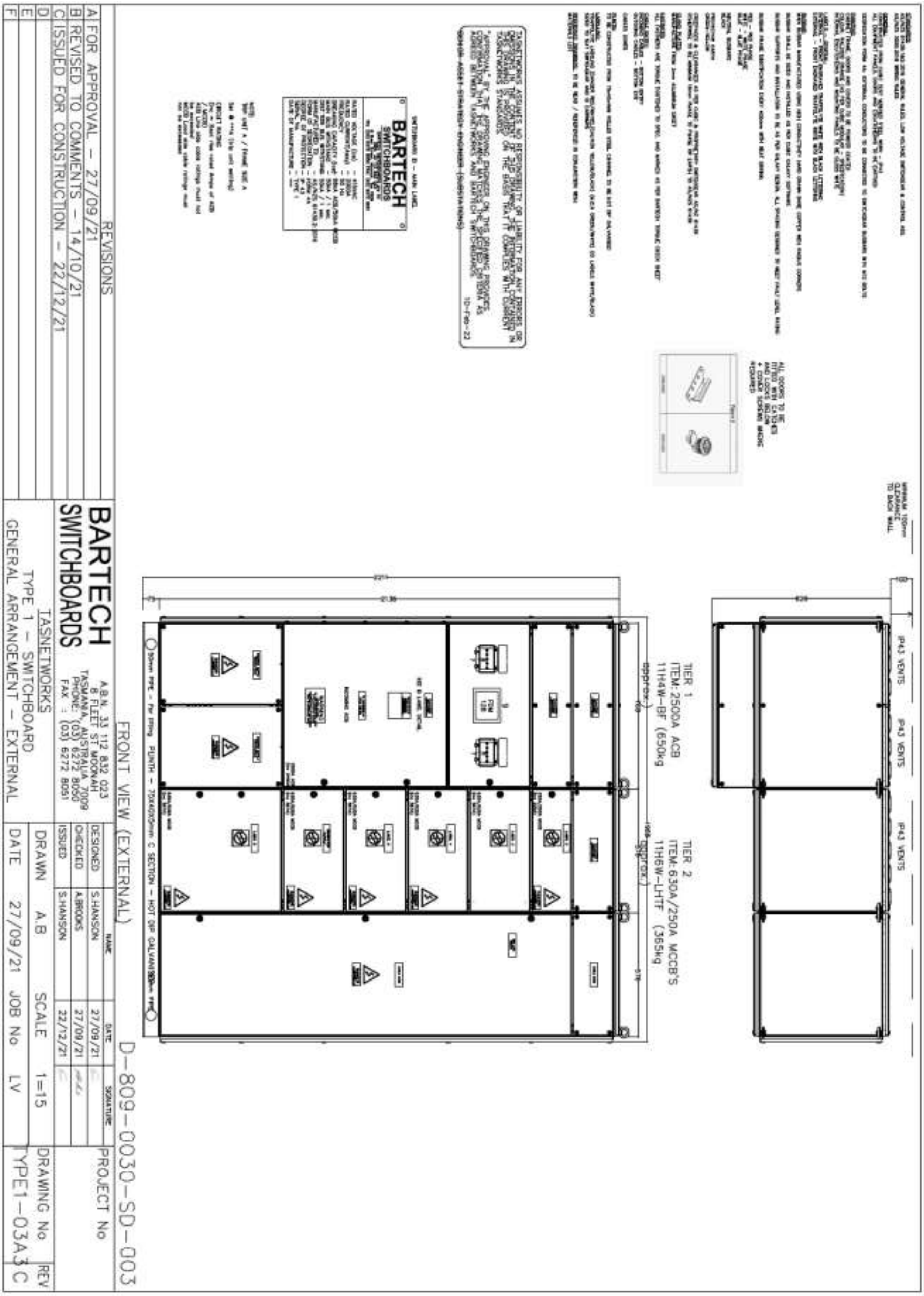
SCALE: -

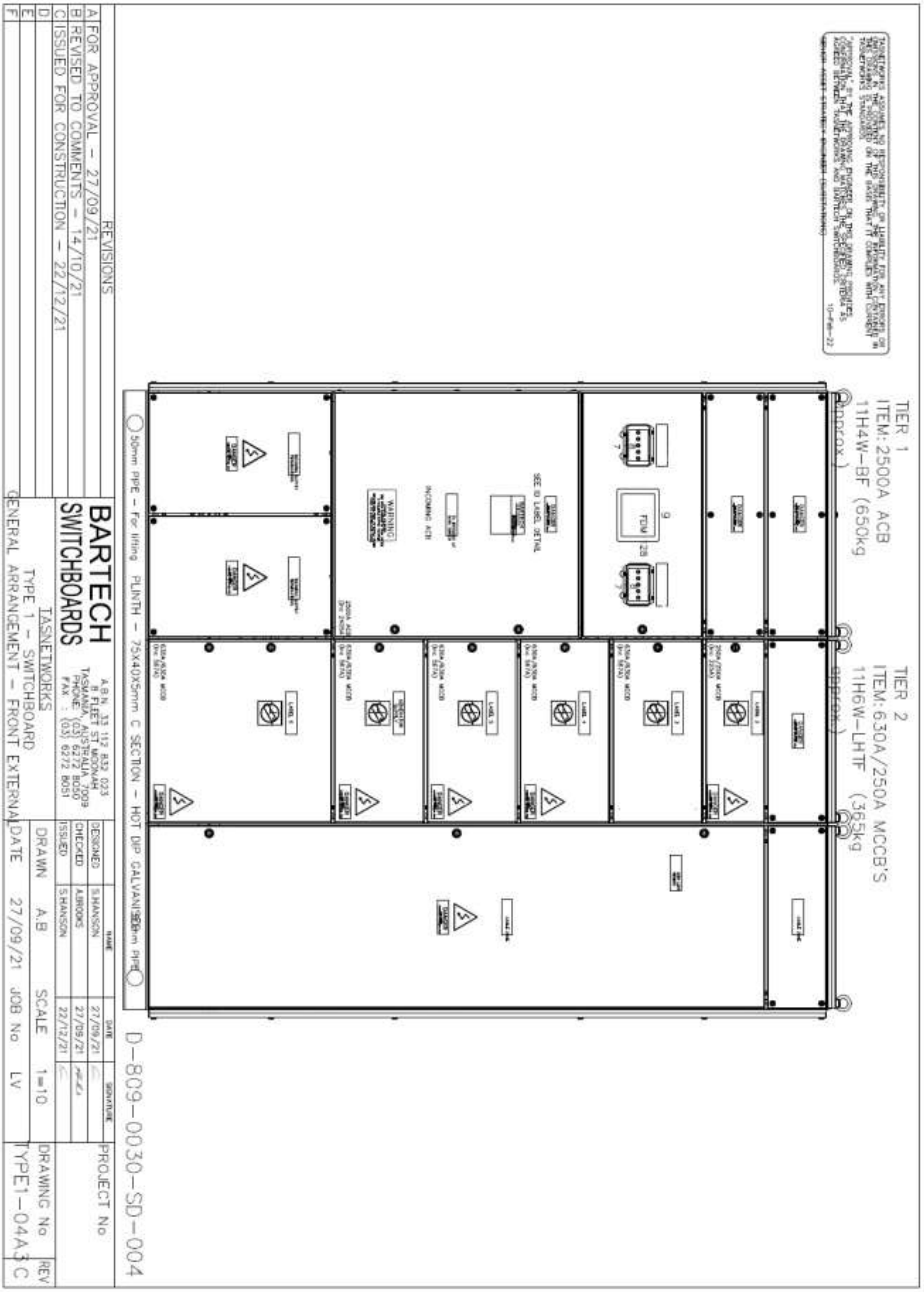
A3

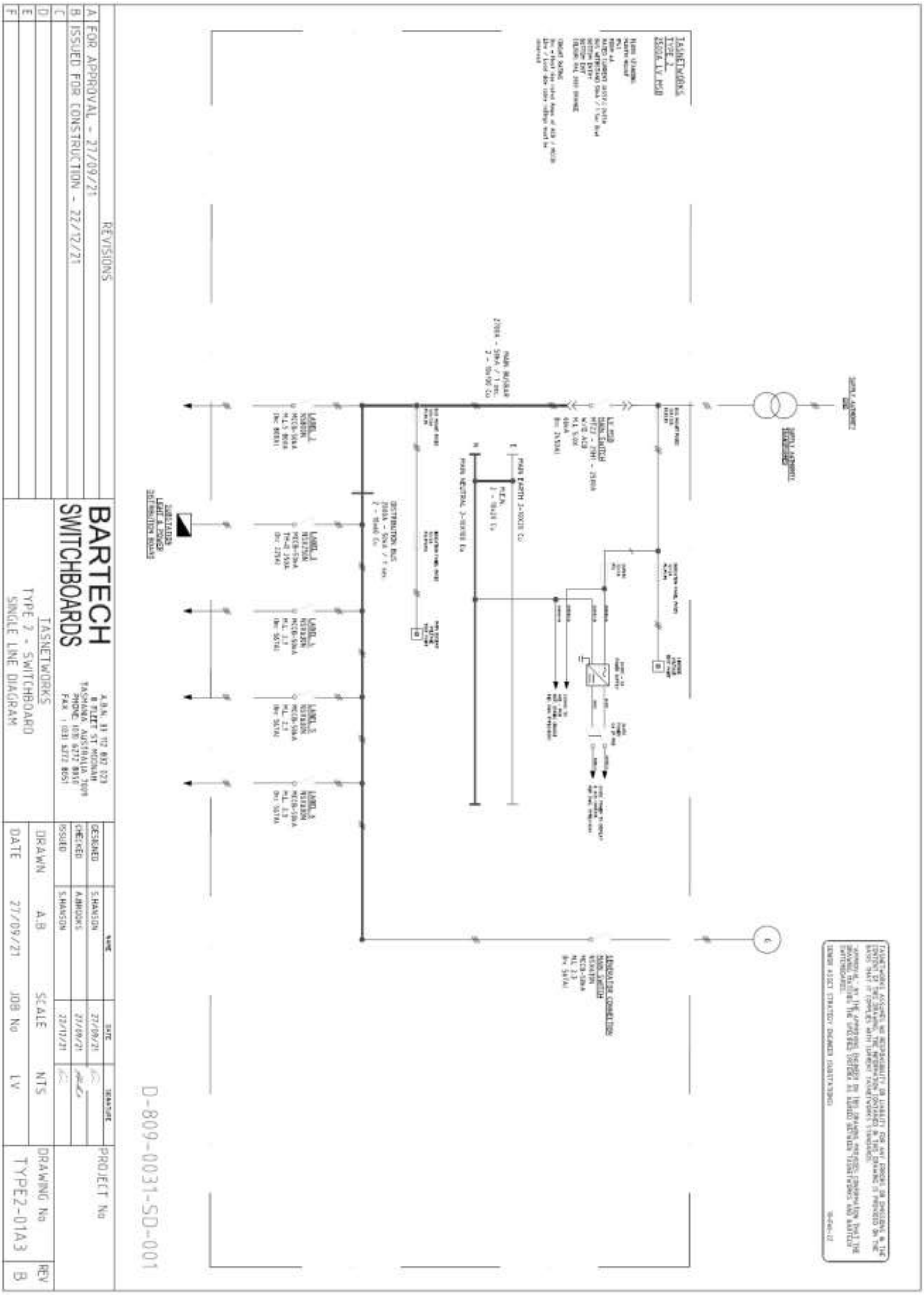
D - BS1 - 0316 - DI - 003

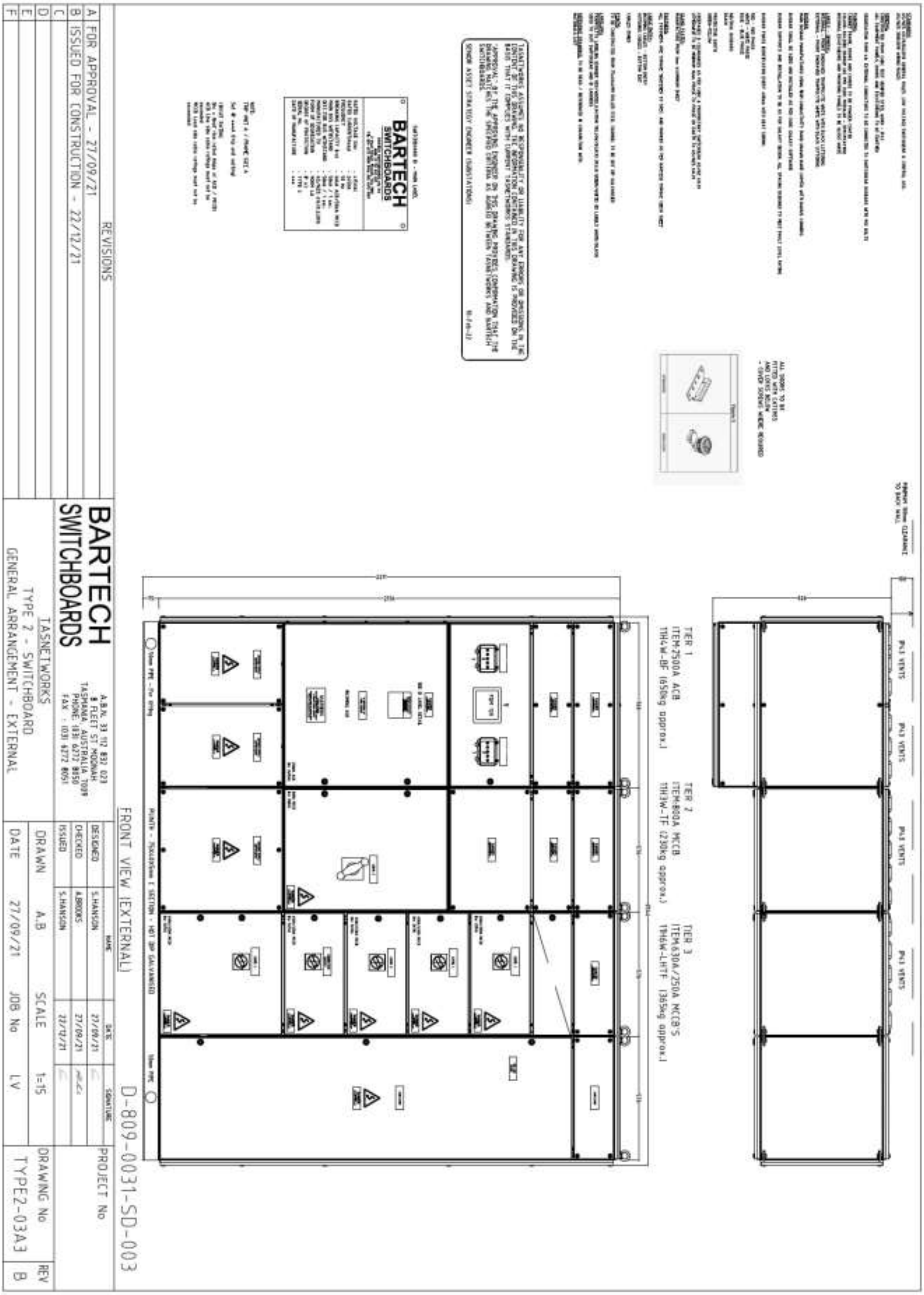
REVISION: 0

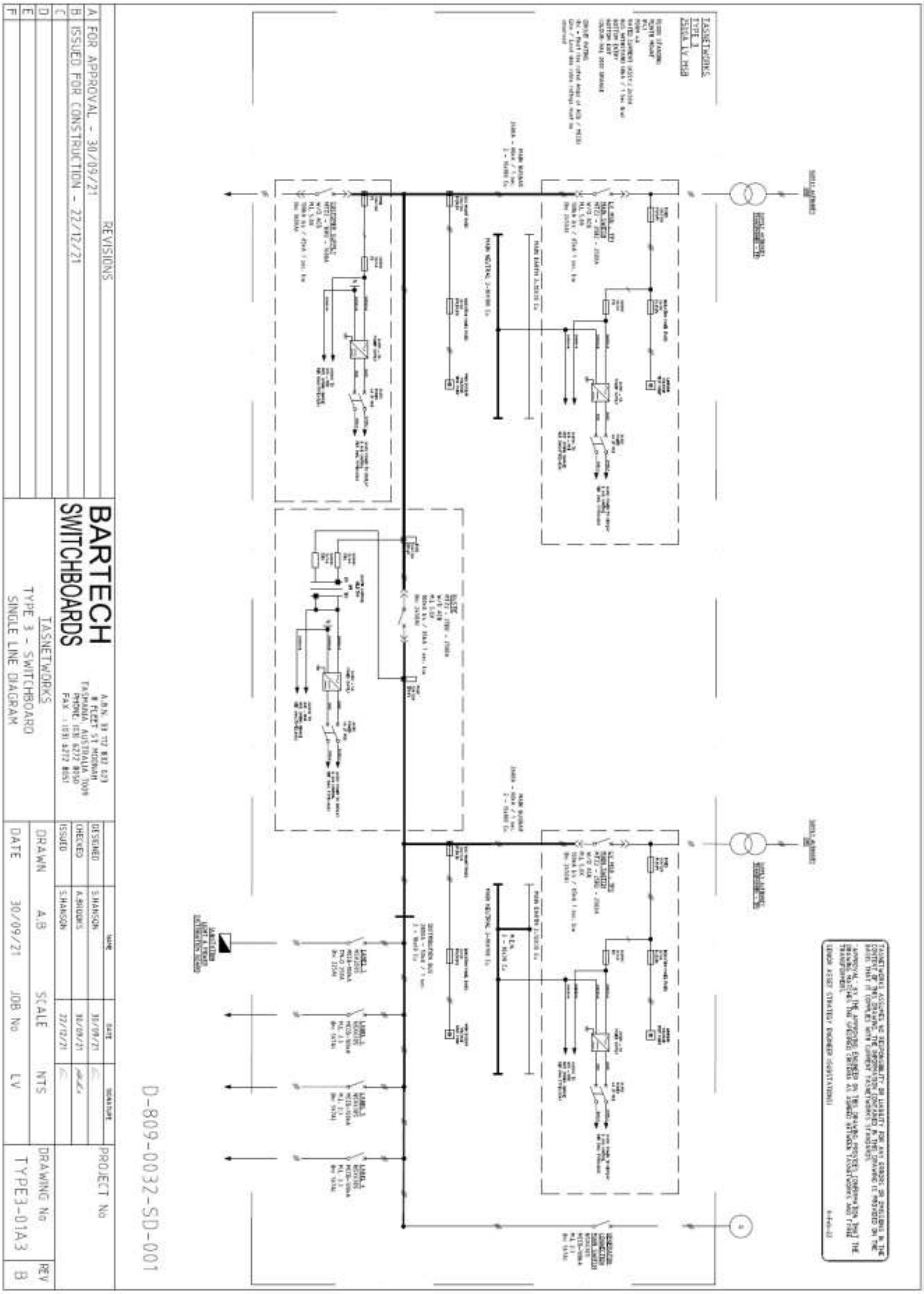

TASNETWORKS
TYPE 1
2000A LV MSB
GENERATOR CONNECTION
MAIN SWITCH
SUPPLY AUTHORITY
1500kVA
LV MSB
MAIN SWITCH
MAIN BUSBAR
2700A - 50kA / 1 sec.
DISTRIBUTION BUS
2000A - 50kA / 1 sec.
MAIN EARTH
MAIN NEUTRAL
M.E.N.
LABEL 1
LABEL 2
LABEL 3
LABEL 4
LABEL 5
SUBSTATION LIGHT & POWER DISTRIBUTION BOARD
REVISIONS
A FOR APPROVAL - 27/09/21
B REVISED TO COMMENTS - 14/10/21
C ISSUED FOR CONSTRUCTION - 22/12/21
D
E
F
BARTECH SWITCHBOARDS
A.B.N. 33 112 832 023
8 FLEET ST MOONAH
TASMANIA, AUSTRALIA 7009
PHONE: (03) 6272 8050
FAX: (03) 6272 8051
TASNETWORKS
TYPE 1 - SWITCHBOARD
SINGLE LINE DIAGRAM
DESIGNED S.HANSON 27/09/21
CHECKED A.BROOKS 27/09/21
ISSUED S.HANSON 22/12/21
DRAWN A.B
SCALE NTS
DATE 27/09/21
JOB No LV
PROJECT No
D-809-0030-SD-001
DRAWING No
TYPE1-01A3
REV C

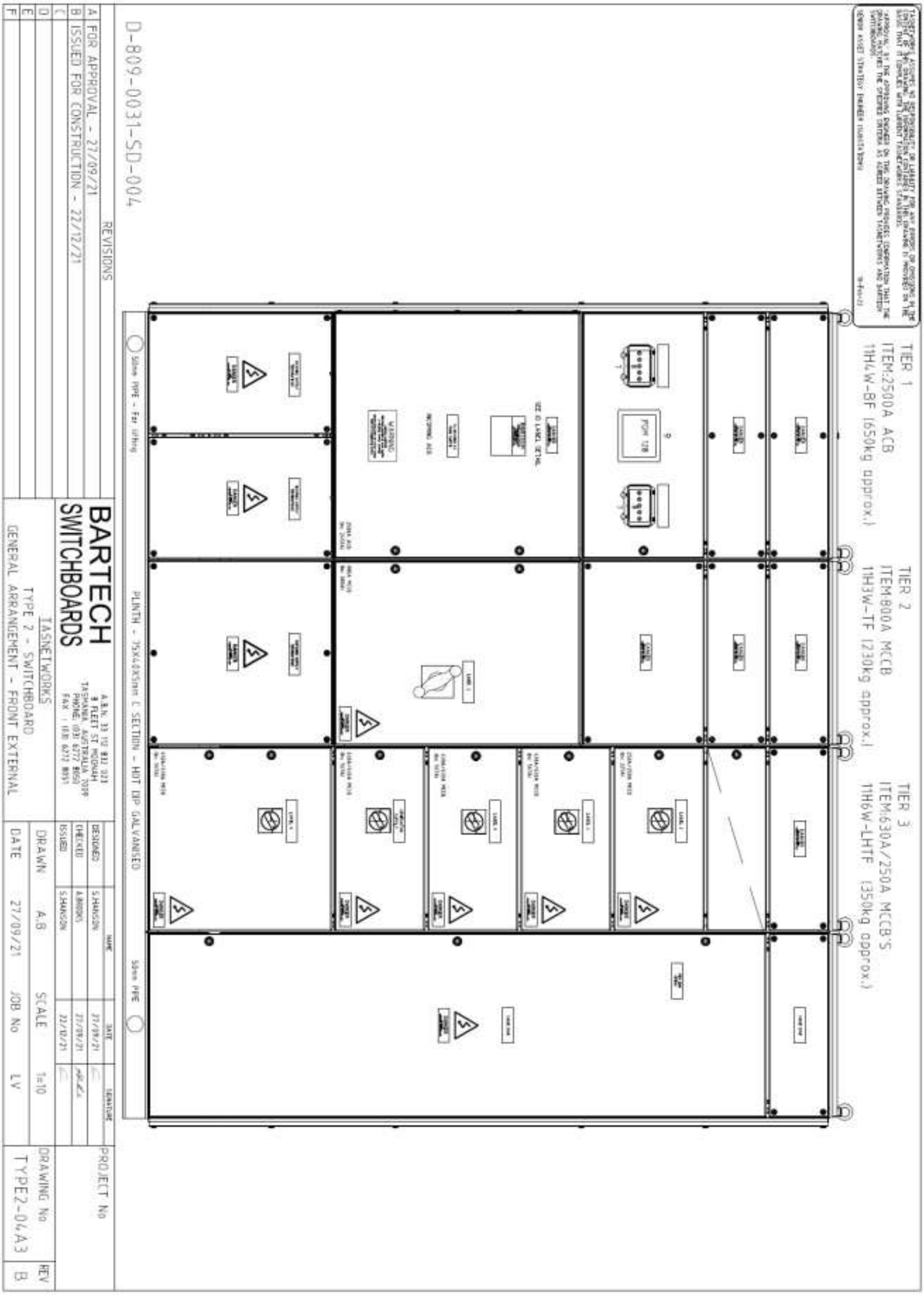

REVISIONS
A FOR APPROVAL – 27/09/21
B REVISED TO COMMENTS – 14/10/21
C ISSUED FOR CONSTRUCTION – 22/12/21
BARTECH SWITCHBOARDS
A.B.N. 33 112 832 023
8 FLEET ST MOONAH
TASMANIA, AUSTRALIA 7009
PHONE: (03) 6272 8050
FAX : (03) 6272 8051
TASNETWORKS
TYPE 1 – SWITCHBOARD
GENERAL ARRANGEMENT – EXTERNAL
FRONT VIEW (EXTERNAL)
D-809-0030-SD-003
PROJECT No
DRAWING No
TYPE1-03A3
REV
C
DESIGNED S.HANSON 27/09/21
CHECKED A.BROOKS 27/09/21
ISSUED S.HANSON 22/12/21
DRAWN A.B
DATE 27/09/21
SCALE 1=15
JOB No LV
TIER 1
ITEM: 2500A ACB
11H4W-BF (650kg
TIER 2
ITEM: 630A/250A MCCB'S
11H6W-LHTF (365kg
IP43 VENTS
IP43 VENTS
IP43 VENTS
BARTECH SWITCHBOARDS

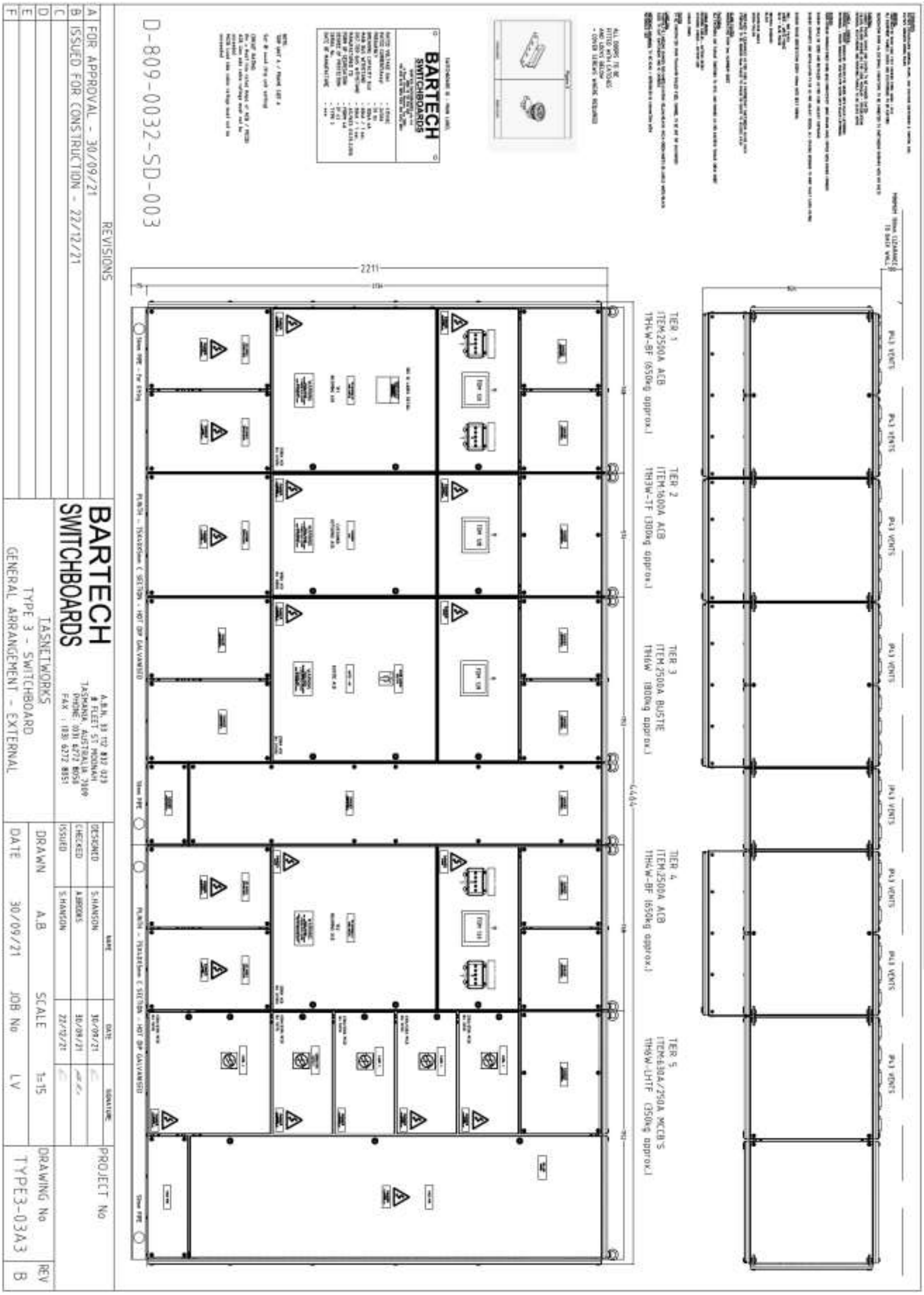

REVISIONS
A FOR APPROVAL – 27/09/21
B REVISED TO COMMENTS – 14/10/21
C ISSUED FOR CONSTRUCTION – 22/12/21
D
E
F
TIER 1
ITEM: 2500A ACB
11H4W–BF (650kg approx.)
TIER 2
ITEM: 630A/250A MCCB'S
11H6W–LHTF (365kg approx.)
50mm PIPE – For lifting PLINTH – 75X40X5mm C SECTION – HOT DIP GALVANISED
50mm PIPE
D–809–0030–SD–004
BARTECH SWITCHBOARDS
TASNETWORKS
TYPE 1 – SWITCHBOARD
GENERAL ARRANGEMENT – FRONT EXTERNAL
DESIGNED S.HANSON 27/09/21
CHECKED A.BROOKS 27/09/21
ISSUED S.HANSON 22/12/21
DRAWN A.B
SCALE 1=10
DATE 27/09/21
JOB No LV
PROJECT No
DRAWING No TYPE1–04A3
REV C


REVISIONS
A FOR APPROVAL - 27/09/21
B ISSUED FOR CONSTRUCTION - 22/12/21
BARTECH SWITCHBOARDS
TASNETWORKS
TYPE 2 - SWITCHBOARD
SINGLE LINE DIAGRAM
DESIGNED S.HANSON 27/09/21
CHECKED A.BROOKS 27/09/21
ISSUED S.HANSON 22/12/21
DRAWN A.B
SCALE NTS
DATE 27/09/21
JOB No LV
PROJECT No
DRAWING No TYPE2-01A3
REV B
D-809-0031-SD-001


REVISIONS
A FOR APPROVAL - 27/09/21
B ISSUED FOR CONSTRUCTION - 22/12/21
BARTECH SWITCHBOARDS
TASNETWORKS
TYPE 2 - SWITCHBOARD
GENERAL ARRANGEMENT - EXTERNAL
FRONT VIEW (EXTERNAL)
D-809-0031-SD-003
TIER 1
ITEM:2500A ACB
TIER 2
ITEM:800A MCCB
TIER 3
ITEM:630A/250A MCCB'S
DESIGNED S.HANSON 27/09/21
CHECKED A.BROOKS 27/09/21
ISSUED S.HANSON 22/12/21
DRAWN A.B
SCALE 1:15
DATE 27/09/21
JOB No LV
PROJECT No
DRAWING No
TYPE2-03A3
REV
B


REVISIONS
A FOR APPROVAL - 30/09/21
B ISSUED FOR CONSTRUCTION - 22/12/21
BARTECH
SWITCHBOARDS
TASNETWORKS
TYPE 3 - SWITCHBOARD
SINGLE LINE DIAGRAM
DESIGNED S.HANSON 30/09/21
CHECKED A.BROOKS 30/09/21
ISSUED S.HANSON 22/12/21
DRAWN A.B
SCALE NTS
DATE 30/09/21
JOB No LV
PROJECT No
DRAWING No
TYPE3-01A3
REV B
D-809-0032-SD-001
TASNETWORKS
TYPE 3


D-809-0031-SD-004
TIER 1
ITEM:2500A ACB
1IH4W-BF (650kg approx.)
TIER 2
ITEM:800A MCCB
1IH3W-TF (230kg approx.)
TIER 3
ITEM:630A/250A MCCB'S
1IH6W-LHTF (350kg approx.)
PLINTH - 75X40X5mm C SECTION - HOT DIP GALVANISED
REVISIONS
A FOR APPROVAL - 27/09/21
B ISSUED FOR CONSTRUCTION - 22/12/21
BARTECH
SWITCHBOARDS
TASNETWORKS
TYPE 2 - SWITCHBOARD
GENERAL ARRANGEMENT - FRONT EXTERNAL
DRAWN A.B
SCALE 1:10
DATE 27/09/21
JOB No LV
PROJECT No
DRAWING No
TYPE2-04A3
REV
B



D-809-0032-SD-003
REVISIONS
A FOR APPROVAL - 30/09/21
B ISSUED FOR CONSTRUCTION - 22/12/21
BARTECH SWITCHBOARDS
TASNETWORKS
TYPE 3 - SWITCHBOARD
GENERAL ARRANGEMENT - EXTERNAL
PROJECT No
DRAWN A.B
DATE 30/09/21
SCALE 1:15
JOB No LV
DRAWING No TYPE3-03A3
REV B
TIER 1
TIER 2
TIER 3
TIER 4
TIER 5
2211
6404